

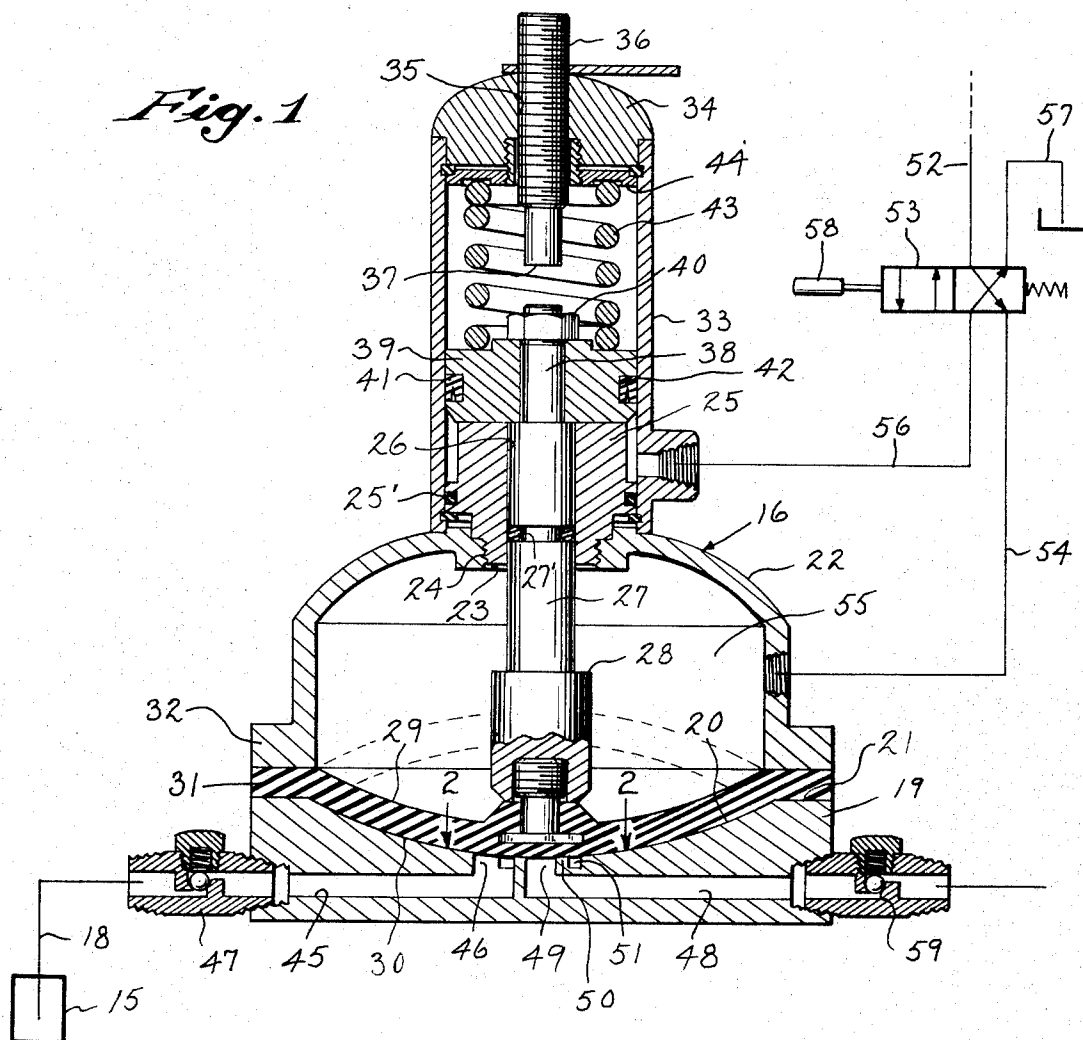
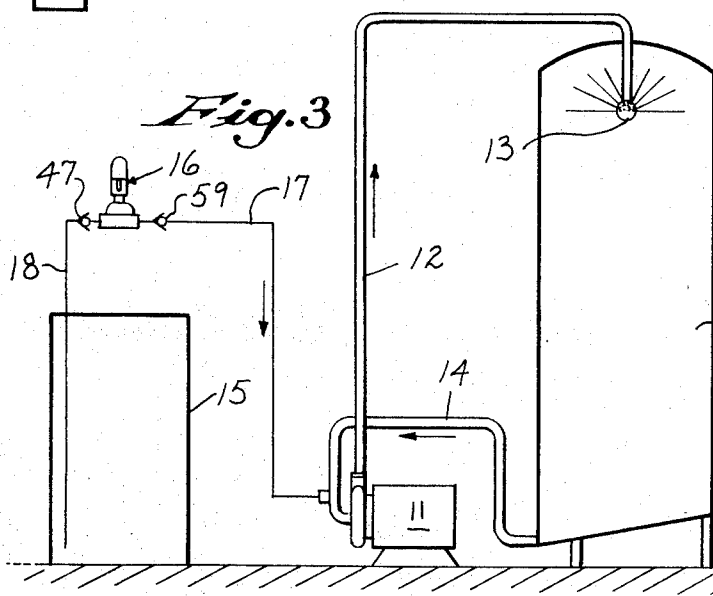
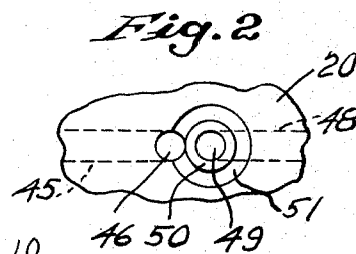
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PUMPING SYSTEM WITH CONTROLLED LIQUID ADDITION.

