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Amren

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[54] **METHOD AND APPARATUS FOR CONVEYING LIQUID THROUGH A LONG CONDUIT**

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[52] **U.S. Cl.** **137/1,** 4/1, 137/205

[51] **Int. Cl.** **C02c 1/00**

[58] **Field of Search** 137/173, 174, 205, 1; 4/1, 77

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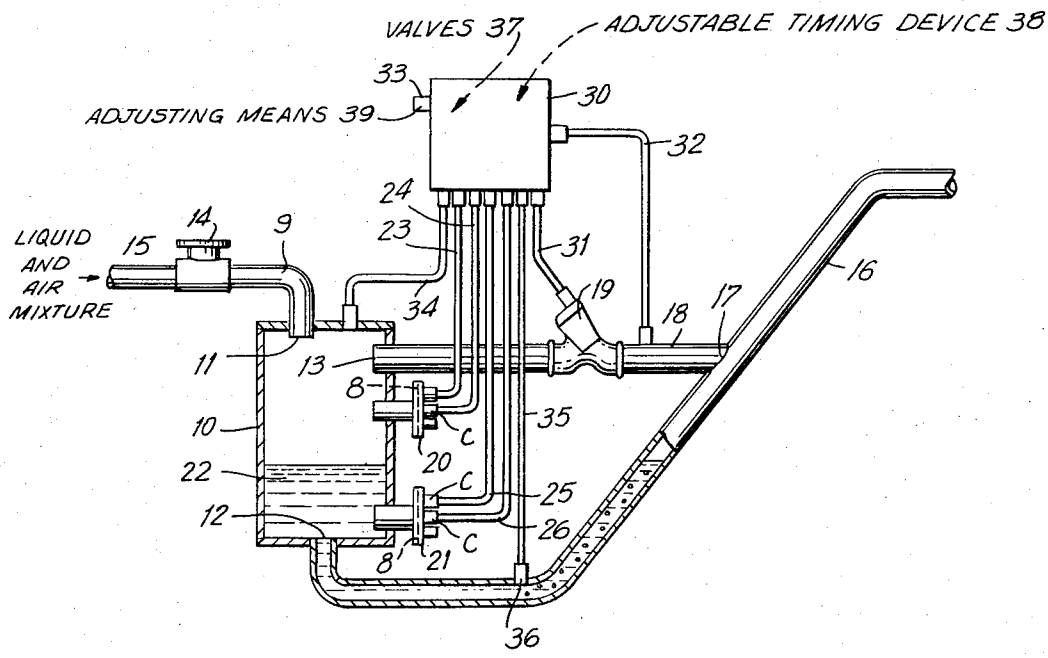
Assistant Examiner—Gerald A. Michalsky

[57] **ABSTRACT**

An arrangement and method for conveying liquid by vacuum, such as sewage, through long conduits without intermediate stations having vacuum generating means. The arrangement results in an efficient liquid transport in conduits of considerable length and also in installations where there is a considerable difference in height of parts of the liquid flow path.

