HIGH PRESSURE SPRAY WASHING SYSTEM

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ABSTRACT

A high pressure washing system wherein the positive action displacement pump is continuously starved and the variable pressure water supply is controlled to reduce the pressure applied thereby to the feed lines to the pump at essentially zero with the result that the ratio of water to cleaning solution can be metered accurately irrespective of substantial variations in pressure of the source of supply. Essentially any desired ratio can be obtained and accurately maintained by adjustment of the orifice of a valve in the cleaning solution line, once the improved control device has been adjusted for the approximate range.

22 Claims, 3 Drawing Figures
HIGH PRESSURE SPRAY WASHING SYSTEM

This invention relates to high pressure washing systems. More particularly, it relates to a high pressure washing system designed for use in conjunction with pressurized supplies of water as commonly furnished to cities and is designed to obviate the difficulties normally experienced in such systems as a result of substantial variations in pressure in the water supply of such cities.

A general object of my invention is to provide a novel and improved high pressure washing system capable of operating effectively irrespective of substantial changes in pressure at the water supply.

A more specific object is to provide a novel and improved high pressure washing system capable of simple, easy and accurate adjustment to provide essentially any desired ratio of cleaning solution to water.

Another object is to provide a novel and improved high pressure washing system which can be adjusted to essentially all desired ratios of cleaning solution to water and will continue to operate accurately at such ratios irrespective of substantial variations in the water supply pressure.

These and other objects and advantages of our invention will more fully appear from the following description, made in connection with the accompanying drawings, wherein like reference characters refer to the same or similar parts throughout the several views, and in which:

FIG. 1 is a diagrammatic view of a preferred embodiment of our invention;

FIG. 2 is a side elevational view of the improved control device with the lower portion thereof broken away to show the interior in vertical section; and

FIG. 3 is a vertical sectional view taken along line 3—3 of FIG. 2.

The preferred system embodying the invention is illustrated diagrammatically in FIG. 1 wherein the water supply source, which may or may not be pressurized, is identified by the numeral 4 and is connected by a conduit 5 to the improved control device 6. An electrically operated valve 7 is interposed within the conduit 5 and moves between completely open and closed positions. The conduit 5 is connected at one of its ends to the water inlet port 8 of the control device. As is the case in the water supply of most cities, the water supply 4 varies substantially in pressure. The system works well, however, with a non-pressurized water supply or even one involving a negative pressure.

As shown in each of the figures, the control device 6 has a liquid outlet port 9 and a pair of cleaning solution inlet ports 10 and 11. The port 10 is connected to a cleaning solution supply source 12 by a conduit 13 within which an electrically controlled adjustable needle valve 14 having a needle valve flow adjustment and a check valve 15 are interposed. The valve 14 moves between open and closed positions and the check valve 15 permits flow only toward the control device 6.

A by-pass conduit 16 is arranged in fluid communication with the portions of the conduit 13 at opposite sides of the check valve 15 and valve 14, as shown in FIG. 1, so as to circumvent or by-pass the same when desired. An electrically operated valve 17 is interposed within the conduit 16 and moves between open and closed positions when activated.

The cleaning solution inlet 11 is similarly connected to a second supply 18 of cleaning solution or concentrate by a conduit 19 within which are interposed check valve 20 and an electrically operated adjustable needle valve 21 having a needle valve flow adjustment. The check flow 20 prevents flow from returning to the concentrate supply 18. If desired, a by-pass circuit similar to elements 16 and 17 may be utilized in conjunction with elements 19–21 for the same purpose.

A positive action displacement pump 22 capable of generating high pressures has its inlet 23 connected by conduit 24 to the liquid outlet 9 of control device 6. The pump outlet is connected by conduit 26 to a flow directing member 27 carrying a valve 28 and having a discharge terminal 29.

Connected to the conduits 24 and 26 at opposite sides of the pump is a conduit 30 with a relief valve 31, preferably of the type shown in U.S. Letters Patent No. 3,140,049 therein to permit the flow of the pump 22 to be recirculated when valve 28 is closed.

