July 13, 1965 W. J. KUDLATY 3,193,988

DEVICE FOR REMOVING A GAS FROM A LIQUID

Filed Jan. 8, 1962

FIG. 1

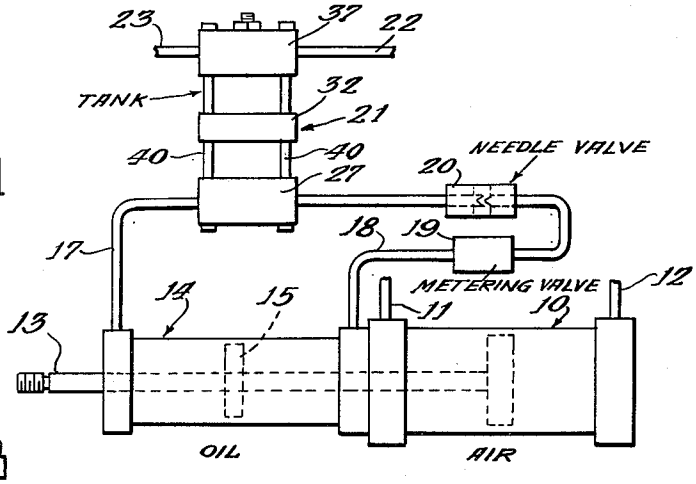


FIG. 3

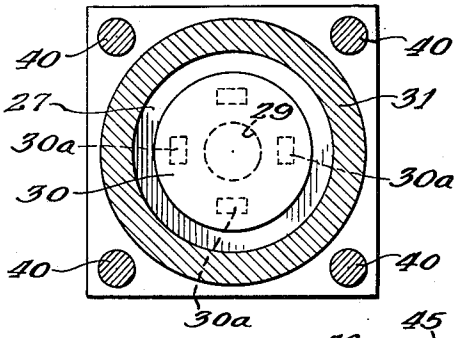


FIG. 2

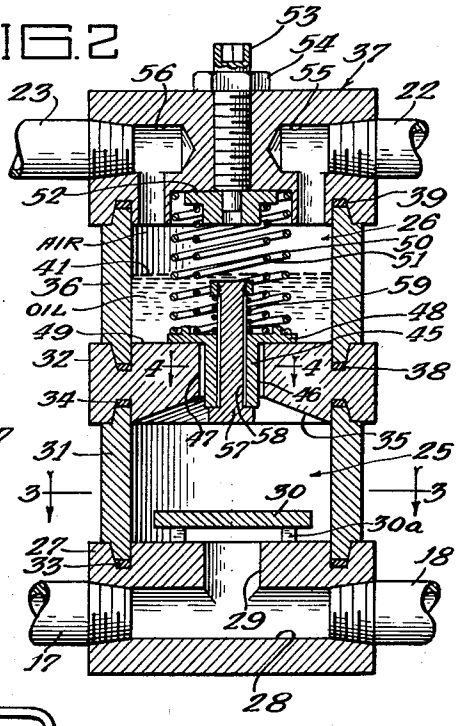


FIG. 4

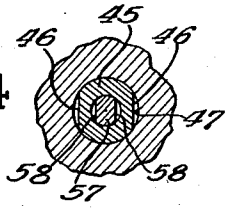
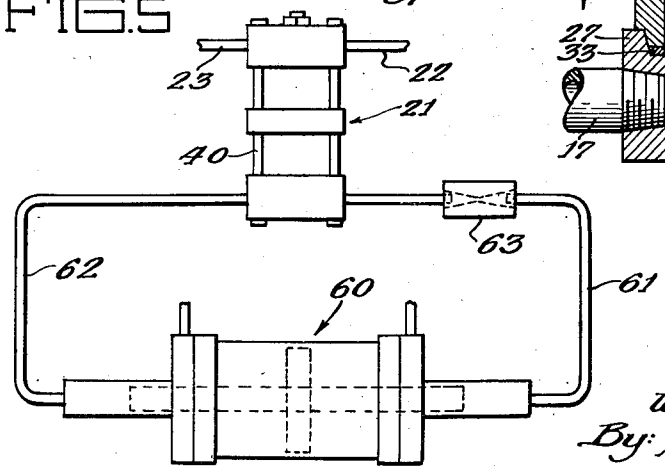


FIG. 5



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DEVICE FOR REMOVING A GAS FROM A LIQUID

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This invention relates to a fluid deaerator. Generally the invention is concerned with a unit which can purge or remove air from a hydraulic liquid, particularly the petroleum oils. The unit may also be useful in separating a mixture of gas and liquid.

