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SLUDGE HANDLING METHOD AND APPARATUS

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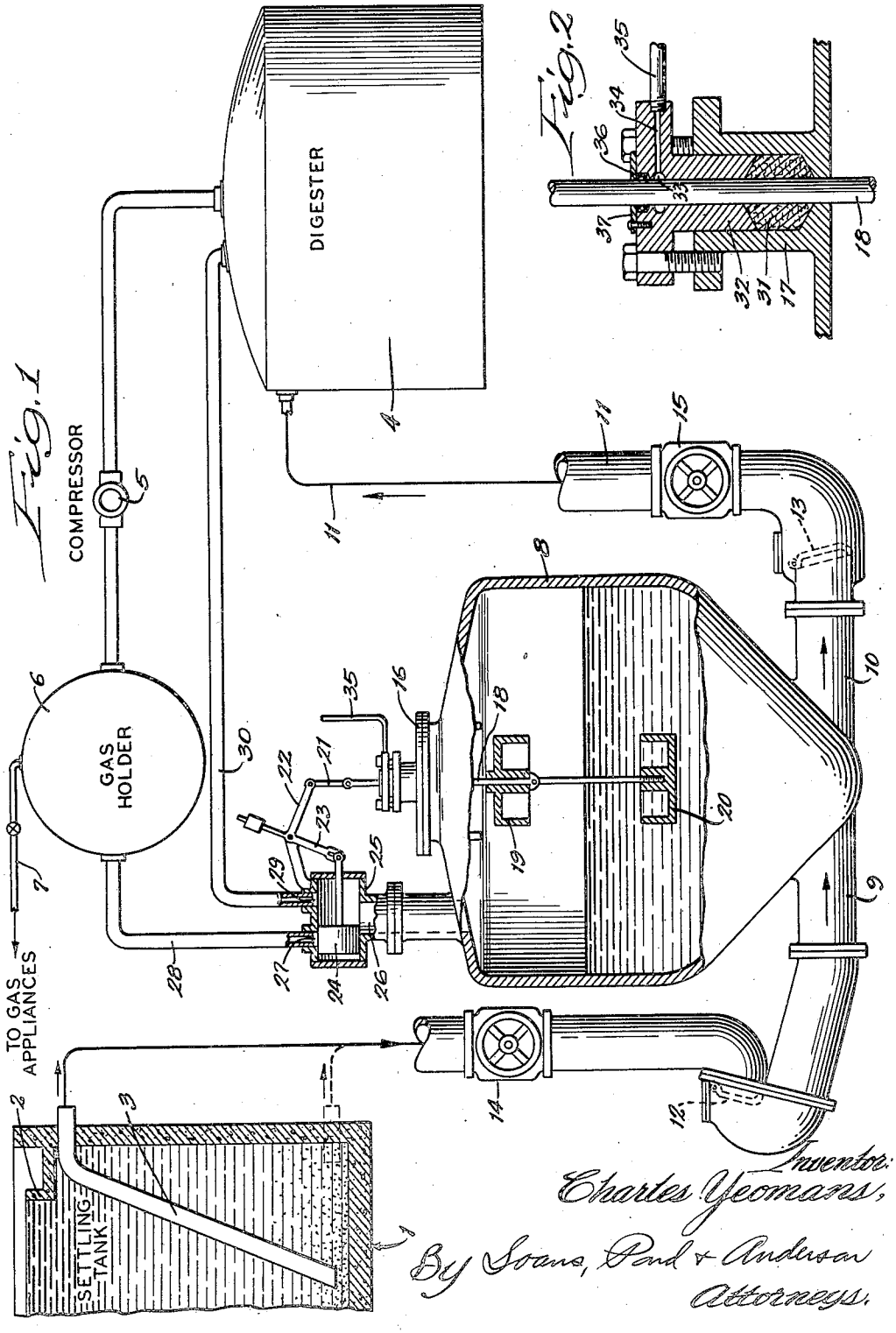


Fig. 1

Fig. 2

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SLUDGE HANDLING METHOD AND APPARATUS

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6 Claims. (Cl. 210—2)

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This invention relates to an improvement in apparatus for pumping sludge from a sewage settling tank to a digester, in which the sludge is decomposed to form a combustible gas which is stored under pressure and delivered to various gas burning appliances.