The control device 6, as more clearly shown in FIGS. 2 and 3, is comprised of an upper member 32 and a lower member 33 which includes a threaded cup 34. The upper member 32 is of inverted cup shape and, with a diaphragm 35, defines a pressure chamber 36. As shown, the diaphragm 35 is clamped in sealing relation across the mouth of the cup member between the two members when they are threaded to each other as shown at 37 in FIG. 3.

A centrally disposed pressure plate 38 is carried by the diaphragm and supports a pressure spring 39 which is urged downwardly by a threaded pressure pin 40 that is threaded into an interiorly threaded tubular element 41 carried by the upper end of the inverted cup-like member 32. The upper end of the spring 39 carries a pressure transmitting cap 42, the lower end of which fits into the spring and the upper surface of which is concaved to receive the lower end of the pressure pin.

A lock nut 43 is provided to secure the pin 40 in desired position once it has been properly adjusted.

The lower member 33 has a recessed area 44 in horizontal wall structure 45 immediately below the diaphragm 35 which has a central vertical passage 46 accommodating valve stem 47 of valve member 48.

The intermediate section of lower member 33 has a plurality of passages formed therein and disposed above its tubular lower end portion 49. One such passage is the water supply inlet passage 50 which communicates with the interior of the tubular lower end portion 49 to constitute a water chamber 51. The remainder of the intermediate section of member 33 defines a cleaning liquid solution inlet passage 52 disposed opposite water inlet passage 50, a second cleaning solution inlet passage 53 extending at right angles thereto, and a liquid discharge outlet passage 54 opposite the latter. Each of the two inlet passages 52 and 53 and the outlet passage 54 communicate with each other in that they terminate in a mixing chamber 55.

The mixing chamber 55 is separated from the water chamber 51 by an arcuate transverse vertical wall structure 56 which surrounds a vertical central passage 57 which brings the mixing chamber 55 into fluid communication with the water chamber 51 when valve element 48 is open.

Valve element 48 is carried by valve stem 47 which extends up into and bears against the concaved under surface of a foot member 60 carried by pressure plate...
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3, 38, whereby movement of the diaphragm is transmitted to valve member 48.

As shown, the lower end portion of valve member 48 is reduced and carries an O-ring 61 in a groove provided therefor adjacent its extremity to function as a piston within an upstanding open ended cylinder 62 carried by interiorly threaded cap member 34.

A spring member 63 surrounds the cylinder 62 and extends between the valve member 48 and the cap member 34 and urges the valve member upwardly toward the valve seat 64 which is carried by the lower end of the structure defining passage 57. A vertical passage 65 extends upwardly through the valve member 48 and centrally of a valve stem 47, as shown in FIGS. 2 and 3 and is connected with a diametrically extending passage 66 which brings the mixing chamber into constant fluid communication with the interior of cylinders 62 behind the piston portion of the valve member 48.

A weep hole 67 extends through wall structure 56 and maintains water chamber 51 in constant minor communication with mixing chamber 55 and serves to maintain pump 22 in primed condition while not in operation. The size of weep hole 67, however, is far from capable of furnishing an adequate supply of water to the pump when the latter is in operation, irrespective of the magnitude of pressure carried by the water supply source.

PRECONDITIONING

To condition the system for operation, we first open the needle pin adjustment of valve 14 to wide open position and then back off pressure pin 40 with valve 7 open until only concentrate is drawn from source 12 and discharged through valve 28 at 29. This reduces the pressure of water being supplied to the inlet of the pump to essentially zero. Since the orifice of valve 14 is substantially less than the rated capacity of pump 22, a flow of essentially 100 percent cleaning solution or concentrate will pass through the pump under these conditions. We then tighten pressure pin 40 until the desired proportions of water to cleaning solution, such as 1:1, is reached. Tightening of pressure pin 40 applies pressure to pressure plate 38 and causes valve 48 to be held open to the desired orifice size. This conditions the system within whatever range is desired and thereafter minor and accurate adjustments to the accurate desired ratios can be accomplished by minor adjustment made at the needle valve adjustment of the valve 14, or, as the case may be, at the valve 21.

