

[54] **PUMP FOR ZINC-RICH MATERIALS OR THE LIKE**

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[51] Int. Cl. **F04b 21/06**

[58] Field of Search **417/554, 900, 566; 137/533.11**

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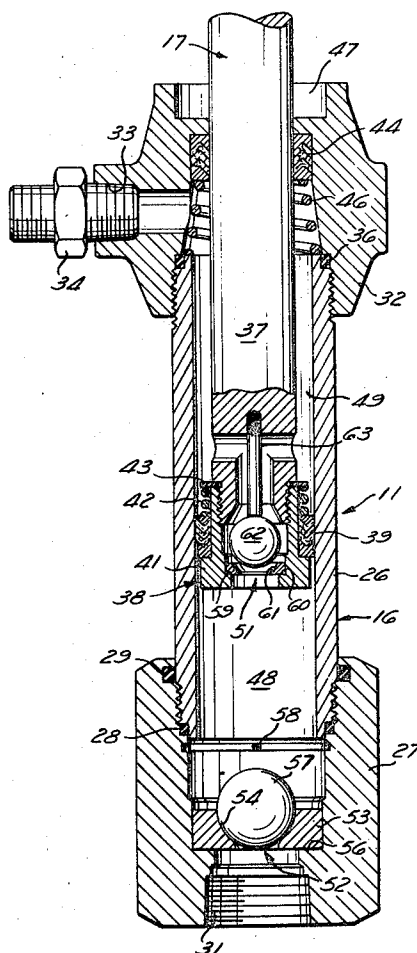
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[57] **ABSTRACT**

A pump for use in the airless spraying of zinc-rich materials or the like is disclosed. The pump is provided with valves in which the mating valve surfaces are constructed to avoid excessive localized pressure and incorporate elements formed of materials with which zinc-rich coating materials or the like do not tend to form weld type bonds. In one embodiment, a ball check valve includes a rigid ball encased in a polyurethane jacket which seats against a spherical valve seat. In another embodiment, the valve seat is provided by an O-ring formed of elastomeric material.

