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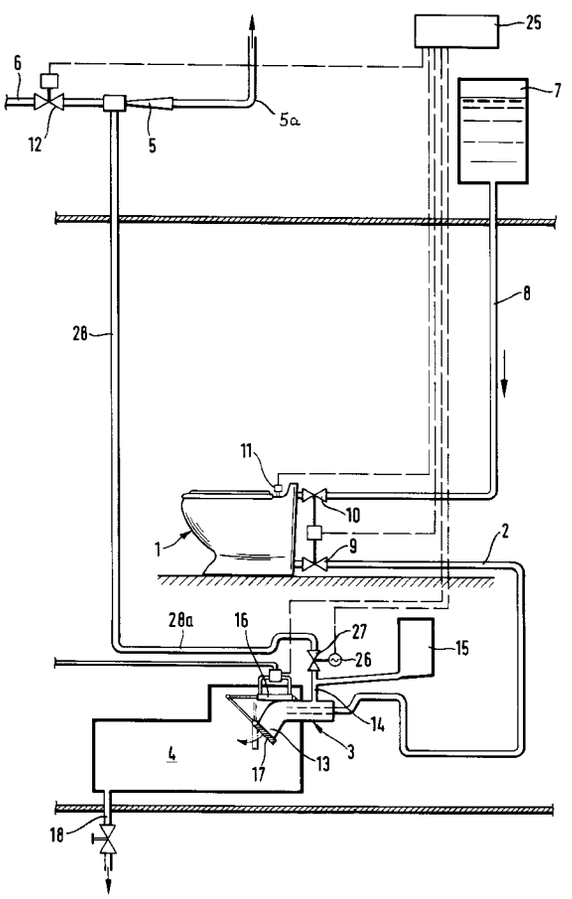
(54) Improvements in and relating to vacuum sewage systems.

(57) A method and an arrangement for cleaning the evacuation duct (28) of a vacuum sewer system is described. In such a system partial vacuum is used for providing transport of waste matter through a sewer pipe (2) from a waste matter providing unit (1) to a collecting chamber (13). Function control units (5, 12, 25) govern the generation of a partial vacuum in the sewer pipe (2) prior to each transport of a volume of waste matter through the sewer pipe (2). After completing the transport of a volume of waste matter from the providing unit (1) to the collecting chamber (13), the function control units (5, 12, 25) are activated to regenerate partial vacuum in the sewer system (2, 13) and thereafter to let in a charge of ambient air to flow through the evacuation duct (28), through which air is normally drawn from the system (2, 13) when the partial vacuum is generated. This provides a purging and cleaning of the evacuation duct (28).



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The invention relates to a method according to the preamble of claim 1 and to a sewage system according to the preamble of claim 5.

In a vacuum sewage system, sewage or other waste matter is transported by means of vacuum. This technique is advantageous in cases such as where low water consumption is required, where small bore sewage pipe dimensions are used and where there is a possibility for the sewage pipe to extend upwards. In small vacuum sewage systems, that is systems with only one or a few sources of waste matter (e.g. WC toilet bowls or the like), it is of advantage to generate vacuum in the sewer pipe separately for each single requirement to transport a volume of sewage or other waste matter. It is then not necessary to continuously maintain vacuum in the sewer pipe as it is in a conventional vacuum sewer system, and accordingly no devices are needed to continuously monitor that there is an adequate vacuum present in the vacuum system. Because the time needed for generating vacuum should not be too long in a system where vacuum is applied only when required, the total volume to be put under vacuum should suitably be less than 100 liters, preferably less than 50 liters. For instance, in a sewage system for a railway car, a vacuum volume as small as 35 liters is normally quite sufficient for the needs of one WC-unit.

Practice has shown that in a vacuum sewage system with intermittently generated vacuum, small amounts of moisture and impurities can be drawn into the evacuation duct of the system. If this duct is not cleaned from time to time, considerable amounts of impurities will accumulate there after the system has been operated for some time, and the duct may then be at least partially clogged. In addition, deposits which may become lodged in the system can cause unpleasant odours and leakage of foul water.