OPERATION

In the operation of our high pressure washer system, the pump 22 is maintained in a starved condition at all times. We prefer to operate the pump at approximately 4-5 inches of vacuum. The combined size of the orifice at valve 48, plus the combined size of the orifices of valves 14 and 21 is sufficient to admit an adequate supply of liquid for the pump 22 to operate at its rated capacity. As a consequence, the pump maintains a downstream vacuum with respect to the control device 6 at all times.

Since the pump 22 is continuously being starved, the amount of liquid drawn through valve 14 and control device 6 will be proportional to the sizes of orifices in these respective members. As a consequence, one can proportion accurately over a very wide range, as from 1:1 to 1:2,000. Such metering is very accurate since it can be accomplished by adjusting the needle adjustments of the valves 14 and 21, for the control device 6 continuously adjusts the orifice thereof in accordance with the extent of negative pressure created downstream by the pump 22 and the extent of restriction of the orifices in the valves 14 and 21.

The accuracy of the desired ratios can be maintained in this system irrespective of very substantial fluctuations in pressure in the source of supply of water. For example, if the pressure in the public supply of water diminishes to less than 20 p.s.i., the ratio of water to cleaning solution discharged by our cleaning system will remain accurate. If the water pressure will diminish, the flow of water past the valve element 48 will likewise diminish and consequently, the pump 22 will be starved to a greater extent, thereby increasing the negative pressure downstream from the control device 6. Such increase of negative pressure causes diaphragm 35 to be drawn downwardly, which in turn forces valve stem 47 to move valve element 48 against the action of spring 63 and increase the orifice thereof. This automatically compensates for the reduction in pressure and the amount of water delivered to the pump 22 remains constant with the result that the ratio of water to cleaning solution likewise remains constant. Such a result is impossible to obtain with high pressure washing systems as heretofore known, for in such instances, conventional high pressure washing systems produce a flow which consists of almost entirely cleaning solution.

It will be noted that the control device 6 maintains a constant negative pressure in the line between the control device and the pump 22.

In the event the water pressure at its source becomes excessively high, the control device 6 similarly maintains a constant negative pressure between that device and the pump 22. This is accomplished because the tendency for the flow to increase past the valve member 48 reduces the negative pressure within the line leading from the control device outlet 54 to the pump 22. This reduction in negative pressure is exerted by diaphragm 35 and causes the same to permit the valve stem 47 to raise and the valve element 48 to restrict the orifice at valve seat 64, thereby restricting the flow of water to the mixing chamber 55 and maintaining a constant negative pressure. Since the valve 48 moves closer to closed position, it diminishes the orifice and thereby prevents the volume of flow to the mixing chamber from increasing and causing the desired ratio to be disturbed.

In the event the operator desires only concentrate to be discharged at the discharge point 29, this can be readily accomplished by electrically closing valves 7, 14 and 21 and opening valve 17. Under these conditions, only concentrate will be furnished to the pump 22 and only concentrate will be discharged as desired.

In the event concentrate from either source 12 or 18 is desired to be mixed with water, this can be accomplished as hereinbefore described by opening the appropriate valve 14 or 21, as the case may be and permitting the other to remain closed. In the event a mixture of the two concentrates is desired, both valves 14 and 21 may be opened. It will be understood, of course, that valve 7 remains open at all times except when pure concentrate is desired.

When the valve 28 is in closed position, pump 22 can continue to run as a result of the relief valve 31 which opens, in that event, and permits the liquid discharged
through the pump outlet 25 to recirculate through the conduit 30 and re-enter the pump at its inlet 24. Under these conditions, check valves 15 and 21 automatically close to prevent return flow into the concentrate supplies 12 and 18.

From the above, it can be seen that we have provided a novel and improved high pressure washing system which effectively eliminates many of the disadvantages heretofore associated with high pressure washing systems since under most working conditions, such systems receive their water supply from public utilities in which the source pressure may vary substantially. Through the use of our high pressure washing system, the operator can be assured of accurate metering of the water and concentrate and such metering may be on any desired level through simple adjustments.

