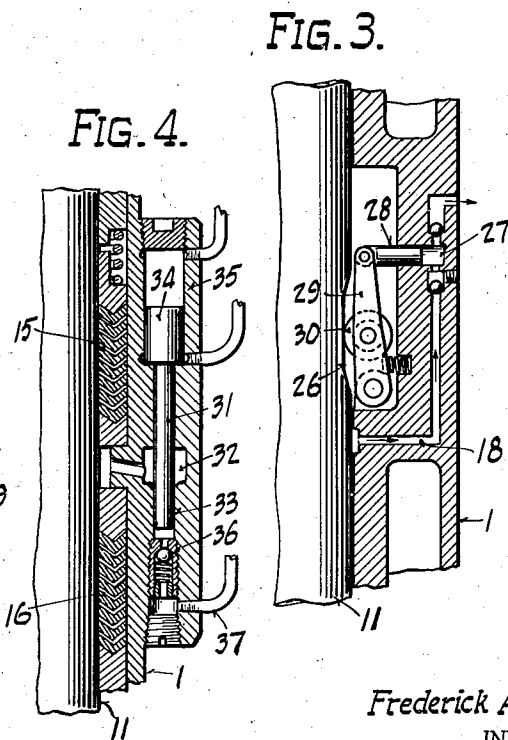
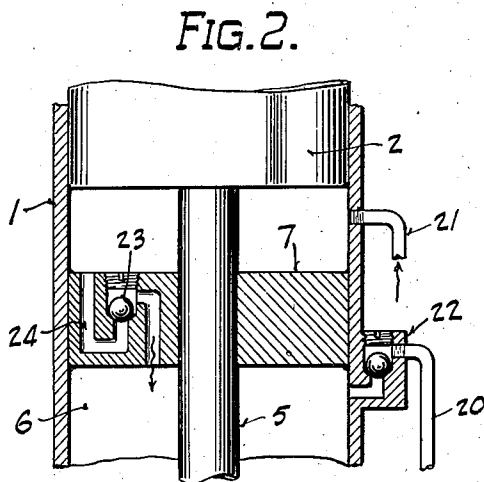
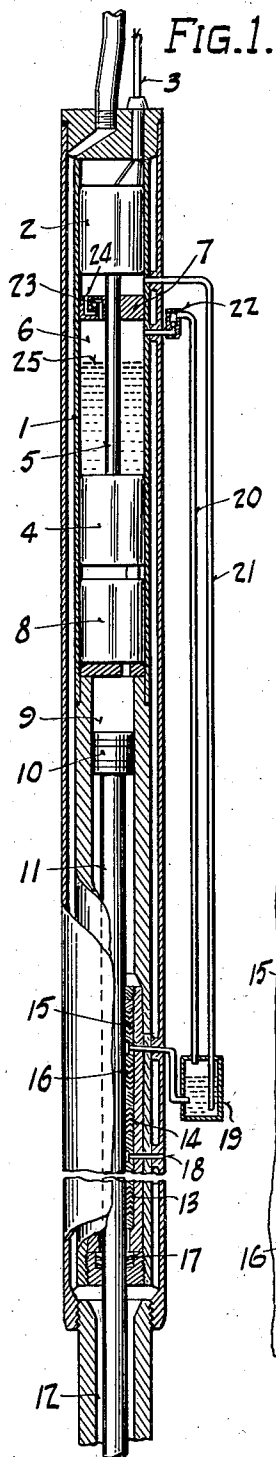


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F. A. GRUETJEN
OIL WELL PUMPING UNIT

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OIL WELL PUMPING UNIT

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13 Claims. (Cl. 103—45)

This invention relates to an improvement in pumping units to pump oil or other liquids from deep wells.

Reciprocating plunger pumps driven by sucker rods have long been used for the pumping of oil from deep wells. Increasing depth of wells has led to increasing difficulties connected with the long string of sucker rods running from the pump to the surface of the earth and has spurred the development of self-contained pumping units placed at or near the bottom of the well and driven by electric energy conveyed to the unit through an electric cable. In one type of these pumping units, an electric motor is used to drive a power pump which circulates carefully cleaned and purified power oil from a reservoir through the power pump, a distributing valve, and a long stroke, slow speed, reciprocating hydraulic motor and back to the reservoir. The hydraulic motor is direct connected to a plunger pump of the same general type that has been operated by sucker rods. This invention relates to an improvement in pumping units of this general kind, and more specifically, to means for returning to the power oil reservoir any power oil which leaks past the packing on the piston rod of the hydraulic motor.

