United States Patent [19]

Nunlist et al.

[11] **3,791,583**

[45] **Feb. 12, 1974**

[54] **SPRAY CLEANING SYSTEM**

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[73] Assignee: **Sybron Corporation**, Rochester, N.Y.

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[52] **U.S. Cl.**..... **239/227**, 239/261, 239/265, 230/288.3, 134/167 R

[51] **Int. Cl.**..... **B05b 3/06**, B05b 1/28, B08b 3/02

[58] **Field of Search** ... 239/225, 227, 240, 241, 243, 239/247, 251, 261, 263, 265, 288, 288.3, 288.5, 264; 134/167 R, 168 R, 167 C, 168 C

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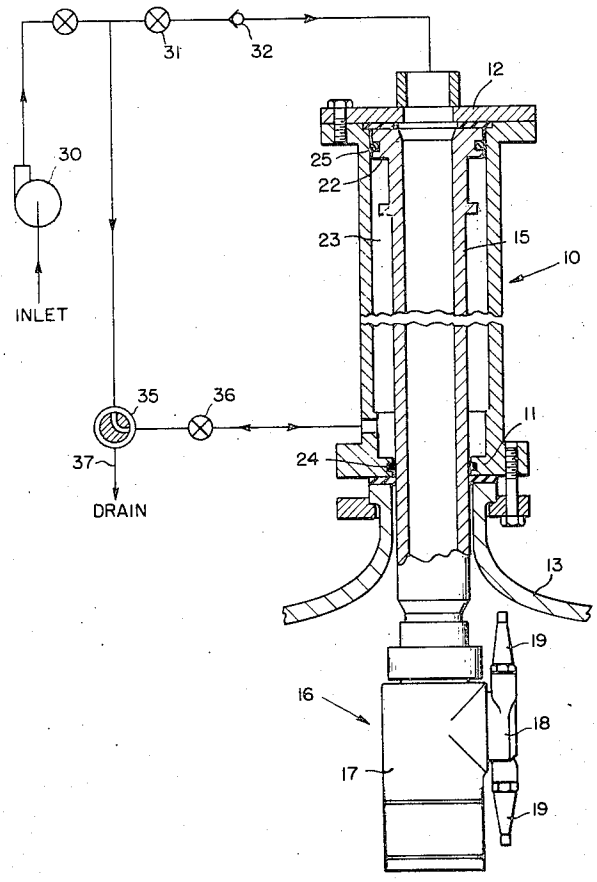
Primary Examiner—Robert S. Ward, Jr.
Attorney, Agent, or Firm—Theodore B. Roessel

[57] **ABSTRACT**

A spray cleaning head is mounted on a reciprocating cleaning fluid supply tube extending from the open end of a hydraulic cylinder. An annular piston on the tube, the tube itself, and the cylinder define an expansible chamber within the cylinder. A pump supplies cleaning fluid to the closed end of the hydraulic cylinder, whereby the cleaning fluid exerts pressure on the annular piston, and means are provided for supplying fluid to and draining fluid from the expansible chamber. The pressure exerted by the cleaning fluid on the annular piston moves the supply tube and the cleaning head from a retracted to an extended position when fluid is drained from the expansible chamber, and the supply tube and cleaning head are moved back to the retracted position when fluid is supplied to the expansible chamber.

In some embodiments, reciprocating the supply tube moves the cleaning head into and out of an open ended casing attached to the hydraulic cylinder and surrounding the supply tube. A lid closes the end of the casing when the cleaning head is in the casing; and means are provided for filling the casing with fluid when the lid is closed, thereby protecting the cleaning head. Where the cleaning head is of the type having a rotating housing and nozzles rotatably attached to the housing, the lid is preferably attached to the rotating housing, and means are provided for pivoting the lid to close the open end of the casing as the cleaning head moves into the casing and for pivoting the lid out of the spray pattern of the nozzles as the cleaning head moves out of the casing.