14 Claims, 5 Drawing Figures



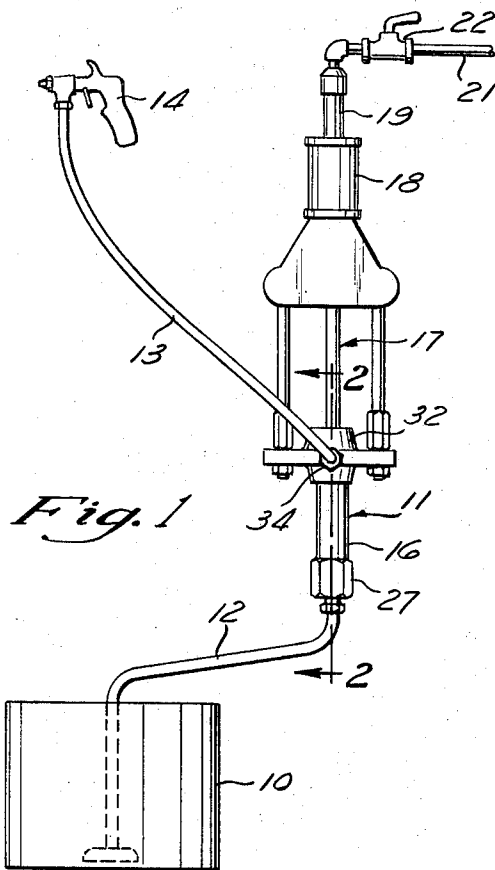


Fig. 1

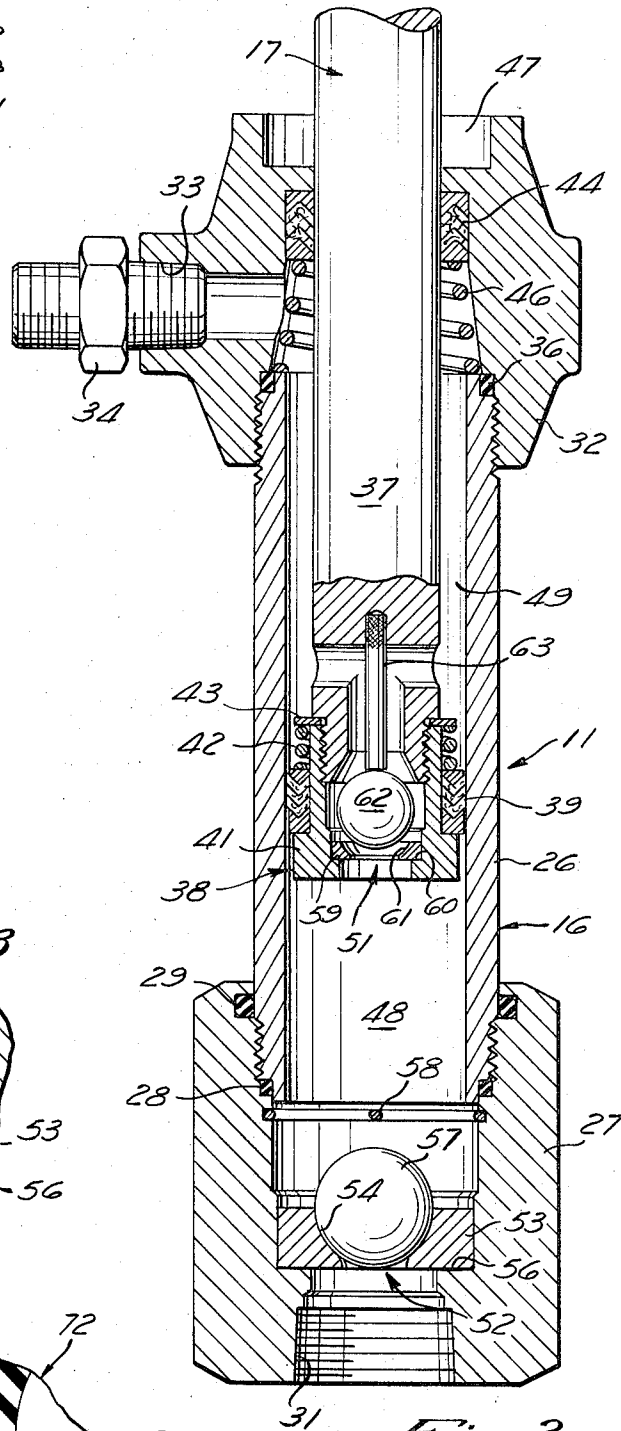


Fig. 2

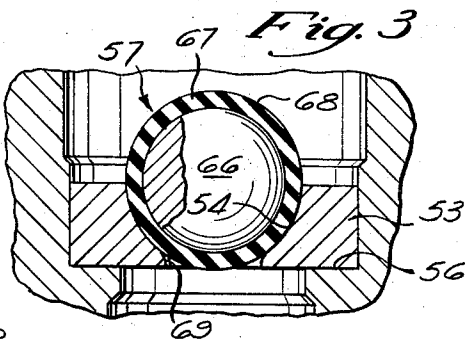


Fig. 3

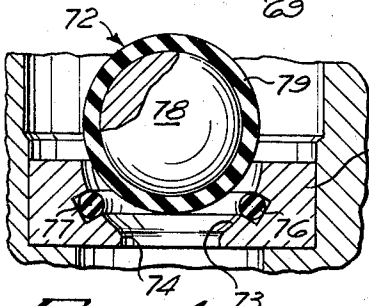


Fig. 4

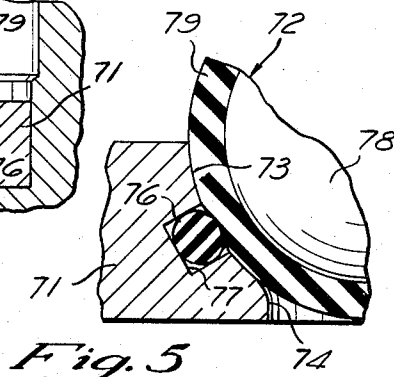


Fig. 5

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PUMP FOR ZINC-RICH MATERIALS OR THE LIKE

BACKGROUND OF THE INVENTION

This invention relates generally to pumping systems and more particularly to a novel and improved pump suited for use in airless spray coating systems with zinc-rich coating materials or the like.