In hydraulic systems various liquids may be used and in general various petroleum oils are employed. Air can be dissolved in hydraulic liquids with very little effect upon the operation of the hydraulic components so long as the air remains in solution. Air may enter hydraulic systems at various locations, through pump suction lines, around faulty packings or through other mechanical defects. It has been authoritatively specified that most commercial oils contain about ten percent of air by volume in solution. When oils are subjected to higher pressures, the amount of air by volume which can be dissolved in the oil increases tremendously.

Air dissolved in a hydraulic liquid comes out of solution under various conditions which are generally present in a hydraulic system. Any cavitation which occurs in the system will have the tendency to cause the air in solution to come out and form a bubble within the hydraulic liquid. These undissolved amounts of air in a hydraulic system cause erratic, unpredictable, and otherwise unwanted failures of correct operation by hydraulic components.

It is therefore the principal object of this invention to provide a device which will when incorporated in a hydraulic system automatically operate to remove and purge gaseous medium from the hydraulic fluid employed.

Another object is to improve the ability to precisely meter and position hydraulic components by the elimination of air from hydraulic fluid, and particularly, from petroleum oils.

Another object is to remove entrained air from hydraulic fluid in order to minimize oxidation thereof.

Another object is to provide a unit which will automatically add hydraulic fluid to a system when conditions in the system provide for cavitation.

Another object is to provide a unit automatically operable to relieve excessive hydraulic pressure which may exist in a hydraulic system due to restriction or to temperature rise therein.

A further object is to provide a unit capable of preparing a hydraulic liquid for use in a system by the removal of gas from the liquid.

Other objects, features and advantages of the present invention will be apparent from the following description of embodiments of the invention illustrated in the accompanying drawings, in which:

FIGURE 1 is a diagrammatic flow diagram of a positioning control unit embodying the present invention;

FIGURE 2 is a vertical sectional view through the center of the tank unit shown uppermost in FIGURE 1;

FIGURE 3 is a horizontal sectional view through the tank unit taken substantially along line 3—3 in FIGURE 2;

FIGURE 4 is a fragmentary sectional view through the valve structure in the tank unit taken substantially along the line 4—4 in FIGURE 2; and

FIGURE 5 is a diagrammatic flow diagram showing a unit capable of preparing a hydraulic liquid for use in a hydraulic system.

Referring to FIGURE 1, there is shown an air cylinder 10 having air line connections 11 and 12 for driving a

piston rod 13 visible on the left hand end of the figure. The air cylinder 10 provides the motive force for the movement of the piston rod to the left and right as shown in the figure. In tandem with the air cylinder is a hydraulic cylinder 14 used for accurately positioning the piston rod 13 through metering a definite volume of oil into one end or the other of the cylinder. For this purpose the piston rod 13 has a piston 15 thereon within the hydraulic cylinder 14. The piston 16 in the air cylinder is also connected to the same rod to provide the motive force specified. Hydraulic lines 17 and 18 are connected to opposite ends of the hydraulic cylinder with a metering valve 19 and a needle valve 20 in one of the lines for controlling the flow therethrough. A tank unit 21 is also connected in the lines 17 and 18 for the purpose of purging air from the hydraulic fluid used. The lines 17 and 18 may be connected respectively to either end of the hydraulic cylinder 14 to effect positioning and control of the piston rod 13 as desired. The air-oil tank unit 21 has port means 22 and 23 open to atmosphere.

Air in the hydraulic liquid used in the system shown in FIGURE 1 can result in inaccurate placement of the piston rod 13. Desirable operation requires that the metering of the hydraulic liquid be quite accurate and unaffected by any air which comes out of solution in the liquid. It is known that the provision of a suddenly enlarged area in the flow path can cause cavitation in a hydraulic system. Air previously in solution has a tendency to come out of solution in areas where cavitation occurs. The presence of an air bubble in the liquid can cause erratic metering and resultant inaccurate positioning of the piston rod 13. It has also been found that metering devices generally pass fluid in accordance with the input pressure. With the presence of air in hydraulic fluid, pressure may rise with the temperature very rapidly. The presence of the air also under such temperature rise conditions may have the affect of causing local oxidation developing sludge in the oil affecting the operation of the hydraulic components adversely.

In the present system a unit is provided for removing from the hydraulic liquid any air which may become separated or come out of solution in the liquid. To insure that conditions in the system are such that cavitation can occur for the purpose of releasing air from the hydraulic oil, the needle valve 20 may be placed in the piping 18 leading to the air-oil tank 21. The needle valve insures the presence of a zone in which a pressure drop will occur which in turn allows dissolved air to come out of solution in the form of bubbles. The operation of the tank is such that its structure will remove these bubbles of air from the liquid.