23 Claims, 4 Drawing Figures



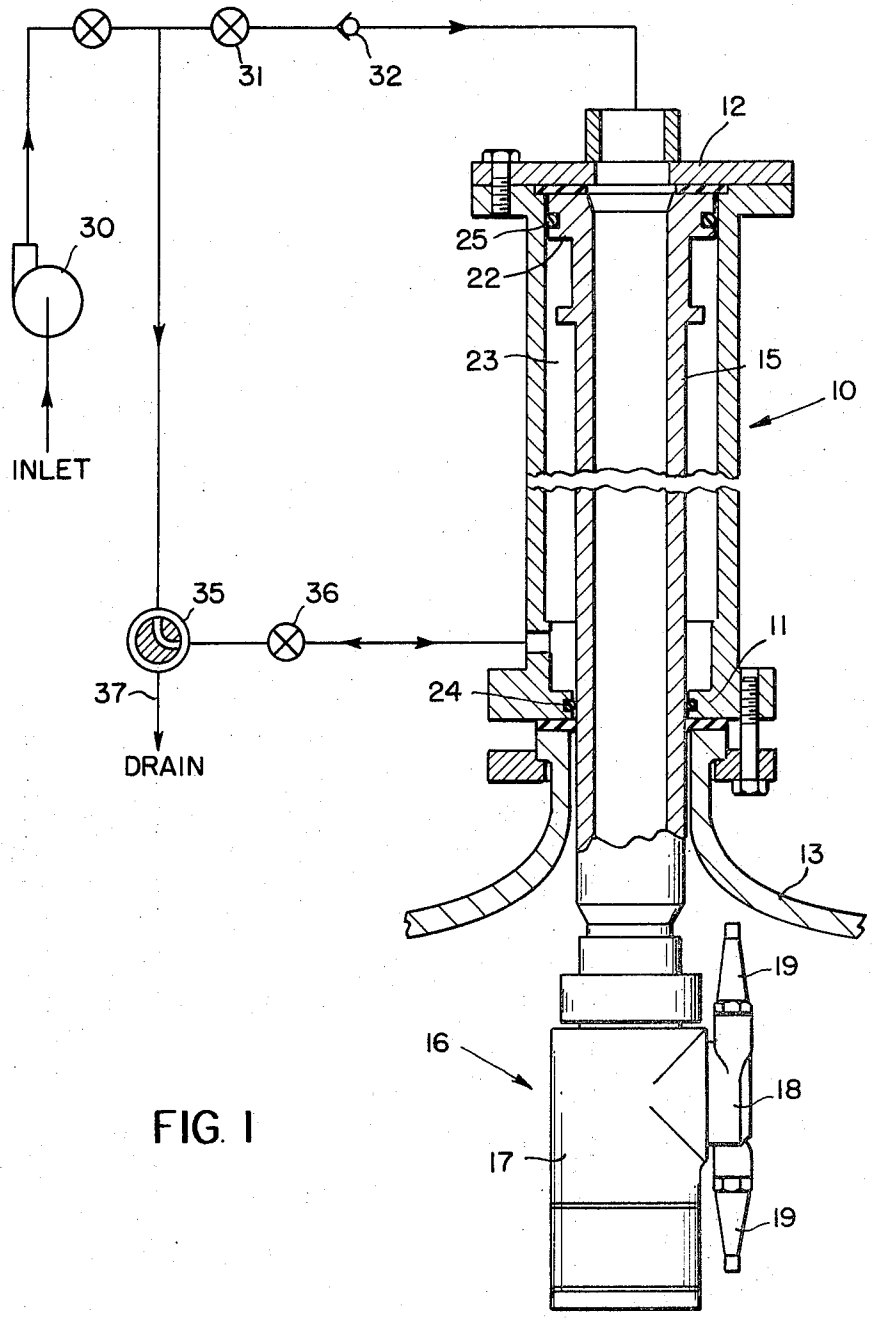

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