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PUMPING SYSTEM WITH CONTROLLED LIQUID ADDITION

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4 Claims

ABSTRACT OF THE DISCLOSURE

Liquids which are to be added in precise amounts to the suction side of a main pump in a liquid system are pumped from an additive tank by a special diaphragm pump which is so constructed and arranged that the diaphragm serves as a normally-closed, positive shut-off valve when the diaphragm pump is not operating to prevent excess chemical from being sucked into the system.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention pertains to pumping systems adapted for use in the liquid food industry, and particularly in systems for circulating cleaning liquid to which precise amounts of clean-in-place chemicals are added from time to time.

Description of the prior art

Heretofore in clean-in-place systems, supplemental pumps have been employed to introduce chemicals or other liquids to the suction side of a main pump such as a centrifugal pump. The supplemental pump conventionally employed has an open passage from inlet to outlet and incorporates two check valves, one on each side, to provide a directional flow and to give a pumping action. However, due to the suction created by the centrifugal pump it is possible, after a desired amount of chemical has been added, to continue to suck such chemical past the check valves into the system, as the check valves in the conventional system are installed to oppose a back-up of fluid and not a suction of fluid. Heretofore, in order to remedy this situation it has been attempted to use spring-loaded check valves which will resist a substantially greater suction. However, when this was attempted it was found necessary to have a larger supplemental pump which was capable of operating at a pressure high enough to overcome the increased setting of the spring-loaded check valves. This undesirably increased the expense of the system. Furthermore, an additional problem existed when there was a failure of one of the check valves.

In clean-in-place systems it is common to add polyphosphates, alkalis, acids, or chlorine, or combinations thereof. If excess chemicals are sucked into the system it can be very expensive, in the case of chemicals such as polyphosphates, or dangerous, in the case of chlorine, as the latter can be boiled off as a gas during the washing cycle, where temperatures are high, becoming a hazard to personnel. Chlorine can also be a problem later in the cleaning cycle, as an excess of chlorine will not be washed away in the post-rinse portion of the cycle. This may then leave a chlorine residue to be rinsed away with acid. However, acid and chlorine can combine to make hydrochloric acid which can result in pitting and hence in ruination of the tank being cleaned.

SUMMARY OF THE INVENTION

The present invention provides, in a pumping system having controlled liquid addition through a diaphragm pump, a novel arrangement whereby the diaphragm pump is so constructed and arranged that it serves as a nor-

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mally-closed positive shut-off valve when the diaphragm pump is not operating, to prevent excess additive from being sucked into the system.

A general object of the invention is to provide, in a system as above described, means whereby the addition of a liquid such as a chemical to a pumping system can be maintained in precisely controlled amounts.

A further object of the invention is to provide an improved pumping system which can be efficiently operated without using special spring-loaded check valves adjacent the additive pump and without increasing the pressure rating of the diaphragm pump.

