

[54] **ANTI-SIPHON AND PUMP PRIMING FOR SEWAGE GRINDER PUMP**

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[22] Filed: **Sept. 18, 1973**

[21] Appl. No.: **398,469**

Related U.S. Application Data

[63] Continuation of Ser. No. 305,712, Nov. 13, 1972, abandoned.

[52] U.S. Cl. **241/36, 241/46.02, 241/258**

[51] Int. Cl. **B02c 13/18**

[58] Field of Search 137/215, 216, 216.1, 217, 137/218; 417/199 A, 200, 306, 435, 478; 241/36, 46, 46.02, 46.06, 46.11, 46.17, 257 R, 257 G, 258, 259

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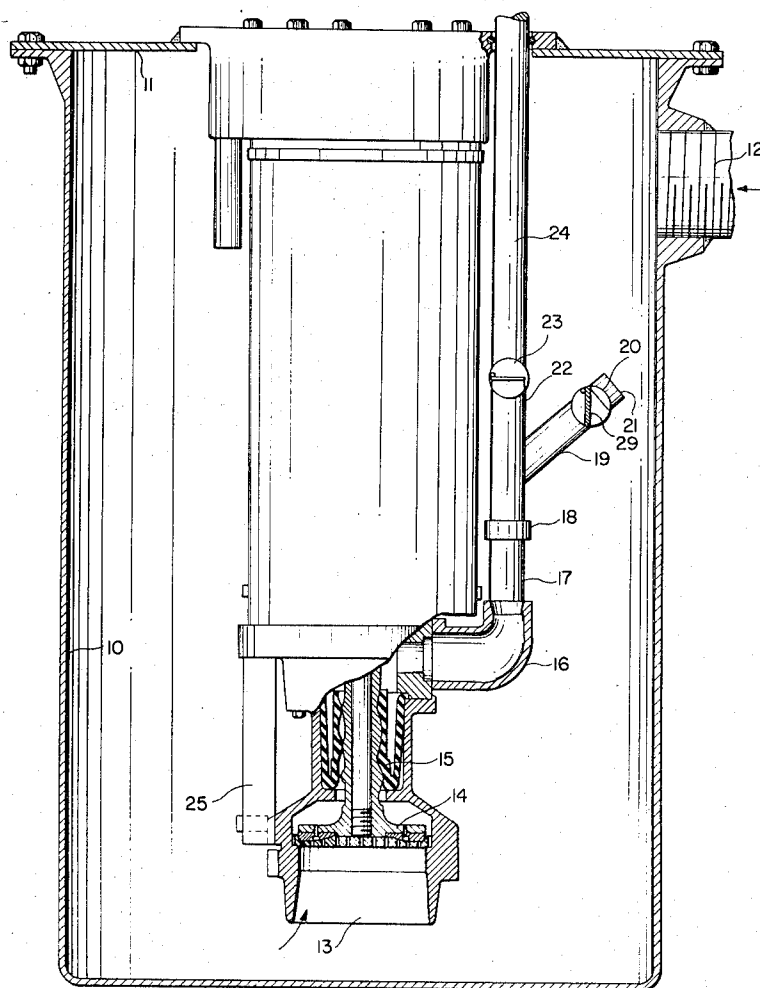
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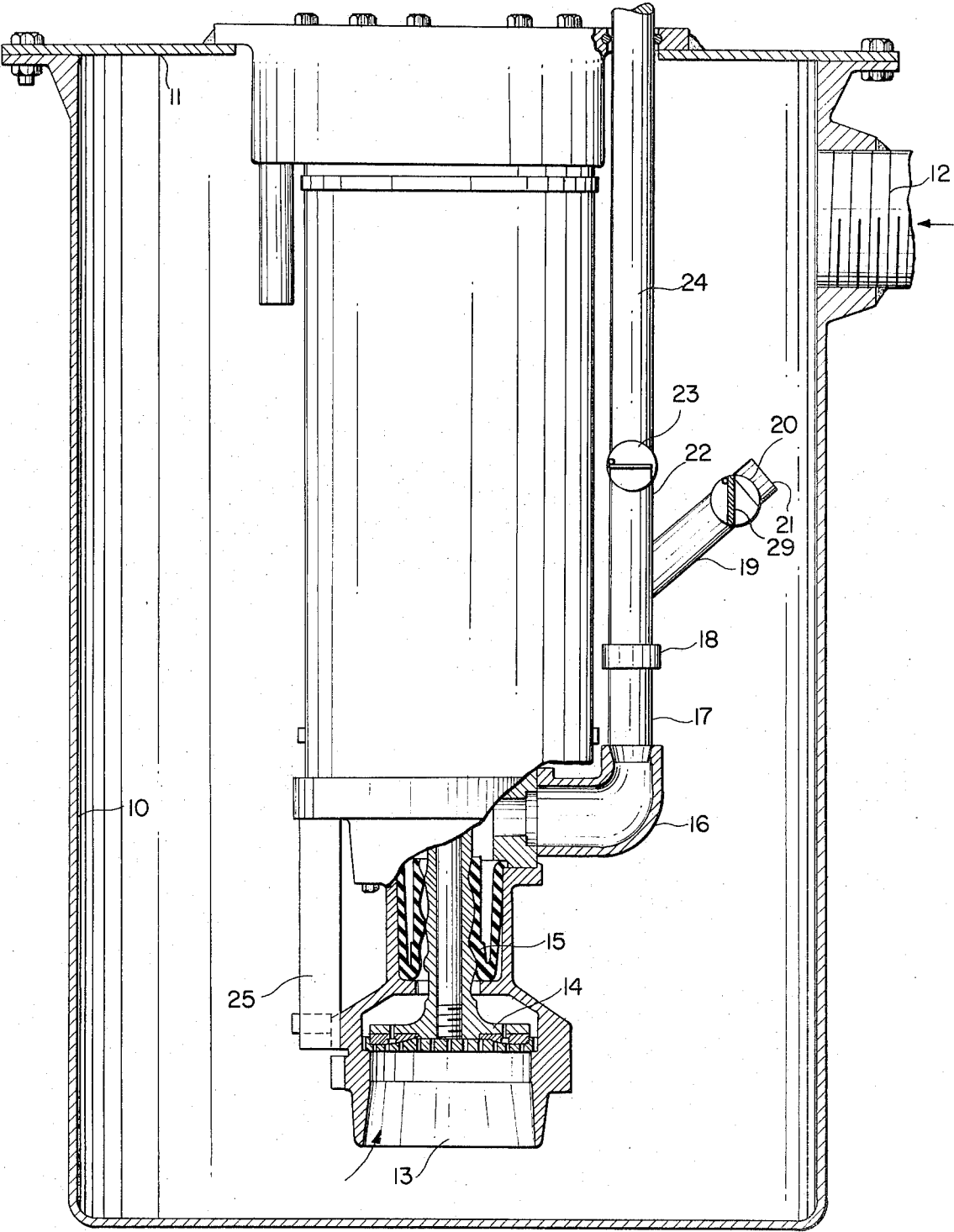
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ABSTRACT