One aim of this invention is to provide a vacuum sewage system in which problems caused by deposits of impurities and by moisture being drawn into the evacuation duct are at least reduced and at best avoided. This is obtained by means of the method set out in claim 1 and by means of the structure defined in claim 5.

By regenerating vacuum in the sewer system after each transportation of a volume of waste matter, it is possible to let in a powerful pulse of air to flow through the evacuation duct of the system in a direction opposite to the normal flow direction during evacuation and use this pulse of air to purge the evacuation duct of moisture and/or other impurities. The only action that is required to secure this cleaning operation is to open the evacuation duct to ambient air when the vacuum generation ceases. Atmospheric air will then, due to its higher pressure, rapidly flow into the sewer system through the evacuation duct, whereby the duct is purged because impurities and liquid present therein are conveyed away by the air flow. The cleaning effect can be increased by arranging a valve in the evacuation duct. By rapidly opening this valve when there is a full range of vacuum in the sewer system, a powerful air flow is obtained which effectively cleans the evacuation duct.

In principle it is not important where, in the evacuation duct, the valve is situated. However, practice has shown that it is most convenient to locate the valve close to the primary sewage collecting chamber of the system and to arrange, close to the opposite side of the valve, means for collecting any liquid present in the evacuation duct. Such collecting means can be a U-bend or a pocket in the evacuation duct, to which liquid flows from higher portions of the duct at each side of the liquid collecting means.

By keeping the valve of the evacuation duct open when vacuum is generated in the system and when cleaning air is let into the system, but keeping it closed at other times, the best control of the function of the system is normally obtained. The valve then also prevents odours from the sewer system spreading into the surroundings.

In a system according to the invention, it is convenient to provide a primary sewage collecting chamber, as known per se, as a preliminary collecting space, in which a volume of waste matter is collected immediately after its transportation for subsequent transfer to a collecting tank or the like under atmospheric pressure. Such an arrangement is described in US-A-4297751. The volume that is to be under vacuum is, in such a system, relatively small. It is convenient that a new vacuum generation for purging the evacuation duct is not started until the primary sewage collecting chamber has been emptied. Thereby the advantage is obtained that the purging of the evacuation duct does not cause spray or splashing in any liquid present in the primary collecting chamber. In addition, any liquid present in the evacuation duct has time to flow to the lowest portion of the duct, whereby more effective cleaning of the duct will be obtained.

By making the valve of the evacuation duct remotely controlled through the control unit of the system in dependence on the control of other valves of the system, the advantage is obtained, that all functions of the system can be controlled by the same control unit. This minimizes the risk of malfunctioning.

The invention will now be described more fully with reference to the accompanying drawing, the single figure of which is a schematic diagram of a vacuum sewage system according to the invention.

In the drawing, 1 indicates a WC toilet bowl connected through a sewer valve 9 to a vacuum sewer pipe 2. The vacuum sewer pipe 2 debouches into an emptying device 3 including a primary collecting chamber 13, from which the waste matter can be transferred to a collecting tank 4. A vacuum pump, in the form of an ejector 5, driven by compressed air re-

ceived from a compressed air network 6, is provided. The compressed air exits the system via an exhaust pipe 5a. The toilet bowl 1 receives rinse water from a water tank 7 through a flush pipe 8 and a rinse water valve 10. Emptying of the toilet bowl and feeding of rinse water to the toilet bowl is controlled by an electrical control unit 25 governing operation of the sewer valve 9 and the rinse water valve 10 when flushing is initiated by operating a flush knob 11. The system is designed basically as shown in US-A-4297751.

When the control unit 25 receives a flush impulse from the flush knob 11, it opens a valve 12 in the compressed air network 6 connected to the ejector 5. The ejector 5 then rapidly generates vacuum in the evacuation duct 28, in the sewer pipe 2 and in the emptying device 3. When a sufficient vacuum, preferably of about half an atmosphere, has been generated the compressed air valve 12 closes, the suction effect of the ejector 5 ceases, and the sewer valve 9 of the toilet bowl 1 opens. Upon emptying of the bowl 1 of the toilet, the sewer valve 9 closes and rinse water flows through the rinse water valve 10, which has opened somewhat earlier, and fills the lower part of the toilet bowl with a small amount of water. The total amount of flush water does not usually have to be greater than a few deciliters.

