May 29, 1956 R. H. DEITRICKSON 2,748,036

METHOD FOR PROVIDING A PRESSURE RESPONSIVE VARIABLE SPRAY

Filed May 10, 1954 3 Sheets-Sheet 1

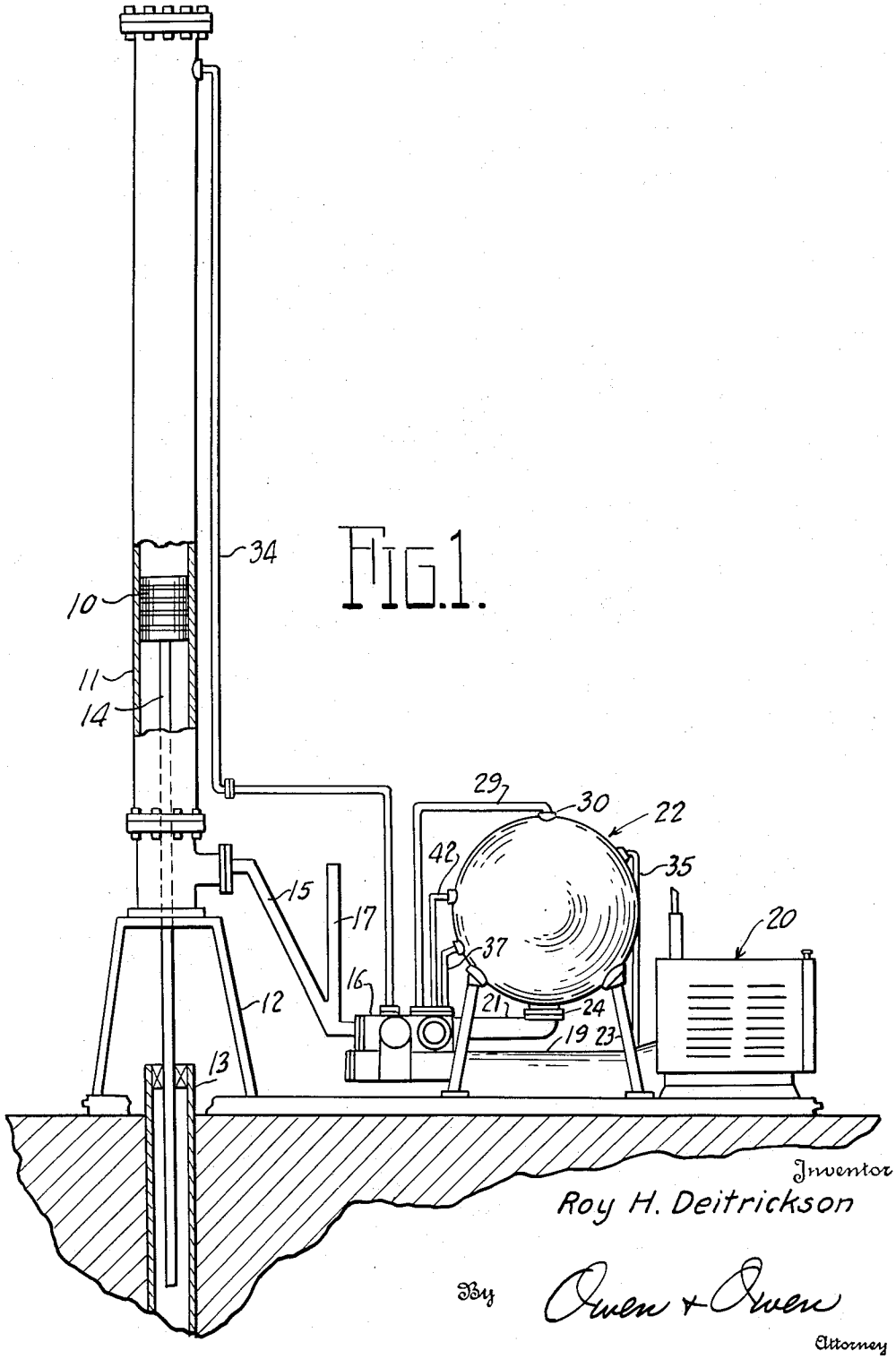


Fig. 1.