One of the difficult problems in moving sludge from the bottom of a settling tank to a digester, is that of maintaining a pump in efficient operating condition. Reciprocating pumps have generally been used for the purpose of transferring the sludge from the settling tank to the digester, and these pumps require frequent cleaning and reseating of valves in order that they may operate efficiently. This is, of course, due to the character of material handled. Such cleaning is not only an expensive, time-consuming operation, but it is also objectionable because it subjects the workmen who do the cleaning to the dangers of serious infection and illness or asphyxiation due to back flow of gas from the digester. There is also the danger of producing an explosive mixture of gas and air incident to the escape of some of the gas. Again, continuity of operation requires the costly provision of alternate pumping equipment, each unit of which may be placed in operation when the other is taken down for cleaning and adjustment.

It has heretofore been proposed to employ pneumatic, or gas displacement type, ejectors for this purpose but their use has not met with general acceptance because of some possibility that air from the pneumatic ejecting equipment will become mixed with the gas produced in the digester to form a highly explosive gas mixture.

The main object of the present invention is to provide an arrangement whereby an ejector similar to a pneumatic ejector, may be employed for moving sludge from a settling tank to a digester without incurring any risk of producing an explosive mixture of air and gas.

Another object of the invention is to provide ejector equipment of the character indicated, which may be employed without incurring any danger from the escape of gas produced in the digester, which gas is highly poisonous. Still another object of the invention is to provide a sludge moving system which will be automatically operative for an extended, if not indefinite, period of time without maintenance or other servicing, and which will for these and other reasons be exceptionally low in cost of maintenance and operation.

Other objects and advantages of the invention will be understood by reference to the following

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specification and accompanying drawing wherein there is diagrammatically illustrated the improved method and apparatus.

In the drawing,

Fig. 1 is a diagrammatic illustration of the system and apparatus, and

Fig. 2 is an enlarged detail sectional view.

In connection with most sewage treatment plants, there is provided a settling tank or basin 1 which is equipped near its top with a peripheral trough forming weir 2. The heavy solid particles of sewage delivered into the basin settle to the bottom of the basin while the supernatant liquid flows over the upper edge of the weir 2 into the trough from which it is in turn conducted to other clarifying treatments or to a point of disposal.

Sludge is drawn from the bottom portion of the tank by an outlet pipe 3 which preferably extends from near the bottom of the settling basin to near the top thereof as shown, the outlet portion of the pipe 3 being, in conventional practice, connected to the suction side of a pump which discharges the sludge through a suitable pipeline into a digester 4. In the digester, the sludge is decomposed and a combustible gas (methane) is formed which is drawn off by a compressor 5 which delivers the gas under suitable pressure, for example, 30 pounds per square inch, to a suitable gas holder 6. From the gas holder 6, the gas is conducted through a pipeline 7 to various appliances wherein the gas is used.

According to the present invention, the sludge is conducted from the settling tank 1 into a receiver 8. The sludge enters the receiver through the inlet pipe 9 communicating with the bottom of the receiver and it is discharged from the receiver through a discharge pipe 10 which communicates through a pipeline 11 with the digester 4. Suitable check valves indicated at 12 and 13 are provided in the intake and discharge pipelines of the receiver 8 to prevent reverse flow of the sludge. Also, suitable valves, such as indicated at 14 and 15 respectively, are provided in said pipelines for permitting closing thereof.

The receiver 8 has a top opening closed by a cover 16 which is equipped with a suitable stuffing box 17 through which there is slidably mounted a shaft or rod 18. The lower end of the rod 18 has connected to it downwardly and upwardly facing bells 19 and 20 respectively, the same being spaced about as shown in the drawing, and so arranged that the weight of liquid

in the lower bell will always tend to move the rod downwardly into the receiver while air trapped in the downwardly facing bell 19 when the sludge level reaches the lower edge of the bell, will operate to lift the bell and move the rod 18 upwardly through said stuffing box.