The electrically operated needle adjustment valves 14 and 21 may be of the type of adjustable solenoid valve No. 8260A54M which may be purchased from Automotive Switch Co., 50-56 Hanover Road, Florham Park, New Jersey.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the parts without departing from the scope of our invention which consists of the matter shown and described herein and set forth in the appended claims.

We claim:

1. In a high pressure washing system,
   a. positive displacement pump having a liquid inlet and a liquid discharge outlet;
   b. means for operating said pump to cause the same to draw liquid thereinto at its inlet and to discharge such liquid through its discharge outlet;
   c. flow directing means connected to said pump outlet for directing the flow of such liquid against a surface to be cleaned;
   d. conduit means connected with said pump inlet and having an intake adapted to be connected to a source of water;
   e. a pressure-sensitive flow control device interposed within said conduit means and sensitive to the downstream pressure within said conduit means and having a variable flow-control orifice;
   f. second conduit means connected in fluid communicating relation with said first mentioned conduit means at a point between said pump and the point of control of said control device and having an intake adapted to be connected to a source of liquid cleaner;
   g. a valve movable between open and closed positions interposed within said second mentioned conduit means between its inlet and the point at which it is connected with said first mentioned conduit means for permitting said pump to draw cleaner into the flow of said first mentioned conduit means when the valve is in open position;
   h. said flow control device and said valve having flow control orifices the combined dimensions of which at all times are insufficient to permit said pump to operate at rated capacity, whereby said first mentioned conduit means is always subjected to a negative pressure when said pump is operating;
   i. said flow control device including down-stream pressure-sensitive control means located downstream of said control device flow control orifice and constructed and arranged to vary its flow control orifice dimensions to increase the same when the downstream pressure decreases and decrease the same when the down-stream pressure increases to thereby maintain a constant negative pressure in said first mentioned conduit means between said pump and said control device irrespective of changes which may take place in the pressure at which the water may be supplied to said first mentioned conduit means.

2. The structure defined in claim 1 wherein said valve has a readily adjustable orifice through which the liquid cleaner must flow whereby the ratio of water to liquid cleaner may be accurately adjusted and metered.

3. The structure defined in claim 1 wherein said control means includes a diaphragm actuated valve member the diaphragm of which is located down-stream of said flow control orifice and is sensitive to down-stream negative pressure and which is resiliently urged in valve opening-direction.

4. The structure defined in claim 1 wherein said flow control device restricts said variable orifice to essentially closed condition while said pump is not operated.

5. In a high pressure washing system,
   a. a positive displacement pump having a liquid inlet and a liquid discharge outlet;
   b. means for operating said pump to cause the same to draw liquid thereinto at its inlet and to discharge such liquid through its discharge outlet;
   c. flow directing means connected to said pump outlet for directing the flow of such liquid against a surface to be cleaned;
   d. conduit means connected with said pump inlet and having an intake adapted to be connected to a source of water;
   e. a flow control device interposed within said conduit means;
   f. second conduit means connected in fluid communicating relation with said first mentioned conduit means at a point between said pump and the point of control of said control device and having an intake adapted to be connected to a source of liquid cleaner;
   g. a valve movable between open and closed positions interposed within said second mentioned conduit means between its inlet and the point at which it is connected with said first mentioned conduit means for permitting said pump to draw cleaner into said first mentioned conduit means when the valve is in open position;
   h. said flow control device being sensitive to the downstream pressure within said first mentioned conduit means and having a controlled variable flow orifice through which the water must pass to said pump;
   i. said control device having a pressure sensing element located down-stream of its said variable flow orifice controlling said variable flow orifice to reduce the effect of the pressure of the water supply within said first mentioned conduit means to substantially zero.

6. The structure defined in claim 5, wherein said valve has a readily adjustable orifice through which the liquid cleaner must flow whereby the ratio of water to liquid cleaner may be accurately adjusted and metered.