Sewage enters and fills a receiving tank to a predetermined maximum level before being pumped through a discharge passage by means of a grinder and pump, with a check valve being provided in the discharge passage to prevent back flow of sewage, in combination with a conduit connected to the discharge passage between the pump pressure side and the back flow preventing check valve. The conduit provides air through a differentially operable check valve to the discharge line for anti siphoning protection and will further provide reverse air flow from the pump into the tank to prime the pump as well as to prevent discharge of liquid sewage out of the conduit into the tank. The conduit opens above the maximum predetermined level that actuates the grinder-pump, and is well above the pump suction inlet and pump working chamber. There are no other outlets or inlets between the tank interior and the discharge line or pump chamber so that the unit can be sealed closed at the factory but may be easily primed upon installation and provides anti siphoning protection.

17 Claims, 1 Drawing Figure





ANTI-SIPHON AND PUMP PRIMING FOR SEWAGE GRINDER PUMP

This application is a Continuation application of U.S. application Ser. No. 305,712, filed Nov. 13, 1972, Richard C. Grace and Frank W. Van Luik, Jr., Inventors, entitled, ANTI-SIPHON AND PUMP PRIMING FOR SEWAGE GRINDER PUMP now abandoned.

BACKGROUND OF THE INVENTION

The sewage pump storage grinder disclosed in Grace U.S. Pat. No. 3,667,692, issued June 6, 1972 employs a check valve in its discharge passage for the purpose of preventing sewage back flow. However, if a suction is created in the discharge line due to siphoning effects, this check valve could open and allow withdrawal of all sewage or liquid within the pump chamber and in the tank down to the pump suction inlet, thus destroying the pump prime. After the suction no longer exists and the sewage again rises within the tank to the predetermined level to actuate the pump, air may be trapped in the pump chamber. This greatly increases the friction between the pump working surfaces and a corresponding increase in wear and hence may prevent proper operation of the pump. Additionally, when the pump storage grinder is first installed, the pump chamber will be completely dry and may not fill with liquid, due to back pressure from the pressure system of which it comprises a part, even though the liquid sewage within the tank rises to the maximum predetermined level. Thus, it may be necessary to open the normally sealed tank and separately prime the pump. Further, it is desirable to prevent siphoning effects when employing a multiplicity of pump storage grinder units in a pressurized sewage system having liquid sewage normally in all of its lines, because leakage in an individual home at a low level can be siphoning withdraw sewage from the surrounding lines and tanks to create a considerable flooding problem. Finally, inclusion of the anti-siphon, self-priming, differentially operable check valve allows the grinder pump to self-drain to the level of sewage in the container on which it takes suction and thereby relieves the discharge site of the grinder pump after each period of operation by allowing it to vent to atmosphere. As a result, on the next start-up of the grinder pump, there is no initial loading due to pressurized sewage at the discharge of the pump and the starting transients imposed on the grinder pump motor are greatly reduced.

SUMMARY OF THE INVENTION

Sewage enters and fills a storage tank to a predetermined maximum level before being pumped through a discharge passage by means of a pump storage grinder. A check valve is provided in the discharge passage to prevent back flow of sewage, in combination with a conduit connected to the discharge passage between the pump pressure side and the back flow preventing check valve. This conduit includes a second differentially operated check valve which provides two-way airflow through the valve to the discharge line to prevent siphoning and assure proper priming, and also acts as a check valve while the pump storage grinder is operating to prevent recirculation of the liquid sewage pump discharge back into the storage tank of the unit.

The pump is preferably of the positive displacement helical screw type employing a flexible boot with an in-

ternal helical surface in cooperative working engagement with a rigid shaft having an external helical surface, but of a different pitch. The shaft that drives the pump preferably has at its lower end, within the pump suction inlet, a grinder for macerating the sewage.

BRIEF DESCRIPTION OF THE DRAWING

Further, objects, features and advantages of the present invention will become more clear from the following detailed description of a preferred embodiment shown in the single FIGURE of the drawing.

DETAILED DESCRIPTION OF THE DRAWINGS

As shown in the single FIGURE, a tank 10 has a sealed upper cover 11 and a sewage inlet 12. When desired, the sewage is pumped from the tank through a pump suction inlet 13, is ground by a grinder macerator 14, is positively pumped through pump working chamber 15 due to the helical screw pumping action in a well known manner, passes under increased pressure through discharge passage elbow 16, discharge passage 17, coupling 18, discharge passage pipe 22, a first check valve 23, and outlet 24 which is connected to a gravity fall sewage line or pressurized sewage line leading ultimately to a sewage disposal site. The pump is actuated automatically by a level control (not shown) whenever the sewage within the tank 10 rises to a predetermined maximum level as determined by the sensor receiving a pressure head through pipe 25. All of this structure, with the exception of the placement of the check valve 23 and the coupling 18, is similar to that shown in the above-mentioned Grace patent, the disclosure of which is incorporated herein in its entirety by reference, although some of the details have been omitted in the present FIGURE for the sake of brevity.