An object of the invention is to provide means to prevent loss of power oil from its circulation system by leakage at the hydraulic motor.

Another object of the invention is to provide means to prevent entry of crude oil from the well into the power oil circulating system.

These and other objects of the invention will be clear from the following detailed description and the accompanying drawing in which:

Figure 1 is a schematic representation of the invention and the pertinent parts of the pumping unit in which it is used;

Fig. 2 is an enlarged section showing the check valve in the partition between the motor compartment and the oil reservoir;

Fig. 3 shows a pump which may be employed in removing either the crude oil or pumping fluid which has leaked past the packing; and

Fig. 4 is an alternative means for returning leakage power oil to its reservoir.

The various parts of the pumping unit are assembled in a casing 1 which may have certain detailed features of construction that are provided to facilitate assembly but are not shown in the drawing as they form no part of this invention. The motor 2, supplied with electric energy through cable 3 extending from the pumping unit to the surface of the earth, drives the

power pump 4 by means of shaft 5. An oil reservoir 6, separated from the motor compartment by a partition 7, serves for storage of the power oil.

A distributing valve 8 controls the flow of power oil to and from the cylinder 9 of the hydraulic motor. The cylinder contains a piston 10 on a piston rod 11 which extends downward into the pump barrel 12 of the crude oil pump and forces oil from the well to the surface. Four sets of packing rings, 13, 14, 15 and 16 are provided around the piston rod for purposes hereinafter set forth in detail.

In the operation of a pumping unit of this kind, the electric motor 2 drives power pump 4 which may be of any suitable type adapted for connection to the motor, either directly or through reducing gears. The pump 4 draws power oil from reservoir 6 and forces it through distributing valve 8 and from there alternately to the opposite ends of the cylinder 9 of the hydraulic motor. The distributing valve is of such a nature as to admit oil from the pump to one end of cylinder 9, simultaneously exhaust oil from the other end of the cylinder back to reservoir 6, and reverse the flow of oil when the piston 10 reaches each end of its stroke, thus causing the piston with its attached plunger to reciprocate back and forth in the cylinder of the hydraulic motor. The valve may be operated either mechanically or hydraulically. The details of its construction and of the oil connection between the reservoir, power pump, valve, and cylinder are not shown as they form no part of this invention.

The crude oil pump in the pump barrel 12 may be either single or double acting and in either case is operated by the piston rod 11. The specific construction of the pump is likewise no part of the present invention and is, therefore, not shown.

In a pumping unit of this kind it is essential for long continued trouble free operation to prevent loss of power oil from its circulating system, and to prevent entrance of crude oil from the well into the power oil circulating system where sand and grit from the well would damage the power pump and interfere with the operation of the distributing valve.

Due to the hydrostatic head in deep wells, high oil pressures are necessarily involved in both the crude oil pump and in the hydraulic motor. It is apparent, therefore, that great care is needed to meet the requirements outlined above.

To this end, sand scrapers 17 are provided

around the piston rod 11. These operate to scrape off sand and grit as the plunger moves upward from its immersion in the crude oil in the pump barrel, and keep the packings free from grit. Two packings 13 and 14 are provided to prevent the leakage of oil upward along the plunger. Similarly, packings 15 and 16 serve to prevent leakage of power oil downwardly from cylinder 9. The crude oil pressure below packing 13 is considerable, being due to the sum of the hydrostatic, friction, and inertia heads of the column of fluid extending upward from the oil level in the well to the surface of the ground, or to the next uppermost pumping unit if two or more are used in series. Because of the high pressure involved, it is difficult to provide any packing which will assure, for an extended period of operation, against all upward leakage of crude oil and the consequent possibility of its admixture with the power oil.