A further object of the invention is to provide a pumping system in which a positive shut-off action automatically occurs when the diaphragm pump is not in operation.

A further object of the invention is to provide, in a pumping system, an improved diaphragm pump which serves as a normally-closed shut-off valve, and which is so arranged as to automatically clear and wipe itself off as it moves to closing position.

Other objects of the invention are to provide a pumping system as above described in which a novel diaphragm pump is used which may be formed of such materials as to be corrosion-resistant to most chemicals; in which the diaphragm pump has no packings to leak; in which there is a stroke adjustment for adjusting the flow rate of the diaphragm pump; and in which the diaphragm pump is easy to service and maintain.

With the above and other objects in view the invention consists of the improved pumping system with controlled liquid addition, and all of its parts and combinations, as set forth in the claims, and all equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, illustrating one complete embodiment of a preferred form of the invention, in which the same reference numerals designate the same parts in all of the views:

FIG. 1 is a vertical sectional view through the diaphragm pump, the air operating system being shown diagrammatically in connection therewith;

FIG. 2 is a sectional view taken approximately on the line 2—2 of FIG. 1; and

FIG. 3 is a partially diagrammatic view in elevation illustrating a complete pumping system with controlled liquid addition.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to the drawings, the improved pumping system as illustrated in FIG. 3 includes a suitable liquid tank 10 which may be a silo tank which is to be cleaned in place, there being a centrifugal pump 11 for delivering a cleaning liquid such as water through a line 12 to a spray ball 13 within the tank. Liquid from the bottom of the tank may be returned to the pump 11 through the suction line 14 leading to the pump. There may also be suitable means, which has not been shown, for introducing fresh make-up water into the system, and there may also be suitable means, which has not been illustrated, for discharging liquid into a drain, these portions of a conventional system forming no part of the present invention.

In this type of clean-in-place system it is common to add certain chemicals to the water before it is pumped into the tank 10 or into the installation which is to be cleaned. In certain systems there may be a plurality of chemicals added to the suction line 14, such as polyphosphates, alkalis, acids and chlorine. Each one of these may have a separate tank. For simplicity only one tank 15 for an additive chemical has been illustrated and it may be

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assumed, for purposes of illustration, that this tank contains chlorine.

As a part of the present invention a specially-constructed and arranged diaphragm pump 16 is employed to add the chlorine in precise amounts at the proper time to the suction line 14 through an additive line 17. This chemical may be withdrawn from the tank 15 through a suction line 18. Where a plurality of chemicals are being introduced there will be a separate pump 16 and a separate delivery line 17 for each one of the chemicals, all leading to the suction line 14.

Referring now more particularly to FIG. 1, the diaphragm pump 16 includes a base portion 19 having an upper surface portion 20 which is spherical and which is surrounded by a flat marginal portion 21. The pump also includes a hollow dome portion or bonnet 22 having a centrally-located top opening 23 provided with straight threading 24 to receive a bushing 25 having a valve stem guiding bore 26. The lower end of the bushing is shaped to thread into the threaded opening 24. There is a suitable seal 25' between the bushing and cylinder 33. The valve stem 27 which is slideable in the opening 26, there being a sealing ring 27' around the stem, has an enlarged lower end 28 which is suitably connected to a diaphragm 29 of plastic, rubber, or other suitable flexible material and which is pre-formed to provide a lower face 30 which fits perfectly against the spherical recess 20 in the top of the base of the pump when the diaphragm is in closing position to seat against the entire area of said spherical recess. The diaphragm has a surrounding flat portion 31 which is suitably clamped between the flat marginal portion 21 of the base, and a surrounding flange portion 32 in the lower end of the bonnet 22. Projecting upwardly from the central portion of the bonnet 22 is an extension 33 forming an air pressure cylinder. The upper end of the cylinder is closed by a cap 34 having a threaded portion 35 through which a threaded adjustment screw 36 extends, the screw having a lower end 37 located in the cylinder to form an adjustable stop. The upper end of the valve stem is of reduced diameter as at 38 to project through the bore of a piston 39, there being a nut 40 on the upper end of the stem to lock the piston in position. A suitable annular seal 41 surrounds the piston in an annular groove 42. A spring 43 acting between the upper face of the piston 39 and a washer 44 at the bottom of the cap 34 normally urges the piston to the position of FIG. 1 and the diaphragm 29 to the valve-closing position of FIG. 1.