The upper end of the rod 18 is connected by means of a link 21 to the arm 22 of a bell crank lever, the other arm 23 of which is connected to the piston 24 of a 3-way valve 25. The valve 25 has one port 26 in communication with the interior of the receiver 8, another port 27 connected by means of a pipeline 28 to the gas holder 6, and another port 29 connected by means of a pipeline 30 to the digester 4.

When the sewage level in the receiver reaches a predetermined high point, the piston 24 of the valve 25 will be moved from the position shown to the right hand side of the valve so as to establish communication between the valve ports 27 and 26 and to close communication between the valve ports 26 and 29. When the valve is shifted to that position, gas under pressure from the gas holder 6 will flow through the pipeline 28, through the valve 25 and into the upper portion of the receiver 8. Said gas being under pressure as aforesaid, will force the sludge downwardly in the receiver and out through the discharge pipe 10 and through the pipeline 11 into the digester. When the sludge level is lowered sufficiently, the weight of liquid in the bell 20 will restore the valve plunger 24 to the position shown, wherein communication between the valve ports 26 and 27 is closed and communication between the valve ports 26 and 29 established. The gas trapped under pressure in the pump part of the receiver 8 will then be permitted to escape through the valve and the pipeline 30 into the digester. The gas accumulated in the digester 4 will generally be under a slight pressure (about 8 inches of water) but that pressure may readily be overcome by so arranging the receiver relative to the settling tank that there is a counteracting or equivalent sludge column in the pipeline leading from the settling tank to the receiver. Hence, the gas pressure in the digester need not interfere with the free exhaust of gas from the receiver to the digester when the valve is adjusted to the position shown in the drawing. Accordingly the operation of filling a receiver and discharging it will be repeated from time to time, the operation being completely automatic and requiring no attention.

By employing the pressure gas from the gas holder for ejecting sludge from the receiver, there is of course no danger of creating an explosive air and gas mixture. Also, the arrangement involves no loss of gas since all of the gas used for expelling the sludge from the receiver 8 is retained in the system by being returned to the digester from which it again flows through the compressor into the gas holder.

It is desirable that the rod 18 be vertically movable without excessive binding by the stuffing box which must be provided to prevent leakage of gas from the receiver around the rod 18.

To prevent the escape of gas without necessitating excessive tightening of the packing 31 around the rod 18, the stuffing box arrangement shown in Fig. 2 is provided. As there shown, the packing gland 32 is provided with a groove or chamber 33 around the rod 18 and near the upper end of the gland. Said chamber 33 communicates through a port 34 with a relief pipe 35, which is preferably vented to the atmosphere where it will offer no danger to life. The small quantity of leakage gas vented to the atmosphere would be negligible so far as health and safety factors are concerned.

Above the chamber 33, the gland is provided with an auxiliary packing filled recess 36, which is closed by a pressure plate 37. The auxiliary packing in the recess 36 will, of course, be sufficiently tight around the rod 18 to prevent the passage of any gas from the chamber 33 upwardly around the rod. The amount of packing in the chamber 33 will be small as compared with the amount of the packing 31 so that said auxiliary packing will not afford any objectionable grip on the rod 18 to interfere with its vertical movement.

Means other than the described vertically movable bell arrangement may be employed for controlling the admission and relief of gas to and from the receiver. Such other means are well known in the art. The described arrangement is intended only to represent a typical control means and it may be replaced by any of the well known alternatives which serve or are adaptable to the same purpose. Also, sewage and materials other than sludge may be moved by the described apparatus, and the term, "sludge" is used in the following claims merely to refer to the material moved rather than to limit the scope of the invention to the moving of that particular material.

I claim:

1. In a treating system of the class described wherein material is delivered to a digester, in which a combustible gas is formed, and wherein such gas is compressed by a compressor and delivered to a gas holder for delivery to gas using appliances, the method of moving material into the digester which consists in delivering the material to be moved to the receiver of a gas displacement ejector, admitting compressed gas from the gas holder to said ejector receiver to effect movement of material from the ejector into the digester, and finally venting the ejector by returning the gas supplied thereto to said digester without substantial loss and without substantial dilution thereof.