Referring particularly to FIGURES 2 to 4, inclusive, it will be observed that the tank has a lower chamber 25 surmounted by an upper chamber 26 formed by three heads and intervening cylindrical sections. The lower head 27 is square in configuration and is provided with a cross bore 28 to which piping 17 and 18 may be connected. A central longitudinal passage 29 provides access for a hydraulic fluid to enter the chamber 25 below a baffle 30. Preferably the baffle which is for the purpose of preventing aeration of the incoming liquid, may be constructed in accordance with Patent No. 2,683,463. The lower chamber side walls are formed by a cylindrical section 31 joined with the lower head 27 and intermediate head 32. Suitable sealing rings 33 and 34 are provided at each end of the cylindrical walls and the walls pilot on the outer portion of the groove in each of the heads. The central head 32 is also square and its undersurface 35 is conical in shape and sloped up to the central area so as to guide any air bubbles in the liquid to the high point in the lower chamber 25.

The upper chamber 26 is formed by the central head

32, a cylindrical side wall 36, and an upper head 37. Suitable packing rings 38 and 39 at each end of the cylindrical wall join the heads and wall together. Tie rods 40 in the corners of the square heads join the three heads and two cylindrical sections together into a single unit.

Any air in the system which comes out of solution because of the cavitation at the needle valve 20 will find its way into the air-oil tank 21 and automatically be removed from the liquid. As the oil enters the lower chamber 25, it passes between the baffle 30 and its supporting legs 30*a* into the lower chamber. Here the air bubble rises to the top of the chamber through the liquid. The liquid is, of course, at whatever pressure exists in the hydraulic system since it is connected directly with that system. The air bubble will rise to the central area of the intermediate head by its own buoyancy. At this point valve means prevent the movement of the air bubble into the upper chamber until there is a pressure rise in the lower chamber to unseat the blocking valve. In the present invention the valve which can allow the air and liquid both to rise into the upper chamber is completely submerged. In the upper chamber the oil level 41 is above the valve structure.

The valve itself comprises an outer spool 45 generally circular in form with a pair of flats 46 on opposite sides. The opening 47 through the intermediate head 32 is circular cylindrical and provides the only passage from the lower to the upper chambers. The spool 45 is guided in the passage 47 and closes the passage by engagement of an outwardly extending circular flange 48 engaging the flat bottom surface 49 of the intermediate head 32. The spool is urged into contact with the head and thus into closed position by two coil springs. One spring 50 is of predetermined strength and engages both the flange 48 on the spool and the upper head 37. The second spring 51 is of adjustable compression in that its upper end rests upon a supporting base 52 adjustable vertically by means of an adjusting screw 53 which supports and carries it. A sealing nut 54 about the screw on the exterior of the head 37 prevents any leakage out of the upper chamber should conditions provide that the upper chamber be under a pressure, above atmospheric but lower than that in the lower chamber.

By the structure just described a bubble of air in the lower chamber may find its way up through the passage 47 to a position just below the flange 48 on the outer spool of the valve. A slight pressure rise in the system will momentarily lift the spool allowing the air bubble to escape into the upper chamber. Once the air is above and past the valve flange 48, it may rise into the air space above the liquid level 41 in the upper chamber. A passage 55 is provided to atmosphere so that the air may be vented. In some instances piping may be connected with this passage leading to a sump or to another vessel.

The present deaerating unit also provides for the automatic addition of oil to a system whenever suction conditions exist in the system. To effect the addition of oil to the system a port 56 may be provided in the upper head for the addition of oil into the upper chamber 26. A light weight valve is incorporated in the spool 45 so as to be sensitive and responsive to a suction condition in the lower chamber 25 to admit oil into the lower chamber. The specific valve is an elongated spool 57 with a flange 58 at its lower end engaging the lower end of the outer valve spool 45. As seen best in FIGURE 4, the inner spool 57 also is provided with flat sides 58 forming a space through which the oil may pass between the spool 45 and spool 57.

This valve is maintained closed by a small coil spring 59 which holds the spool 57 in its upper position. This spring 59 is sufficiently strong to support the weight of the spool 57 but allow the spool to be moved downwardly quickly under influence of any suction in the lower chamber 25. Any surge in the hydraulic system which causes the withdrawing of liquid from the chamber 25 will immediately add liquid to that chamber from the upper chamber. No cavitation because of suction conditions is thus allowed to occur and aeration because of such cavitation is prevented.