Zinc-rich coating products have as a principal component powdered zinc with a content from about 25 percent to as much as 70 percent solids by volume or from about 25 percent to 95 percent solids by weight. These materials are usually divided into two main families consisting of the ethyl silicate vehicle type and the alkali metal silicate vehicle type. The zinc-rich coatings with the ethyl silicate vehicle are usually in the lower solids content category of 30 percent to 40 percent solids by volume and use organic solvents such as xylene, glycol ethers or alcohols. The second family of zinc-rich coatings with the alkali metal silicate vehicle is usually compounded with a 45 percent to 60 percent solids by volume and water is the solvent base. A third family includes the quaternary ammonium silicate with weight and volume characteristics similar to alkali metal coating. Such zinc-rich coatings are usually applied over a properly prepared metal surface, normally sandblasted to produce a particular anchor pattern, and provide a high level of corrosion resistance. Such coatings are often required, for example, on structures used in the marine, petrochemical, and utilities fields.

Such coatings have in the past normally been applied with a conventional paint spray pressure pot and a conventional air atomizing spray gun. Such application is subject to many disadvantages. For example, the ethyl silicate vehicle coatings are moisture cured in that they polymerize by exposure to moisture. Consequently, they tend to be subject to premature polymerization as a result of moisture contamination from the air supply used in the conventional pressure pot, hose and air gun. Further, because of the heavy solids characteristic of such zinc-rich coatings, it has been impractical to drive the coating material from the conventional pressure pot to any working position in excess of 15 or 20 feet above the level of the supply pot. In addition, since there is a tendency for the heavy materials to settle and separate, the length of the hose has had to be restricted. Still further, conventional air spraying of the zinc-rich coating causes objectionable overspray which tends to cause damage to downwind objects and represents a substantial material loss as overspray waste. Further, air spraying makes application of a wet film in hot, windy weather almost impossible with a consequent tendency to mud cracking in the dry film. A powdery non-cohesive film may result. Also, it imposes limitation on the thickness of the coating that may be applied and subjects the work to the risk of atmospheric contamination after a first conventional air spray coating is applied and before the second coating can be applied over the first coat.

It has been recognized that these and other problems could be eliminated or minimized if airless spraying could be used for the spray coating of such zinc-rich coatings or the like. For example, an airless pump operating in the range of 600 psi to 1,500 psi has ample power to lift the material any required distance and is not subject to the height or distance limitations of the air spray systems described above. With airless spray-

ing, the overspray problem is drastically reduced, and the tendency to cause damage to downwind objects or to encounter excessive overspray is drastically reduced and actual coverage is significantly better than with conventional air spray equipment. Further, with airless spraying, much heavier coatings can be applied often eliminating or reducing the need for multiple coatings, thus reducing the likelihood of atmospheric contamination and reducing the labor costs involved. Coatings with much higher viscosity are easily handled with airless equipment.

PRIOR ART

The recognized advantages of airless spraying have in the past been available only in the spray application of zinc-rich materials in which the solids constitute between 20 percent and 40 percent solids by volume, usually in an organic solvent system. In the past, it has been completely impractical to attempt to use airless spray equipment for the zinc-rich materials having the higher solid content because the reciprocating pumps of such systems have malfunctioned and lost the ability to pump within five to 15 minutes after operation has been commenced. The length of the operation period, without malfunction, was usually an inverse proportion of the solid content of the material being sprayed.