FIG. 1

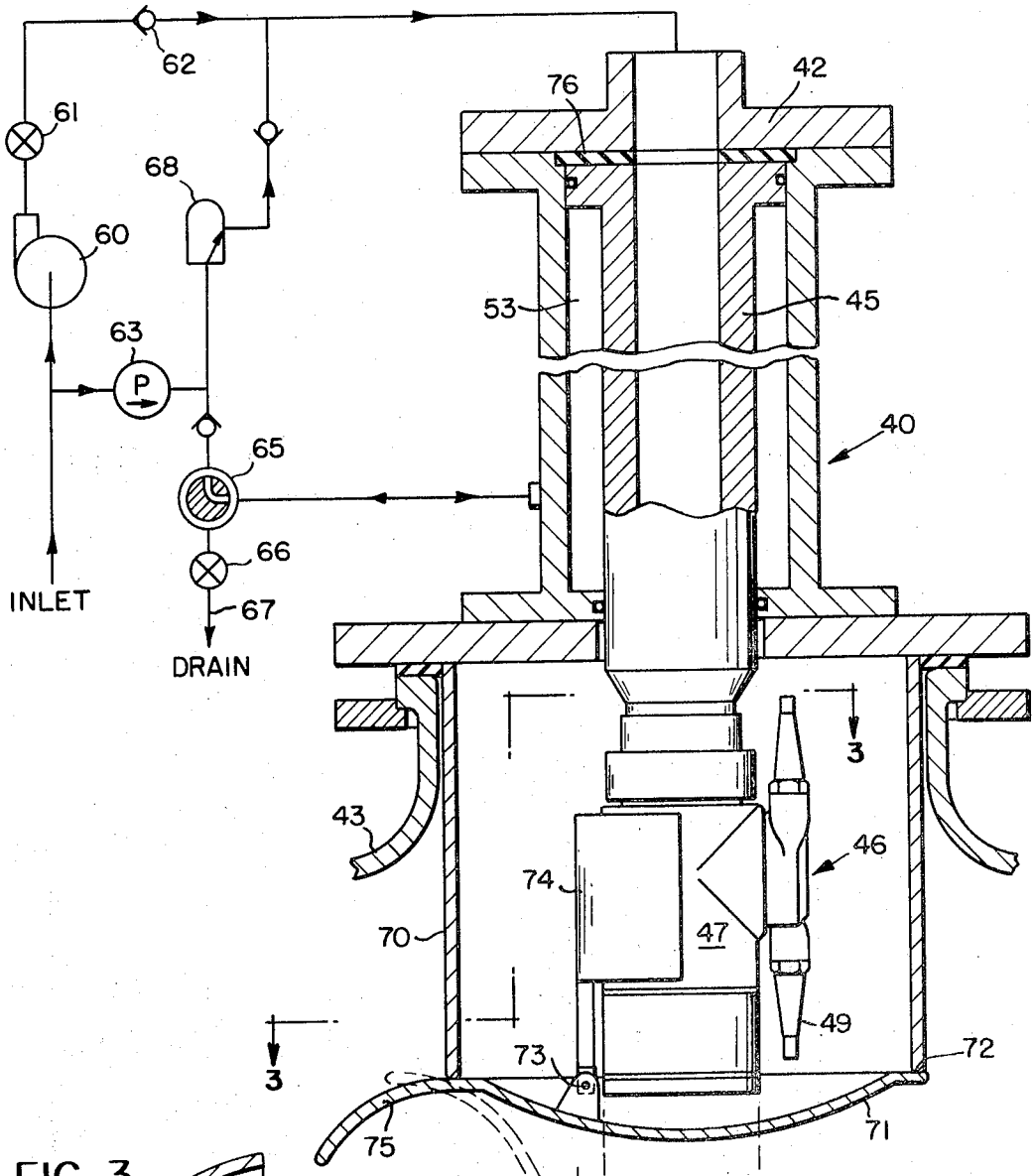
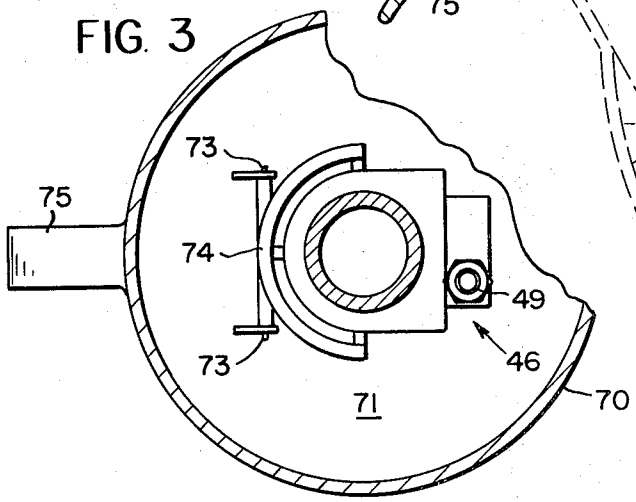