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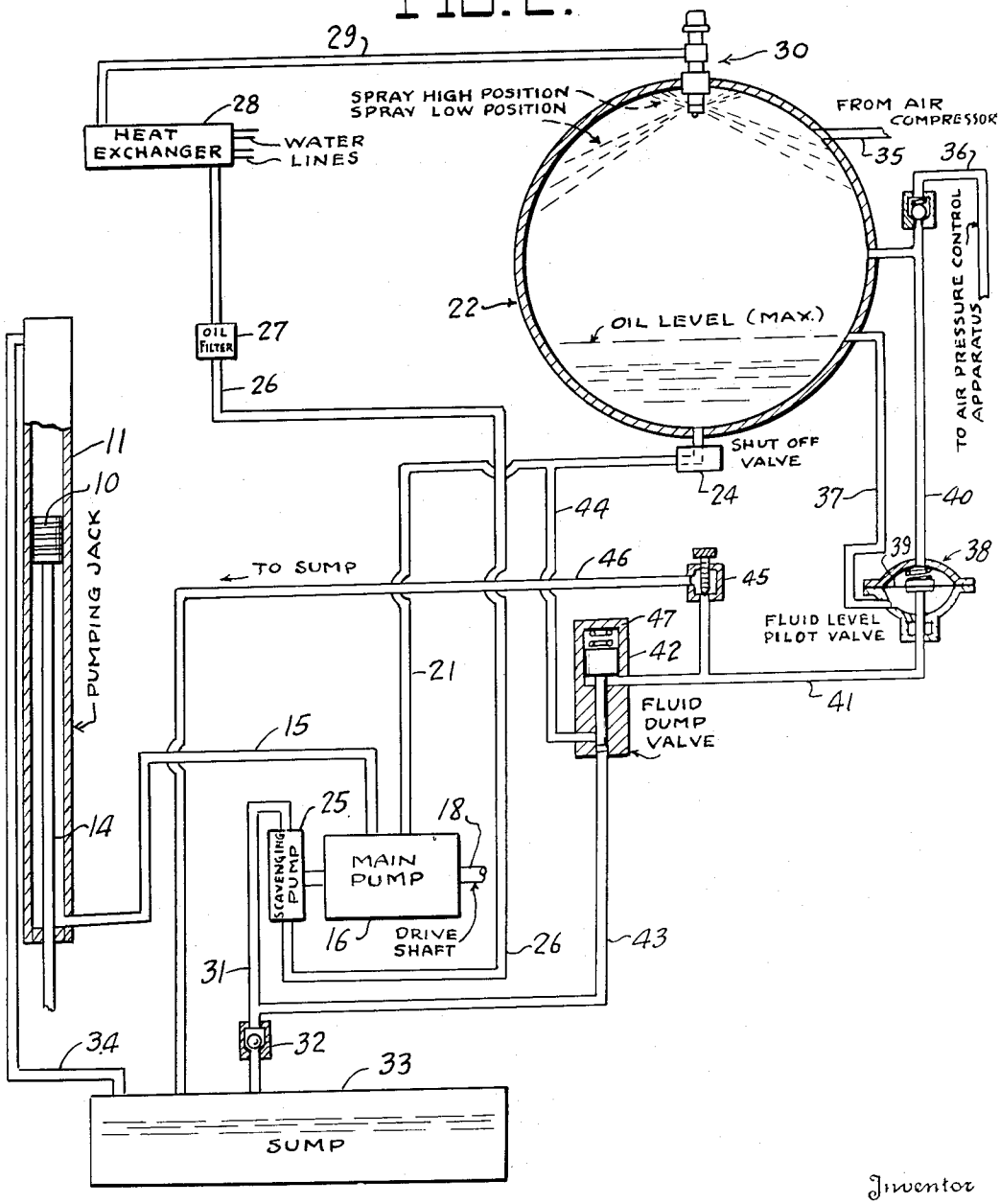
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FIG. 2.



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FIG. 3.