If the pump storage grinder unit as shown in the FIGURE is used in a pumping network of pressurized sewage lines, particularly a pressurized system wherein pressurized liquid is maintained in all of the network lines, a break in one of the low lines, that is below the unit shown in the FIGURE, would produce a suction in outlet pipe 24 and have a siphoning effect that would draw sewage from the discharge passage through check valve 23. This siphoning effect could destroy the prime on the pump by removing all of the liquid wastewater including liquid from the sewage within the tank down to the bottom-most portion of the pump suction inlet 13, and allow the passage of considerable liquid wastewater through the above-mentioned broken line of the pressurized system with possible undesirable flooding effects on other units of a pressure sewer system, particularly if the units are installed in housing basements. While the check valve 23 desirably prevents the back flow of sewage from the outlet to the pump, it alone will not prevent such siphoning effects.

In the event that siphoning in the above described manner occurs, or alternatively, when the pump storage grinder unit is initially installed, the entry of sewage into the tank in rising to the predetermined maximum level that actuates the level sensing switch, may not prime the pump. This is due to the back pressure from the system which in conjunction with the sealing effect of the rotor, prevents entry of liquid into the pump chamber. This sealing effect, which is inherent in the pump construction, it not absolute so as to provide a positive seal and may not be sufficient to prevent si-

phoning, but may prevent priming due to the fact that the pressure differentials in the sewage rising to its maximum predetermined level within the tank and siphoning are considerable.

These problems are solved according to the present invention by the provision of a conduit 19 sealingly secured to and opening into the discharge passage pipe 22 at its lower one end and extending upwardly to its other terminal free end 21. The conduit 19 has mounted therein a second, differentially operated check valve 20 to allow for the flow of air to and from its open end 21 to the end thereof connected to the discharge pipe 22 at a point intermediate the discharge of pump 15 and first check valve 23 for anti siphoning and priming as will be explained later. During pump out of the tank when the discharge passage is pressurized with sewage being pumped out of the outlet, the check valve 20 will close due to the action of the pressurized liquid sewage which may be at a pressure of the order of 40 p.s.i.

If siphoning tends to occur with the unit of the present invention, suction will be produced within the outlet pipe 24 as described above to draw sewage through the check valve 23. However, continued withdrawal of sewage due to siphoning below the connection of conduit 19 to discharge pipe 22 will cause the differentially operated check valve 20 to open and allow air to pass from the space above the liquid level of the tank to enter discharge pipe (22) and break the siphon effect.

At this point, it should be noted that the liquid level actuated grinder pump unit is set so that the maximum level of liquid wastewater and sewage collected in tank (10) normally does not rise above the open end of conduit (19) unless a failure or power outage occurs. Thus, an air space normally exists in the space within tank (10) above the liquid level of the sewage and wastewater. This space is vented to atmosphere through the inlet opening (12) and through the normally installed plumbing system stack vent to atmosphere of the house or other structure in which the unit is installed. As disclosed in U.S. Pat. No. 3,667,692, it is also possible to separately vent this space to atmosphere. Hence, it will be appreciated that the space in tank (10) over the level of the liquid wastewater and sewage collected therein comprises a source of venting gas.

For the above stated purpose, check valve 20 is designed and installed in a manner such that it differentiates between air and liquid fluid in its operation. In the particular embodiment disclosed, such differential action is achieved with a gravity operated flapper closure member 29 which normally hangs open. Hence, upon the occurrence of a siphoning condition, air is readily drawn through the valve 20 around the normally open flapper closure member 29 to break the siphoning effect and prevent pump 15 from losing its prime. Further, only a small amount of sewage will be drawn through the outlet pipe 24 upon the occurrence of siphoning to thereby minimize possible flooding of other units in a system, and thereafter the siphoning effect will be broken by the passage of air through differentially operated check valve 20. This same minimal siphoning effect is achieved throughout a pressurized system employing numbers of such pump storage grinder units thereby greatly reducing the threat of undesired flooding of any one of the units in the system.

