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APPARATUS FOR CONTROLLING, SCAVENGING AND RECLAIMING WASTE HYDRAULIC FLUID

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FIG. 1.

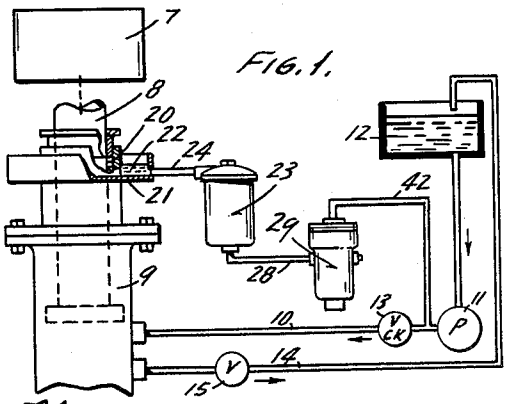
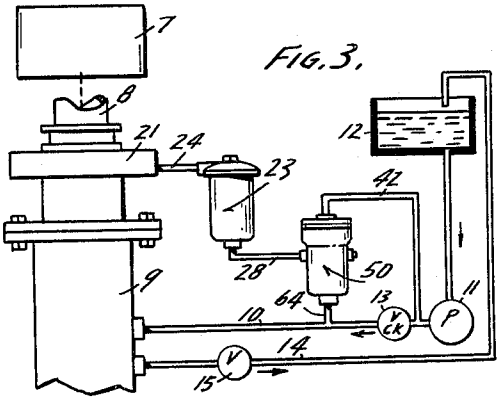


FIG. 3.



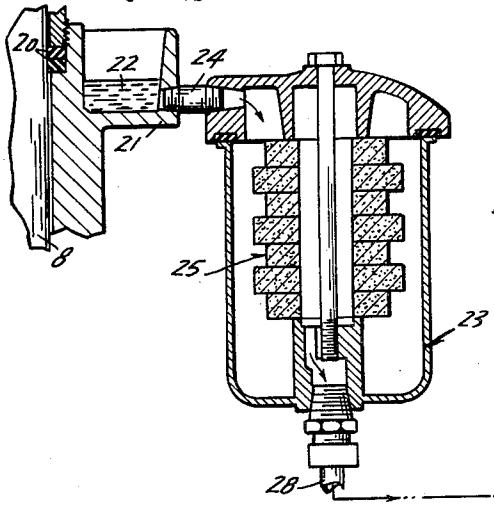


FIG. 2.

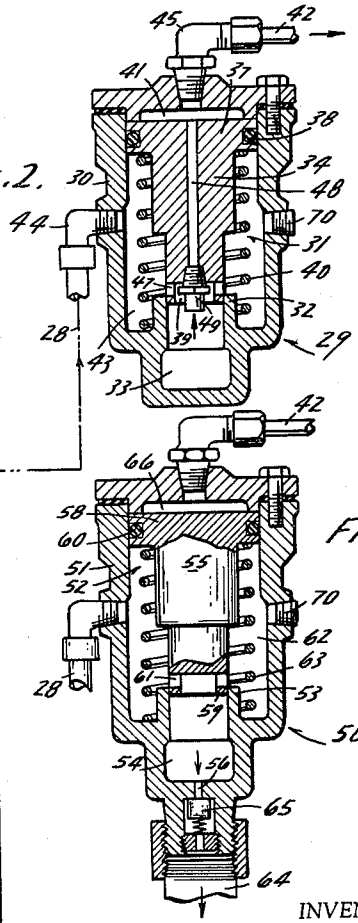
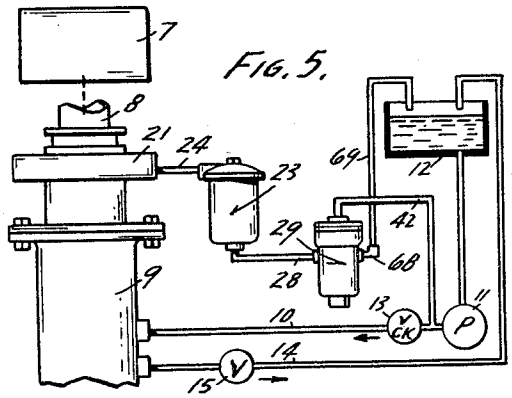


FIG. 4.

FIG. 5.