7 Claims, 2 Drawing Figures



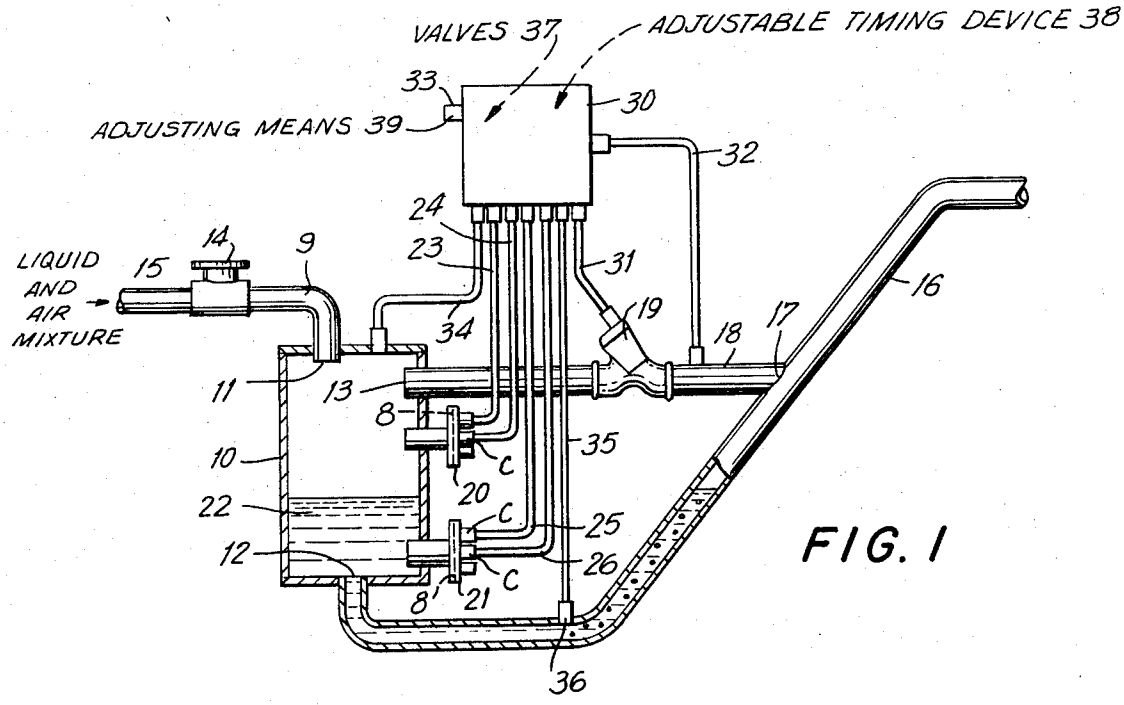

VALVES 37
ADJUSTABLE TIMING DEVICE 38
ADJUSTING MEANS 39
LIQUID AND AIR MIXTURE
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FIG. 1

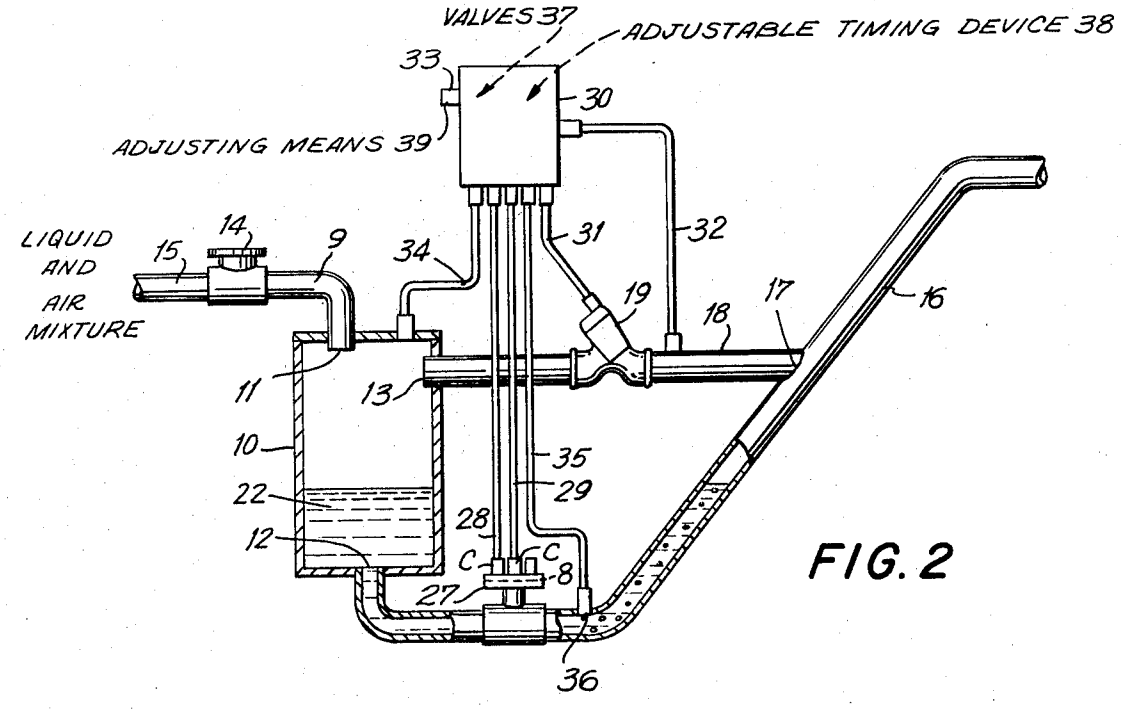
VALVES 37
ADJUSTABLE TIMING DEVICE 38
ADJUSTING MEANS 39
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FIG. 2

