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## (54) Electronically controlled lavatory flush tank

(57) An electronically controlled lavatory flush tank (1) includes a hydraulic circuit (2) fitted with at least one valve (3; 4); and the hydraulic circuit (2) in turn has a fill inlet (10, 11) connectable to a water mains, and a vessel (12) having a drain hole (13). The tank (1) includes an electronic level sensor (5) for detecting the level of a fluid in the vessel (12); an electronic control circuit (6); and at least one electromechanical actuator (7; 8) activated by the electronic control circuit (6) for alternatively opening and closing the valve (3; 4) on the basis of the level detected by the level sensor (5).

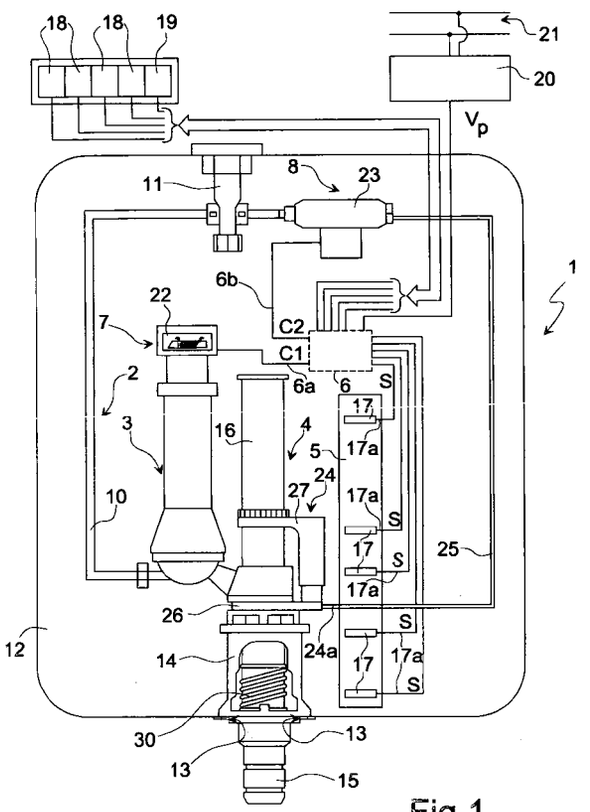


Fig.1

EP 1 426 502 A2

## Description

**[0001]** The present invention relates to a lavatory flush tank with electronic fill and drain control.

**[0002]** As is known, lavatory flush tanks normally comprise fill and drain valve control devices permitting various tank draining modes, and which include: single-drain devices for simply draining all the water from the tank; dual-drain devices for selectively draining all or only part of the water from the tank; and devices of both the above types enabling drain-off to be interrupted manually as required.

**[0003]** Known dual-drain devices normally comprise a valve fitted to the bottom end of a movable member (which normally also acts as an overflow pipe) and associated with a float for delaying closure of the valve to allow all the water to be drained off. Conversely, to drain off only part of the water, an additional weight is connected reversibly to the valve to accelerate return of the valve to the closed position.

**[0004]** A drawback of known devices of this type lies in reversible connection of the additional weight to the valve involving delicate, relatively complex mechanisms subject to malfunctioning and failure. Moreover, the mechanisms are normally located at the surface of the water in the tank, precisely where lime is known to form, and which tends to deposit on the mechanisms, thus resulting in damage and impaired operation. What is more, in the event the mechanism is damaged, the additional weight normally remains attached to the valve with no possibility of disconnecting it, so that only partial drain mode is operative (whereas, in the event of damage, full drain mode would be preferable).

**[0005]** It is an object of the present invention to provide a flush tank designed to eliminate the aforementioned drawbacks, and which is also cheap and easy to produce.

**[0006]** According to the present invention, there is provided an electronically controlled lavatory flush tank comprising a hydraulic circuit fitted with at least one valve; said hydraulic circuit comprising a fill inlet connectable to a water mains, and a vessel having a drain hole; and the tank being characterized by comprising an electronic level sensor for detecting the level of a fluid in said vessel; an electronic control circuit; and at least one electromechanical actuator activated by said electronic control circuit for alternatively opening and closing said valve on the basis of the level detected by said level sensor.

**[0007]** The invention has the advantage of simplifying the fill and/or drain valve control devices, and making them less subject to damage or failure. More specifically, the electromechanical actuators employed according to the invention are more reliable than commonly used all-mechanical devices.

**[0008]** According to a further aspect of the invention, the level sensor comprises a number of detectors at respective separate predetermined levels.

