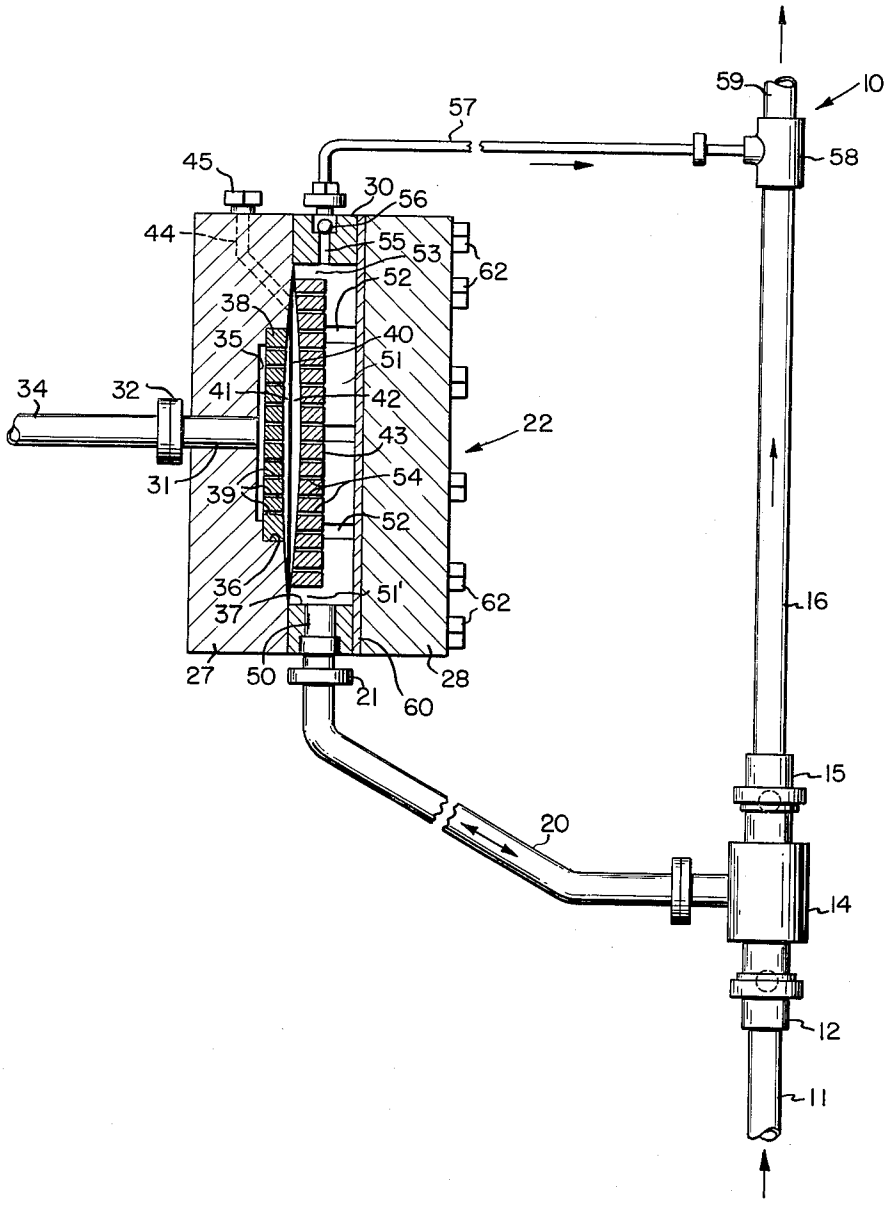
Nov. 9, 1965 L. F. WILSON ETAL 3,216,360

FLUID TRANSPORT DEVICE

Filed June 10, 1963



INVENTORS
LAWRENCE F. WILSON
AND VICTOR H. LEIPOLD

BY Cumpston & Shaw
ATTORNEYS

United States Patent Office 3,216,360 Patented Nov. 9, 1965

3,216,360

FLUID TRANSPORT DEVICE

Lawrence F. Wilson, Caledonia, and Victor H. Leipold, Le Roy, N.Y., assignors to Lapp Insulator Company, Inc., Le Roy, N.Y., a corporation of New York

Filed June 10, 1963, Ser. No. 286,803
1 Claim. (Cl. 103—44)

This invention relates to a fluid transport device. More particularly, the invention relates to a pumping device that is useful for effecting the transport of fluids that contain particulate solids suspended therein.

