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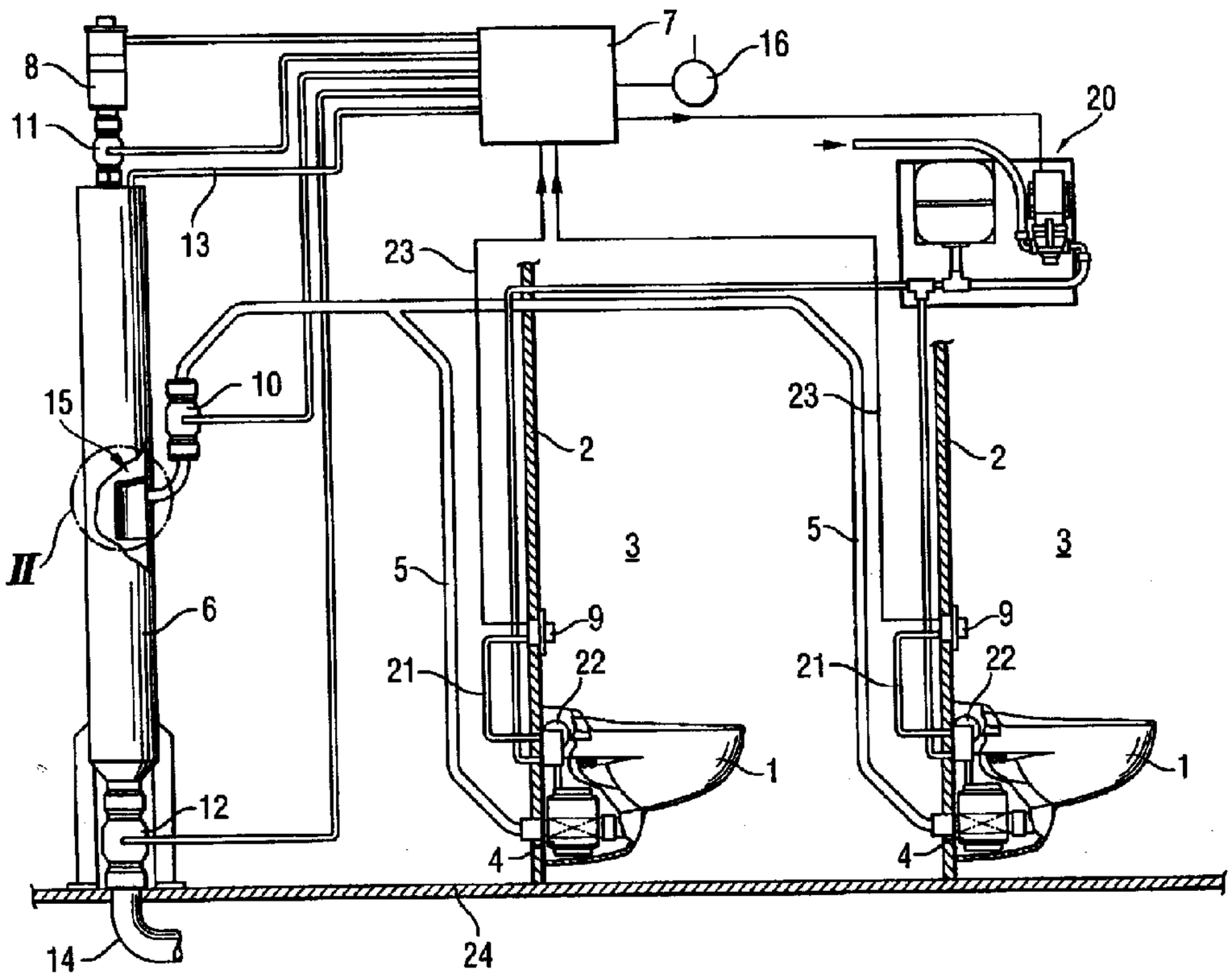
(54) **SIEGE DE TOILETTE A ASPIRATION**
(54) **VACUUM TOILET SYSTEM**



(57) A vacuum toilet system for railway cars and other vehicle units, comprising at least one toilet placed within a heated room and connected through a discharge valve to a sewer pipe and a collecting container, which may be put under vacuum for emptying a selected toilet. In order to achieve a compact solution with a reliable function, the collecting container comprises an elongated and substantially vertically arranged receptacle that is positioned in close relation to the room so that it is heated by the controlled temperature of said room.