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FIG. 2

FIG. 3


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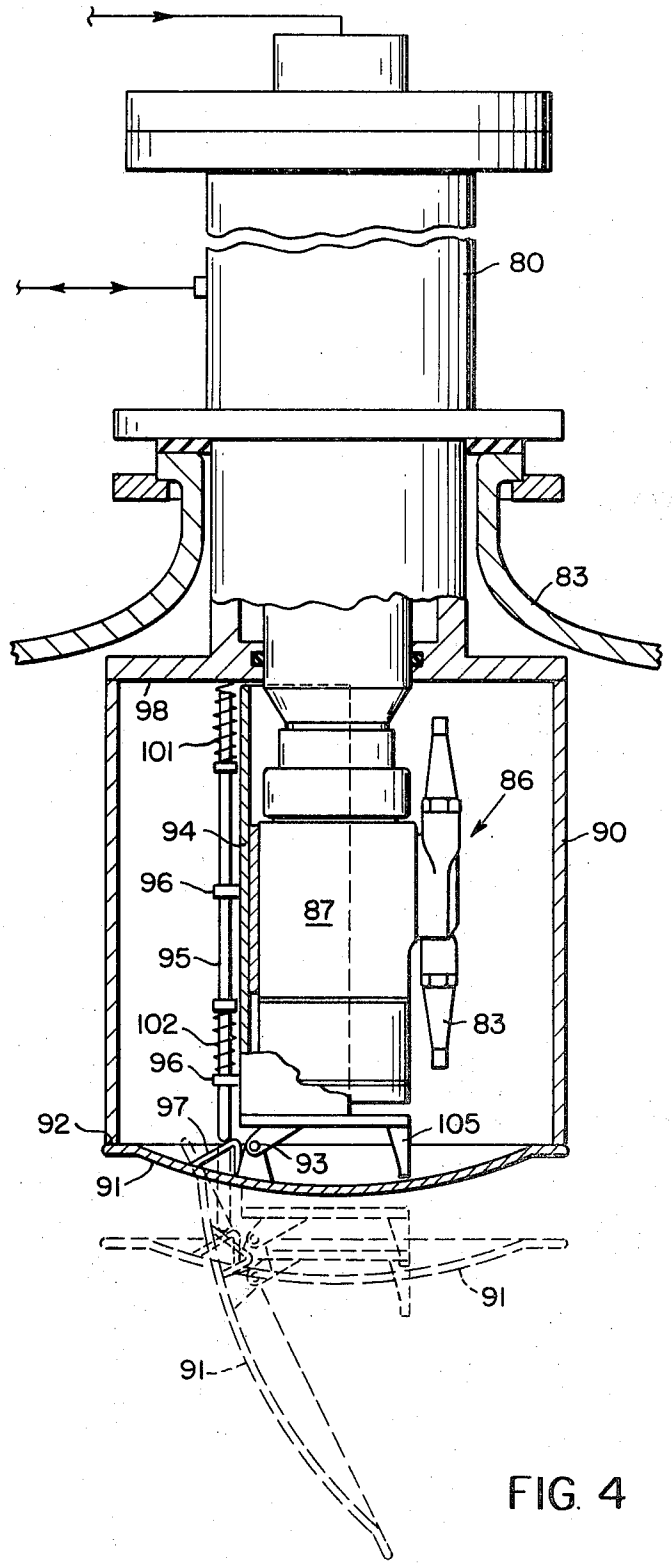


FIG. 4

SPRAY CLEANING SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to cleaning apparatus, and more particularly to an improved spray cleaning system for vessels such as chemical reactors, storage tanks and the like.

The chemical, food, and beverage processing industries use various processing and storage vessels that must be cleaned frequently. For example, batch polymerizers usually must be cleaned after each batch. Typical prior art spray cleaning systems for cleaning vessels of this sort are disclosed in U.S. Pat. Nos. 3,444,869 -- Guignon, 3,599,871 -- Ruppel and 3,645,452 -- Stoeckel. While these systems offer advantages over older techniques for cleaning these vessels, such as hand scraping, spraying with a hand lance, and flushing with solvent, they still present certain drawbacks.

Stoeckel and Ruppel disclose portable systems that are inserted into the vessel during the cleaning cycle and then removed. This adds steps to the operation of the systems and necessitates pulling a vacuum on and purging the vessel with an inert gas one or more times after the cleaning system is removed in order to remove air. Furthermore, in certain cases it may be desirable to clean a portion of the vessel, such as the head, while the vessel is pressurized, as for example during a processing cycle. The Stoeckel and Ruppel systems cannot be used for this type of cleaning in most cases.

Guignon's system, which is permanently mounted in the vessel, eliminates the purging and handling problems inherent in Stoekel and Ruppel, and also provides a system which can be utilized during a processing cycle. However, Guignon's system for moving the cleaning head within the vessel is somewhat complicated. Furthermore, since no provisions are made for protecting the spray head from chemicals being processed or stored in the vessel, Guignons spray head is subject to fouling, product build-up, and/or corrosion.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an improved system for cleaning vessels.

Another object of this invention is to provide a simpler system for positioning and supplying cleaning fluid to a spray cleaning head within a vessel. The system includes a hydraulic cylinder having an open end and a closed end. A cleaning fluid supply tube extends through the open end of the cylinder and is adapted for reciprocation within the cylinder. The cleaning head is supported by and reciprocates with the supply tube. The cylinder, the supply tube and an annular piston on the supply tube define an expansible chamber within the cylinder. A pump supplies cleaning fluid to the closed end of the cylinder, whereby the cleaning fluid exerts pressure on the annular piston, and means are provided for supplying fluid to and draining fluid from the expansible chamber. The pressure exerted by the cleaning fluid on the annular piston moves the supply tube and the cleaning head from a retracted to an extended position when fluid is drained from the expansible chamber, and the supply tube and cleaning head are moved back to the retracted position when fluid is supplied to the expansible chamber. Thus, the cleaning fluid supplied by the pump also serves as a means for positioning the cleaning head at the desired location within the vessel.

Yet another object of this invention is to provide means for protecting the spray head when it is not in use. According to the invention, the reciprocating supply tube is surrounded by an open ended casing. Reciprocating the tube moves the cleaning head into and out of the casing. A lid closes the end of the casing when the cleaning head is inside, whereby the cleaning head is protected from materials within the vessel. Preferably, in order to maximize the isolation of the cleaning head, means are provided for filling the casing with fluid when the lid is closed.