METHOD AND APPARATUS FOR CONVEYING LIQUID THROUGH A LONG CONDUIT

BACKGROUND OF THE INVENTION

It is known that when liquid, for example, sewage, is conveyed through a long conduit which may have upwardly sloping sections, it is desirable that the liquid movement is brought about by a vacuum. Thus, the conduit does not have to be provided with continual general downgrade, but can more or less follow the contour of the ground. However, if there are large variations in the level of the ground, difficulties may arise since the vacuum available must be sufficient to raise the liquid to a level corresponding to the total difference in height between certain portions of the conduit. Nevertheless, the avialable vacuum in an arrangement for conveying liquid can be used to lift liquid considerably higher if the liquid is mixed with air. Thus, a liquid column in a riser will have a lower specific weight and may be considered as equivalent to a considerably shorter liquid column.

The mixing of air with the liquid to be transferred from one place to another has the advantage of causing the improved acceleration of the liquid when its transport is commenced. Moreover, the large forces which are present when a liquid column in a long conduit is stopped are considerably reduced by mixing the air with the liquid.

In spite of the intermixing of air with the liquid to be transported, this alone was not sufficient to effectively convey the liquid, because of large differences in height of sections of the vacuum conduit. Prior to the present invention, it was not possible to use transport conduits of considerable length without costly intermediate way stations along the long conduit which are equipped with vacuum generating means.

The present invention relates to an apparatus and method for effectively conveying liquid by vacuum through long conduits.

An object of the present invention is to provide an arrangement for conveying liquid by vacuum through long conduits and without employing expensive intermediate stations for increasing the vacuum supply to the system. Instead of utilizing the aforesaid expensive intermediate stations, a simple and inexpensive means is provided at a selected location or locations along the vacuum conduit which makes it possible for an effective conveyance of the liquid even when there is a great difference in height of various sections of the long conduit.

It is another object of the present invention to provide a construction having a liquid collecting receptacle provided with an inlet to which the input of the vacuum pipe is connected. The receptacle has a first outlet to which the output of the vacuum pipe is connected and a second outlet opening to which is connected an air conducting conduit having a valve that is open in the idle position. The air conducting conduit is connected to the output of the vacuum pipe.

A further object of the present invention is to provide a method and apparatus for conveying liquid by vacuum in which only a small portion of the liquid conveyed is present in the vacuum pipe while air is in the pipe at all times and assists in the efficient transport of liquid through the long conduit. The liquid collected in the receptacle may be again mixed with air during the continual passage through the vacuum pipe.

An object of the present invention is to selectively introduce atmospheric air into the apparatus in order to create a pressure difference in the system to thereby effect a continual transport of the collected liquid through the long conduit.

Another object of the present invention is to provide more than one level sensing means in the collecting receptacle to operate a vacuum controlled valve connected through a vacuum conduit to a control device.

Still another object of the present invention is to provide an adjustable timing device in the control device by which can be determined the time during which the normally open valve is closed and the collected liquid continues to be transported in the long conduit.

The invention will now be more fully described with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic view of the apparatus and method for effectively conveying liquid by vacuum through long conduits in accordance with the teachings of my invention; and

FIG. 2 is a diagrammatic view of an alternate embodiment of the invention disclosed in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As seen in FIGS. 1 and 2, a collecting receptacle **10** is shown which is provided with an inlet pipe **9** having an inlet opening **11** as well as an outlet opening **12** in the bottom of the receptacle. Another outlet opening **13** is located in the side of the receptacle **10** rather close to the top thereof. The input portion of the vacuum conduit bears the reference numeral **15** and is connected to the inlet pipe **9** by means of a check valve **14.** The outlet portion of the vacuum conduit bears the reference numeral **16** and is connected to the outlet opening **12** in the bottom of the receptacle. A shunt conduit **18** is connected between the outlet opening **13** and the outlet portion **16** of the vacuum conduit at the location **17.** A vacuum controlled valve **19** which is open when in the idle position is coupled to the shunt conduit **18.**

Referring particularly to FIG. **1,** the receptacle **10** is shown having two level sensing means **20** and **21.** Both of these level sensing means are provided with connection elements C which can be made operative or inoperative by the action of a pressure sensing device such as a diaphragm **8.** The level sensing means **20** and **21** are dependent upon the level of the liquid **22** in the receptacle **10** and each is arranged to open and close connection elements C between the vacuum conduits **23,24** and **25,26,** respectively. In a corresponding manner, the level sensing means **27,** illustrated in FIG. **2,** is coupled to the outlet portion **16** of the vacuum conduit to open or close the connection elements C between the vacuum conduits **28** and **29.**