ABSTRACT

A vacuum toilet system for railway cars and other vehicle units, comprising at least one toilet placed within a heated room and connected through a discharge valve to a sewer pipe and a collecting container, which may be put under vacuum for emptying a selected toilet. In order to achieve a compact solution with a reliable function, the collecting container comprises an elongated and substantially vertically arranged receptacle that is positioned in close relation to the room so that it is heated by the controlled temperature of said room.

VACUUM TOILET SYSTEM

FIELD OF THE INVENTION

The present invention generally relates to vacuum toilet systems for use on vehicles, such as railway cars.

BACKGROUND OF THE INVENTION

Common to all vacuum toilet systems is that sewage, which has been transferred from a toilet into a sewer pipe connected to the toilet, must be temporarily stored in a container for various periods of time before the sewage may be further transported from the container. This process is related to the function of a vacuum toilet, in which sewage from the toilet is collected in a system where the pressure is substantially lower (i.e., generally about a half atmosphere lower) than the surrounding, ambient pressure. As used herein, this lower pressure will be called "vacuum" and the surrounding pressure "atmospheric pressure".

Special measures must be taken in order to remove the waste from the container, which is under vacuum, to the surrounding area, where atmospheric pressure prevails. The most common procedure is to break the vacuum, (i.e., to let atmospheric air temporarily flow into the vacuum system) and remove the sewage using known means before vacuum is re-established. In order to perform such a pressure change, structure must be provided which allows the pressure change to take place. As used herein, this structure is called a "collecting container", and at least one such structure is present in all vacuum toilet systems.

Conventional vacuum toilet systems on trains typically use relatively large collecting containers that are emptied during the maintenance stops of the railway cars. These containers are placed in areas on the railcar having suitable storage capacity. Accordingly, the containers are often supported from the undercarriage of the railway car, which creates a risk that the contents of the container will freeze in cold weather. To address the risk of freezing, conventional collecting containers have been provided with heating systems, which considerably raise the cost of the system.

SUMMARY OF THE INVENTION

In view of the foregoing, a main object of the present invention is to achieve a simple, robust and cost-effective train vacuum toilet system. The system is particularly intended for use in countries where emptying of toilet sewage on the track is allowed.

In accordance with certain aspects of the present invention, therefore, a vacuum toilet system is provided for use on a vehicle unit having a heated room. The vacuum toilet system comprises at least one toilet positioned within the heated room, a discharge valve connected to an outlet of the toilet, and a sewer pipe having a first end connected to the discharge valve and a second end. A collecting container adapted to withstand vacuum on the order of 0.5 bar is provided, the collecting container comprising an elongated, substantially vertically oriented receptacle having a sewage intake port positioned in a central portion of the receptacle connected to the second end of the sewer pipe. The collecting container is in close proximity to the heated room, whereby the collecting container is heated by the room.

Other features and advantages are inherent in the disclosed apparatus or will become apparent to those skilled in the art from the following detailed description and its accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partially schematic side elevation view of a preferred embodiment of a vacuum toilet system in accordance with the present invention.

FIG. 2 is an enlarged side elevation view, in partial cross section, of detail II of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1, reference numeral 1 indicates a vacuum toilet of known design fastened to a wall 2 in a toilet room 3 of a vehicle, such as a railway car. Each toilet 1 has a normally-closed discharge valve 4, which is opened only when the toilet is flushed to remove sewage present in the toilet bowl. The valve 4 opens towards a sewer pipe 5, which is placed under a vacuum level when the toilet is emptied. The

vacuum level is typically approximately half the atmospheric pressure, and thus the pressure difference between the toilet room and the sewer pipe is usually approximately 0.5 bar. When the discharge valve 4 is opened, the air in the toilet room 3 pushes the sewage present in the toilet bowl into the sewer pipe 5 and drives the sewage in the form of a discrete volume (or "plug") with a high speed into a collecting container 6 connected to an end part of the sewer pipe 5. The inner diameter of the sewer pipe 5 is preferably about 50 mm.