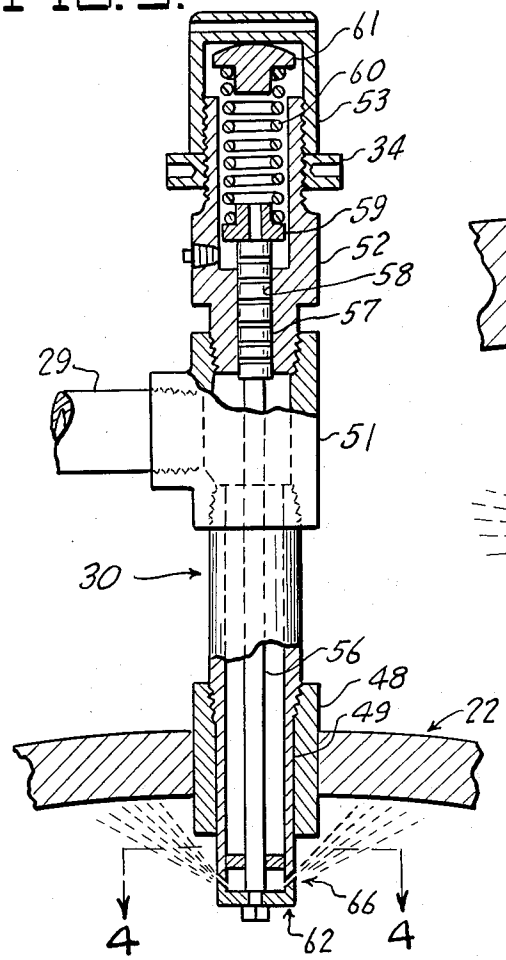


FIG. 5.

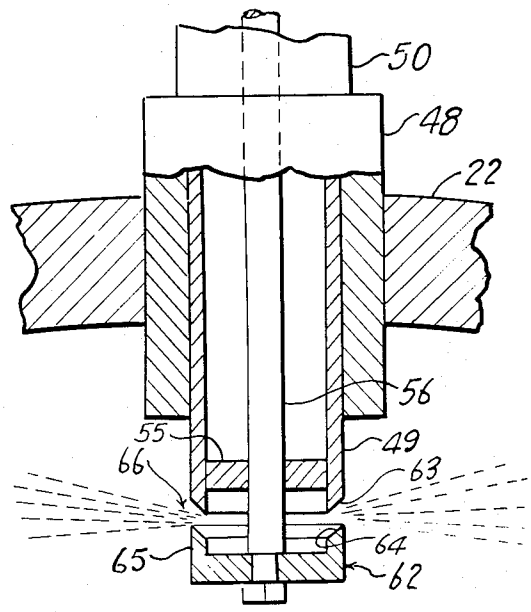
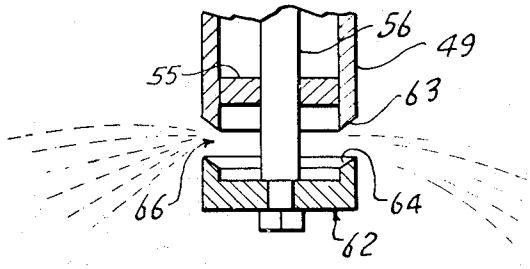


FIG. 6.



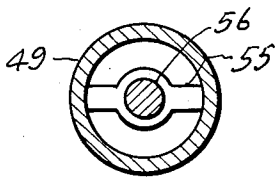


FIG. 4.

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2,748,036

METHOD FOR PROVIDING A PRESSURE RESPONSIVE VARIABLE SPRAY

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Application May 10, 1954, Serial No. 428,546

2 Claims. (Cl. 134—24)

This application is a continuation-in-part of my application Serial No. 354,168, filed May 11, 1953, now abandoned.

This invention relates to a method for introducing a variable spray into a pressure tank of a hydraulic system.

A surface hydraulic apparatus includes a pumping cylinder or pumping jack in which there is located a piston that is connected to a pump rod which usually extends downwardly from the pumping jack and is operatively linked to the sucker rod string extending down to the pump itself at the production area level. A hydraulic system for the introduction of working fluid under high pressure into the pumping jack to force the piston upwardly usually includes a main pump and an engine for driving the pump, a sump for providing a supply of working fluid, a so-called "counter-balancing tank" in which a volume of working fluid is kept under pressure for the storage of energy so that the load on the pump engine can be kept relatively constant during both up and down strokes and the necessary controls, valves and hydraulic lines properly to connect one part of the apparatus with the others.