A still further object of the invention is to provide an enclosure for a spray cleaning head mounted on a reciprocating cleaning fluid supply tube, and having a housing adapted for rotation about the supply tube's longitudinal axis and nozzles rotatably attached to the housing. An open ended casing surrounds the reciprocating supply tube, whereby reciprocating the supply tube moves the cleaning head into and out of the casing. A lid is attached to the rotating housing. The lid pivots out of the spray pattern of the nozzles as the cleaning head moves out of the casing, and pivots to close the open end of the casing as the cleaning head moves into the casing.

Other objects and advantages of this invention will be apparent from the following description.

DRAWINGS

FIGS. **1, 2** and **4** are partially sectioned, partially diagrammatic views of three embodiments of this invention.

FIG. **3** is a cross-sectional view taken along lines **3—3** of FIG. **2.**

DETAILED DESCRIPTION

FIG. **1** illustrates a system suitable for use in relatively small openings in existing vessels. Typically, this system only requires about a three inch opening in the vessel wall, whereas the systems shown in FIGS. **2** and **4** require approximately fourteen and six inch openings respectively.

In FIG. **1,** a hydraulic cylinder **10** with an open end **11** and a closed end **12** is mounted on a nozzle **13** such as is typically used on glass linked vessels for connecting feedlines and installing baffles, dip pipes and the like. A cleaning fluid supply tube **15** extends through the open end **11** of the cylinder, through the nozzle **13** and into the vessel. A spray cleaning head, generally referred to as **16,** is attached to and reciprocates with the tube. A variety of commercially available spray heads may be used in this invention, however, heads such as the one shown in U.S. Pat. No. 3,637,138 to J. H. Rucker are preferred because this type of unit provides a concentrated, forceful spray that removes adhered material from the walls of the vessel. Units such as these have a first rotating housing **17** that rotates about the longitudinal axis of the supply tube, a nozzle housing **18** attached to the first housing and adapted for rotation about an axis normal to the supply tube's axis, and a plurality of nozzles **19** attached to the nozzle housing. Typically, the nozzles are offset so that the reactive force of the liquid discharged from the nozzles helps rotate the housings. In some units of this type, this reactive force assists a turbine (not shown) driven by

the cleaning fluid and connected to the first rotating housing **16** by a gear train.

The cleaning fluid is supplied by a pump **30**, typically a centrifugal pump with a capacity of 200 to 300 gpm at a discharge pressure of 200 to 300 psi, which is connected to the closed end **12** of the hydraulic cylinder by a throttling valve **31** and a check valve **32.** In most cases, water will provide satisfactory cleaning with this system, however, various other cleaning fluids may be used if desired.

The cleaning fluid is also used to position the cleaning head within the vessel. An annular piston **22** is mounted on or made integrally with the supply tube **15**, and the cleaning fluid entering the closed end of the cylinder bears against this piston, thereby urging the cleaning head towards the center of the vessel. The piston **22**, supply tube **15** and cylinder **10** also define an expansible chamber **23** within the cylinder. Seals **24, 25** are provided at the open end **11** of the cylinder and on the annular piston **22** to prevent leakage of fluid from or into this chamber. The chamber **23** is connected to the supply pump **30** by a three-way valve **35.** At the end of each cleaning cycle, the valve **35** is turned to the position shown in FIG. **1**, and the throttling valve **31** is partially closed. As a result, cleaning fluid passes into the expansible chamber **23**, forcing the piston **22** upward and retracting the cleaning head **16** toward the cylinder. A needle valve **36** is provided in the line to the expansible chamber **23** in order to control the rate of movement of the piston in the cylinder.

At the beginning of the next cleaning cycle, the three-way valve **35** is turned to connect the expansible chamber **23** to a drain line **37**, thereby allowing fluid to escape from the expansible chamber. At the same time, the supply pump **30** is started and the throttling valve **31** is opened to exert the full pressure of the pump on the piston **22**, thereby moving the cleaning head into the extended position.

Positioning of the cleaning head is achieved simply and without opening the vessel. Furthermore, this system can be used with the vessel pressurized, and with the cleaning head either fully extended into the vessel, partially extended, or in the retracted position shown in the drawing. Operation with the cleaning head retracted or only partially extended may be desirable in certain cases in order to clean specific parts of the vessel. For example, in batch polymerization it may be desirable to operate the system with the head retracted in order to prevent build up of polymer in the head space at the top of the vessel. If desired, various indicators can be added to the hydraulic cylinder so that the operator can readily determine the position of the piston and of the cleaning head.