Due to the relative positions of the toilet 1 and collecting container 6, the sewer pipe 5 must span both a vertical space and a horizontal space. For vacuum flow and sewage handling purposes, it has been determined that the sewer pipe 5 should preferably first run vertically upward from the toilet 1 to the vicinity of the ceiling level of the toilet room 3, then generally horizontally along the ceiling level, and finally vertically downward to a point where it is connected to the collecting container 6.

A vacuum generator is provided for evacuating the collecting container 6 and sewer pipe 5. The vacuum may be generated intermittently (i.e., separately for each time a toilet bowl is to be emptied), or constantly, where vacuum is continuously maintained between an upper and a lower level, at least when the vehicle is in motion. A constant vacuum system requires a pressure sensor for sensing pressure in the vacuum system and controlling operation of the vacuum generator to maintain a desired vacuum level. Due to leakage in valves and pipe connections, the energy consumption of a constant vacuum system is relatively high. In the illustrated embodiment, an ejector 8 is provided which is capable of being driven by pressurized air and is connected to an upper portion of the collecting container 6. The ejector 8 is activated when a flush button 9 is pressed and thus arranged to give a signal for the toilet 1 to be emptied. In response to the signal, the ejector 8 rapidly sucks out air from the sewer pipe 5 and the collecting container 6 until the absolute pressure in the system is lowered to the desired vacuum level, preferably about 0.5 bar. The use of an ejector is particularly suited for applications in which the system collects sewage from toilets located in a single railcar. In such an application, the total vacuum volume remains small, so that an ejector driven vacuum generator may create the necessary

vacuum in a very short time (i.e., within a few seconds). Vacuum generation then preferably takes place intermittently in response to a flush command. If a longer time is needed to generate sufficient vacuum, start up of the vacuum generator may be triggered by other actions, such as by entry of a person into the toilet room or by lifting the cover of the toilet seat.

In the illustrated system, the valves 4 are entirely pneumatically controlled by the system vacuum and atmospheric pressure. The control is effected through an air duct 21, which from the flush button 9 leads to a pneumatic control unit 22 for controlling the opening and the closing of the valve 4, depending on the vacuum level in the sewer pipe 5. A pneumatic valve control of this type is generally known in the art.

In accordance with certain aspects of the present invention, the collecting container 6 is relatively small for mounting inside the cabin of the railcar. As best shown in FIG. 1, the collecting container 6 has an elongate shape aligned along a vertical axis to give the container a compact footprint. As a result, the collecting container 6 may be advantageously placed in a corner of the toilet room 3 and may be covered, for aesthetic purposes, by a wall panel or the like. The toilet room 3 is heated, such as by a general heating system (not shown) of the vehicle. As a result, the collecting container 6 is heated by the controlled temperature of the toilet room, thereby eliminating the risk of freezing the container contents. While the collecting container 6 is shown in FIG. 1 positioned inside the toilet room 3, it may be positioned in other places in the cabin of the vehicle without departing from the present invention. When the collecting container 6 is attached to two or more toilets, it may be placed between the toilet rooms or in other positions near the heated toilet rooms 3, as long as the collecting container 6 is heated by the toilet rooms.

Operation of the collecting container 6 and the toilets 1 are controlled by a control center 7. The control center 7 receives, through a wire 23, an electric signal when the flush button 9 is pressed. The control center 7 activates a device 20 which supplies and, if necessary, pressurizes flush water to the toilets, provides for the supply of drive medium (i.e., pressurized air) to the ejector 8, and controls the function of the remote controlled valves 10, 11, and 12 of the system.

The collecting container 6 is separated from the sewer pipe 5 by the sewer valve 10 and from the ejector 8 by the vacuum valve 11. These valves 10, 11 are closed when the collecting container 6 is to be pressurized. In the embodiment according to FIG. 1, the valves 10, 11, and 12 are controlled by pressurized air, but other types of control, such as, for example, electric, may be used in accordance with the present invention. By supplying pressurized air through a conduit 13 to the collecting container 6 when the valves 10 and 11 are closed, an overpressure of about 0.5 to 0.7 bar is created in the collecting container. With the container so pressurized, the discharge or bottom valve 12 of the collecting container 6 is opened, whereby a rapid and effective emptying of the collecting container 6 is carried out through an emptying conduit 14, which opens under the floor 24 level of the railway car.