There are many applications, particularly in the oil refining industry, where it is necessary to transport particulate solid material, that is suspended in fluid, through a pipeline. In some cases, this has been accomplished by the injection of air or flue gas, under pressure, into a lower level of the pipeline, to carry the solid material upward. Ordinary pumps are not practical for use in transporting such suspensions, because of the destructive effects caused by the abrasive nature of the solid particles. When the solid particles are corrosive as well as abrasive, an even more difficult problem is presented to the engineer who wishes to transport the fluid efficiently, using a pump.

One object of the present invention is to provide an improved means for effecting transport through a pipeline of a fluid that contains particulate solids suspended therein.

Another object of this invention is to provide a fluid transport device, for positively effecting the movement of a fluid through a pipeline, that can operate effectively and efficiently with fluids that contain particulate solids in suspension therein, and particularly, that can operate effectively and efficiently over long periods of time even through the particulate solids are both abrasive and corrosive in nature.

A more specific object of the invention is to provide a pumping device for effecting the transport through a pipeline of a fluid that contains a substantial quantity of particulate solid material suspended therein, and that operates in a practical and efficient way that minimizes the contact between the moving parts of the pumping device and the particulate solids, to prolong the life of the pump.

Still another object of the invention is to provide a pumping device having the above advantages and capabilities and, as well, a practical and efficient type of construction that is capable of being manufactured and installed readily and that can operate in an accurate and reliable manner.

Other objects of the invention will be apparent hereinafter from the specification and from the recital of the appended claim. To these and other ends, the invention resides in certain improvements and combinations of parts, all as will hereinafter be more fully described, the novel features being pointed out in the claim at the end of this specification.

The single figure of drawing is a fragmentary schematic diagram, partly in section and partly in elevation, of a pumping device that is constructed in accordance with one preferred embodiment of this invention.

The preferred form of the invention, that is disclosed herein by way of illustration only, comprises a generally upright main line **10** that has a lower section **11**. A first ball check valve **12** is connected to the upper end of the pipe section **11**, and is disposed to permit fluid to move upwardly from the pipe section **11**, and to prevent fluid from moving downwardly into the pipe section **11**.

A T fitting **14** is mounted above the ball check valve **12**, and a second ball check valve **15** is mounted above the T and is also disposed to permit fluid movement in an upward direction only. An upper section **16** of the main pipe line is connected above the second, upper ball check valve **15**.

A line **20** is coupled to the side port of the T **14**. This line **20** is inclined upwardly and has a diameter of substantially the same order of magnitude as the diameter of the main line **10** and its several sections. For example, if the main line **10** has a diameter of 2", the diameter of the side or secondary line **20** preferably should also be 2" or larger. The line **20** is connected, at its opposite end, to an inlet fitting **21** of a diaphragm pump **22**.

The diaphragm pump **22** has a known type of construction, and comprises a pair of generally cylindrical plates **27** and **28** that are made of a corrosion-resistant material such as, for example, stainless steel. These plates are formed with a substantial thickness and thus are adapted to withstand high fluid pressures. A third plate **30** is interposed and secured between the two other plates **27** and **28**.

The plate **27** is formed with an internal transverse bore **31** that can be coupled through an external fitting **32** to a hydraulic fluid supply line **34**. The plate **27** is also formed, in its internal face, with a shallow circular bore **35** that communicates with the transverse bore **31** and with a counterbore **36**, that is concentric with and of slightly larger diameter than the bore **35**. A small insert plate **38** is seated in the counterbore **36**. This insert plate is formed with a plurality of transverse holes **39** that provide communication between the bore **35** and the opposite face of the plate **38**.

The plate **30** is formed with a circular recess **37** that confronts the plate **27** and its insert **38**. This recess is larger in diameter than the counterbore **36** in which the insert **38** is seated. An insert **43** is seated in this recess.