**[0009]** Moreover, each of said detectors has an output connected to said electronic control circuit and supplying a respective level signal having a first value when said detector is immersed, and a second value when said detector is exposed.

**[0010]** As such, various water levels inside the vessel can be detected accurately to enable various partial drain programs. That is, as the water level in the vessel gets lower, the detectors are exposed successively, and the respective signals switch, so that drain-off can be arrested automatically by the control circuit on detecting a given user-selected level.

**[0011]** A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawing, which shows a schematic front cross section of a lavatory flush tank in accordance with the present invention.

**[0012]** Number 1 in the accompanying drawing indicates as a whole a lavatory flush tank. Tank 1 comprises a hydraulic circuit 2 fitted with a fill valve 3 and a drain valve 4; an electronic level sensor 5; an electronic control circuit 6; and electromechanical fill and drain actuators 7 and 8 for activating fill valve 3 and drain valve 4 respectively.

**[0013]** Hydraulic circuit 2 comprises a fill pipe 10 connectable to a water mains (not shown) by a fitting 11; and a flush water vessel 12 having a drain hole 13. Fill valve 3 is located along fill pipe 10, and drain valve 4 is inserted inside drain hole 13. More specifically, drain valve 4 comprises a base 14 fitted integrally to a bottom wall of vessel 12; an outlet conduit 15; and a tubular body 16 inserted in axially sliding manner inside base 14 and normally set to close outlet conduit 15. A return spring 30 is connected between base 14 and tubular body 16, and tends to keep tubular body 16 in the rest position closing outlet conduit 15. More specifically, return spring 30 provides for restoring tubular body 16 to the closed position, following operation of drain valve 4.

**[0014]** Level sensor 5 comprises a number of detectors 17 located at respective separate predetermined levels with respect to a bottom wall of vessel 12. Each of detectors 17 has an output 17a connected to control circuit 6 and supplying a respective level signal S. More specifically, level signals S each have a first value when respective detector 17 is immersed, and a second value when respective detector 17 is exposed. In the embodiment described herein, five detectors 17 are employed. A first detector 17, located substantially at the bottom wall of vessel 12, detects when vessel 12 is empty; a second detector 17 determines the water surface level when vessel 12 is full; and the other detectors 17 determine respective intermediate water levels in vessel 12.

**[0015]** In a preferred embodiment of the invention, control circuit 6 comprises a numeric processing unit, and is fitted to the outside of a rear wall of vessel 12. In a variation not shown, control circuit 6 is sealed and housed inside vessel 12.

**[0016]** Control circuit 6 has a number of control inputs,

each connected to a respective control button 18; a stop input connected to a stop button 19; a first output 6a connected to the fill actuator 7 and supplying a first control signal C1; and a second output 6b connected to the drain actuator 8 and supplying a second control signal C2. More specifically, control signals C1, C2 are related to the level signals S from level sensors 17, and provide for alternatively enabling and disabling fill actuator 7 and drain actuator 8 respectively.

**[0017]** A transformer 20, having inputs connected to a mains power line 21, has an output connected to control circuit 6 and supplying a drive voltage $V_p$ for activating actuators 7, 8.

**[0018]** Fill actuator 7 is associated with fill valve 3, and comprises an electromagnetic circuit 22 for controlling fill valve 3.

**[0019]** Drain actuator 8 cooperates with drain valve 4, and comprises a solenoid valve 23 and a hydraulically controlled piston device 24. Solenoid valve 23 is located between fitting 11 and a control inlet 24a of piston device 24, to which it is connected by a control pipe 25. Solenoid valve 23, which is normally closed, has a terminal connected to second output 6b of control circuit 6, and is therefore activated by control circuit 6 by means of second control signal C2.

**[0020]** Piston device 24 comprises a support 26 carried by base 14 of drain valve 4; and an extendable arm 27 connected integrally to tubular body 16 of drain valve 4. Piston device 24 has at least one withdrawn operating configuration, in which drain valve 4 is closed, and one extended operating configuration, in which tubular body 16 is raised in opposition to return spring 30, and drain valve 4 is open. More specifically, when solenoid valve 23 is open, control inlet 24a of piston device 24 is connected by fitting 11 to the water mains, so that piston device 24 is in the extended configuration and drain valve 4 is open. Conversely, when solenoid valve 23 is closed, control inlet 24a is disconnected from fitting 11 and the water mains, so that the water in control pipe 25 flows out through an outflow opening (not shown) of piston device 24, which assumes the withdrawn configuration and, cooperating with return spring 30, closes drain valve 4.