The emptying of the collecting container 6 may be controlled in many different ways. The emptying function may be controlled by the speed of the train, so that emptying does not take place when the train is stopped at a station or when the speed of the train is so high (e.g., more than 70 km/h) that the emptying causes an overly large spread of sewage over the undercarriage of the car and possibly on the steps and couplings. It is also advantageous to let automatic emptying take place each time the train slows down before entering a station area. The toilets may then be used while the train is stopped at a station.

A strictly speed dependent control of the emptying function does not always provide desirable results. The speed dependent emptying may therefore be supplemented or replaced by another control function, for example remote control from impulse giving units at different sections of the railway or from a relevant railway section programmed travel recorder in the train. The emptying intervals have a great importance for the optimal dimensioning of the collecting container. It is therefore important that an automatic emptying system be adapted to the passenger load and driving distance of the train.

The vacuum toilet system of the present invention is intended for use in applications in which the collecting container may be emptied while the vehicle is traveling between stops. Accordingly, the collecting container 6 has a relatively small volume, and is sized to receive at least 5 toilet flushes, and preferably at least 10 toilet

flushes, before it must be emptied. The number of toilets connected to a collecting container is adapted to the chosen volume of the collecting container based on an expected usage frequency of the toilets on one hand and an expected emptying frequency of the collecting container on the other hand. In addition, flush volume must be considered when sizing the collecting container. While a vacuum toilet can be emptied without supplying rinse water, such operation is unhygienic. More typically, vacuum toilets use between approximately 0.2 to 1.5 liters of rinse water per flush, which must be taken into consideration when sizing the collecting container.

In view of the foregoing, it has been found that a container having a cylindrical main portion with an inner diameter of approximately 160-350 mm and a height of approximately 1-2 m will adequately hold such a volume while maintaining a relatively small size for installation inside the cabin. The inner diameter is preferably approximately 175-300 mm and most preferably approximately 200 mm, while the height is preferably at least approximately 1.4 m and more preferably 1.5 m. The total inner volume of the container preferably exceeds the maximum sewage volume by at least 15 liters, and more preferably 40 liters. Such a container is easy to manufacture and may be made to resist the pressure strain caused by a pressure difference of a half an atmosphere. In addition, a container 6 of such dimensions may be easily installed inside a toilet room.

In a container 6 having such dimensions, the distance between the center point of the sewer pipe 5 at its connection point to the collecting container 6 and the bottom part of the cylindrical portion of the collecting container is preferably 70 cm. When a flow control or splash guard device 15 is arranged at the connection point of the sewer pipe 5 to the collecting container 6, as shown in FIG. 1, the liquid level in the collecting container 6 is preferably maintained well below the device 15 to ensure that a sufficiently large air volume (i.e., approximately 30 liters) is present inside the collecting container 6.

An impulse activator 16 is provided to prevent emptying of the collecting container 6 at such occasions when emptying is inconvenient. The impulse activator 16 is connected to the control center 7 and is programmed according to the operating characteristics of the train to control emptying of the container 6 in any of

the ways disclosed above.

The collecting container 6 is further adapted to reduce splash, thereby reducing the risk of sewage being pulled into the vacuum generator. As noted above, the collecting container 6 has an elongate shape that is vertically oriented. The sewer pipe 5 is preferably connected to a middle portion, such as at a sewage intake port of the container 6, so that a large free space above the fluid level is created by an upper section of the container 6. The free space increases the distance between the valve 11 and the fluid level in the tank, thereby reducing the risk of sewage splashing into the valve and being pulled into the vacuum generator. In addition, the free space facilitates separation of air from the fluid in the container, and provides a relatively large volume of air inside the container, even when it holds a maximum amount of fluid.