The confronting faces of the assembled plate **27** and of its insert plate **38**, and of the intercalary plate **30**, and its insert **43**, are formed over central areas thereof respectively with concave depressions that together provide a void space at their interface. A thin, flexible diaphragm **40** that is formed from a material such as, for example, stainless steel, rubber, or some insert synthetic plastic material, is securely fastened between the confronting faces of these plates, to form a liquid-tight seal between them. The diaphragm **40** divides the interface space into a first chamber **41**, intermediate the face of the diaphragm and the confronting faces of the plate **27** and its insert **38**, and a second chamber **42** intermediate the opposite face of the diaphragm and the confronting faces of the plate **30** and of its insert **43**. The holes **39** in the insert **38** are in communication with the chamber **41**.

The plate **27** is also formed at its upper end with an inclined passage **44** that communicates at its lower end with the chamber **41**, and that is coupled, at its upper end, with a bleed valve **45**.

The plate **30** is formed at its lower end with a port **50** in which the outlet fitting **21** is secured. The plate **30** is also formed with a generally upright channel or slot **51** that extends through approximately one-half of the thickness of the plate **30** and from adjacent its lower end to adjacent its upper end. At its lower and upper ends, the plate **30** is formed with transverse dogleg slots **51'** and **53** respectively, that provide communication between the chamber **42** and the upright slot **51**. The plate **30** is also formed with other generally upright slots (not shown), that also extend about half way through its thickness, and with a plurality of spaced horizontal slots **52**, that intersect and communicate with the upright slots, as shown, and that also extend about half way through the thickness of the plate.

The plate **30** is also formed with a plurality of transverse holes **54**, that provide communication between the chamber **42** and the slots **51** and **52** respectively. The

port 50, the slot 51, the other upright slots, and the horizontal slots 52, have substantial cross sectional areas, as compared to the internal diameter of the pipe 20, to provide unrestricted communication between the chamber 42 and the bore of the pipe 20.

The plate 30 is also formed adjacent its upper end with a relatively small diameter vent opening 55. A ball check valve 56 is mounted in the vent opening 55, and this vent opening is coupled through a line 57 with a T 58 in the main line 10. A pipe section 59 of the main line 10 is connected to the upper opening of the T 58.

A gasket 60 is interposed between the confronting faces of the plates 30 and 28, and the entire pump head assembly is securely held together by a plurality of fasteners 62.

This installation is particularly useful for effecting the transport through the main line 10 of a fluid that contains a substantial content of particulate solid material, that may be abrasive and even corrosive. For example, in the oil refining industry, there are many different applications where finely divided solid particles of a catalytic material must be transferred from one point to another. These materials are usually hard and abrasive in nature and, in some instances, may be chemically active and quite corrosive, particularly at the elevated temperatures at which they are often maintained.

To use the installation herein described for transferring a fluid containing such particulate solids through the main line 10, the main line section 11 is coupled to a source of fluid containing such solids in suspension, and the main line section 59 is coupled to the receiver into which it is desired to discharge the suspension. The hydraulic fluid line 34 is connected to a source of hydraulic fluid that pulsates in pressure, to drive the diaphragm. Each pulsation in the hydraulic fluid causes the diaphragm 40 to move to the right, relative to the figure of drawing, toward the concave faces of the plate 30 and of the insert 43; and then back to the left until it engages against the concave faces of the plate 27 and its insert 38. Succeeding pulsations in the pressure of the hydraulic fluid cause the diaphragm to repeat the cycle. The extent of movement of the diaphragm from left to right is governed by the hydraulic fluid in the line 34, which in turn is caused to pulsate by adjustable pumping means of known construction; and by adjustment of such known pumping means, the stroke of the diaphragm can be adjusted, so that the volume of fluid moved by the diaphragm can be regulated. Usually, the diaphragm does not engage against the faces of the plate 30 and of the insert 43, in normal operation of the pump.

As the diaphragm 40 is drawn to the left, fluid is drawn up through the main line section 11 and the ball check valve 12 through the T 14 and into the line 20. The chamber 42 and the line 20 tend to retain a constant increment of fluid that is oscillated back and forth as the diaphragm moves back and forth, and the actual introduction and movement of fluid tends to be confined to the part of the secondary line 20 that is remote from the pump and that is in direct communication with the T 14. When the diaphragm is returned to the right, to force fluid out of the chamber 42, in the pump, the pressure that is applied to the fluid in the line 20 causes the fluid to discharge through the ball check valve 15 into the main line section 16, through which it is caused to move, by the action of the pump, to pass up through the T 58 and the pipe section 59. The ball check valve 56 permits venting of the chamber 42 directly into the main line, whenever sufficient pressure is developed within the pump head to open the valve.