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APPARATUS FOR CONTROLLING, SCAVENGING AND RECLAIMING WASTE HYDRAULIC FLUID

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This invention relates to apparatus for controlling, scavenging and reclaiming waste hydraulic fluid in a hydraulic system.

For purposes of exemplification, the invention is described herein as it is embodied in apparatus for reclaiming waste hydraulic fluid from a hydraulic elevator piston, the seals of which tend to leak as they become worn during continued use of the elevator.

Heretofore, such waste hydraulic fluid has been collected in a piston drip ring and passed through a hose or the like to a container which will ultimately fill. Unless the filled container is periodically replaced with an empty container, it may overflow and cause a fire hazard and otherwise contaminate the elevator pit.

According to the present invention, the collected waste hydraulic fluid is pumped back into the hydraulic system and against the pressure of the main hydraulic fluid pump. The scavenger pump also incorporates valve structure which controls the cycle of the pump to coordinate its action with the lift and lower cycle of the elevator. Waste fluid is accumulated in the valve during the at rest cycle and the lower cycle and is pumped back into the system during the lift cycle.

The scavenger valve and pump includes a force multiplying ram which places the collected waste fluid under a higher pressure during the lift cycle of the elevator than the pressure of the main pump.

An important advantage of the present invention resides in the reduction in the number of hydraulic lines that are needed in connection with the scavenger pump and valve. According to the present invention, it is unnecessary to provide a separate waste fluid return line to the fluid reservoir. This is because the scavenger valve and pump returns the fluid to the same line which powers the scavenger pump. Accordingly, the costs of initial installation and maintenance are kept to a minimum.

Another advantage resides in the adaptability of the scavenger valve and pump to subsequent modifications for higher capacity operation.

Alternative embodiments of the invention will be herein disclosed. Each of these is characterized by the force multiplying pump ram aforesaid, although specific details of construction may differ.

Other objects, advantages and features of the invention will appear from the following disclosure in which:

FIG. 1 is a diagrammatic view showing the hydraulic circuitry of apparatus embodying the invention.

FIG. 2 is an enlarged fragmentary view showing a portion of the circuitry of FIG. 1 and in which the filter and scavenger valve are shown in cross section.

FIG. 3 is a diagrammatic view of the hydraulic circuitry of modified apparatus embodying the invention.

FIG. 4 is an enlarged cross section taken through the scavenger valve of the circuit shown in FIG. 3.

FIG. 5 is a diagrammatic view of the hydraulic circuit of the apparatus of FIG. 1 modified for higher capacity operation.

Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structure. The scope of the invention is defined in the claims appended hereto.

Hydraulic piston 8 for elevator car 7 operates in cylinder 9, which is pressurized in the lift cycle of the elevator through the main hydraulic fluid supply line 10 from hydraulic fluid pump 11. Pump 11 has a typical pressure of 300 p.s.i. and receives makeup fluid, usually oil, from reservoir 12.

There is a main check valve 13 in line 10, which precludes reverse flow of fluid in the line 10. There is a return line 14 subject to the control of valve 15 to depressurize the cylinder 9 and permit the elevator piston 8 to re-enter the cylinder 9 on the lower or down cycle of the elevator.

The piston 8 moves through hydraulic fluid seals 20 which are intended to confine the fluid within the cylinder 9. As these seals become worn with use, or if the piston wall is scored by misuse, hydraulic fluid from the cylinder 9 will not be completely wiped off of the piston as it passes the seal 20. Such fluid tends to adhere to the side wall of the piston 8 when the piston moves out of the cylinder 9. When the piston re-enters the cylinder, most of this fluid will be wiped off the wall by the seal 20 and will be collected at 22 in a drip pan or ring 21. As before indicated, prior practice has been to run a drain hose from the rip ring 21 to a container to collect the waste or "weep" oil.

According to the present invention, the waste oil 22 in the ring 21 is reclaimed and returned to the hydraulic system. For this purpose, a conventional oil filter 23 is connected to the drip ring 21 through the pipe 24. The filter cartridge 25 filters out impurities in the oil and the filtered oil is drawn from the filter 23 through the tube 28.

Tube 28 is connected to the inlet connector 44 of a scavenger valve and pump unit 29. One embodiment thereof is shown in FIG. 2. The scavenger valve unit consists of an outer cylindrical wall 30 which defines a large chamber 31 therewithin. Within the wall 30 there is a second cylindrical wall 32 coaxial and concentric with wall 30 and which defines therewithin a smaller chamber 33.