In order to provide this assurance, a vent 18 in the casing 1 is provided between packings 13 and 14. The vent is arranged to open into the well from which the oil is pumped, and to return to it any crude oil which may leak upward past packing 13. As the immersion of the pumping unit in the well is far less than the height to which the oil is pumped, the pressure acting below packing 14 is relatively small and the packing can be relied upon to prevent upward leakage of crude oil past it. These means provide for preventing admixture of crude oil with the power oil and consequent possibility of damage to the mechanism. Packing 14 which is above the vent 18 serves to prevent crude oil from passing further upwardly along the piston under the pressures of submersion in the well. Instead of venting the crude oil from 18 directly to the well, an auxiliary pumping means may be provided to create a suction on vent 18 thereby assuring that crude oil will not pass packing 14. This is shown in Fig. 3 and will be described hereinafter.

The power oil circulating system can be hermetically sealed against loss of oil except where the piston rod 11 passes out of the hydraulic motor through packings 15 and 16. Any of the power oil which may leak downward past the packing 15, collects in the space between packings 15 and 16 and drains into the closed sump 19. From here it is pumped back to the oil reservoir. This is accomplished by connecting a tube or passageway 20 to the upper part of oil reservoir 6, and a tube or passageway 21 to the motor compartment. The first of these tubes or passageways 20 opens into the upper part of the sump; the other, 21, into the lower part. A check valve 22 is provided in tube 20, and another check valve 23 in a passage 24, in the partition 7 between the oil reservoir 6 and the motor compartment. The first of these valves 22, opens when the pressure in the reservoir 6 exceeds that in the lower part of tube 20; the second valve, 23, opens when the pressure in the motor compartment exceeds the pressure in the oil reservoir.

Assume now, that a small amount of power oil has accumulated in sump 19 due to leakage past packing 15 and that the piston 10 of the hydraulic motor is on its down stroke. For a given downward movement of piston 10 the volume of power oil withdrawn from the oil reservoir and forced into the upper end of the cylinder 9 is equal to the piston movement times the cross sectional area of the cylinder. The amount of power oil returned to the oil reservoir from the lower end of the cylinder is equal to the piston movement times the annular area between the cylinder and

piston rod 11. This is less than the volume withdrawn, and consequently, when the piston moves down, the oil level 25 in the reservoir 6 also moves down. Conversely, when the piston moves up, the oil level in the reservoir also moves up.

Downward movement of the oil level 25 when the piston moves down expands the gas in the upper part of reservoir 6 and lowers its pressure. Check valve 22 is held closed since the pressure below it is greater than the pressure above, but the check valve 23 opens to permit the passage of oil and gas from the motor compartment into reservoir 6. There is, therefore, also a reduction of the gas pressure in the motor compartment and oil from sump 19 rises in the tube or passageway 21 to a level which corresponds to the difference between the gas pressures in the sump and motor compartment.

When the piston 10 reverses its stroke and begins to rise, the oil level 25 in reservoir 6 rises with it, compresses the gas in the upper part of the reservoir, and closes check valve 23 in the partition between the reservoir and motor compartment to prevent a corresponding increase of gas pressure in the motor compartment. The increased gas pressure in the oil reservoir is transmitted through tube 20 and its valve 22 to the sump 19 and forces oil from the sump upward through tube 21 into the motor compartment in which the gas pressure has a lower value due to the operation of check valve 23. On the next downward stroke of the piston, check valve 23 opens as previously described due to lowering of the oil level in the reservoir and consequent reduction in gas pressure, and the oil previously forced up from the sump to the motor compartment is returned to the oil reservoir. As a consequence of the periodic motion of the piston, any leakage of power oil past packing 15 is returned to the reservoir and not lost. In case there is no oil leakage, there is merely a circulation of gas through the sump.

While in the embodiment illustrated in the drawings, a tight partition is provided between the oil reservoir and the motor compartment and the oil from the sump is returned to the latter, it is possible to dispense with partition 7 and return the oil from the sump to some other gas space located above the oil reservoir and separated from it by a check valve. For the purpose of more clearly illustrating the invention, the oil sump 19 and tubes 20 and 21 are shown to one side of the casing 1 which encloses the pumping unit. It is to be understood, of course, that in an actual construction, these parts will also be within the casing.

Referring now to Fig. 3, which illustrates a pump that can be employed for pumping the crude oil which has leaked past packing 13, the packings 13 and 14 are spaced apart a distance greater than the length of stroke of the piston rod 11, and the latter is provided with a depression 26 located at a point which never comes into contact with either packing. A small piston pump 27 has its plunger 28 connected to a pivoted spring pressed arm 29 on which a roller 30 is journaled to ride against piston rod 11 and to enter and leave the depression 26 to reciprocate plunger 28 as the rod 11 moves up and down.