The differentially operated check valve 20 also serves the dual function of facilitating priming of the pump 15 either when it is initially installed and placed in operation or after it has lost its prime for some reason such as servicing. In this regard, it should be noted that the gravity operated flapper closure member 29 normally hangs open. Consequently, air can flow around it readily in either direction. Upon initially filling tank 10 after it has been emptied for one reason or another, liquid will rise to and above the level of the pump 15 in advance of actuation of the pump motor by the level sensitive switch through pipe 25. As liquid rises through the macerator 14 and pump housing 15, air at a very low velocity will be forced out through discharge pipe 17. In the absence of differentially operated valve 20, the back pressure of the system network of piping acting on check valve 23 would prevent check valve 23 from opening, thus pressuring the pump housing 15, and preventing priming of the pump. However, differentially operated valve 20 (whose gravity operated flapper closure member 29 normally hangs open), allows the air being forced out through macerator 14, pump housing 15 and discharge pipe 17 to be vented to the top of tank since the low velocity air being vented is not adequate to close flapper closure member 29. This is to be contrasted to the high pressure liquid discharge produced while pump 15 is operated, and which is more than adequate to assure closure of the flapper closure member 29. Thus, it will be appreciated that the check valve 20 is a differentially operated check valve that differentiates between liquid and gaseous fluids, and allows two way flow of gaseous fluids while preventing flow of liquid fluids out of the free end (21) of conduit (19) back into tank (10).

Installation of the unit is greatly facilitated by the features of the present invention which allow the pump storage grinder unit to be assembled, operated and sealed at the factory with all connections required thereafter during installation in the field to be made externally of the sealed tank. Following installation, entry of sewage within the tank 10 will cause liquid to rise above the level of the suction inlet 13 of macerator 14 and to prime the pump 15. All of this will happen before actuation of the pump, because the pump 15 is considerably below the maximum predetermined sewage level within the tank that will actuate the pump through the sensor 25 by the level control means. This is achieved by reason of the above-described differential action of the differentially operable check valve 20 in allowing the pump 15 housing to be vented to the interior of tank 10. Thereafter, upon operation of the pump, valve 20 will be sealed closed in the normal manner of a check valve by the pressure of the sewage discharge. However in the event of the occurrence of a siphoning condition, the differentially operated check valve opens to provide anti siphoning in the above described manner. The actual construction of the schematically shown check valves 20, 23 may be of any type, but preferably they are of the flapper type shown and described.

In addition to the above-described important features, an unexpected and extremely valuable operating advantage is obtained for the sewage grinder pump by reason of the inclusion of the novel anti-siphon and pump priming device made possible by the present invention. This valuable new operating advantage occurs at the end of each operating pump out period of the

grinder pump unit by reason of the inherent action of the differentially operable check valve (20). It will be appreciated that, during operation of the grinder pump unit, pressurized sewage flowing in the discharge outlet of the grinder pump unit will cause the differentially operable check valve flapper (29) to be closed and the first check valve (23) to be open so as to provide a discharge flow of ground liquid sewage slurry through outlet conduit (24) to a low pressure sewage main or other disposal site. Upon completion of the pump-out of the tank (10), an appropriate sensor causes the grinder pump unit to turn off. As the grinder pump unit turns off, the discharge pressure at its outlet will drop below the operating pressure head of the sewage in the receiving low pressure sewage main and the check valve (23) will close thus preventing backflow of pressurized sewage from the receiving main into the grinder pump unit and its collection tank (10). Since the collection tank (10) is vented to atmosphere through the inlet pipe (12) (and the normal housing plumbing vent), the liquid trapped in the column (22) and conduit (17) will drain out due to gravity through the pump (15) stator and rotor which do not act as a positive seal. This slight backflow of the trapped ground liquid sewage slurry occurs because of the differentially operating characteristic of the check valve (29) which allows this valve to open and break any seal or vacuum that otherwise might be produced due to the above-noted drainage from discharge passage pipe (22) and (17). Thus, it will be appreciated that the discharge passage comprised by the pipes (17) and (22) is essentially drained of all pressurized fluid and assumes the pressure of the interior of the collection tank (10), namely atmospheric pressure.