Within the valve body there is a force multiplying ram or plunger 34 having within the large chamber 31 a large piston 37 slidable on the cylindrical wall 30 and a small piston 39 slidable on the cylindrical wall 32. Piston 37 may be provided with an O-ring seal 38. Both pistons 37, 39 move concurrently by reason of their incorporation in the common plunger or ram 34. A compression spring 40 coiled about the ram 34 biases it to its uppermost position, as shown in FIG. 2.

The chamber space 41 behind the piston 37 in chamber 31 is connected through a coupling 45 and copper tube 42 to the main fluid supply line 10 between the outlet of the main pump 11 and the check valve 13, as shown in FIG. 1. Accordingly, chamber space 41 is at the same pressure as the pump 11. Space 41 will be pressurized in the lift cycle of the elevator and will be depressurized in the lower cycle of the elevator.

Sump space 43 in chamber 31, which is ahead or below the piston 37, communicates with the tube 28 from filter 23 through a check valve coupling 44 and collects fluid drawn into the valve 29 from filter 23.

Ram 34 has a transfer duct 47 which provides communication between sump space 43 and small chamber 33 when the ram 34 is in its uppermost position as shown in FIG. 2. Accordingly, any oil in the piston drip ring 21 may flow through the filter 23, tube 28, into the sump space 43 of large chamber 31 in the scavenger valve 29 and thence through the duct 47 into the small chamber 33. This can happen only when the main pump 11 is not under pressure sufficient to overcome the bias of the spring 40, for example during the at rest cycle and the lower cycle of the elevator.

Ram 34 is also provided with an axial duct 48, which

communicates between the small chamber 33 and the chamber space 41 which is behind piston 37. Duct 48 is provided with a check valve 49, which permits flow of hydraulic fluid from chamber 33 into the chamber space 41 only when the fluid in chamber 33 is at a pressure higher than is the fluid in space 41.

On the lift cycle of the elevator, main pump 11 is energized to pressurize the main supply line 10. Tube 42 will be equally pressurized and will pressurize fluid in space 41 behind piston 37 in the scavenger valve 29. This pressure will be sufficient to overcome the bias of spring 40 and to move the ram or plunger 34 downwardly as shown in FIG. 2 and force piston 39 into the chamber 33 where waste hydraulic fluid has collected.

Because of the difference in the areas of the two pistons 37, 39, the ram 34 functions to multiply the force exerted on piston 37 and to pressurize the fluid in chamber 33 at a higher level than the fluid in chamber 41. Accordingly, check valve 49 will open and the slug of waste fluid in chamber 33 will be bypassed through duct 48 from chamber 33 into space 41 against the pressure of main pump 11.

The inlet end of valve 49 is considerably below transfer duct 47. The volume of chamber 33 desirably exceeds the volume displaced by piston 39. For this purpose, chamber 33 may be laterally enlarged and its axial length exceeds the length of the stroke of the ram 34, as shown in the drawing. Moreover, the volume of transfer duct 47 must be included in that of chamber 33 to arrive at the total volume of the chamber 33. In a practical embodiment of the invention, the total volume of chamber 33 is about double the displacement volume of piston 39.

The excess volume of chamber 33 provides an accumulation or storage space for any air which might be present in chamber 33. For example, where oil leakage is light, chamber 33 may contain only air in the lift cycle of the elevator. At the end of its down stroke, piston 39 will have increased the pressure on the air in chamber 33 by one atmosphere. This is insufficient to open check valve 49 against the higher pressure in chamber 41 (one hundred p.s.i. or more), which is needed to compress spring 40. Because the air is compressible, it will accumulate in the storage portion of chamber 33.

Accordingly, no air will be injected from chamber 33 through duct 48 into chamber 41.

If, for example, chamber 33 is three-fourths full of oil, the air trapped above the oil will again be compressed by about one atmosphere, and will accumulate in transfer passage 47. As the plunger 34 continues its descent, the depending inlet end of valve 49 will dip into the oil, the pressure in chamber 33 will multiply, and when pressure in chamber 33 exceeds pressure in chamber space 41, the oil will be injected through valve 49 and duct 48 into chamber space 41.

The air trapped in transfer duct 47 is above the level of the inlet to valve 49 and will not be transferred from chamber 33 to chamber space 41.