As seen in FIG. **1,** a control device **30** is shown which is connected to the level sensing means **20** and **21** through the vacuum conduits **23,24,25,** and **26** respectively. In FIG. **2,** the control device **30** is shown connected to the level sensing means **27** through vacuum conduits **28** and **19.** Another vacuum conduit **31** connects the vacuum controlled valve **19** to the control device **30.**

It should be noted that the vacuum conduit **16** has continuous sub-atmospheric pressure prevailing therein, that forms a vacuum which is transferred to the control device **30** by the conduit **32.** A nipple **33** is connected to the control device for the admission of atmospheric air thereto. This atmospheric air can be further conducted by the control device **30** to the receptacle **10** by means of the air conduit **34,** and to the outlet portion **16** of the vacuum conduit by means of another air conduit **35.**

The control device **30** is provided with valves **37** that interconnect the conduits and the control valves **19.** The valves **37** can be controlled by the vacuum prevailing in the conduit **16** and by an adjustable timing device **38** which is also positioned within control device **30.** Furthermore, the control device is provided with an adjustable means **39** for selectively varying the quantity of air mixed with the liquid.

The apparatus disclosed herein operates as follows: a mixture of air and liquid flows through the input portion **15** of the vacuum conduit and the check valve **14** to the receptacle **10.** The latter is located in the system immediately ahead of the riser section of the outlet portion **16** of the vacuum conduit. The liquid is separated and collected in the receptacle **10** while the air passes through the outlet **13** and the shunt conduit **18.** The latter serves as an air conduit to an upper part of the outlet portion **16** of the vacuum conduit. The valve **19** is open because vacuum is supplied to it from the vacuum conduit **16** through the conduit **32,** the control device **30,** and the conduit **31.** The level of the liquid **22** collected in the receptacle **10** is sensed by the level sensing means **20** and **21,** and when the liquid level has reached the level sensing means **20** or is slightly above it, the control device **30** is acted upon through the conduits **23** and **24** to close the valve **19.** This result can be achieved, for example, in such a manner that air of atmospheric pressure passes through the nipple **33** to an operating member of the valve **19.** Simultaneously, the control device **30** transfers air of atmospheric pressure to the upper part of the receptacle **10** through the conduit **34.** Since the outlet portion **16** is under vacuum, the pressure difference prevailing on either side of the liquid **22** in the receptacle **10** will generate a considerable force to raise the liquid upward in the upward sloping outlet portion **16** of the vacuum conduit.

Thus, in order to ensure the transport of the liquid when there is a large height difference and to improve the subsequent transport through the vacuum conduit, the liquid being conveyed is again mixed with air. This is brought about by the control device **30** which supplies air to the location **36** in the outlet portion **16** of the vacuum conduit. The control means **30** is provided with adjusting means **39** that facilitates the variation of the quantity of air to be mixed with the liquid. In this regard, it should be noted that if the differences in height are great, more air is mixed with the liquid than if there are small differences in height. If several arrangements constructed in accordance with the teachings of the present invention are located at spaced locations along a long vacuum conduit, it will thus be possible to adjust each arrangement individually to provide the most favorable transport of liquid in the conduit. The intermixing of a large quantity of air in the liquid mesns that the quantity of liquid which on one occasion is to be lifted to a higher level can be proportioned so as to be small enough to be well below the length of the largest solid liquid column that the available vacuum is capable of conveying.

When the level of the liquid **22** in the collecting receptacle **10** has decreased, the level sensing means **20** is no longer acted upon. However, the valve **19** is maintained in a closed condition because the level sensing means **21** is still being acted upon by the liquid **22.** However, when the level of the liquid **22** in the receptacle **10** drops below the level sensing means **21,** the timing device **38** is switched on which maintains the valve **19** in a closed condition during an easily adjustable period so that the receptacle **10** and the upwardly rising outlet portion of the vacuum conduit is emptied of liquid. Accordingly, the instant construction and arrangement ensures that the impurities present in the receptacle **10** are removed. If it is not necessary to completely empty the receptacle **10,** the control device **30** can be set, of course, to open the valve **19** immediately after the liquid level **22** rises and has passed the level sensing means **21.**