Since there is vacuum in the sewer pipe 2 when the sewer valve 9 opens, waste matter present in the bowl 1 is, by atmospheric pressure, pressed out into the sewer pipe 2 and flows through the pipe 2 to the primary collecting chamber 13. For proper sewage transport it is essential that at the outlet end of the sewer pipe 2 there is a sufficiently large air space. If the primary collecting chamber 13 and the pipes connected thereto do not together form a space large enough, a separate air tank 15 may be connected to a portion 14 of the evacuation duct close to the emptying device 3. As a dimensioning example could be mentioned that the sewer pipe 2 may have an internal volume of 5 to 10 liters, the emptying device 3 together with its primary collecting chamber 13 a volume of about 7 liters and the air tank 15 a volume of about 18 liters.

During transportation of a volume of waste matter, the vacuum in the sewer pipe 2 and in the emptying device 3 is almost completely lost. The sewer valve 9 may be so designed that it closes automatically, when there is no longer any substantial vacuum in the sewer pipe 2. Immediately after the transportation, a small power cylinder 16, preferably driven by compressed air, opens a bottom flap 17 of the primary collecting chamber 13 and the waste matter present in the collecting chamber 13 drops into the collecting tank 4. The power cylinder 16 then again closes the bottom flap 17. The collecting tank 4 is emptied, at suitable intervals, through an outlet pipe 18. The collecting tank 4 may be provided with conventional alarm and safety devices (not shown) to prevent overfilling.

Emptying of the primary collecting chamber 13 takes place automatically after each transport of waste matter. The automatic control unit 25 takes care of this by controlling the power cylinder 16. This has the advantage that the primary collecting chamber 13 may be small and that it does not need, for instance, a level sensor or other surveillance equipment.

At each evacuation of the sewer system, a small amount of impurities and moisture is drawn into the evacuation duct 28. To avoid that there will, after a time, be a build-up of any significant amount of impurities and/or liquid, the duct 28 must be periodically cleaned. In accordance with this invention this cleaning occurs by regenerating vacuum in the sewer system after each transportation of sewage from the toilet bowl 1 to the primary collecting chamber 13 and after the collecting chamber has been emptied into the tank 4. The regeneration of vacuum takes place in the same manner as when sewage is to be transported, that is, by means of the vacuum pump 5. When the required vacuum level has been reached, a cleaning air valve 27 in the evacuation duct 28 is closed by transmitting a closing impulse from the control unit 25 to the control device 26 of the valve 27. Valve 12 is now closed and since the sewer valve 9 remains closed, on rapid opening of the cleaning air valve 27, atmospheric air rushes in through the exhaust pipe 5a and the evacuation duct 28 to the spaces defined by the bore of the pipes 2 and 14 and by the chambers 13 and 15 equalizing the vacuum present there and blowing any moisture or impurities present in the duct 28 into the emptying device 3.

Cleaning of the duct 28 is enhanced by arranging, in the duct, a pocket (shown in the drawing by a lowest portion 28a of the duct) to which moisture can drain before air-purging of the duct 28 is carried out. It may be of advantage for the generation of vacuum for the cleaning of the evacuation duct 28 to take place considerably more slowly than when vacuum is generated for the emptying of the toilet bowl 1. By generating vacuum slowly it is avoided that moisture present in the pocket 28a is drawn up to the ejector 5.

Because all the control devices 9, 10, 12, 16 and 27 of the system are controlled by the same control unit 25, it is a simple matter to coordinate the different functions and control them in desired sequences dependent on one another.

The invention should not be interpreted as being limited to the embodiment illustrated since several variations and modifications thereof are feasible within the scope of the following claims.