To further reduce splashing, the splash guard or flow control device 15 is positioned at the connection point of the sewer pipe 5 to the collecting container 6. The flow control device 15 comprises a top wall portion 17, having a semicircular shape when viewed from above, which is angled to slope downwardly from the container wall toward the center of the container 6. A substantially planar side wall portion 18 depends downwardly from the inner edge of the top wall portion 17. The side wall portion 18 is connected to opposed interior portions of the collecting container wall, and extends downward to a level 19, which is at a distance h from the center point of the opening of the sewer pipe 5 or the connection point of the sewer pipe 5 to the collecting container 6. In the current example, a distance "b" from the side wall portion 18 to the opening of the sewer pipe 5 is 70-110 mm, and preferably approximately 75-100 mm, while the distance "h" is at least 100 mm, and preferably at lest approximately 130 mm. According to the illustrated embodiment, the sewer pipe 5 connects substantially at a right angle to the wall of the collecting container 6. As a result, sewage entering the container 6 is deflected downward, away from the valve 11.

Splashing may further be reduced by shutting off vacuum generation before the sewage from a toilet reaches the collecting container. This requires exact control of the vacuum generation and a relatively large volume of air in the collecting

container 6.

A vacuum toilet system according to the invention may further include additional sanitary units, such as for example urinals and washing basins, that are connected to the vacuum sewer (i.e., the sewer pipe). Such units are connected in a known manner to the sewer pipe through a grey water valve that automatically allows fluid that has been accumulated to flow into the vacuum sewer. From the grey water valves, as well as from the toilets, function signals may be given to the control center, which keep count of which fluid amounts have been transferred to the collecting container, making it possible to block the functions of the system directly through the control center if there is a risk of overflow in the collecting container.

Furthermore, while the illustrated embodiment depicts two toilet 1 connected to the system, it will be appreciated that a single toilet or more than two toilets may be connected to the collecting container in accordance with the present invention.

Although certain apparatus constructed in accordance with the teachings of the invention have been described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all embodiments of the teachings of the invention fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

What Is Claimed Is:

1. A vacuum toilet system for a vehicle unit having a heated room, the vacuum toilet system comprising:

at least one toilet positioned within the heated room;

a discharge valve connected to an outlet of the toilet

a sewer pipe having a first end connected to the discharge valve and a second end;

a collecting container adapted to withstand vacuum on the order of 0.5 bar, the collecting container comprising an elongated, substantially vertically oriented receptacle having a sewage intake port positioned in a central portion of the receptacle connected to the second end of the sewer pipe, the collecting container being positioned in close proximity to the heated room, whereby the collecting container is heated by the room.

2. The vacuum toilet system of claim 1, in which the collecting container is sized to have a volume suitable for receiving at least 5 toilet flushes.

3. The vacuum toilet system of claim 2, in which the volume of the collecting container is suitable for receiving at least 10 toilet flushes.

4. The vacuum toilet system of claim 1, in which the collecting container has a substantially cylindrical shape with an inner diameter of approximately 160 to 350 mm.

5. The vacuum toilet system of claim 4, in which the inner diameter of the collecting container is approximately 175 to 300 mm.

6. The vacuum toilet system of claim 4, in which the collecting container comprises a substantially cylindrical main portion with a length of at least approximately 1.0 m.

7. The vacuum toilet system of claim 6, in which the length is at least approximately 1.4 m.

8. The vacuum toilet system of claim 1, in which the sewer pipe comprises a vertically upward running section in the vicinity of the toilet, and a vertically downward running section nearer the collecting container, the vertically downward running section leading to the sewage intake port of the collecting container.

9. The vacuum toilet system of claim 1, in which the collecting container is sized to have a total inner volume which is at least 15 liters larger than a total amount of sewage which is to be received by the collecting container.

10. The vacuum toilet system of claim 9, in which the total inner volume is at least 40 liters larger than the total amount of sewage.

11. The vacuum toilet system of claim 1, further comprising a vacuum generator connected to the collecting container for generating vacuum in the collecting container and the sewer pipe, the vacuum generator comprising a control center for activating vacuum generation.

12. The vacuum toilet system of claim 11, further comprising a flush actuator connected to the control center.

13. The vacuum toilet system of claim 11, further comprising a sewage valve disposed in the sewage pipe, a vacuum valve disposed between the vacuum generator and the collecting container, a pressurizing pipe connected to the upper portion of the collecting container for supplying a pressurized medium to the collecting container, and a discharge valve for emptying the collecting container.