Accordingly, under oil leakage conditions, the scavenger pump structure prevents injection of air into line 42.

When the main pump 11 is depressurized in the at rest cycle or in the down cycle of the elevator, the fluid in space 41 will similarly be depressurized and the spring 40 will lift the ram 34 and piston 37 to discharge hydraulic fluid collected in the space 41 back through tube 42 to the main pump 11, thus reclaiming the waste fluid which had previously collected in the small waste chamber 33.

If, during the down cycle of the elevator as aforesaid, there remains some waste fluid collected in the drip ring 21 and filter 23, such fluid will be sucked into the sump space 43 in large chamber 31 in the scavenger valve as a consequence of the upward movement of ram 34. As soon as the duct 47 clears the top rim of wall 32, such fluid will drain or overflow into the small chamber 33 in readiness to be scavenged and reclaimed in the next lift cycle of the elevator.

By reason of the connection of tube 42 to the main supply line 10 at a point between main pump 11 and main check valve 13, this portion of the line 10 is depressurized during the down-cycle of the elevator. Accordingly, the spring 40 can discharge oil from space 41 back to the pump against little or no back pressure. Accordingly, care should be taken in installation of this embodiment of the invention not to connect the line 42 to the side of the main check valve 13 nearest the cylinder 9.

Note also that only a single line 42 need be connected to the valve 29 in the embodiment just described. The scavenged oil is returned to the system through the same line 42 that pressurizes the pumping mechanism within the valve 29.

A modified embodiment of the invention is shown in FIGS. 3 and 4. Like parts have been given similar reference characters. The scavenging valve 50 is somewhat different in construction and has a somewhat different connection to the system. Valve 50 has an outer cylindrical wall 51 which defines a large cavity 52 and within which there is a coaxial cyclindrical inner wall 53 which defines a small cavity 54, much the same as in the previously described valve embodiment 29.

Valve 50 also has a force multiplying ram or plunger 55, which has a large piston 58 at one end and a small piston 59 at its other end. Piston 58 is provided with an O-ring seal 60 slidable on wall 51. In this embodiment, there is also an oil transfer duct 61 in the ram body 55 which communicates between sump portion or space 62 of chamber 52 which is ahead of the piston 58, and the small chamber 54. The ram 55 is biased to uppermost position as shown in FIG. 4 by the compression spring 63.

Unlike the scavenging valve 29, scavenging valve 50 does not have an axial duct 48 such as is shown in FIG. 2. In this embodiment of the invention, small chamber 54 communicates through duct 56 with the main pressure line 10 through a pipe coupling 64. There is a check valve 65 between chamber 54 and the coupling 64 which will permit passage of fluid from chamber 54 through duct 56 into the line 10 only when the chamber 54 is at a higher pressure than the line 10.

The overall operation of valve 50 is quite similar to that of valve 29. In the downcycle of the elevator, such waste oil as accumulates in the drip ring 21 will flow into sump portion 62 of chamber 52 and through transfer duct 61 into the small chamber 54. On the lift cycle of the elevator when pump 11 is pressurized, the portion 66 of chamber 52 which is behind piston 58 is pressurized through the line 42 and forces the ram 55 downwardly as shown in FIG. 4. Duct 61 will be sealed off against the side of wall 53 after slight downward movement of the ram. Because of the force multiplying characteristic of the ram 55, small chamber 54 will be at a higher pressure than line 10. This will open check valve 65 and bypass the slug of oil in the small chamber 54 back into the line 10 and against the pressure of the main pump 11, to reclaim this oil which would otherwise be wasted.

On the next downcycle of the elevator, when pump 11 is depressurized, check valve 65 will close and spring 63 will return the ram 55 to its uppermost position as shown in FIG. 4 and at the same time will suck into the sump chamber 62 waste oil which has previously collected in the ring 21 and filter 23.

In both embodiments of the invention thus far disclosed, the scavenging valve and pump will automatically cycle in time with the up and down cycle of the elevator. In each complete elevator cycle, a slug of reclaimed oil will be returned to the system. In practical embodiments of the invention, the amount of oil in the small chamber in the scavenging valve and which is displaced in each pumping cycle of the valve is ⅓ of a cubic inch.