In the base of the pump is an inlet duct 45 having a horizontal portion which communicates with a short, axially-extending end portion 46 leading to the spherical face 20 at the top of the base near the center thereof. Threaded into the base to communicate with the outer end of the duct 45 is a ball check valve 47, the suction line 18 from the tank communicating with the ball check valve. Also in the base is a discharge duct having a horizontally-extending portion 48 which communicates with a short, axially-extending end portion 49 which is located centrally of the pump. The axial discharge port 49 is surrounded by stock of the base as at 50 which forms an annular sealing surface, which in turn is surrounded by a ring-shaped groove 51 (see FIG. 2) which allows 50 to become a sealing surface. Discharge of chemical through the duct 48 is through a check valve 59 which communicates with the additive line 17.

The combination diaphragm pump and shut-off valve 16 may be operated by any suitable mechanism. In the illustrated embodiment the entry of air from a suitable source of supply under pressure entering through line 52 is controlled by a spool valve 53. When the valve is in the position shown in FIG. 1, the air under pressure is directed to line 54 to create pressure within the sealed chamber 55 of the bonnet 22 to act in moving the diaphragm to the valve-closing position shown in FIG. 1, air below the piston 39 being exhausted through the line

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56, valve 53, and line 57 leading to the atmosphere. By shifting the valve operator 58 the action of the air may be reversed so that air under pressure enters through line 56 and causes raising of the piston 39 against the spring 43 to cause movement of the diaphragm 29 to an upwardly-bowed position. When this occurs, air will be exhausted from the chamber 55 through the line 54, valve 53 and line 57 to atmosphere.

OPERATION

In operation of the simplified system shown in FIG. 3, when it is desired to effect clean-in-place of the tank 10 and associated liquid lines, the pump 11 is started to cause circulation of water through the line 12 and tank 10, some of which may be suitably-admitted fresh water. In a clean-in-place system there is usually a hold period in which the pump 11 continues to run while steam is suitably added to the liquid in the line 14 to bring the temperature up to 135° F. It is during this hold period, which may last for four to six minutes, that the chemicals are added. In the illustrated system shown in FIG. 3, only one chemical tank 15 which may for example contain chlorine, is illustrated. The amount of chemical added must be very precisely controlled and it is the function of the present system and diaphragm pump 16 to provide for such precise control. Chemical added to the suction line 14 is mixed in the centrifugal pump with the hot liquid to provide a hot chemical solution which is pumped through the system for a certain length of time. Thereafter there may be certain rinse cycles which have no bearing upon the present invention.

The chemicals are added through operation of the valve operator 58 either manually or automatically. When chemical is to be added, the control valve 53 is shifted to the reverse position of that shown in FIG. 1 so that air under pressure causes raising of the piston 39 and raising of the diaphragm 29. This sucks chemical from the tank 15 past the check valve 47 into the pump chamber which is formed between the upwardly-bowed diaphragm 29 (see dotted line position of FIG. 1) and the spherical surface 20. Then, by shifting the valve 53 to the position of FIG. 1, the action of the air pressure will be reversed to move the diaphragm downwardly, aided by the spring 43. This downward movement will pump the charge of chemical from the pump chamber through the discharge line 48, past the check valve 59, into the line 17. Any material in the line 17 is under the influence of suction from the pump 11 inasmuch as it is connected to the suction line 14. Due to the novel shape of the diaphragm and its coating recess in the pump chamber, the pump automatically clears itself and wipes itself clean at the end of each stroke.

