May 6, 1969 J. F. WILLIAMS 3,442,283

ADDITIVE PUMP

Filed Aug. 31, 1967

FIG. 1

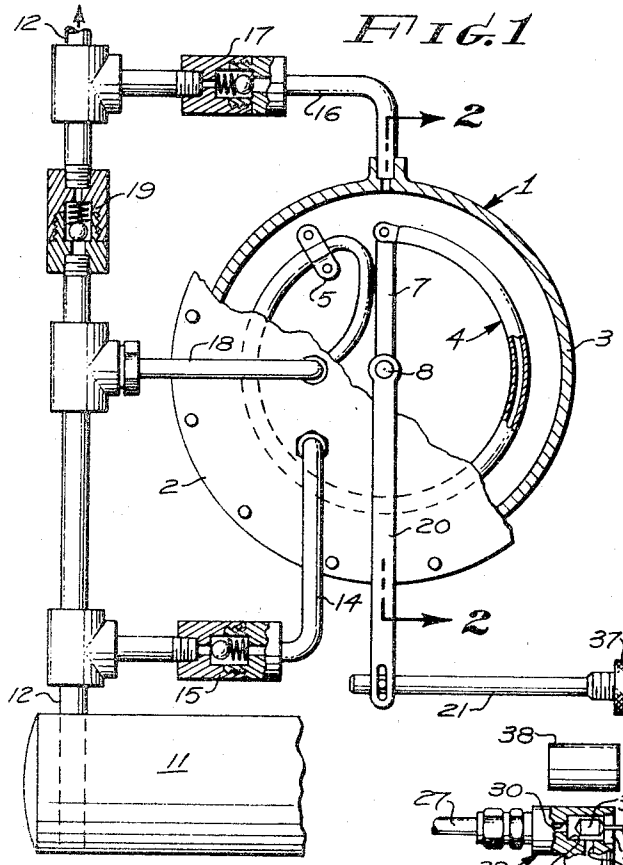
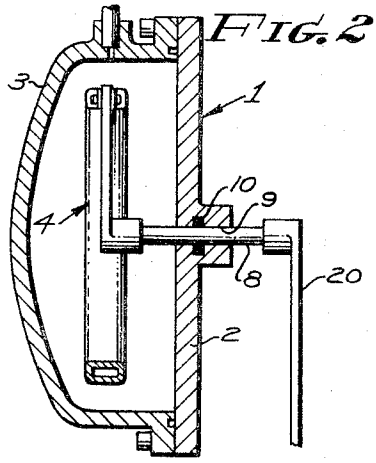


FIG. 2



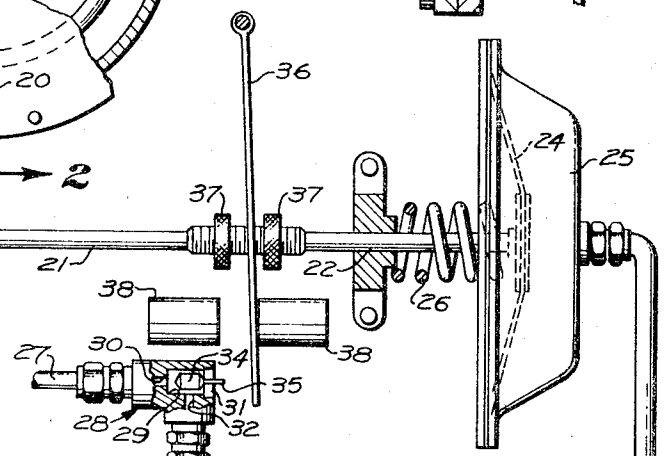
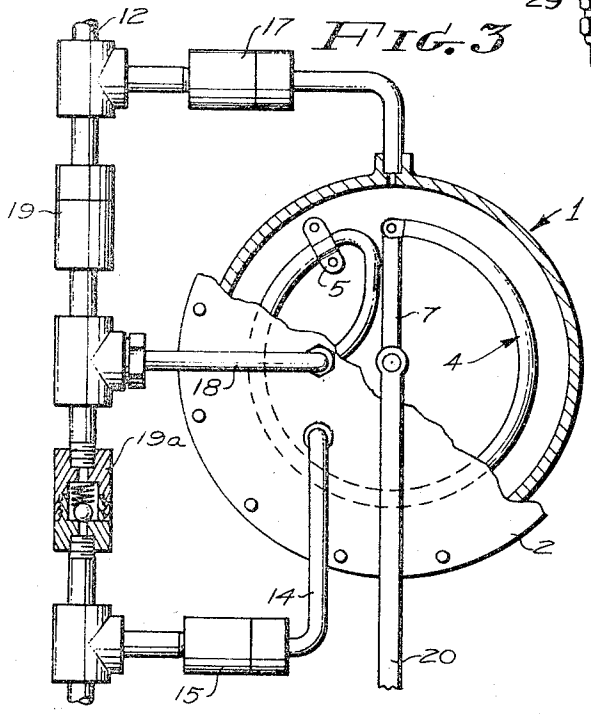
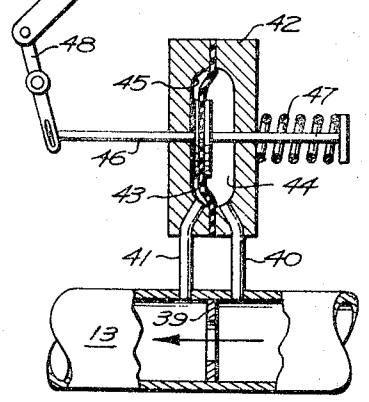