The present deaerating unit may be used in a hydraulic system by the placement of the unit at various high points in a system. The springs 50 and 51 may be chosen in strength to provide a resilient urging of the valve to closed position against whatever pressure is being used in a particular system. The solidification of the hydraulic fluid results from the elimination of the air and once the hydraulic liquid becomes "solid" accurate metering and proper functioning of hydraulic components results.

A simple system for making hydraulic fluid solid and in condition for use in hydraulic systems may be accomplished by pumping of hydraulic liquids through an orifice. Air cavitation can occur, thus releasing the entrapped air. Such a system is illustrated in FIGURE 5 wherein an air driven booster 60 pumps oil through lines 61 and 62 with an orifice or other restriction 63 provided to insure that cavitation occurs. The air-oil tank unit 21 is similar to that described, however, the hydraulic oil supply line 23 may be connected to a source of oil to be treated and a line from the lower chamber or at a low point in the system may be led to a reservoir for treated oil. It has been found that a short period of use of the deaerating unit may result in oil in which any air remaining will remain in a dissolved state and thus not adversely affect either metering or proper operation of hydraulic components.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom for some modifications will be obvious to those skilled in the art.

I claim:

1. A device for purging air from hydraulic liquid in a system having means causing air to come out of solution in the hydraulic liquid, comprising: an air-oil tank unit having a lower chamber for connection with the system to receive hydraulic liquid therein, said tank unit having an upper chamber above the lower chamber with means providing a single passage for communication between the chambers and valve means in such passage connecting the chambers, said valve means being mounted respectively at a high area in the lower chamber and a low area in the upper chamber, said valve means having a valve closure resiliently urged closed against pressure in the lower chamber, said valve closure forming the sole gas outlet and being responsive to pressure in the lower chamber in excess of said resilient urge to pass air and liquid from the lower chamber into the upper chamber, said upper chamber having means for passage of the air therefrom, said valve means carrying a member responsive to suction in the lower chamber for passing only liquid into the lower chamber from the upper chamber.

2. A device for removal of air from hydraulic liquid, comprising: an air-oil tank unit having a lower and upper chamber, the lower chamber having a connecting port for passage of hydraulic liquid into and out of the lower chamber of the tank unit, and valve means comprising the sole connection between said chambers, said valve means having a first part responsive to pressure in the lower chamber to open for passage first of separated air followed by liquid from the lower to the upper chamber, and a second part responsive to suction in the lower chamber to pass only liquid from the upper chamber into the lower chamber, and means for removing the separated air from the upper chamber.

3. A device for removal of gas from solution and mixture with a liquid, comprising: a liquid and gas tank unit having ports for connection with a system containing the liquid from which the gas is to be removed, said tank unit having a pair of chambers one above the other and automatically opening, biased closed valve means con-

necting the chambers, said valve means being located at a high point in the lower chamber and having separately acting parts, one part being responsive to superatmospheric pressure in the lower chamber to pass gas and liquid upwardly only from the lower chamber to the upper chamber and another part responsive to suction pressure in the lower chamber to pass liquid from the upper chamber into the lower chamber whereby bubbles of gas in the liquid may be discharged into the upper chamber, said upper chamber having means for discharge of said separated gas.

4. A purging unit for separation of gaseous medium mixed, entrained or absorbed in a liquid medium, comprising: a tank unit having a pair of chambers one above the other, port means solely in the lower chamber for connecting the lower chamber to a source of said liquid medium, first biased closed valve means between the chambers responsive to pressure in the lower chamber for opening to pass gaseous and liquid medium upwardly into the upper chamber, and second biased closed valve means responsive to suction in the lower chamber for opening only to pass liquid medium from the upper chamber into the lower chamber, said valve means and port means comprising the only outlets from said lower chamber, and means communicating with the upper chamber for conducting the gaseous medium out of the upper chamber.

5. Apparatus for removing air from a hydraulic system and replenishing the system with hydraulic liquid as the system requires it, comprising: a hydraulic system; a tank unit connected at its lower end to a high point in the system and having a first lower and second

upper chamber, the first chamber having a lower passage in its lower portion connecting the chamber with the hydraulic system, said first and second chambers being connected by a valve spaced above said lower passage and biased closed against the pressure in said first chamber, the upper surface of the first chamber sloping upwardly to the valve to facilitate an accumulation of air bubbles below the valve when the first chamber is filled with fluid, said valve being responsive to fluctuation of system pressure to allow air first and liquid thereafter to pass from the first chamber to the second chamber; and a quantity of hydraulic liquid in the upper chamber submerging the valve, said valve including a portion biased closed against flow of such quantity of liquid into the lower chamber and being responsive to suction in the lower chamber permitting such flow to replenish liquid to the system.

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