As a consequence of the above drainage of the discharge pipes (17) and (22) occurring after each operation of the grinder pump unit, at the next operating interval, when the level sensor operating through coupling (25) again calls for the grinder pump unit to turn on and pump out tank (10), the grinder pump unit will see at its immediate discharge only the atmospheric pressure within tank (10) as noted above. Accordingly, it will be appreciated that this characteristic operating feature essentially unloads the grinder pump unit so that the electric motor driving the grinder pump unit does not have to start-up under high torque loaded conditions which otherwise would occur if fluid were trapped in the discharge passage pipes (22) and (17) at the normal or design pressure head of the low pressure sewage main into which the unit discharges. In contrast, the pump rotor sees only the atmospheric pressure of the tank thus allowing the pump to come up to speed under an essentially unloaded condition until the discharge passage pipes (17) and (22) are filled with pressurized sewage and the check valve (23) opens. This characteristic operating advantage, which is inherent in the grinder pump system shown in FIG. 1 of the drawings, greatly reduces the transient starting load on the grinder pump unit during initial start-up for each operating pump-out period.

While a preferred embodiment has been shown and described in detail for purposes of illustration, further embodiments, variations and modifications are contemplated with the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. An anti-siphoning pumping system for liquids comprising a receiving tank having an inlet and an outlet, pump means having a suction inlet below the liquid level in said tank for tanking suction on the contents of the tank and discharging the same under increased pressure from an outlet, a discharge passage connected to the outlet from said pump means for discharging liquid from said tank under pressure through said tank outlet, first check valve means coupled to said discharge passage permitting fluid flow only in the direction from said pump outlet to said tank outlet and to prevent backflow of pressurized liquid, conduit means connected at one end to said discharge passage between said first check valve means and said pump outlet, said conduit means being freely open at its other end to a source of venting gas, and second differentially operable check valve means within said conduit means for passing gaseous fluids through said conduit means in either direction and for preventing the passage of liquid from said one end to said open end of said conduit means.

2. An anti-siphoning pumping system according to claim 1 further including level control means for actuating the pump means upon the liquid within the tank reaching a predetermined maximum level, and wherein the pump means has its suction inlet substantially below the maximum level, the open end of said conduit means opens directly into the receiving tank at a level substantially above said predetermined maximum level, and the receiving tank is vented to atmosphere.

3. An anti-siphoning pumping system according to claim 2 wherein the system comprises a sewage pump grinder for grinding and discharging under pressure raw sewage collected in the receiving tank, a sewage grinder macerator mounted within the pump suction inlet to grind sewage before it passes through the pump means, the pump means comprises a positive helical screw-type pump employing a flexible boot with an internal helical surface in cooperative working engagement with a rigid shaft having an external helical surface, but of a different pitch, the discharge from said helical screw-type pump being directly connected to said discharge passage, the inlet to said pump means being mounted below said maximum predetermined level and said maximum predetermined level being below the open end of said conduit means; said conduit means and said second differentially operable check valve means constituting pump priming means for relieving build-up gaseous fluids and allowing liquid sewage to rise through the suction inlet into the flexible boot of the pump means as the liquid sewage within said tank rises to said predetermined maximum level that actuates the pump means.

4. An anti-siphoning pumping system according to claim 3 wherein said conduit means and said second differentially operable check valve means comprise anti-siphon means for preventing the removal of the pump liquid prime and liquid from said tank below the level of the point of connection of the conduit means to the discharge passage upon vacuum being produced in said discharge line due to siphoning whereupon said anti-siphon means allows removal of the liquid sewage in said discharge line down to the point of connection of said conduit means and thereafter provides passage of venting air through said conduit means open end and through said second differentially operable check valve means into said discharge line.