FIG. 3





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ADDITIVE PUMP

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Continuation-in-part of application Ser. No. 467,595, June 28, 1965. This application Aug. 31, 1967, Ser. No. 664,761

Int. Cl. G05d *11/02;* F04b *43/08*

U.S. Cl. 137—98 7 Claims

ABSTRACT OF THE DISCLOSURE

A pump for introducing small quantities of a liquid additive into a flow line which utilizes a Bourdon tube and a surrounding housing as a pump chamber, interposed with appropriate check valves between a source of liquid additive and a flow line; the Bourdon tube being connected by an oscillating shaft to a reciprocable motor moved in one direction by a motive fluid and in the opposite direction by a spring.

Background of invention

This application is a continuation-in-part of application, Ser. No. 467,595, filed June 28, 1965 for Additive Pump and now abandoned.

Summary of invention

This invention relates to additive pumps, more particularly, to pumps for introducing small quantities of a liquid additive, such as an odorant, into a gas line, or a disinfectant into a water line.

With reference to use of the additive pump for introduction of an odorant in a gas line, the gas stream may range from less than one million cubic feet per day to in excess of 400 million cubic fee per day. An optimum qantity of odorant is about a pound of odorant per million cubic feet of gas. The percentage varies, however, due in part to the fact that the gas may contain some odorant naturally, or odorant that has been previously introduced, and it is only necessary to introduce sufficient additional odorant to bring the overall percentage to some optimum standard.

If a Bourdon tube is coiled into a circle and the circle thus formed is caused to expand or contract, the volume within the tube will increase and decrease. This concept is indicated in Patent 2,428,912. However, should the liquid being pumped contain any gas, the gas will eventually collect at the closed extremity of the Bourdon tube and impair the volumetric efficiency.

A primary object of this invention is to provide a pump utilizing a Bourdon tube as a pumping element in such a manner that even though some gas is present, it does not accumulate, but escapes; this being accomplished by mounting the Bourdon tube in a housing and utilizing the tube and housing as a pump chamber having an outlet at its upper side.

A further object is to provide a double acting pump of this type operable under conditions in which the liquid is free of gas.

A further object is to provide an additive pump which utilizes a Bourdon tube in such a way that only one seal for an oscillating shaft of small diameter is required between the interior and the exerior of the pump housing, thus eliminating any loss of fluid, while permitting introducton of the additive from a low pressure reservoir into a high pressure pipe line.

A further object is to provide a means of operating a Bourdon tube pump wherein the stroke of the pump may

be extremely slow but reversal may take place relatively rapidly so as to minimize fluid loss at the valves and maintain high volumetric efficiency.

A further object is to provide an additive pump, the volumtric output of which is proportional to the rate of flow of fluid in the pipe line so that a constant ratio of additive-to-fluid may be maintained.

Description of drawings

Other objects and advantages of the present invention will be apparent from the following description, reference being made to the accompanying drawing wherein:

FIGURE 1 is a diagrammatical view of the pump unit and its operating motor, shown in relation to a fluid supply line, the scale of the supply line being greatly reduced.

FIGURE 2 is a fragmentary sectional view taken through 2—2 of FIGURE 1.

FIGURE 3 is a diagrammatical view of a modified form of the pump unit.

Reference is first directed to FIGURES 1 and 2. The additive pump includes a pump unit **1** having a back plate **2** covered by a cup shaped casing **3**. Mounted within the casing is a Bourdon tube **4** which includes a fixed extremity secured to the back plate **2** by a clamp **5** and a free end **6** which is attached to a lever arm **7**.

The lower arm is attached to an oscillatable shaft **8** of small diameter which extends through a bearing **9** provided in the back plate **2**. The bearing is provided with a seal **10**, preferably an O-ring.

A reservoir **11** for a liquid additive is provided. Extending from the reservoir is an additive flow line **12** which ultimately connects with a pipe line **13**. The connection therewith being omitted from the drawings.