7. The structure defined in claim 5; and
   a. a flow control device interposed within said conduit means;
   b. means for operating said pump to cause the same to draw liquid thereinto at its inlet and to discharge such liquid through its discharge outlet;
   c. flow directing means connected to said pump outlet for directing the flow of such liquid against a surface to be cleaned;
   d. conduit means connected with said pump inlet and having an intake adapted to be connected to a source of water;
   e. a flow control device interposed within said conduit means;
   f. second conduit means connected in fluid communicating relation with said first mentioned conduit means at a point between said pump and the point of control of said control device and having an intake adapted to be connected to a source of liquid cleaner;
   g. a valve movable between open and closed positions interposed within said second mentioned conduit means between its inlet and the point at which it is connected with said first mentioned conduit means for permitting said pump to draw cleaner into said first mentioned conduit means when the valve is in open position;
   h. said flow control device being sensitive to the downstream pressure within said first mentioned conduit means and having a controlled variable flow orifice through which the water must pass to said pump;
   i. said control device having a pressure sensing element located down-stream of its said variable flow orifice controlling said variable flow orifice to reduce the effect of the pressure of the water supply within said first mentioned conduit means to substantially zero.
a point between said pump and the point of control of said control device and having an intake adapted to be connected to a second source of liquid cleaner, and
k. a valve movable between open and closed positions interposed within said third conduit means between its intake and the point at which it is connected with said first mentioned conduit means for permitting said pump to draw cleaner from such second source into the flow of said first mentioned conduit means when the valve is in open position.

8. A method of accurately metering proportions of a plurality of liquid components of a mixed cleaning solution within the fluid line of a high pressure washing system wherein the source of one of the components is furnished under variable pressures, consisting in:
   a. providing a positive action displacement pump having a fluid inlet and outlet;
   b. connecting the inlet of the pump by conduit with a constant pressure source of one of the liquid components of the solution to be mixed;
   c. concurrently connecting the fluid inlet of the pump by conduit to the variably pressurized source of liquid component;
   d. restricting the flow of the liquid from the first source to less than that at which the pump is rated, and
   e. variably restricting the flow to the pump from the source of the second liquid component sufficiently to create a pressure of essentially zero at the point of restriction when the pump is not operating and to produce at all times when the pump is operated a combined flow from the two sources of less than that at which the pump is rated.

9. The method defined in claim 8, wherein the flow of liquid from the first source is adjustably restricted to a predetermined desired ratio relative to the flow from the variably pressurized source.

10. The method defined in claim 8, wherein the variable restriction of the flow to the pump from the variably pressurized source of the second liquid component automatically compensates for changes in negative pressure between the pump and the point of restriction.

11. A method of accurately metering proportions of a plurality of liquid components of a mixed cleaning solution within the fluid line of a high pressure washing system wherein the source of one of the components is furnished under variable pressures, consisting in:
   a. providing a positive action displacement pump having a fluid inlet and outlet;
   b. connecting the inlet of the pump by conduit with a constant pressure source of one of the liquid components of the solution to be mixed;
   c. concurrently connecting the fluid inlet of the pump by conduit to the variably pressurized source of liquid component;
   d. variably restricting the flow to the pump from the variably pressurized source of the second liquid component to less than that at which the pump is rated and in inverse proportion to the negative pressure created in the conduit between the pump and the point of restriction when the pump is operating; and
   e. restricting the flow of liquid to the pump from the first source sufficiently to produce a combined flow from the two sources of less than that at which the pump is rated.

12. The method defined in claim 11 and adjustably restricting the flow of the liquid component from the constant pressure source to a predetermined desired ratio relative to the flow from the variably pressurized source.

13. The method defined in claim 11 wherein the flow to the pump from the variably pressurized source of the second liquid component is restricted sufficiently when the pump is not operating to reduce the pressure between the pump and point of restriction to essentially zero.

14. The method defined in claim 11 wherein the variable restriction of the flow to the pump from the variably pressurized source of the second liquid component is automatically varied and automatically compensates for changes in negative pressure between the pump and the point of restriction.

15. A method of accurately metering proportions of a plurality of liquid components of a mixed solution consisting in:
   a. providing a positive action displacement pump having a fluid inlet and outlet;
   b. concurrently connecting by conduit the fluid inlet of the pump to separate sources of the liquid components of the solution to be mixed;
   c. restricting the flow to the inlet of the pump of each of the liquid components to be mixed sufficiently to cause the pump to operate under a starved condition at all times whereby the relative flows of each component will be metered in proportion to the relative sizes of the minimum dimensions of the conduit through which each of the components must flow to the pump inlet.