5. An anti-siphoning pumping system according to claim 4 wherein said discharge passage is permanently sealed with respect to the interior of said tank between said pump discharge head and said conduit means.

6. A sewage grinder pump for taking suction on a sewage collection tank that receives liquid sewage containing entrained solids from a sewage generating site, said sewage grinder pump having a discharge passage and a suction inlet and being adapted to be mounted within a collection tank for taking suction on the contents of the tank and discharging ground liquid slurry sewage under pressure from the discharge passage to a pressurized sewage main, first check valve means coupled to said discharge passage for permitting ground liquid slurry flow only in one direction from said discharge passage to the pressurized sewage main and to prevent backflow of pressurized liquid slurry sewage, and second differentially operable check valve means coupled to a source of venting gas and to said discharge passage at a point intermediate the first check valve means and the grinder pump for passing gaseous fluids in either direction through said discharge passage to or from said grinder pump preventing flow of liquid there-through in a direction from said discharge passage to said source of venting gas and allowing liquid sewage collected in the tank to rise within the grinder pump for self-priming said grinder pump, reducing transient loads on the grinder pump during start-up and anti-siphon protection.

7. A sewage grinder pump according to claim 6 further including sewage level control means for sensing the liquid sewage level and actuating the grinder pump upon the sewage level in a collection tank reaching a predetermined maximum level, and wherein the grinder pump is adapted to have its suction inlet substantially below the predetermined maximum liquid level of a collection tank upon being mounted therein, and the second differentially operable check valve means opens directly into a collection tank in which the grinder pump is mounted at a level substantially above the predetermined maximum level.

8. A sewage grinder pump according to claim 7 wherein said grinder pump comprises a positive helical screw-type pump employing a flexible boot with an internal helical surface in cooperative working engagement with a rigid shaft having an external helical surface, but of a different pitch, the discharge from said helical screw-type pump being directly connected to said discharge passage, the grinder pump being mounted in a collection tank below the maximum predetermined level and the maximum predetermined level being below the open end of the conduit means; the conduit means and the second differentially operable check valve means constituting pump priming means for relieving build-up of gaseous fluids and allowing liquid sewage to rise through the suction inlet into the flexible boot of the grinder pump as the liquid sewage within a collection tank rises to a predetermined maximum level that actuates the grinder pump.

9. A sewage grinder pump according to claim 8 wherein the conduit means and the second differentially operable check valve means also comprise anti-siphon means for preventing the removal of the pump liquid prime and liquid from a collection tank below the level of the point of connection of the conduit means to the discharge passage upon a vacuum being

produced in the discharge passage due to siphoning whereupon said anti-siphon means allows removal of the liquid sewage in said discharge passage down to the point of connection of the conduit means and thereafter provides passage of venting air through the conduit means open end and through the second differentially operable check valve means into the discharge passage.

10. A low pressure sewage grinder pump system including in combination a collection tank, grinder means having its inlet taking suction on the liquid sewage contents of the tank and discharging ground liquid slurry sewage from an outlet, positive displacement pump means having an inlet connected to the outlet from said grinder means and providing a discharge flow of ground liquid slurry sewage under pressure from its outlet irrespective of the pressure head into which the discharge is directed, a discharge passage connected to the outlet from said pump means for discharging ground liquid slurry sewage from said tank under pressure, first check valve means within said discharge passage permitting liquid sewage flow only in the direction from the outlet of said pump means to the receiving point and preventing backflow of pressurized liquid sewage, first conduit means connected at one end to said discharge passage and freely open at its other end to a source of venting gas, second differentially operable anti-siphon check valve means within said first conduit means for passing gaseous fluids through said conduit means in either direction and for preventing the passage of liquid sewage from said one end to said open end of said first conduit means.