2. In a sewage treating system wherein sludge is settled out in a settling tank and delivered to a digester, in which a combustible gas is formed, and wherein such gas is compressed by a compressor and delivered to a gas holder for delivery to gas using appliances, the method of moving sludge from the settling tank to the digester which consists in delivering the sludge to be moved to the receiver of a gas displacement ejector by gravity flow from the settling tank to the receiver, admitting gas under pressure from said gas holder to said receiver to effect movement of sludge from the receiver into the digester, and finally venting the ejector receiver by returning the gas supplied thereto to said digester without substantial loss and without substantial dilution thereof.

3. In a sewage treating system wherein sludge is settled out in a settling tank and delivered to a digester in which a combustible gas is formed, and wherein such gas is compressed by a compressor and delivered to a gas holder, the method of moving sludge from the settling tank to the digester which consists in delivering the sludge to be moved to the receiver of a gas displacement ejector having inlet and outlet openings, which openings are respectively connected to the settling tank and to the digester, admitting gas under pressure from said gas holder to said receiver when sludge has filled said receiver to a predetermined level, said gas under pressure serving

to effect movement of the sludge from the receiver through said outlet opening and into the digester, and finally venting the ejector receiver, by returning the gas supplied thereto to said digester without substantial loss and without substantial dilution thereof, when the level of sludge in the receiver reaches a predetermined low level, thereby to permit sludge to again flow into the receiver.

4. In apparatus of the class described, a digester, means for collecting and holding under pressure the gas produced in said digester, said means including a gas holder, piping, and a compressor which is connected to said gas holder and to said digester by said piping and which is operable to withdraw gas from said digester and to deliver said gas under pressure to said gas holder, a gas displacement ejector which includes a receiver having inlet and outlet connections, means operable to cause the material to be moved by said ejector to flow into said receiver through said inlet connection, piping connecting said outlet connection with said digester, valve means for preventing reverse flow through the inlet and outlet connections to said receiver, a three-way, ejector-control valve, piping connecting one port of said three-way valve to said digester, another port to said gas holder, and the third port to said receiver, means responsive to the level of the material in said receiver for actuating said three-way valve to effect the flow of gas under pressure from said holder to said receiver when the level of the material in the receiver reaches a predetermined level, thereby to effect movement of material from said receiver to said digester, said level responsive means being also operative to actuate said three-way valve when the level of the material in said receiver reaches a predetermined lower level to vent said ejector and to effect the return of the pressure gas supplied from said holder to said digester without substantial loss and without substantial dilution thereof.

5. In apparatus of the class described, the combination of a settling tank, a digester, means for collecting and for holding under pressure the gas produced in said digester, said means including a gas holder, piping, and a compressor which is connected to said gas holder and to said digester by said piping and which is operable to deliver said gas under pressure to said gas holder, a gas displacement ejector which includes a receiver, a pipeline connecting said settling tank with said receiver, means operable to cause material which settles out in said settling tank to flow through said pipeline into said receiver, a second pipeline connecting said receiver with said digester for the transmission of material from said receiver to said digester, valve means for preventing reverse flow in said pipelines, a three-way valve having one port connected to said digester, another port connected to said gas holder, and the third port connected to said receiver, means responsive to the level of material in said receiver for actuating said three-way valve so as to cause gas under pressure to flow from said gas holder into said receiver when the level of the material in said receiver reaches a predetermined level, said level responsive means being also operative to actuate said valve to establish communication between the upper portion of said receiver and said digester when the level of the material in said receiver reaches a predetermined lower level, thereby venting said receiver and causing the pressure gas so vented to be returned to said digester.

6. Apparatus according to claim 5 wherein said level responsive, valve actuating means comprises a rod movable inwardly and outwardly through a portion of said receiver, a stuffing box disposed around said rod for preventing the escape of gas around said rod from said receiver, said stuffing box including a gland having an annular recess surrounding said rod and a port, extending from said annular recess, for venting the gas collected in said recess, and an auxiliary stuffing box in said gland above said recess.

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