16. A flow control device comprising:
   a. a hollow body having wall structure defining separate pressure, mixing and water chambers;
   b. diaphragm means separating said pressure chamber from said mixing chamber;
   c. the wall structure defining said mixing chamber having a passage formed therethrough and connecting said mixing chamber with said water chamber and supporting a valve seat thereon surrounding said passage;
   d. valve means positioned adjacent said valve seat in position to engage and close the same;
   e. resilient means engaging said valve means and urging the same in a predetermined direction towards closed position against said valve seat;
   f. a valve stem carried by one of said diaphragm and valve means and extending therebetween to cause said valve to be opened when said diaphragm moves in an opposite direction;
   g. adjustable spring means engaging said diaphragm means and urging the same against said valve stem in said opposite direction;
   h. said body wall structure also defining a water inlet port communicating with said water chamber and a liquid outlet port communicating with said mixing chamber and at least one liquid inlet port communicating with said mixing chamber and said liquid outlet port, and
   i. a weeper passage extending through said wall structure between said water chamber and said mixing chamber whereby water may pass into said mixing chamber in small quantities for pump priming purposes when said water inlet is connected to a source of water.
17. The structure defined in claim 16 and
j. cooperating piston-cylinder means carried by said
valve means and said water chamber defining wall
structure for compensating for substantial pressure
differentials within said mixing chamber and said
water chamber.
18. The structure defined in claim 16, and
j. an open ended cylinder carried by said water cham-
ber defining wall structure;
k. a piston member carried by said valve member and
extending into said cylinder; and
l. fluid passage means extending between said mixing
chamber and the interior of said cylinder behind
said piston member and providing fluid com-
munication therebetween.
19. The structure defined in claim 18 wherein the
cross-sectional area of said piston member approxi-
mates the cross-sectional area of the opening within
said valve seat.
20. The structure defined in claim 16 and pressure
differential compensating means associated with said
valve member for compensating for substantial pres-
sure differentials within said mixing chamber and said
water chamber at opposite sides of said valve means
when such pressure differentials exist.
21. The structure defined in claim 18 wherein said
resilient means surrounds said cylinder and said piston
member and extends between and bears against said
valve member and said water chamber defining struc-
ture.
22. A flow control device comprising:
a. a hollow body having wall structure defining sepa-
rate pressure, mixing and water chambers;
b. diaphragm means separating said pressure cham-
ber from said mixing chamber;
c. the wall structure defining said mixing chamber
having a passage formed therethrough and con-
necting said mixing chamber with said water cham-
ber and supporting a valve seat thereon surround-
ing said passage;
d. valve means positioned adjacent said valve seat in
position to engage and close the same;
e. resilient means engaging said valve means and
urging the same in a predetermined direction to-
ward closed position against said valve seat;
f. a valve stem carried by one of said diaphragm
and valve means and extending therebetween to cause
said valve to be opened when said diaphragm
moves in an opposite direction;
g. adjustable spring means engaging said diaphragm
means and urging the same against said valve stem
in said opposite direction;
h. said body wall structure also defining a water inlet
port communicating with said water chamber and
a liquid outlet port communicating with said mixing
chamber and at least one liquid inlet port com-
municating with said mixing chamber and said liq-
uid outlet port;
i. an open ended cylinder carried by said water cham-
ber defining wall structure;
j. a piston member carried by said valve member and
extending into said cylinder;
k. fluid passage means extending through said valve
stem, said valve means, and said piston member
and bringing said mixing chamber into fluid com-
munication with the interior of said cylinder behind
said piston member;
l. said resilient means extending around said cylinder
and said piston and between said valve means and
said water chamber defining wall structure; and
m. a weeper passage extending through said wall
structure between said water chamber and said
mixing chamber whereby water may pass into said
mixing chamber in small quantities for pump prim-
ing purposes when said water inlet is connected to
a source of water under pressure.