Claims

1. A method for cleaning the evacuation duct (28) of

a vacuum sewer system, in which partial vacuum is used for providing transport of waste matter through a sewer pipe (2) from a providing unit (1) to a collecting chamber (13), and where function control units (5, 12, 25) govern the generation of a partial vacuum in the sewer pipe (2) separately for each transport of a volume of waste matter through the sewer pipe (2), **characterised in that** after completing the transport of a volume of waste matter from the providing unit (1) to the collecting chamber (13), the function control units (5, 12, 25) are activated to regenerate partial vacuum in the sewer system (2, 13) and thereafter to let air into the system through the evacuation duct (28), through which air is normally drawn from the system (2, 13) when the partial vacuum is generated, thereby purging the evacuation duct (28) to clean the latter.

2. A method according to claim 1, **characterised in that** ambient air is let into the evacuation duct (28) in the form of a pulse of air by rapidly opening a cleaning valve (27) controlling passage through the evacuation duct (28).

3. A method according to claim 2, **characterised in that** the cleaning valve (27) is kept open when partial vacuum is generated in the sewer system (2, 13) and when air is let into the system, but otherwise is kept closed.

4. A method according to any one preceding claim, **characterised in that** the collecting chamber (13), as known per se, is arranged to form as an intermediate collector unit, from which waste matter collected therein is transferred to a collecting tank (4) or the like, preferably under atmospheric pressure, and in that vacuum generation for cleaning the evacuation duct (28) is not commenced until the collecting chamber (13) has been emptied of waste matter.

5. A system for cleaning the evacuation duct (28) of a vacuum sewer system, in which partial vacuum is used for providing transport of waste matter through a sewer pipe (2) from a providing unit (1) to a collecting chamber (13) or the like, and where function control units (5, 12, 25) are arranged to generate partial vacuum in the sewer pipe (2) separately for each transport of a volume of waste matter through the sewer pipe (2), **characterised in that** cleaning means (27) is provided whereby, after completing the transport of a volume of waste matter from the providing unit (1) to the collecting chamber (13) and the function units (5, 12, 25) of the system have been arranged to regenerate partial vacuum in the sewer system, the cleaning means (27) can be activated to let air into the system through the evacuation duct (28), through which air is normally drawn from the system (2, 13) when the partial vacuum is generated, in order to clean the evacuation duct (28) by means of the pulse of air thus introduced into the evacuation duct (28).