A pump of the type generally utilized to pressurize and pump the paint in an airless spray system is illustrated in United States Letters Pat. Nos. 3,018,968 and 3,336,066. In such pumps, a piston is reciprocated in a cylinder by an air actuator. A check valve is provided in the lower end of the cylinder and operates to permit flow only in a direction toward the main pumping chamber. A second check valve carried by the piston permits flow only from the main pumping chamber toward the secondary pumping chamber and therefrom into the discharge line.

In the past, it has been believed that the malfunctioning of such pumps when pumping zinc-rich coating materials or the like resulted from "packing" of the pump which caused the check valves to malfunction. The conventional pumps, of the type illustrated in the Letters Patent, supra, normally employ check valves consisting of a hardened steel ball which seals against a conical valve seat formed in a tungsten carbide seat member.

SUMMARY OF THE INVENTION

In accordance with the present invention, a novel and improved pump structure employs ball check valves which have been found in actual practice to function satisfactorily over extended periods of time, even when pumping zinc-rich coating materials having a solid content as high as 95 percent by weight. Such pumps function satisfactorily and provide at least the same order of service life and reliability as has been encountered in similar prior art pumps when such pumps were employed to pump typical paint materials.

We have discovered that the conventional prior art pumps have failed not from "packing," but rather from the formation of a weld type deposit of the zinc material on the valve elements.

In the preferred embodiment of this invention, the deposit problem is avoided by substantially reducing the unit pressure occurring between the ball valve and the seat and by utilizing materials with which the metal powder in the coating material does not form a weld

type bond. In one illustrated embodiment, the valve seat member is formed of metal such as carbon steel or a stainless steel shaped to provide a seat which conforms to the shape of the ball check valve element. In such illustrated embodiment, the ball element is formed with a rigid, preferably brass, ball core encased within a jacket of an elastomeric material such as polyurethane or the like. The polyurethane, because it is elastic, deforms a sufficient amount to permit full seating of the ball along the entire area of the spherical mating seat. This greatly reduces the pressure of such engagement thereby greatly reducing the tendency of the zinc to pressure weld in the valve. Further, the polyurethane material has the physical character of not providing a weld type bond with zinc. This further inhibits the build-up of zinc deposits on the valve elements. The increased surface area of the valve seat also prevents excessive wear of the elastomeric surface of the ball valve as compared to a conventional valve seat.

In another illustrated embodiment, the valve seat surface is provided by an elastomeric material and is used either with a ball element of the type used in the first embodiment or with a simple steel ball. Here, again, the elastomeric material deforms when the valve closes to prevent the occurrence of excessively high pressures along the area of engagement and also provides a surface on which the zinc does not deposit with a weld type bond.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of an airless spray system provided with a pump in accordance with the present invention;

FIG. 2 is an enlarged fragmentary section of the pump illustrating the structural arrangement thereof;

FIG. 3 is an enlarged fragmentary section of the ball check valve mounted at the lower end of the cylinder wherein the seat is spherical and the ball valve element consists of a rigid steel ball core encased within an elastomeric jacket such as polyurethane;

FIG. 4 is an enlarged fragmentary view of a ball check valve, in its open position, in accordance with a second embodiment of this invention in which the valve seat is provided with an elastomeric O-ring type sealing element, and the ball valve element has the same structure as the first embodiment; and

FIG. 5 is a view similar to FIG. 4, but illustrating the elements in the seated or valve closed position.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically illustrates an airless spray system incorporating a pump in accordance with this invention. In this system, the coating material such as the zinc-rich coating material described above is located in a supply tank 10. A pump 11 draws the material out of the tank 10 through an intake line 12 and discharges the coating material under pressure through a discharge line 13 to an airless spray gun 14. The pump 11 includes a cylinder assembly 16 and a piston assembly 17 reciprocable therein. The piston assembly 17 is powered by a pneumatic piston and cylinder actuator 18. The reciprocating operation of the actuator 18 is controlled by a valve mechanism 19 which connects the actuator 18 to an air pressure line 21 through a shutoff valve 22. The United States Letters Patents referred to above disclose the structural details of a suitable pneumatic actuator and valve mechanism. The pump 11 is

double-acting and supplies material at substantially the same pressure on each stroke of the pump.