The check valve **14** functions to prevent air of atmospheric pressure from passing into the inlet portion **15** of the vacuum conduit. However, when valve **19** again opens, the liquid is continued as before through the check valve **14** to the receptacle **10.** The intermixed air passes through the shunt conduit **18** to the outlet portion **16** of the vacuum conduit. A small quantity of liquid may follow the transported air through the shunt conduit **18,** but this liquid will settle on the walls in the upwardly rising outlet portion **16** and will consequently flow back to the receptacle **10.**

Referring to FIG. **2,** it will be noted that the construction shown therein functions in the same manner as the arrangement shown in FIG. **1** with the exception that only one level sensing means **27** is used. The level sensing means **27** can be set to act on the control device **30** when a predetermined level of liquid **22** has been reached in the receptacle **10.** Moreover, the timing device **38** can be arranged to keep the valve **19** closed for a period of time that is necessary to empty the receptacle **10.** The level sensing means **27** may be adjusted so as to act again on the control device **30** when the level of the liquid has been depressed below the means **27.** As seen in FIG. **2,** the location of the means **27** ensures that the receptacle **10** can be completely emptied.

The control device **30** having valves **37** and an adjustable timing device **38** as well as the valve **19** and the level sensing means **20, 21,** and **27** are operated by a vacuum. The vacuum source of supply is the vacuum present in the portion **16** of the vacuum conduit. In this arrangement, there is no dependence on a supply source outside of the present conveying system. Accordingly, the arrangement is self-sustaining. Furthermore, the present arrangement can be connected anywhere along a long vacuum conduit and also at locations which are difficult to reach. In addition, the present arrangement can be modified to operate electrically.

The apparatus and method herein described results in an effective but economical conveyance of liquid, such as sewage, through long conduits which may have height differences.

What I claim:

1. In an apparatus for conducting liquid from a collecting receptacle to a long conduit and including a source of vacuum comprising: a liquid collecting receptacle, means for supplying a mixture of air and liquid

to said receptacle, said conduit having an inlet portion connected to the bottom of said collecting receptacle and extending below the plane of said bottom, said conduit having an outlet portion provided with an upwardly sloping section through which the liquid flows by means of said vacuum, an air-conducting shunt pipe located above the inlet portion and connecting the upper part of said receptacle to said upwardly sloping section, the opposite ends of said shunt pipe being positioned at substantially the same level, said shunt pipe being provided with a valve, control means for said valve, said valve being open in the idle position of said apparatus thereby permitting the air to flow through the shunt pipe and collecting the liquid in the receptacle, and at least one liquid level sensing means in said receptacle to operate said control means for opening and closing said valve, said liquid in the collecting receptacle being mixed with air and conveyed through the conduit when the valve is in the closed position.

2. The apparatus as claimed in claim **1** wherein two liquid level sensing means are provided in the receptacle, one of said means being located in the bottom of the receptacle and the other means being positioned adjacent to the top thereof.

3. The apparatus as claimed in claim **1** further comprising means connecting the control means to the normally open valve and to the liquid level sensing means, said control means being provided with additional valve means to admit air to the receptacle and to the outlet portion of the long conduit when the normally open valve is closed under the action of the liquid level sensing means when a given liquid level has been reached in the receptacle.

4. The apparatus as claimed in claim **3** wherein said control means is provided with an adjustable timing device means for determining the time period during which the normally open valve is closed and the continued transport of the collected liquid in the long conduit.

5. A method for conducting liquid from a collecting receptacle and through a long conduit connected thereto having an upwardly sloping section, supplying a mixture of liquid and air to said collecting receptacle, separating the air from the liquid in the receptacle, passing the separated air through a shunt pipe connecting the upper portion of the receptacle to the upwardly sloping section of the long conduit, collecting the liquid in the receptacle, conveying the liquid through the conduit by closing a valve in the shunt pipe when the liquid has reached a predetermined level in the receptacle, and mixing air into the liquid while said liquid is being conveyed.

6. The method as claimed in claim **5** further supplying atmospheric air to the liquid to create a pressure difference in the system that effects a continued transport of the collected liquid through said conduit.

7. The method as claimed in claim **5** wherein said collecting receptacle where the air is separated from the liquid is immediately ahead of an upwardly sloping part of the conduit.

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