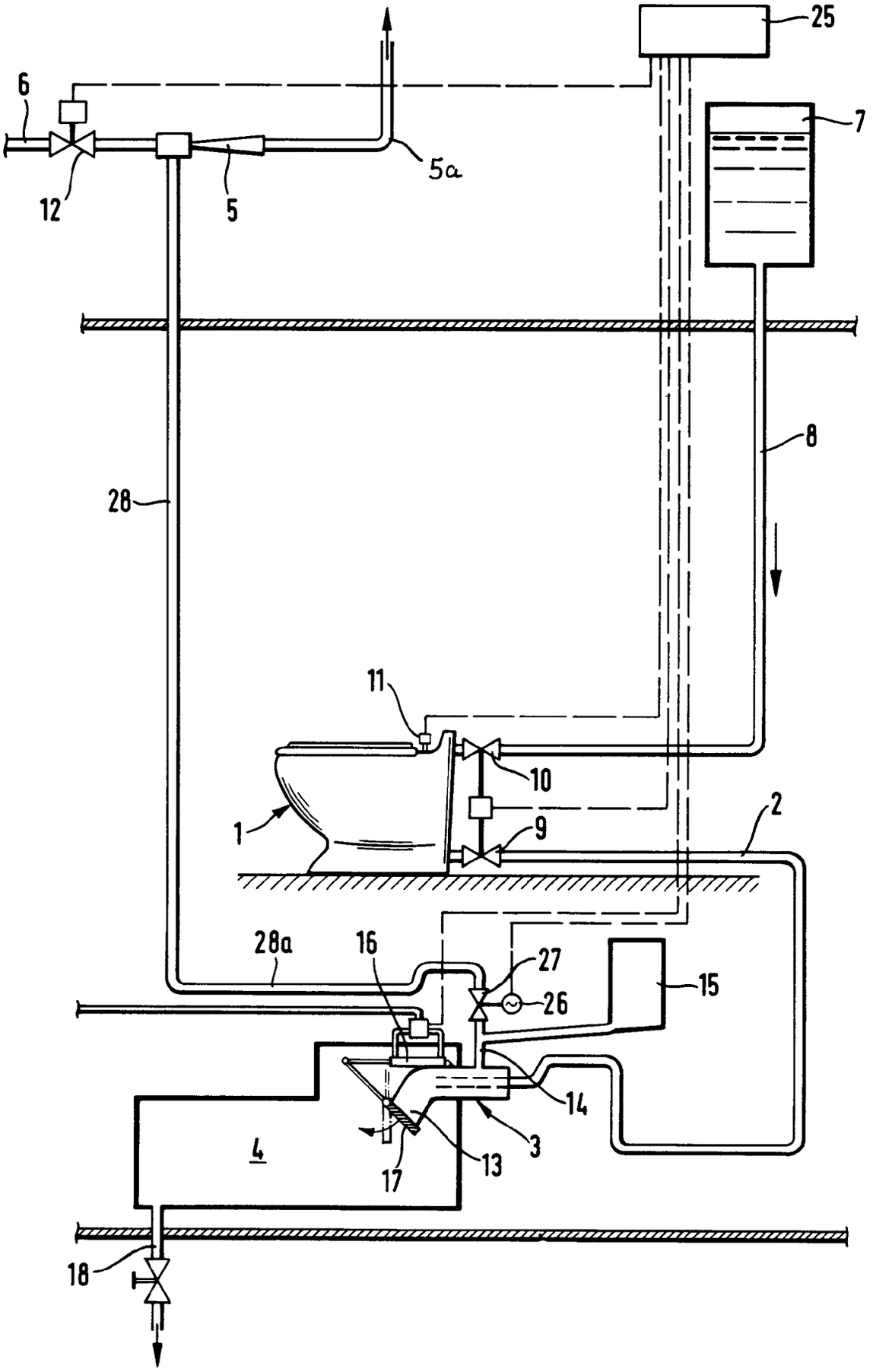
6. A system according to claim 5, **characterised in that** there is a, preferably rapidly opening, cleaning valve (27) in the evacuation duct (28) for letting in a cleaning air flow into the duct (28).

7. A system according to claim 6, **characterised in that** means is provided to keep open the cleaning valve (27) of the evacuation duct (28) when partial vacuum is generated in the system (2, 13) and when cleaning air is let into the system, said means being arranged to otherwise keep said cleaning valve (27) closed.

8. A system according to any one of claims 5 to 7, **characterised in that** the collecting chamber (13), as known per se, is arranged to form an intermediate collector unit, from which waste matter can be transferred to a collecting tank (4) or the like, preferably under atmospheric pressure, before a new vacuum generation for cleaning of the evacuation duct (28) is commenced.

9. A system according to any one of claims 6 to 8, **characterised in that** the cleaning valve (27) of the evacuation duct is located close to the collecting chamber (13) and that close to the opposite side of the cleaning valve (27) there is means (28a) for collecting liquid present in the evacuation duct (28).

10. A system according to any one of the claims 6 to 9, **characterised in that** the valve (27) of the evacuation duct is remotely controlled by a function control unit (25) of the system in dependence of the control of other valves (9, 10, 12) in the system.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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 4502

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-4 297 751 (H. OLIN) * column 3, line 54 - column 4, line 51; figure 1 *	1,4,5,8, 9	E03F1/00
A	EP-A-0 363 012 (OY WÄRTSILÄ AB) * column 10, line 35 - column 11, line 19; figure 5 *	1,4	
A	GB-A-2 203 461 (OY WÄRTSILÄ AB) * page 4, line 33 - page 5, line 27 * * page 7, line 4 - line 30; figure 1 *	1,4	
A	FR-A-2 637 304 (NESITE OY)	-	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E03F
E03D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03 SEPTEMBER 1992	KRIEKOUKIS S.

CATEGORY OF CITED DOCUMENTS

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