The structural arrangement of the pump is best illustrated in FIG. 2. The cylinder assembly 6 includes a cylinder tube 26 threaded at its lower end into a valve body 27. Seals 28 and 29 prevent leakage therebetween. The lower end of the valve body 27 is provided with a threaded inlet port 31 for connection to the intake line 12. The upper end of the tube 26 is threaded into a pump block 32 which is provided with a threaded port 33 for connection to a fitting 34 on the end of the discharge line 13. Here again, a seal 36 prevents leakage between the tube 26 and the pump block 32. The piston assembly 17 includes a piston rod 37 which extends through the pump block 32 into the cylinder tube 26. Mounted on the lower end of the piston rod 37 is a piston head assembly 38 which includes a chevron type packing 39 carried by a piston head member 41. A spring 42 extends between the packing assembly 39 and a stop ring 43 to compress the packing.

A second chevron type packing 44 is carried by the pump block 32 and is compressed by a spring 46 which extends between it and the upper end of the cylinder tube 26. A lubrication cup 47 is formed in the pump block 32 around the piston rod 37. The cylinder assembly 16 is divided by the piston assembly 38 into a lower or main pump chamber 48 and an upper or secondary pump chamber 49. Communication between the two chambers 48 and 49 is controlled by a piston supported check valve assembly 51. A foot valve or inlet check valve assembly 52 is mounted in the valve body 27 and permits flow only in a direction from the inlet line 12 toward the main pump chamber 48.

The check valve assembly 52 includes a valve seat member 53 formed with a spherical valve seat 54. The valve seat member 53 is positioned in the valve body 27 against a shoulder 56. A ball valve 57 is movable into and out of engagement with the spherical valve seat 54 and is illustrated in FIGS. 2 and 3 in the closed position. A ball retainer 58 is mounted in the valve body to retain the ball in position.

When the pressure in the main valve chamber 48 is lower than the pressure in the inlet port 31, which occurs on the upstroke of the piston assembly 17, the ball valve 57 lifts away from the seat allowing flow into the main pump chamber. Conversely, on the downstroke of the piston assembly, when the pressure in the main pump chamber exceeds the pressure in the inlet port 31, the ball valve 57 seats and prevents flow out of the main chamber toward the inlet port.

The piston check valve 51 includes a similar structure. Here again, a valve seat member 59 is formed with a spherical valve seat 61 and is seated against a shoulder 60 in the piston head member 41. A ball valve 62 is sized to mate with the valve seat 61 and is movable from the open position illustrated in FIG. 2 to a closed position in which it prevents flow from the secondary pump chamber 49 toward the main pump chamber 48. In this instance, a ball retaining pin 63 is provided to limit the movement of the ball 62 in a direction away from its associated valve seat 61. The ball 62 moves away from the seat 61, as illustrated, on the downstroke of the piston and engages the seat on the upstroke of the piston.

In the first embodiment of this invention, both of the ball valves 57 and 62 have a structure as best illustrated in FIG. 3, and it should be understood that the follow-