FIG. **2** illustrates another embodiment of this invention, which offers the same simplicity and flexibility of operation as the system shown in FIG. **1**, and also provides protection for the cleaning head. In this system, an open ended cylindrical casing **70** is attached to the hydraulic cylinder **40** and extends coaxial to and surrounding the cleaning fluid supply tube **45.** Reciprocating the supply tube **45** moves the cleaning head **46** into and out of the casing **70.** A lid **71**, attached to the rotating housing **47**, seats against a lip **72** on the open end of the casing and closes the end of the casing when the cleaning head is in the casing. When the lid is closed, the casing can be filled with fluid in order to protect the head from the materials in the vessel and thereby minimize corrosion and/or fouling of the head.

As in FIG. **1**, the cleaning fluid is supplied by a centrifugal pump **60** connected, by a shut-off valve **61** and a check valve **62**, to the closed end **42** of the hydraulic cylinder. However, in FIG. **2**, fluid is supplied to the expansible chamber **53** by a second pump **63**, which is connected to the expansible chamber by a three-way valve **65.** Pump **63** is also connected by a pressure relief valve **68** to the closed end **42** of the hydraulic cylinder. The second pump **63** has a much smaller capacity and a higher discharge pressure than the main supply pump **60.** Whereas the main supply pump is typically a centrifugal pump with a capacity of 250 gpm at a pressure of 250 psi, the second pump **63** may be a small positive displacement pump having a capacity of around 1 gallon per minute. Since this pump supplies fluid to the expansible chamber **53** at a low rate, there is no need for a flow control valve in the line to the chamber. However, a needle valve **66** is provided in the drain line **67** in order to control the rate at which the cleaning head is moved into the extended position.

The cleaning head is retracted by turning the three-way valve **65** to the position shown in FIG. **2.** When the cleaning head is fully retracted, the fluid from pump **63** passes through the pressure relief valve **68** and fills the casing **70** with fluid. Pump **63** may be allowed to continue to run, thus supplying a slow flow of liquid to the casing **70** in order to make up for any leakage between the lid **71** and the casing.

As is shown in phantom in FIG. **2**, the lid **71** is adapted to pivot out of the spray pattern of the nozzle as the cleaning head moves out of the casing, and to pivot back again to close the end of the casing as the cleaning head moves back inside. As is best seen in FIG. **3**, the lid **71** is pivotally attached to pins **73** extending from a frame **74** attached to the rotating housing **47** of the cleaning head **46.** Thus, the lid rotates with the housing. The pivot pins **73** are located on the opposite side of the rotating housing **47** from the nozzles **49**, which allows the lid to pivot out of the nozzles' spray pattern. The pivot pins are also offset from the center of gravity of the lid. Thus, as the cleaning head moves out of the casing, the weight of the lid pivots it down and out of the spray pattern. If desired, counterweights may be added to the lid to insure that the lid pivots completely out of the spray pattern.

Since the weight of the lid is used to open it, this system can only be utilized where the unit is installed with the supply tube's axis generally in a vertical position. It is believed that this system will operate satisfactorily if the supply tube's axis is within about 30° of vertical. If the system is installed in some other position, various modifications can be made. For example, torsion springs may be utilized to pivot the lid.

In the system shown in FIGS. **2** and **3**, the lid is closed by a curved member **75** extending from one side of the lid **71.** As may be seen in the phantom view in FIG. **2**, when the lid is in the open position, the curved member **75** extends at least as far from the supply tube's axis as the lip **72** of the casing, which is generally coaxial with the supply tube **45.** As the cleaning head is retracted into the casing, the curved member pivots the lid **71** so that it seats squarely against the lip. The lip is located in a plane at right angles to the supply tube's axis, and the lid pivots about an axis parallel to the plane of the lip. Thus, the lid seats squarely against the lip regard-

less of the rotational position of housing **47.** Shims **76** are provided at the closed end **42** of the hydraulic cylinder to adjust the retracted position of the cleaning head, and to insure that the lid seats against the lip with the desired seating force.

In the system shown in FIG. **2,** the casing **70** is mounted in the nozzle **43** and the hydraulic cylinder **40** is located outside of the vessel. This arrangement is generally preferable where a large enough opening is available because it minimizes the intrusion of the retracted cleaning system into the vessel. For example, when the system is the mounted in the top of a chemical reactor such as a polymerizer, the system shown in FIG. **2** allows the maximum liquid level in the reactor. However, the system shown in FIG. **2** generally requires approximately a fourteen inch opening in the reactor. FIG. **4** illustrates a system which only requires approximately a 6 inch opening, and thus may be more suitable for existing vessels without large openings. In this system the hydraulic cylinder **80** extends through the nozzle **83** in the vessel wall, and the casing **90** is supported by the hydraulic cylinder.