In a system of this general type various control means must be provided for automatically controlling the connections between the various elements, the operation of the pump, and the proper pressures and volumes of both the working fluid and air within the system.

One of the many problems existing in apparatus of this type arises from the fact that the counterbalancing tank must contain both working fluid and air. The air is pumped into the tank, usually by an air compressor under pressure control means, and carries moisture along with it which, under the conditions of pressure in the tank, condenses out of the air onto the wall of the tank.

Condensation on the inner wall of the tank corrodes the tank wall which not only harms the tank wall but the oxides formed get into the working fluid and are harmful to various elements of the apparatus.

It is usual to provide inhibitors and anti-corrosive agents in the working fluid which, in the present invention are used to keep the tank interior clean by so spraying the working fluid onto the upper inner wall of the tank that it runs down the wall, washing away condensates and protecting the surface of the tank wall. It is also usual to pass the working fluid through filters and heat exchangers prior to spraying it onto the tank walls.

Conventional spray arrangements, however, have two difficulties. One, their orifices tend to become clogged and, two, while the areas of impingement of the sprays on the wall of the tank are kept clean, surrounding areas are not protected uniformly.

It is, therefore, the principal object of this invention to provide a method for spraying the make up and anti-corrosive liquid into a pressure tank and varying the area of impingement of the spray on the tank wall.

Another object of this invention is to provide a method for operating a spray having a single 360° spray orifice which is opened and closed in direct response to pressure within the tank, thereby varying both the orifice size (and consequently the velocity of the fluid through the orifice) and the area of impingement of the spray on the tank wall.

Other and more specific objects and advantages of the invention will be better understood from the specification which follows and from the drawings in which:

Fig. 1 is a simplified view, in elevation and on a very small scale, of a surface hydraulic apparatus for actuating the sucker rod of a downwell pump, certain parts being shown in section.

Fig. 2 is a simplified schematic hydraulic diagram of the main apparatus and lines constituting a surface hydraulic system and, in particular, the fluid circulation systems, both for pump operation and working fluid cleaning and level control.

Fig. 3 is a greatly enlarged vertical sectional view of a spray operable according to a method embodying the invention, parts being broken away.

Fig. 4 is a horizontal sectional line on the line 4—4 of Fig. 3.

Fig. 5 is a further enlarged fragmentary vertical sectional view showing the lower portion of the spray illustrated in Fig. 3.

Fig. 6 is a fragmentary view similar to Fig. 5 but showing the spray in different position.

A surface hydraulic system embodying the invention includes a number of conventional structures, the operation of which the invention is designed to facilitate. A surface hydraulic apparatus is designed for the purpose of actuating a piston **10** in its pumping jack **11** which may be erected upon suitable framework **12** extending vertically above a casing **13** of a well. A sucker rod **14** is attached to the piston **10** and extends down the casing **13** where it is connected to the plunger of a pump (not shown) located in the production area of the well. The pumping jack **11** is connected by a main pump line **15** to a main pump **16**. The line **15** may be provided with an accumulator pipe **17** (see Fig. 1—not shown in Fig. 2) for the purpose of reducing the peak sucker rod stresses by absorbing pulsations in power fluid beneath the piston **10**.

The pump **16** is driven by a shaft **18** (Fig. 2) extending through a shaft tunnel **19** (Fig. 1) and connected by suitable clutch means (not shown) to an engine **20**.

The pump **16** also is connected by a main tank line **21** to the bottom of a counterbalancing tank generally indicated at **22**. The counterbalancing tank **22** is mounted upon legs **23** and provided with a shut off valve **24**.

In addition to the main pump **16** the present system includes a constantly driven scavenging pump **25** which is connected by a scavenging pump output line **26** through an oil filter **27** and heat exchanger **28** to a tank return line **29**. The tank return line **29** is attached to a spray nozzle generally indicated at **30** (Fig. 2) located at the top of the tank **22** and through which working fluid returned to the tank by the scavenging pump **25** is sprayed onto the interior surface of the tank **22**. Spraying the working fluid onto the interior surface of the tank **22** at its top provides for thorough washing over the surface of the tank **22** so that the rust and oxidization inhibitors introduced into the working fluid may prevent corrosion and condensation on the inner surfaces of the tank **22**.