ing description of the ball 57 applies equally to the ball 62. The ball 57 is provided with a spherical rigid core 66 preferably formed of brass or the like which is encased within a jacket 67 of elastomeric material. The outer surface 68 of the elastomeric material 67 is sized to mate with the associated valve seat 54 and provide sealing engagement therewith as illustrated in FIG. 3. One elastomeric material which has been found to be particularly suitable is polyurethane having a durometer sufficiently high so that it can withstand the seating forces without sufficient deformation to cause damage but providing sufficient flexibility or elasticity to insure proper seating and sealing. Such polyurethane material provides good wear characteristics since it is relatively tough and provides a surface with which the coating material such as zinc-rich coating materials do not form a weld type bond. In the illustrated embodiment, the spherical valve seat 54 is formed so that it provides an area engaged by the ball 57 which is about 35 percent to 40 percent of the total area of the ball 57. The piston check valve 51 in the illustrated embodiment is provided with a spherical valve seat 61 having an area engaged by the ball 62 which is about 15 percent of the total area of the ball 62. The brass core serves two functions. It provides rigidity and it adds weight to reduce the tendency of the ball to float in the coating material. In some instances the ball may be formed of a homogeneous mixture of flexible material such as polyurethane mixed with particles of heavy material such as lead to increase weight. Such ball does not tend to form weld bonds because of the lower pressures encountered and because the polyurethane again provides a surface to which the material does not tend to bond. Preferably, the valve seat 54 is provided with a curved relief section as illustrated at 69 so that the elastomeric material is not cut during valve operation. In the first embodiment, the valve seat member 53 is formed of carbon steel or stainless steel since such material provides very good wear characteristics, however, other suitable materials may be utilized.

Because the seat 54 is formed with a spherical shape which mates with the exterior surface 68 of the ball 57, a substantial area of contact is provided between the ball and the seat to resist the axial force applied to the ball by the material within the associated chamber. Consequently, excessive pressures are not encountered between the mating surface and the pressure of engagement is below the pressure required to cause a weld type deposit of the material on the valve seat 54. Consequently, deposits do not build up on the valve seat and the valve continues to function even when the pump is used to pump zinc-rich material or other powdered metal coating having a metal content up to 95 percent by weight. Such a valve also insures seating even if a slight roughness develops along the valve seat because of the ability of the jacket material 67 to deform and provide proper sealing.

In practice, a pump provided with such valves was found to have a reliable service life, when pumping a zinc-rich coating, which was substantially as long as the service life experienced with conventional valves when pumping common paint coatings. The zinc-rich material with which such service life was established is marketed under the trade name "Rust-Ban 193" by The Enjay Chemical Company. This material is a modified sodium lithium silicate stabilized with surfactants plus zinc powder and water.

FIGS. 4 and 5 illustrate a second embodiment. Each of the check valves is provided with a seat member 71 formed of tungsten carbide or the like and a ball valve member 72. The seat member 71 of this embodiment is again formed with a spherical valve seat 73 provided with a curved entrance 74. However, in this embodiment, an elastomeric O-ring seal 76 is mounted within a groove 77 formed in the valve seat 73. The groove 77 is located so that its upper wall extends in over the O-ring seal 76 to retain it in position even when the valve is in the open position of FIG. 4. Here again, the ball valve 72 is formed with a rigid core 78 of steel or the like and an elastomeric jacket 79 preferably formed of polyurethane or the like. When the ball valve 72 is seated as illustrated in FIG. 5, the materials of both the O-ring and the jacket 79 are deformed from their unstressed condition so that the jacket seats against the valve seat 73 to limit the force of engagement between the two elastomeric materials and to limit the pressure of engagement therebetween. In some instances, a valve seat assembly having an O-ring seal as illustrated in FIGS. 4 and 5 may be used with a unitary rigid ball valve element which is not provided with an elastomeric jacket. In such a valve, the structure is arranged so that the pressure of engagement between the O-ring and the ball valve is sufficiently low to prevent the weld type build-up of the coating material on the ball.

Since pumps incorporating this invention employ valves which include materials with which zinc-rich coatings do not tend to form weld type bonds and since the structure is arranged to prevent the occurrence of excessive localized pressure, such pumps may be used for pumping such zinc-rich materials without difficulty.

Although preferred embodiments of this invention are illustrated, it should be understood that various modifications and rearrangements of parts may be resorted to without departing from the scope of the invention disclosed and claimed herein.