As in FIG. **2,** the casing **90** of the system in FIG. **4** is closed by a lid **91** pivotally attached to pins **93** mounted on a frame **94** attached to the rotating housing **87** of the cleaning head. The pins are also parallel to the plane of the lip **92** on the casing, and are located on the opposite side of the rotating housing from the nozzles **83.**

In this embodiment, the lid **91** is closed by a rod **95** supported in guides **96** attached to frame **94.** The rod extends generally parallel to the supply tube's axis between a cam surface **97** on the lid and an annular surface **98** at the top of the casing **90.** The annular surface **98** is parallel to the plane of the lip **92** on the casing, which, as in the system in FIG. **2,** is at right angles to the supply tube's axis.

A coil spring **101** surrounds and extends beyond the end of the rod **95** nearest to the annular surface **98.** As the cleaning head **86** moves into the casing **90,** spring **101** contacts the annular surface **98** and moves the rod **95** longitudinally with respect to the rotating housing **87.** The other end of the rod **95** presses against the cam surface **97** on the lid, thereby pivoting the lid **91** into the closed position. As may be seen in phantom in FIG. **4,** the lid is pivoted into the closed position, that is, it is pivoted substantially parallel to the lip **92,** before the cleaning head **86** has moved all the way into the casing **90.** A stop **105** is provided on frame **94** in order to prevent the spring **101** and the closing rod **95** from pivoting the lid past the point where it is substantially parallel to the plane of the lip.

A second coil spring **102** surrounds the closing rod **95** and biases the rod towards the annular surface **98.** This spring insures that the closing rod **95** will not stick in the guides and prevent the lid **91** from opening as the cleaning head moves out of the casing. Preferably, the second coil spring **102** has a much lower spring factor than coil spring **101,** that is, less force is required to compress it. Thus, the first coil spring **101** can easily overpower the second spring **102** and close the lid as the cleaning head moves into the casing.

Since the lid **92** is pivoted into the closed position before it reaches the casing **90,** it does not slide across the lip **92** of the casing. This reduces wear on the lid and lip. However, since the system shown in FIGS. **2** and **3** uses fewer moving parts, the possibilities of corrosion and/or fouling are reduced. Thus, the preference for one system as opposed to the other may vary from installation to installation. However, in most cases, either system will effectively protect the cleaning head from the environment inside the vessel. Either system may be used with the hydraulic system shown in FIG. **1,** the hydraulic system shown in FIG. **2,** or a variety of other hydraulic systems to provide a simple, effective way for operating the system from outside the vessel and for flooding the closed chamber with fluid. Of course, it should be understood that those skilled in the art may make various modifications to the illustrated embodiments within the scope of this invention, which is defined by the following claims.

We claim:

1. Apparatus for supplying cleaning fluid to and positioning a spray cleaning head within a vessel comprising:

a hydraulic cylinder having an open end and a closed end;

a cleaning fluid supply tube extending through the open end of the cylinder and adapted for reciprocation within the cylinder, said cleaning head being supported by and reciprocating with the fluid supply tube;

an annular piston on the tube, said cylinder, tube and piston defining an expansible chamber within the cylinder;

a pump for supplying cleaning fluid to the closed end of the cylinder, whereby the cleaning fluid exerts pressure on the annular piston; and

means for supplying fluid to and draining fluid from the expansible chamber, whereby the pressure exerted by the cleaning fluid on the piston moves the supply tube and cleaning head from a retracted position to an extended position when fluid is drained from the expansible chamber, and the supply tube and cleaning head are moved back to the retracted position when fluid is supplied to the expansible chamber.

2. Apparatus according to claim **1** wherein the means for supplying fluid to and draining fluid from the expansible chamber comprises a multi-way valve adapted to connect the expansible chamber to the discharge of said pump or to a drain line.

3. Apparatus according to claim **1** wherein:

the means for supplying fluid to the expansible chamber comprises a second pump; and

a pressure relief valve connects the discharge of the second pump to the closed end of the hydraulic cylinder.

4. Apparatus according to claim **1** further comprising:

an open ended casing attached to the hydraulic cylinder and surrounding the supply tube, whereby reciprocating the supply tube moves the cleaning head into and out of the casing; and

a lid adapted to close the end of the casing when the cleaning head is in the casing, whereby the cleaning head is protected from materials inside the vessel.

5. Apparatus according to claim **4** further comprising means for filling the casing with fluid when the lid is closed.

6. Apparatus according to claim **5** wherein the means for filling the casing comprises the cleaning fluid supply pump.

7. Apparatus according to claim **5** wherein:

the means for supplying fluid to the expansible chamber comprises a second pump; and

the means for filling the casing with fluid comprises a pressure relief valve connecting the discharge of said second pump to the closed end of the hydraulic cylinder.