The scavenging pump **25** has an input line **31** which is connected through an upwardly openable check valve **32** to a main sump **33**. The top of the pumping jack **11** also is connected by a line **34** to the sump **33** so that leakage past the jack piston is returned to the sump. Since the hydraulic system operates under a substantial pressure as hereinafter described, leakage is bound to

occur at various points, and it is the function of the scavenging pump to make up for these losses.

An air compressor (not shown) is connected by a line 35 to the upper portion of the tank 22 and functions to maintain pressure within the tank 22.

In general, the apparatus operates as follows: During an up stroke the pressure maintained within the tank 22 forces working fluid through the line 21 to the main pump 16. The pump 16 raises the pressure on the fluid and pumps it through the main line 15 into the pumping jack 11. The high pressure working fluid thus introduced into the pumping jack 11 beneath the piston 10 raises the piston 10 lifting the sucker rod 14 and the column of production fluid located in the casing 13 or in the tubing (not shown) within the casing 13 and delivering a quantity of the production fluid to the top of the well and to the production fluid manifold (not shown) whence it is led to storage or further treatment.

Upon the completion of an up stroke caused by the introduction of high pressure working fluid beneath the pumping jack piston 10, suitable reversing valves are actuated and the fluid within the pumping jack 11 flows back through the main line 15 to the main pump 16 and then with higher pressure added by the main pump 16 is pumped back into the counterbalancing tank 22.

By suitable air pressure control means which are connected to the tank 22 by an air pressure control line 36, the air pressure within the tank 22 is maintained at a desired level by controlling the operation of the air compressor. The pressure to be maintained within the tank 22 is calculated according to the work to be performed by the equation

$$P_r+\frac{P_s}{2}=P_c$$

in which P_r is the unit pressure beneath the piston 10 created by the weight of the sucker rod 14, P_s the unit pressure exerted on the piston 10 by the static head of the column of production fluid in the well tubing and P_c equals the counterbalancing pressure to be applied by the counterbalancing tank 22. If, for example, the sucker rod 14 creates a pressure of 200 p. s. i. beneath the piston 10 and the weight of the column of production fluid creates a similar pressure of 400 p. s. i., then

$$200+\frac{400}{2}=400$$

the pressure to be supplied by the counterbalancing tank 22. Using these figures, the air pressure control means is so adjusted as to control the air compressor to maintain an average pressure of 400 p. s. i. in the tank 22.

On the up stroke the 400 p. s. i. pressure provided by the tank 22 is added to the additional pressure provided by the main pump 16 in order to overcome the 200 p. s. i. pressure of the sucker rod 14 and the 400 p. s. i. pressure of the column of production fluid, a total of 600 p. s. i. Therefore, the main pump 16 must supply a pressure of 200 p. s. i. On the down stroke the weight of the sucker rod 14 causes a 200 p. s. i. pressure on the input side of the pump 16 and the pump must again add 200 p. s. i., in order to pump the fluid back into the tank 22, the tank pressure being maintained at 400 p. s. i. Thus energy is stored in the tank 22 on the down stroke by the action of the pump and extracted to assist the pump 16 in performing the work of the up stroke.

In the present system, during such operation the scavenging pump 25 also is constantly pumping to draw make-up working fluid from the sump 33 through the check valve 32 to pump it through the output line 26, oil filter 27 and heat exchanger 28 to the tank line 29 and into the tank 22. While the scavenging pump 25 delivers a higher pressure than the pressure within the tank 22 so that the make-up fluid can be introduced into the tank 22, the volume delivered by the scavenging pump is relatively small. It produces, however, a recirculation of all of the fluid in the system thus filtering and cooling the fluid to keep it in good condition.

The level of working fluid within the counterbalancing tank 22 of course rises and falls as it is pumped from the counterbalancing tank 22 during the up stroke of the pumping jack piston 10 and returned to the counterbalancing tank 22 during the down stroke of the pumping jack piston 10. The out-flow and in-flow of the main volume of working fluid from and to the tank 22 produces substantial changes in the pressure within the tank 22.