The casing **3** is provided with an inlet line **14** which is joined to the additive flow line **12** and in which is incorporated an inlet valve **15**. The casing is also provided with an outlet line **16** leading from the top of the casing **3** and connected to the additive flow line **12**. Interposed in the outlet line **16** is an outlet valve **17**.

The fixed end of the Bourdon tube **4** is joined by a surge line **18** to the additive flow line **12** between the points of connection of the casing inlet line **14** and casing outlet line **16**. Interposed in the additive flow line **12** between its connection with the surge line **18** is a check valve **19**.

The outer extremity of the oscillatable shaft **8** is joined to an operating lever **20** which in turn is connected to a reciprocable operating shaft **21**. The shaft **21** is restrained to reciprocating motion by guide means **22**. The shaft **21** is reciprocated by a motor **23** which includes a diaphragm **24** joined to an end of the shaft **21**. The side of the diaphragm opposite from the shaft **21** is enclosed by a diaphragm housing **25**. A spring **26** urges the diaphragm in one direction whereas motive fluid urges the diaphragm **24** in the opposite direction.

A motive fluid supply line **27** is provided which terminates in a control valve **28** having a valve chamber **29**. The valve chamber is provided with an inlet port **30** and a coaxial vent port **31**. The valve chamber is also provided with a side port **32** which is connected by an inlet-outlet **33** with the diaphragm housing **25**.

Mounted within the valve chamber **29** is a reciprocable valve element **34** having valve seats at opposite ends for engaging alternatively the inlet port **30** or the vent port **31**. A pin **35** extends from the valve element through the vent port and is externally accessible.

Suitably mounted so that its extended end may engage the pin **35** is a pivotable blade **36** having a hole therethrough which loosely receives the operating shaft **21**. The operating shaft is provided with adjustment screws

37 disposed at opposite sides of the blade 36. Also disposed at opposite sides of the blade are magnets 38.

The pipe line 13 is provided with an orifice plate 39 or other means for establishing a pressure differential between two spaced points in the pipe line. From these points extend two pressure lines 40 and 41. The pressure lines extend to a diaphragm housing 42 divided by a diaphragm 43 into two pressure chambers 44 and 45. Connected with the diaphragm 43 is a shaft 46 which is urged in one direction by a spring 47 and in the opposite direction by the force resulting from the pressure differential between the two pressure chambers. The shaft 46 is connected by a linkage 48 to a throttle valve 49 positioned in the inlet-outlet line 33.

Operation of the additive pump is as follows:

Motive fluid is made available to the supply line 27. The motive fluid may be derived from the fluid flowing in the pipe line and passing through a suitable conventional regulator, not shown, so that its pressure remains constant. The motive fluid may also be provided by some extraneous source such as a pressure vessel. In either case, the pressure of the motive fluid as supplied to the control valve 28 is constant.

The blade 36 tends to adhere to one or the other of the magnets 38 and the control valve 28 supplies motive fluid to the housing 25 or bleeds motive fluid therefrom depending upon the position of the blade 36.

Under the condition as shown in FIGURE 1, the blade 36 is free of the pin 35 so that motive fluid flows to the diaphragm housing and urges the diaphragm to the left against the force of the spring 26 and also against the resistance of the blade 36 when held by the right hand magnet. When the pressure has built up to a predetermined value, the blade 36 snaps to its other position and engages the pin 35 so that the motive fluid may bleed from the diaphragm housing through the vent port 31 to the atmosphere. When the pressure in the diaphragm housing drops below a critical point, the condition reverses and the blade 36 returns to the position shown in FIGURE 1.

Between reversals, the shaft 21 moves slowly back and forth. This movement rocks the operating lever 20 and lever arm 7 so as to cause the Bourdon tube 4 to expand and contract. During expansion of the Bourdon tube, the additive is forced from the casing 3 into the additive flow line while other fluid is drawn into the Bourdon tube. During the return movement, no flow of additive into the gas line occurs; however, fluid does surge in and out of the interior of the Bourdon tube without opening the check valve 9 and passing into the gas line 13. Preferably, the additive fluid is free of gas; however, should some gas exist, it discharges readily from the pump chamber into the discharge line 16.

The rate at which the Bourdon tube pump reciprocates is dependent upon the setting of the throttle valve 49. The setting of the throttle valve is in turn determined by the position of the diaphragm 43 which is positioned by the pressure differential across the orifice plate 39, by other means, or manually. Still further, this differential is dependent upon the rate of flow in the pipe line 13. As a consequence, the flow of additive into the pipe line is in proportion to the flow of fluid therein. Stated otherwise, the ratio of additive to pipe line fluid tends to remain constant.

The snap action or overcenter action afforded by the magnets 38 and blade 36 ensure quick opening and closing of the valves 15, 17 and 19 to maintain volumetric efficiency even though the pumping cycle may be extremely slow. For example, the reciprocation of the Bourdon tube pump may be a matter of minutes.