As soon as the diaphragm 29 reaches its lowered position of FIG. 1 it forms a complete shut-off for any further discharge of chemical inasmuch as the inlet port end 46 is tightly sealed off from communication with the outlet portion 49. In certain large pumps one complete stroke may be enough to meter a proper quantity of chemical. However, where pumping chlorine, more accuracy is desirable and a smaller pump with a 6 cc. stroke is preferred. In this case it would take about twenty-five strokes to add the proper amount of chlorine to a typical clean-in-place system. After the proper amount has been delivered, then the valve 53 is placed in a neutral position to stop pumping and the spring 43 will positively hold the diaphragm in the shut-off position of FIG. 1. This is very important because the suction created by the centrifugal pump 11 is such that, with conventional installations, it is possible to suck chemicals past the check valves 47 and 59 unless they are spring-loaded to hold against at least twenty-eight inches of mercury or approximately 15 p.s.i., when being used in connection with conventional diaphragm pumps where there is no way of preventing flow through except the check valves. A further problem exists in conventional systems should these check valves fail.

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With the present invention there is a positive seal preventing excess chemicals from being sucked into the system past the check valves and, therefore, inexpensive lightly-loaded check valves may be employed.

It is very important that the chemicals be added in only precisely-controlled amounts and that there be no sucking of excess chemicals into the system. In the case of polyphosphates, the sucking of excess chemicals over that needed can be very expensive. In the case of chlorine, sucking of excess chemicals can be dangerous. Excessive chlorine is bad as this can be boiled off as a gas during the wash cycle when the temperatures are high, becoming a hazard to personnel. It may also be a problem later in the cleaning cycle as an excess of chlorine may not be effectively washed away, leaving a residue in the tank 10 which, in conventional clean-in-place systems, will later be rinsed with an acid. Acid and chlorine will then combine to form hydrochloric acid which can pit and ruin the equipment being cleaned.

The combination pump and shut-off valve of the present system has effectively eliminated the need for special check valves or other valves to prevent excess chemicals from being drawn into the system. Also the diaphragm 29 may be Teflon-coated, and the body parts of FIG. 1 may be formed of stainless steel or Teflon so that all wetted parts are corrosion-resistant to most chemicals. The present pump construction 16 requires no packings such as are used in piston type pumps and which may leak. In addition, a stroke adjustment may be made through the threaded adjustment member 36 to adjust the flow rate. It is also obvious that, because of the simplicity of parts shown in FIG. 1, service and maintenance are relatively easy.

It is to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

What I claim is:

1. In a pumping system having equipment through which liquid with an additive is to be pumped and having means including a main pump for delivering such liquid to said equipment, there being a suction line leading to said main pump, a tank having additive liquid, an additive line leading from said additive tank to the suction line of the main pump, an additive pump interposed in said additive line and having a wall with a spherical recess on its inner side, said latter pump having a pump chamber defined on one side by the wall which has the spherical recess and said pump having check-valve-controlled inlet

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and outlet ducts with end portions communicating with the pump chamber through said wall which has the spherical recess, said additive pump having fluid-pressure-operated means including a movable spherical diaphragm forming the other side of the pump chamber for withdrawing a measured amount of additive liquid from the additive tank into said additive pump chamber upon movement of the diaphragm in a direction away from the wall with the spherical recess and for discharging said measured amount when the diaphragm is moved in a reverse direction toward said wall, said spherical diaphragm being complementary in size and shape to the spherical recess in the pump wall to contact all portions of said spherical recess and completely empty the pump chamber when the diaphragm is at the end of a discharge stroke, said end portions of the inlet and outlet ducts which communicate with said wall of the additive pump chamber being so located that they are shut off by the diaphragm when the latter is at the end of the discharge stroke, and spring means for maintaining the diaphragm in said shut-off position when the fluid-pressure-operated means is inoperative to thereby prevent excess additive liquid being sucked into the suction line of the main pump.

2. A pumping system as claimed in claim 1 in which the end portion of the outlet duct which communicates with the pump chamber is located centrally of said spherical recess.

3. A pumping system as claimed in claim 2 in which there is a central sealing surface in the spherical recess surrounding the end portion of the outlet duct against which the center of the diaphragm is adapted to seat at the end of its discharge stroke.

4. A pumping system as claimed in claim 1 in which the fluid-pressure-operated means is arranged to move the diaphragm away from its seat and also to assist the spring means in moving the diaphragm to shut-off position.

References Cited

UNITED STATES PATENTS

2,711,134	6/1955	Hughes	417-495
2,808,934	10/1957	Rivas	210-169 X
3,458,414	7/1969	Crane et al.	210-169 X

ROBERT M. WALKER, Primary Examiner

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