What is claimed is:

1. A pumping system comprising a source containing a zinc-rich coating material having a solid content of at least about 45 percent by volume or the like, a pump having an inlet connected to said source operable to pump said coating material from said source to said outlet at a substantially increased pressure, said pump including a pair of relatively movable members cooperating to define a variable volume pump chamber the volume of which is changed by relative movement of said members, inlet and outlet check valves for controlling the flow of said coating material to and from said chamber, at least one of said valves including a spherically curved seat element and a ball valve element formed with mating surfaces of substantial area which are engagable to prevent backflow through said one valve, the area of the mating surface on said seat element being at least about 15 percent of the total area of said ball element, at least one of said mating surfaces being provided by elastomeric material operating to distribute the force of engagement between said elements evenly over said mating surfaces.

2. A pumping system as set forth in claim 1 wherein said zinc-rich coating material has a water base, said one valve is said inlet check valve, and said mating surface of said valve seat has an area from about 15 percent to about 35 percent of the total area of said ball valve element.

3. A pumping system as set forth in claim 2 wherein said elastomeric material is provided by said ball valve element and said seat element is provided with a curved relief at least along the inlet side of said spherical seat.

4. A pumping system as set forth in claim 3 wherein said ball valve element is provided with a rigid core and a layer of elastomeric material enclosing said core.

5. A method of pumping water based zinc-rich materials or the like comprising connecting a source of said zinc-rich material having a solid content of at least about 45 percent by volume to a pump having at least one ball check valve which includes a seat and a ball, providing said seat and ball with mating surfaces of substantial area which are engagable to prevent backflow, providing said mating surface of said seat with an area at least about 15 percent of the total area of said ball, and forming at least one mating surface from an elastomeric material operating to evenly distribute the force of engagement between said elements over said engaging and mating surfaces.

6. A method as set forth in claim 5 wherein said one ball check valve is the inlet valve, the area of said mating surface of said seat is from about 15 percent to about 35 percent of the total area of the ball.

7. A method as set forth in claim 6 including forming a curved relief on the seat of the ball check valve at least along the inlet side of the seat therein.

8. In a pumping system including a source of zinc-rich coating material having a solid content of at least about 45% by volume or the like, a pump having an outlet and an inlet connected to said source operable to pump said coating material from said source to said outlet at a substantially increased pressure, said pump including a pair of relatively movable members cooperating to define a variable volume pump chamber the volume of which is changed by relative movement of said members, inlet and outlet check valves for controlling the flow of said coating material to and from said chamber, the improvement comprising at least one of said valves including a spherically curved metal valve seat and a ball check valve comprising a substantially rigid metal core encased within a layer of elastomeric

material, said valve seat and said ball check valve having mating surfaces of substantial area with substantially the same radius of curvature, said mating surface of said valve seat having an area at least about 15% of the total area of said ball, said valve seat being provided with a curved relief adjacent to the inlet side of said spherically curved seat, said surfaces being engagable to prevent backflow through said one valve.

9. The improvement set forth in claim 8 wherein said layer of elastomeric material is polyurethane.

10. The improvement set forth in claim 9 wherein said one valve is the inlet valve, and said mating surface of said valve seat has an area from about 15 percent to about 35 percent of the total area of said ball check valve.

11. In an airless spray pump for liquid coating material including a pair of relatively movable members cooperating to define a variable volume pump chamber the volume of which is changed by relative movement of said members, an inlet and an outlet to said chamber, inlet and outlet check valves for controlling flow to and from said chamber, the improvement comprising at least one of said valves including a spherically curved metal valve seat and a ball check valve comprising a substantially rigid metal core encased within a layer of elastomeric material, said valve seat and said ball check valve having mating surfaces of substantial area with substantially the same radius of curvature, said mating surface of said valve seat having an area at least about 15 percent of the total area of said ball check valve, said surfaces being engagable to prevent backflow through said one valve.

12. The improvement set forth in claim 11 wherein said layer of elastomeric material is polyurethane.

13. The improvement set forth in claim 11 wherein said one valve is said inlet valve.

14. The improvement set forth in claim 13 wherein said mating surface of said valve seat has an area from about 15 percent to about 35 percent of the total area of said ball check valve.

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