**[0021]** Flush tank 1 operates as follows.

**[0022]** Initially, vessel 12 is full, so that detectors 17 are all immersed, and control circuit 6, by means of control signals C1 and C2, closes both fill valve 3 and drain valve 4. By pressing one of buttons 18, the user selects a flush water quantity, which corresponds to a respective fall in the surface level inside vessel 12; and control circuit 6 opens solenoid valve 23, and consequently drain valve 4, while fill valve 3 remains closed. As the water level inside vessel 12 falls, detectors 17 are exposed successively, and the respective level signals S switch.

**[0023]** As the user-selected level is reached and the level signal S from the corresponding detector 17 switches, control circuit 6 closes solenoid valve 23. Piston device 24 is thus disabled, by its control inlet 24a being disconnected from the water mains, so that tubular body 16 of drain valve 4, also with the aid of return spring 30, is restored to the closed position closing outlet conduit 15. At the same time, control circuit 6 excites electromagnetic circuit 22 controlling fill valve 3, which is opened. More specifically, when full flushing is selected by the user, the control circuit intervenes upon switching of the level signal S from the detector located at the bottom wall of vessel 12.

**[0024]** Alternatively, flushing is interrupted by the user pressing stop button 19 before the selected level is reached.

**[0025]** Fill valve 3 is kept open until the surface of the water reaches the full level and switches the corresponding level signal S.

**[0026]** Control circuit 6 preferably disables further flushing until vessel 12 is full.

**[0027]** In other words, fill and drain actuators 7 and 8 are activated by electronic control circuit 6 on the basis of the level detected by level sensor 5, for alternatively opening and closing fill valve 3 and drain valve 4 respectively, and so control emptying of vessel 12.

**[0028]** Clearly, changes may be made to the tank as described herein without, however, departing from the scope of the present invention.

**[0029]** In particular, fill valve 3 or drain valve 4 and the relative control device may be conventional types. More specifically, fill valve 3 may be controlled by a float device.

**[0030]** Flush buttons 18 may be replaced by other types of manual control devices, such as capacitive touch sensors; or an automatic photocell or ultrasound control device may be provided to detect the presence and subsequent departure of the user.

## Claims

1. An electronically controlled lavatory flush tank comprising a hydraulic circuit (2) fitted with at least one valve (3; 4); said hydraulic circuit (2) comprising a fill inlet (10, 11) connectable to a water mains, and a vessel (12) having a drain hole (13); and the tank being **characterized by** comprising an electronic level sensor (5) for detecting the level of a fluid in said vessel (12); an electronic control circuit (6); and at least one electromechanical actuator (7; 8) activated by said electronic control circuit (6) for alternatively opening and closing said valve (3; 4) on the basis of the level detected by said electronic level sensor (5).

2. A tank as claimed in Claim 1, **characterized in that** said level sensor (5) comprises a number of detectors (17) located at respective separate predetermined levels.

**3.** A tank as claimed in Claim 2, **characterized in that** each of said detectors (17) has a respective output connected to said electronic control circuit (6) and supplying a respective level signal (S) having a first value when said detector (17) is immersed, and a second value when said detector (17) is exposed.

**4.** A tank as claimed in any one of the foregoing Claims, **characterized in that** said valve (4) is a drain valve, and **in that** said electromechanical actuator (8) comprises a solenoid valve (23) activated by said electronic control circuit (6) on the basis of the level detected by said electronic level sensor (5); and a hydraulically controlled piston device (24) associated with a closing member (16) for closing said valve (4), and having a control inlet (24a) connectable selectively to said fill inlet (10, 11) of said hydraulic circuit (2) by said solenoid valve (23).

**5.** A tank as claimed in Claim 4, **characterized in that** said piston device (24) comprises a support (26) integral with said vessel (12), and an extendable arm (27) connected integrally to said closing member (16); said piston device (24) having at least a first operating configuration, in which said valve (4) is closed, and a second operating configuration, in which said valve (4) is open.

**6.** A tank as claimed in Claim 5, **characterized in that** said piston device (24) is selectively set to said first operating configuration when said control inlet (24a) is disconnected from said fill inlet (10, 11), and to said second operating configuration when said control inlet (24a) is connected to said fill inlet (10, 11).

**7.** A tank as claimed in any one of Claims 4 to 6, **characterized by** comprising elastic return means (30) fitted to said closing member (16) to keep said closing member (16) in a closed position closing said valve (4).