As has been mentioned, during operation of the device make-up working fluid constantly is being drawn from the sump 33 by the scavenging pump 25 and pumped into the tank 22 at a constant pressure through the spray 30. When the accumulated working fluid in the tank 22 introduced both through the spray 30 and by return to the tank 22 of fluid from the main pump 16 reaches a level above the maximum desired level, some of it flows down a fluid level sensing pipe 37 to a fluid level control pilot valve 38 where it is applied beneath a diaphragm 39 subjected on its upper side to air pressure in the tank 22 from an air pressure pipe 40 and on its lower side to the air pressure plus the head of fluid standing in the pipe 37. When the diaphragm 39 is raised in response to the accumulation of a predetermined head of fluid in the pipe 37 the fluid level pilot valve is opened allowing fluid in the pipe 37 to flow under tank pressure into a line 41 where it actuates a fluid dump valve 42 to connect a scavenging pump suction line 43 to a tank branch line 44. This directly connects the scavenging pump in series with the bottom of the counterbalancing tank 22 and the oil filter 27, heat exchanger 28 and top spray 30 on the counterbalancing tank 22. With this path for recirculation established the check valve 32 is closed and no additional working fluid is drawn from the sump 33 until the head of fluid in the pipe 37 drops sufficiently far to allow the fluid level pilot valve 38 to close and fluid in the pipe 41 bleeds away through a fluid bleeder valve 45 and a sump line 46 to the sump 33. When this occurs the fluid dump valve 42 is closed by its spring 47 and the scavenging pump once more draws fluid from the sump 33 and pumps it into the tank 22 through the spray head 30.

Depending on the level of working fluid in the counterbalancing tank 22, then the working fluid pumped through the spray head 30 originates either in the sump 33 or is directly recirculated from the quantity of working fluid within the tank 22. The variations in pressure within the counterbalancing tank 22 caused by the variations in working fluid level, air pressure, and atmospheric conditions around the tank 22, are made use of in spray apparatus operated according to the invention to vary both the spray orifices and the areas of impingement of the spray upon the interior of the counterbalancing tank 22.

The spray head generally indicated at 30 in Figs. 2 and 3 comprises a number of parts designed to be responsive to variations in pressure within the counterbalancing tank 22 according to the invention. The spray head 30 is mounted in the tank 22 by a sleeve-like nipple 48 (Fig. 3) in which a tube 49 is threaded intermediate its ends. The tube 49 carries a T 51 into which the line 29 is threaded and into the upper end of which there is threaded a cup 52. The cup 52 is coaxial with the tube 49. A cap 53 is threaded on the exterior of the upper end of the cup 52 and provided with a spanner nut 54 by which the cap 53 is rotated for vertical adjustment.

Near the bottom of the tube 49 a guide web 55 is fixed in place and acts as a guide for a valve rod 56 which extends upwardly through the tube 49 and is connected to a larger diameter piston 57. The piston 57 is slidably engaged in a bore 58 in the base of the cup 52 and mounts a shouldered collar 59 at its upper end. A

coil spring 60 extends between the collar 59 and a spring cap 61 which bears on the undersurface of the cap 53. Thus by rotating the cap 53 the spring 60 can be compressed or extended to vary its downward thrusting force on the collar 59, the piston 57 and rod 56.

An orifice cap 62 (see also Fig. 5) is mounted on the lower end of the rod 56 and extends across the open lower end of the valve tube 49. As can best be seen in Figs. 5 or 6 the lower end of the valve tube 49 is beveled providing a conical edge 63 which is opposed to an oppositely beveled edge 64 cut on an upwardly extending rim 65 on the cap 62. The opposed edges 63 and 64 form an orifice, generally indicated at 66, extending horizontally 360° around the cap 62.

As was explained above, the pressure of the fluid pumped into the line 29 and spray 30 by the scavenging pump 25 is higher than the maximum pressure normally to be expected within the counterbalancing tank 22. The balance of forces acting in the spray 30 results in the cap 62 being thrust downwardly greater distances as the pressure within the counterbalancing tank 22 lowers and being raised as the pressure within the counterbalancing tank 22 rises. The working fluid pumped through the line 29 into the closed chamber formed by the spray tube 49, T 51 and piston 57 acts downwardly on the upper surface of the cap 62 over an annular area on the upper face of the cap 62 defined by the diameter of the piston 57 at the inside and the outer edge of the disk 52 at the outside. Thus the higher pressure of the scavenging pump fluid acts over an area smaller than the total area of the undersurface of the cap 62 against which pressure within the counterbalancing tank 22 is applied.