11. A low pressure sewage grinder pump system according to claim 10 wherein said positive displacement pump means comprises a positive helical screw-type pump employing a flexible boot with an internal helical surface in cooperative working engagement with a rigid shaft having an external helical surface, but of a different pitch, the discharge from said helical screw-type pump being directly connected to said discharge passage, said first conduit means and said second differentially operable check valve means comprising pump priming means for relieving build-up of gaseous fluids in the pump means and allowing liquid sewage to rise through the suction inlet into the flexible boot of the pump means as liquid sewage accumulates within the collection tank to some predetermined maximum level and actuates the pump means.

12. A low pressure sewage grinder pump system according to claim 11 wherein said first conduit means and said second differentially operable check valve means also comprise anti-siphon means for preventing the removal of the pump liquid prime and liquid from said collection tank below the level of the point of connection of the first conduit means to the discharge passage upon a vacuum being produced in said discharge line due to siphoning, said anti-siphoning means allowing removal of liquid sewage in said discharge line down to the point of connection of said first conduit means and thereafter providing passage of venting gas through said first conduit means open end and through said differentially operable check valve means into said discharge line.

13. A low pressure sewage grinder pump system according to claim 12 wherein said discharge passage is permanently sealed with respect to the interior of said collection tank between said outlet from said pump and

said first conduit means, the interior of said collection tank is vented to the atmosphere, said first conduit means is sealed and uninterrupted between its one end connected to the discharge passage and its open end save for the second differentially operable check valve means and the open end of said first conduit means opens directly into said collection tank at a level substantially above the maximum predetermined level of sewage collected in the tank.

14. A low pressure sewage grinder pump including in combination grinder pump means designed for mounting within the interior of a sewage collection tank and having an inlet taking suction on the liquid sewage contents of the tank and discharging ground liquid slurry sewage from an outlet; said grinder pump means including positive displacement pump means having its inlet connected to the outlet from the grinder means and providing a discharge flow of ground liquid slurry sewage under pressure from its outlet irrespective of the pressure head into which the discharge is directed, a discharge passage connected to the outlet from said pump means for discharging ground liquid slurry sewage from said tank under pressure; first check valve means within said discharge passage permitting liquid sewage flow only in the direction from the outlet of said pump means and preventing backflow of pressurized liquid sewage; first conduit means connected at one end to said discharge passage and freely open at its other end to a source of venting gas; and second differentially operable anti-siphon check valve means within said first conduit means for passing gaseous fluids through said conduit means in either direction and for preventing the passage of liquid sewage from said one end to said open end of said first conduit means.

15. A low pressure sewage grinder pump according to claim 14 wherein said positive displacement pump means comprises a positive helical screw-type pump employing a flexible boot with an internal helical surface in cooperative working engagement with a rigid shaft having an external helical surface, but of a differ-

ent pitch, the discharge from said helical screw-type pump being directly connected to said discharge passage, said first conduit means comprising pump priming means for relieving build-up of gaseous fluids in the pump means and allowing liquid sewage to rise through the suction inlet into the flexible boot of the pump means as liquid sewage accumulates within a collection tank in which the grinder pump is mounted to some predetermined maximum level.

16. A low pressure sewage grinder pump according to claim 15 wherein said first conduit means and said second differentially operable check valve means also comprise anti-siphon means for preventing the removal of the pump liquid prime and liquid from a collection tank in which the grinder pump is mounted below the level of the point of connection of the first conduit means to the discharge passage upon a vacuum being produced in said discharge line due to siphoning, said anti-siphoning means allowing removal of liquid sewage in said discharge line down to the point of connection of said first conduit means and thereafter providing passage of venting gas through said first conduit means open end and through said differentially operable check valve means into said discharge line.

17. A low pressure sewage grinder pump according to claim 16 wherein the collection tank in which the grinder pump is designed to be mounted is vented to atmosphere, the discharge passage is permanently sealed with respect to the interior of the collection tank in which the grinder pump is mounted between the outlet from said pump and said first conduit means, said first conduit means is sealed and uninterrupted between its one end connected to the discharge passage and its open end save for the second differentially operable check valve means and the open end of the first conduit means is designed to open directly into the collection tank in which the grinder pump is mounted at a level substantially above the maximum predetermined level of sewage collected in the tank.

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