14. The vacuum toilet system of claim 13, further comprising an impulse activator attached to the control center, the impulse activator being operable to disable

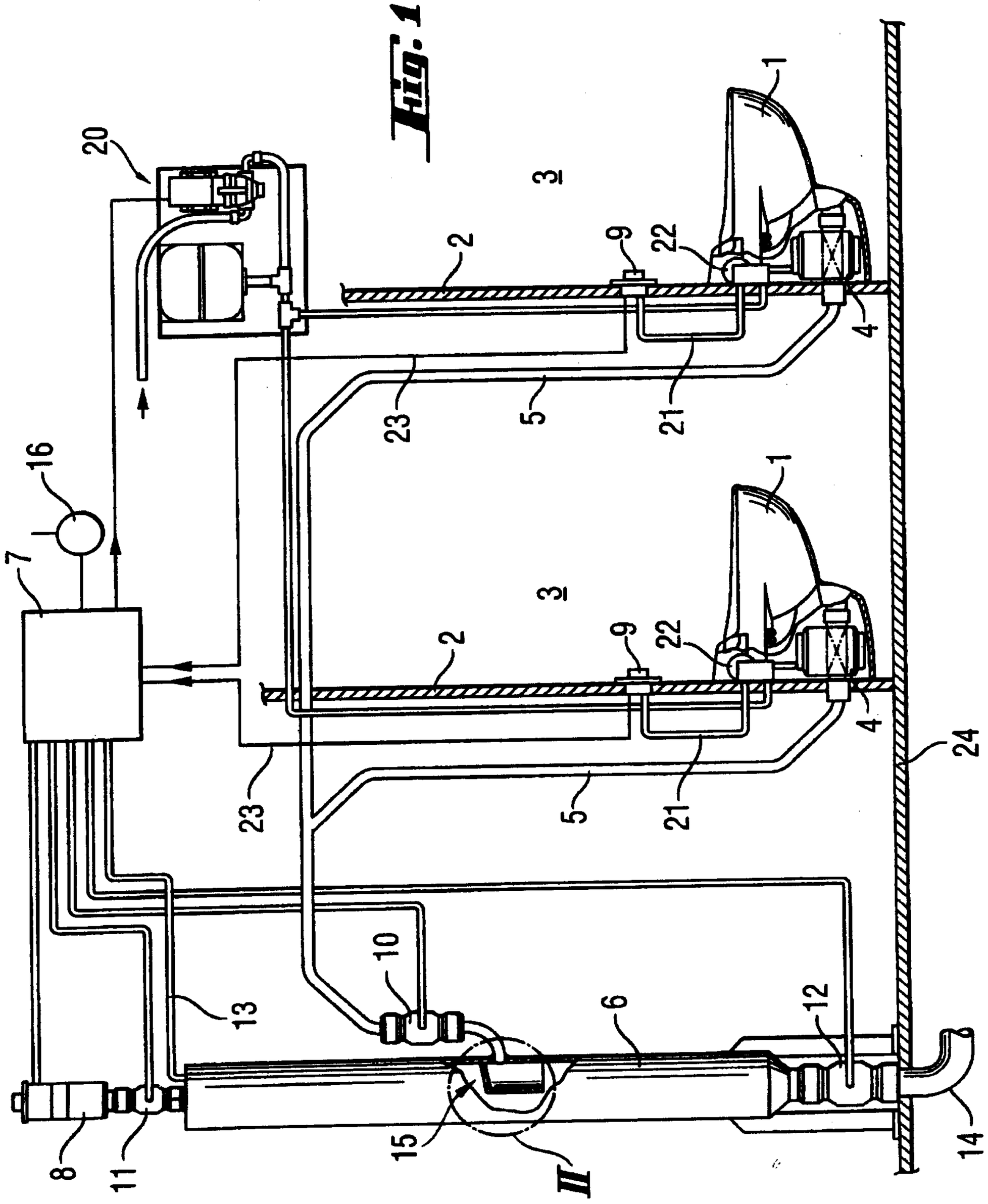
the discharge valve in response to travel parameters.