FIGURE 5 shows a simple modification of the structure and circuits aforesaid and which can be readily made in either described embodiment where the volume of waste fluid exceeds the capacity of the small chamber of the valve. This modification will greatly increase the valve capacity and is resorted to only on old elevator installations where the seals are very worn with heavy leakage. It is contemplated that one or another of the aforedescribed embodiment will suffice until leakage becomes heavy enough to justify the modification about to be described.

According to the modifications of FIGURE 5, tube **69** is connected into the sump chamber of either valve shown in FIGURES 2 and 4. Taking FIGURE 2 as an example, the connection is to chamber **43** through a check valve coupling **68** which replaces plug **70**. Tube **69** discharges into the reservoir **12** for the main pump **11**. This discharge is at atmospheric pressure. In an elevator installation with heavy leakage, more waste fluid will accumulate in sump portion **43** of chamber **31** than can be transferred through the duct **47** into the small chamber **33**. In this modification of the invention, however, the downward movement of the ram **34** will discharge some of the waste fluid remaining in the sump space **43** through the line **69** and into the reservoir **12**. This discharge is against atmospheric pressure as aforesaid.

Check valve coupling **44** precludes reverse flow in line **28** and check valve coupling **68** precludes flow of fluid back into sump chamber **43** when spring **40** lifts the plunger **34**.

The foregoing modification increases the capacity of the scavenging valve so that it can reclaim as much as 2½ cubic inches of waste fluid in each cycle of the elevator.

The modification of the device, as shown in FIG. 5, has the disadvantage of requiring an additional hydraulic fluid line **69**. Accordingly, it is only resorted to where the hydraulic system has heavy leakage. The adaptability of the scavenging valve for conversion to high-capacity operation, however, is a distinct advantage, as it greatly simplifies accommodation of the apparatus to changing conditions.

What is claimed is:

1. Apparatus for reclaiming waste hydraulic fluid in a hydraulic system which includes a hydraulic piston and a main pump for supplying hydraulic fluid under pressure to said piston, said apparatus comprising:

(*a*) a first pressure fluid line from the main pump to the hydraulic piston,

(*b*) a scavenger pump,

(*c*) a second pressure fluid line from the main pump to the scavenger pump,

(*d*) a waste fluid line from the said hydraulic piston to the scavenger pump,

(*e*) a first chamber within said pump to collect waste fluid when the second pressure fluid line is depressurized,

(*f*) a second chamber within said pump and exposed to said second pressure fluid line,

(*g*) a waste fluid duct from the first chamber to one of said pressure fluid lines,

(*h*) a force multiplying ram within said scavenger pump and having a large piston face exposed to said second chamber and a small piston face exposed to said first chamber to discharge collected waste fluid in said first chamber through said waste fluid duct to said one pressure fluid line and against the pressure of said main pump when the second pressure fluid line is pressurized.

2. The apparatus of claim 1 in which said waste fluid duct communicates through said ram between said first and second chambers, and a check valve in said waste fluid duct to pass waste fluid from the first chamber to said second chamber when the second pressure line is pressurized.

3. The apparatus of claim 1 in which said waste fluid duct connects said first pressure fluid line to said first chamber, and a check valve between said first pressure line and said first chamber to pass waste fluid from the first chamber to said first pressure line when the second pressure line is pressurized.

4. The apparatus of claim 1 in which said scavenger pump comprises:

(*i*) a pump body having

(1) an outer cylindrical wall about said second chamber and on which said large piston slides,

(2) an inner cylindrical wall about said first chamber concentric with the outer wall and on which said small piston slides,

(3) and a sump chamber ahead of the large piston of the ram and defined by said outer and inner walls and by said ram,

(*j*) a transfer duct communicating between said first chamber and said sump chamber, said transfer duct being open when the ram is at one end of its stroke when the second pressure fluid line is depressurized to permit flow of waste fluid from said sump chamber to the first chamber,

(*k*) and a spring biasing said ram toward said one end of its stroke.

5. The apparatus of claim 1 in combination with a check valve in said first pressure line between said hydraulic piston and the connection of the second pressure fluid line to the main pump.

6. The apparatus of claim 1 in which said scavenger pump has a sump chamber intermediate said waste fluid line and said first chamber, and a waste fluid discharge line connected to said sump chamber.

7. The apparatus of claim 1 in which said first chamber has a volumetric capacity exceeding the displacement volume of said small piston face and providing an accumulating space for air trapped in the first chamber.

8. The apparatus of claim 1 in which the waste fluid duct has an inlet below the top of said accumulating space.

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