Because the pump 22 is mounted above the ball check valves 12 and 15, any particulate solids that may be drawn into the line 20 or into the slots 51, 51' and 52, within the pump itself, eventually tend to drop downwardly, because of the influence of gravity, to return through the line 20 to the main line. An installation in accordance with this invention permits continuous high efficiency pump performance, since there is a minimum exposure of the moving element of the pump to the solids. The portion of the fluid, containing solids suspended therein, that is drawn into the secondary line 20 during each pulsation of the pump, is returned to the main line immediately, with each pump pulsation; and the continuous movement of fluid back and forth in the line 20 tends to eliminate settling of solids in this line; and should any settling occur, the solids would tend to be returned by gravity into the main line.

By employing a secondary line 20 having a diameter on the same order of magnitude as the diameter of the main line 10, or larger, the fluid velocities in both lines are maintained at substantially the same order of magnitude. This keeps any settling at a minimum, and also minimizes any scouring or abrasive action that occurs.

The ball check valve 56 and the vent line 57 are purposely made to have much smaller diameters than the secondary line 20. The function of the vent valve and the vent line is to prevent inefficient operation or binding in the pump caused by an accumulation of air or vapor. During normal operation of the pump, a relatively small amount of gas and/or small amount of the fluid suspension will often be vented during each pulsation of the pump.

Because of the intended use of a pumping device, that is constructed in accordance with the present invention, for effecting the transfer of suspensions of particulate solids, the use of a diaphragm to cause the pulsations is preferred. However, a plunger pump could be substituted for the diaphragm pump. Moreover, while the invention has been described herein, for purposes of illustration, in connection with an application where the suspension is to be transferred from one location to a higher location, through a generally upright main line, the invention is equally applicable to transfers through generally horizontal or inclined lines. For such an installation, slightly different connections would have to be made, spring-loaded ball check valves might be needed, and the pump and its intake-discharge line would, as in the illustrated embodiment of the invention, be arranged to be above the ball check valves and above the main line at the ball check valves.

While the invention has been disclosed herein by reference to the details of a preferred embodiment, then, it is to be understood that such disclosure is intended in an illustrative, rather than a limiting sense, and it is contemplated that various modifications of the construction and arrangement of the parts will readily occur to those skilled in the art, within the spirit of the invention and the scope of the appended claim.

We claim:

In means for effecting transport of fluid through a main line and including a pair of valves that are disposed respectively to permit unidirectional flow of fluid through said main line and that are spaced apart, a secondary line communicating with said main line intermediate said valves, a pump body, said pump body being formed with a chamber that communicates with said secondary line, and a movable diaphragm that is disposed in said chamber and that is movable first in one direction, then in the other, for oscillating fluid in said secondary line and chamber thereby to cause said unidirectional flow of fluid through the main line, the improvement comprising:

(a) means for venting the pressure side of said pump body to the pressure side of said valves in said main line;

(b) means for inclining said secondary line continuously upward from the point of its communication with said main line for elevating said chamber above the level of said valves so that materials settling from said oscillating fluid tend to move downward from said chamber and said secondary line and into said main line under the influence of gravity; and

(c) said secondary line being of substantially the same diameter as said main line and extending from said main line for a distance at least several times the amplitude of a fluid oscillation in said secondary line from one stroke of said diaphragm so that in normal operation the distance of travel of said main line fluid into said secondary line is small relative to the length of said second line, and so that the amplitude of said fluid oscillation in said secondary line is relatively low to facilitate settling of abrasive materials from said fluid.

References Cited by the Examiner

UNITED STATES PATENTS

1,905,284	4/33	Heitger	103—44
2,346,964	4/44	Harper	103—44
2,444,586	7/48	Wuensch	103—44
2,691,943	10/54	Wilson	103—44
3,048,114	8/62	Browne	103—203 X

FOREIGN PATENTS

3,132	1862	Great Britain.

LAURENCE V. EFNER, *Primary Examiner.*
ROBERT M. WALKER, *Examiner.*