15. The vacuum toilet system of claim 14, in which the travel parameters comprise a measured speed of the vehicle unit in which the vacuum toilet system is disposed.

16. The vacuum toilet system of claim 1, in which the collecting container further comprises a deflector for directing sewage flow downward into the tank positioned near the sewage intake port, the deflector comprising a top wall portion extending inwardly from a wall of the container and a side wall portion extending downwards from the top wall portion in a substantially lengthwise direction of the collecting container, wherein the side wall portion is horizontally spaced from the sewage intake port by a distance “b”.

17. The vacuum toilet system of claim 16, in which the side wall portion of the deflector has a bottom edge vertically spaced below a center point of the sewage intake port by a distance “h”.

Fig. 1



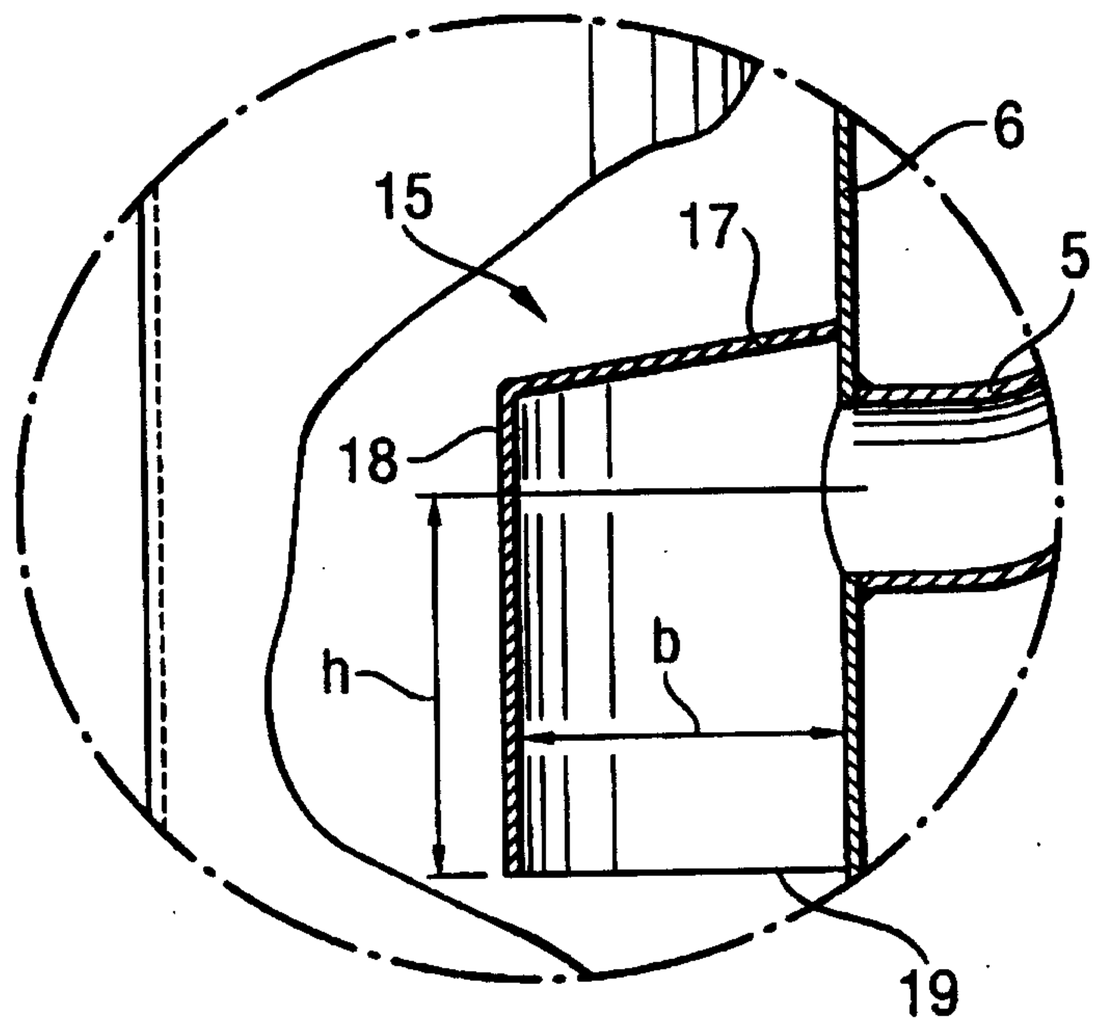
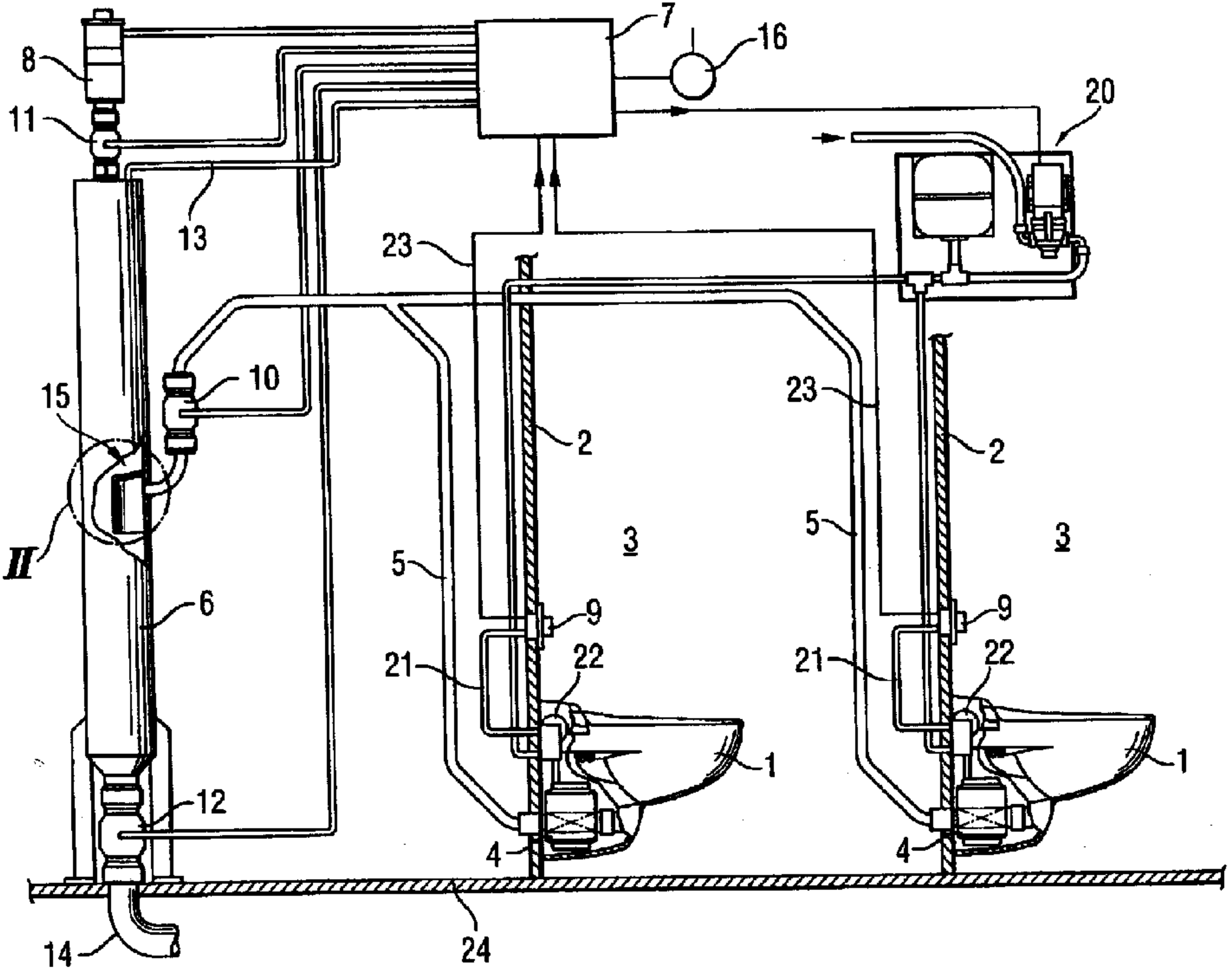


Fig. 2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