The force of the spring 60 is so selected and so adjusted by rotating the cap 53 that it applies a downward force through the piston 57 and rod 56 to the disk 62 which is added to the force of the working fluid acting on the annular area above described and overcomes the pressure within the counterbalancing tank acting against the underside of the cap 62. By adjustment of the force applied to the spring 60 it can be predetermined when the cap 62 will move downwardly, opening the orifice 66.

As explained above, when the pressure conditions within the counterbalancing tank 22 change the cap 62 moves upwardly or downwardly varying the size of the annular orifice 66 directly in response to such variations in internal pressure in the tank 22.

In Fig. 3 the cap 62 is shown near its uppermost position closely adjacent the end of the tube 49 and thus with the orifice 66 almost closed. Because the orifice 66 is almost closed the working fluid pumped through the line 29 from the scavenging pump is sprayed through the orifice 66 with higher velocity and therefore the upward inclination of the two edges 63 and 64 forming the orifice 66 causes the spray to jet upwardly closely adjacent the nipple 48 and to impinge on the inner wall of the tank 22 in an annular area at its very top.

As pressure within the tank 22 drops the balance of pressures described above causes the cap 62 to move to a position more or less like that shown in Fig. 5. Under these conditions with the orifice 66 opened more widely, the velocity of the fluid spraying out through the orifice 66 is less than it is when the orifice 66 is smaller, and the area of impingement of the spray on the wall of the tank 22 widens and moves downwardly along the wall of the tank 22.

Similarly, when pressure within the tank 22 is at its lowest and the orifice cap 62 moves downwardly to the position shown in Fig. 6, the orifice 66 is even wider and the velocity of the working fluid pumped therethrough is still lower. It may, in fact, reach such a low point that the upward component of its direction of spray caused by the upwardly inclination of the edges 63 and 64, may be entirely overcome. In this case the spray is jetted out horizontally and it may impinge the wall of the tank 22 at levels as low as those indicated generally in Fig. 2 by the legend "spray low position."

As the pressure within the tank 22 varies during the normal in-flow and out-flow of fluid and for the other reasons explained above, the annular area of impingement of the sprayed fluid from the spray 30 thus rises and lowers and varies in size over the upper half of the tank. Simultaneously the velocity of the working fluid being sprayed through the orifice 66 also is constantly changing. These two variations accomplish the two objectives of preventing the clogging of the spray orifice 66 which might occur were the orifice to remain of the same size and the fluid always to have the same velocity and "wiping" the fluid spray up and down the tank to insure that the tank wall is thoroughly and completely treated with the anti-oxidants and anti-corrosives contained in the working fluid.

While the method of the present invention has been explained in connection with a specifically disclosed apparatus it should be expressly understood that other apparatus may be used.

What I claim is:

1. The method for the introduction of constant pressure anti-corrosive make-up liquid into a spherical pressure tank that is subject to substantial changes of interior pressure and volume of liquid therein and that is subject to corrosion on its walls, said method consisting of introducing into said tank at its upper center, a circular, outwardly directed spray of make-up liquid comprising a material that is anti-corrosive to the interior surface of said tank, maintaining a constant pressure on the make-up liquid being supplied to said spray and varying the vertical cross sectional area of said spray inversely to the volume of liquid and the pressure in said tank whereby said spray impinges on the walls of said tank at a high point when the pressure therein is high and at a lower point when the pressure in said tank is reduced and a fluctuating tank pressure causes said spray to sweep vertically over said walls.

2. The method for the introduction of constant pressure make-up liquid into a spherical pressure tank that is subject to substantial changes of interior pressure and volume of liquid therein and that is subject to corrosion on its interior walls, said method consisting of introducing a circular, outwardly directed spray of make-up liquid comprising a material that is anti-corrosive to the interior surface of said tank into said tank at its upper center, maintaining a constant pressure on the make-up liquid being supplied to said spray and concomitantly varying the velocity of said spray directly to the product of the volume of liquid and the pressure in said tank and varying the volume of said spray and its area of impingement on the wall of said tank inversely thereto.

No references cited.