8. In a vessel cleaning system including a cleaning fluid supply tube adapted for reciprocation along its axis and a spray cleaning head mounted on and reciprocating with the supply tube, said cleaning head having a housing adapted for rotation about the supply tube's axis and nozzles rotatably attached to the housing, an enclosure for the cleaning head comprising:

an open ended casing surrounding the supply tube, whereby reciprocating the supply tube moves the cleaning head into and out of the casing;

a lid attached to the rotating housing;

means for pivoting the lid out of the spray pattern of the nozzles as the cleaning head moves out of the casing; and

means for pivoting the lid to close the open end of the casing as the cleaning head moves into the casing.

9. Apparatus according to claim **8** wherein:

the lid seats against an annular lip on the open end of the casing, said lip lying in a plane at right angles to the supply tube's axis; and

the lid pivots about an axis parallel to the plane of the lip.

10. Apparatus according to claim **8** wherein the nozzles are attached to one side of the rotating housing and the lid is pivotally attached to the other side of the rotating housing.

11. Apparatus according to claim **8** wherein:

the supply tube's axis is generally vertical; and

the lid is pivotally attached to the rotating housing at a location offset from the lid's center of gravity, whereby the means for pivoting the lid out of the spray pattern comprises the weight of the lid.

12. Apparatus according to claim **8** wherein:

the lid seats against an annular lip on the open end of the casing;

the lip is generally coaxial with the supply tube, and

the means for pivoting the lid to close the open end of the casing comprises a member extending from one side of the lid and adapted to contact the lip as the cleaning head moves into the casing.

13. Apparatus according to claim **8** wherein the lid engages an annular lip on the open end of the casing and the means for pivoting the lid to close the open end of the casing comprises:

an annular surface within the casing parallel to the plane in which the lip lies;

a cam surface on the lid;

a rod extending generally parallel to the supply tube's axis between said cam surface and said annular surface, said rod being supported by the rotating housing and adapted for longitudinal movement with respect to the housing; and

a coil spring surrounding the end of the rod nearest to the annular surface and extending beyond the end of the rod, said spring being adapted to contact the annular surface as the cleaning head moves into the casing, whereby the rod moves towards the lid and the lid is pivoted to close the open end of the casing.

14. Apparatus according to claim **13** further comprising a second coil spring surrounding said rod and biasing the rod towards the annular surface, said second spring having a lower spring factor than the spring that contacts the annular surface.

15. Apparatus according to claim **13** wherein said rod and said coil spring are adapted to pivot said lid into a position generally parallel to said lip before the cleaning head has moved all the way into the casing.

16. Apparatus according to claim **8** wherein the casing is attached to a hydraulic cylinder adapted to reciprocate the supply tube and thereby move the cleaning head into and out of the casing.

17. Apparatus according to claim **16** wherein the casing is mounted in an opening in a vessel and the hydraulic positioner is located outside the vessel.

18. Apparatus according to claim **16** wherein the hydraulic cylinder extends through an opening in a vessel and supports the casing inside the vessel.

19. A vessel cleaning system comprising:

a hydraulic cylinder having a reciprocating cleaning fluid supply tube extending therefrom;

a cleaning head mounted on the end of the supply tube, said cleaning head having a housing adapted for rotation about the longitudinal axis of the supply tube and nozzles rotatably attached to one side of the housing;

an open ended cylindrical casing attached to the hydraulic cylinder and extending coaxial with and surrounding the supply tube, whereby reciprocating the supply tube moves the cleaning head into and out of the casing;

an annular lip on the open end of the casing, said lip lying in a plane at right angles to the axis of the supply tube;

a lid pivotally attached to the opposite side of said rotating housing from the nozzles;

means for pivoting the lid out of the spray pattern of the nozzles as the cleaning head moves out of the casing; and

means for pivoting the lid to seat against the lip on the casing as the cleaning head moves into the casing.

20. Apparatus according to claim **19** wherein:

the supply tube's axis is generally vertical; and

the lid is attached to the rotating housing at a location offset from the lid's center of gravity, whereby the means for pivoting the lid out of the spray pattern comprises the weight of the lid.

21. Apparatus according to claim **19** wherein the means for pivoting the lid to seat against the lip comprises a member extending from one side of the lid and adapted to contact the lip as the cleaning head moves into the casing.

22. Apparatus according to claim **19** wherein there is an annular surface within the casing parallel to the plane of the lip and the means for pivoting the lid to seat against the lip comprises:

a cam surface on the lid;

a rod extending generally parallel to the supply tube's axis between said cam surface and said annular surface, said rod being mounted in guides attached to the rotating housing and adapted for longitudinal movement with respect to the housing; and

a coil spring surrounding the end of the rod nearest to the annular surface and extending beyond the end of the rod, said spring being adapted to contact the annular surface as the cleaning head is moved into the casing whereby the rod is moved towards the lid and the lid is pivoted parallel to the plane of the lip.

23. Apparatus according to claim **22** wherein said coil spring is adapted to contact the annular surface and pivot the lid parallel to the lip before the cleaning head has moved all the way into the casing.

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