It should be noted that the Bourdon tube pump is capable of operating under conditions of high pressure differential between its intake and discharge sides so that the additive reservoir 11 may be at atmospheric pressure even though the pipe line pressure may be several hundred pounds. If desired, however, the additive reservoir may be subject to pipe line pressure.

The additive pump herein described has in tests been successful in supplying an odorant to a pipe line and maintains a constant ratio of odorant-to-gas over a wide range of pressures. However, the additive pump is equally capable of introducing additives into liquid lines. For example, chlorine to water lines.

It should be noted that if gas is present in the additive liquid, even in small amounts, it tends to collect within the closed end of the Bourdon tube and cannot escape; however, any gas received in the housing readily escapes.

It should be further noted that the interior of the Bourdon tube may be vented to atmosphere if the pressure in the pipe line permits.

Reference is now directed to FIGURE 3. The construction here illustrated is feasible in the absence of gas in the additive liquid. Essentially, the pump is made double acting instead of single acting by providing an inlet check valve 19*a* between the surge tube 18 and the connection to the line 15.

If a double acting pump is needed, and gas presents a problem, the surge line 18 may be provided with a floating piston and the Bourdon tube prefilled with a gas free liquid.

I claim:

1. An additive pump for pipe lines, comprising:
(a) a liquid additive reservoir;
(b) an additive supply line extending between said reservoir and or said pipe line;
(c) a pump including a Bourdon tube and a housing enclosing said Bourdon tube, forming a first chamber within said Bourdon tube and a second chamber between said Bourdon tube and said housing, a first flow line connecting said first chamber with said additive supply, a second flow line connecting said second chamber with said additive supply line, and check valves between said second chamber and said supply line to cause flow of additive fluid to said pipe line on expansion and contraction of said Bourdon tube;
(d) a fluid motor including a housing and diaphragm forming a diaphragm chamber;
(e) valve means for admitting a motive fluid to said diaphragm chamber and exhausting said fluid therefrom;
(f) a linkage operatively connecting said diaphragm and Bourdon tube;
(g) and means operatively connected with said linkage for controlling said valve to effect expansion and contraction of said Bourdon tube, thereby to pump additive fluid to said pipe line.

2. An additive pump, as defined in claim 1, wherein:
(a) said first flow line is in continuous comunication with said additive reservoir, for surge flow of additive fiuid into and out of said Bourdon tube without entering said pipe line;
(b) and second flow line includes a connection at the top of said housing for escape of gas therefrom.

3. An additive pump, as defined in claim 1, wherein:
(a) other check valves are provided between said first chamber and said supply line to effect pumping of additive from said first chamber to said pipe line.

4. An additive pump for pipe lines, as defined in claim 1, which further comprises:
(a) means responsive to change in flow within said pipe line for regulating the rate of flow of motive fluid to and from said motor thereby to maintain a predetermined ratio between flow of said additive and flow of fluid in said pipe line.

5. Means for introducing small quantities of liquid additive to pipe lines, comprising:
(a) a reservoir for a liquid additive;
(b) a supply line connecting said reservoir with a pipe line;

(c) a pump interposed in said supply line, including a Bourdon tube, a housing enclosing said tube to form therewith an expansible and contractible chamber, and check valves operable to pump additive liquid through said chamber, said chamber having an outlet for said liquid at the top thereof;

(d) an oscillatable shaft attached to said Bourdon tube to cause expansion and contraction of said tube.

(e) a reciprocable motor including a lever connected to said shaft;

(f) means for causing relatively slow reciprocation of said motor;

(g) and means for causing relatively quick change in direction of said motor between reciprocations thereof, thereby to effect change in position of said check valves.

6. A means, as defined in claim **5**, wherein:

(a) a second pump including the interior of said Bourdon tube and check valve is interposed in said supply line.

7. Means for introducing small quantities of liquid additive to pipe lines, comprising:

(a) a reservoir for a liquid additive;

(b) a supply line connecting said reservoir with a pipe line;

(c) a pump interposed in said supply line, including a Bourdon tube, a housing enclosing said tube to

form therewith an expansible and contractible chamber, and check valves operable to pump additive liquid through said chamber, said chamber having an outlet for said liquid at the top thereof;

(d) an oscillatable shaft attached to said Bourdon tube to cause expansion and contraction of said tube;

(e) a reciprocable diaphragm motor, including a lever connected to said Bourdon tube shaft;

(f) a valve having a first position for supplying motive fluid to said diaphragm motor and a second position for bleeding said fluid therefrom, thereby to cause relatively slow reciprocation thereof;

(g) and means operable as said motor reaches the extremities of its movement to snap said valve from either position to the other to facilitate operation of said check valves.

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HAROLD W. WEAKLEY, *Primary Examiner.*

U.S. Cl. X.R.

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