**8.** A tank as claimed in Claim 7, **characterized in that** said elastic return means (30) comprise a spring connected to said closing member (16) and to a base (14) of said valve (4).

**9.** A tank as claimed in any one of Claims 1 to 3, **characterized in that** said valve is a fill valve (3), and **in that** said electromechanical actuator (7) comprises an electromagnetic circuit (22) controlling said valve (3).

**10.** A tank as claimed in any one of the foregoing Claims, **characterized in that** said electronic control circuit (6) comprises a numeric processing unit.

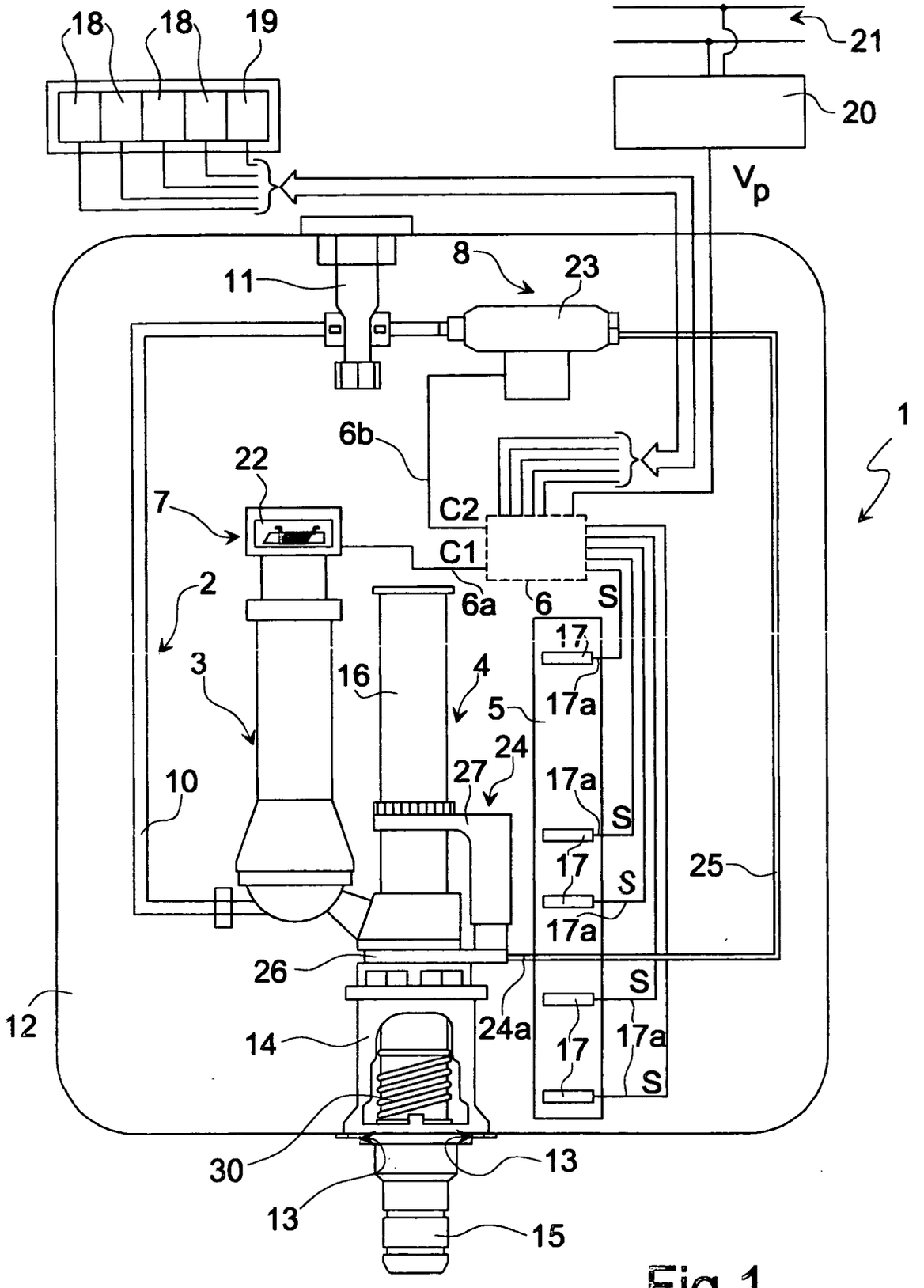
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Fig.1