The pump 27 has its intake connected to vent 18 and its discharge to the outside of the casing. The intake and discharge ports have suitable check valves. The pump serves to keep a suction on the vent 18 and prevents any possibility

of crude oil leaking upwardly into the power fluid system.

A similar pump may be provided between packings 15 and 16 for the power fluid. In this case, the pump intake would be connected to sump 19 and the pump would discharge into reservoir 6.

Fig. 4 illustrates a modified form of pump for returning leakage fluid, in this case from the space between packings 15 and 16 to the power fluid reservoir. This pump comprises a plunger 31 extending through the sump chamber 32 and into a cylinder 33. The plunger 31 is reciprocated by a motor piston 34 in a cylinder 35 at the upper end of the plunger rod. The upper end of cylinder 35 is connected by a passage to the upper end of the power cylinder 9 and the lower end of cylinder 35 is similarly connected by a passage to the lower end of the power cylinder 9 to effect operation of the plunger 31 in synchronism with the piston 10 and rod 11.

The cylinder 33 has its intake directly from chamber 32 when the plunger 31 is raised and its outlet is through check valve 36 and passage 37 leading from the bottom end of the cylinder 33 to the reservoir 6. The check valve 36 prevents return of oil from the reservoir to cylinder 33 upon upward movement of the plunger 31 and allows the cylinder to fill from chamber 32 when the plunger uncovers the upper end of the cylinder.

The detail construction of the packings illustrated herein is set forth and claimed in the co-pending application Serial Number 390,783 filed on even date herewith by the present inventor now Patent 2,320,589, June 1, 1943. Certain features of the present invention constitute an improvement upon the invention set forth and claimed in applicant's co-pending application Serial Number 390,782 filed on even date herewith now Patent 2,330,419, Sept. 28, 1943.

Various embodiments of the invention may be employed within the scope of the accompanying claims.

I claim:

1. In a deep well pumping unit having a reciprocating hydraulic motor, a liquid reservoir for the storage of power oil with a liquid level which periodically rises and falls during the operation of the unit, a closed gas space above the liquid level in the reservoir in which gas is alternately increased and decreased in pressure by the rising and falling of the liquid level, a second closed gas space separated from the first by a check valve which opens when the gas pressure is greater in the second than in the first and closes when the pressure difference is reversed, a packing around the piston rod of the hydraulic motor to prevent leakage of power fluid from the hydraulic motor, a sump below the packing to collect any liquid which may leak past the packing, a passageway joining the first gas space to the upper portion of the sump, a check valve in the passageway to permit the flow of gas to the sump but not away from it, and a fluid passageway to return liquid collected in the sump to the second named gas space.

2. In a deep well pumping unit, a reciprocating hydraulic motor driven by power liquid under pressure, packing around the piston rod to prevent the leakage of power liquid from the cylinder of the hydraulic motor, a sump below the packing to collect any liquid which may leak past the packing, and pneumatically operated means to restore fluid from the sump to the power liquid system.

3. In a deep well pumping unit, a vertically disposed cylinder of a reciprocating hydraulic motor, a pump barrel below the cylinder, a piston rod extending from the piston of the hydraulic motor into the pump barrel, four packings around the piston rod of which two are disposed to prevent leakage from the pump barrel upwards longitudinally of the piston rod and the other two to prevent leakage of power liquid from the hydraulic motor, a vent between the first two packings opening into the supply of fluid to be pumped, a sump between the other two packings to collect power liquid which may escape past the packing from the hydraulic motor, and pneumatically operated means to return liquid from the sump to the power liquid circulating systems.

4. In a pumping unit having a pump with a pump casing, a reciprocating hydraulic motor with a piston rod which extends from the motor cylinder into the pump, packing between the rod and pump casing, means to collect any liquid which may leak past the packing and return it to the source from which it is pumped, packing between the rod and cylinder of the hydraulic motor, means to collect power liquid which may leak past the second named packing, and pneumatically operated means to return the liquid so collected to the power liquid circulating system.

5. In combination with a reciprocating hydraulic motor, a liquid storage reservoir from which liquid is pumped to operate the motor and in which the liquid level rises and falls as the motor operates, a closed gas space above the liquid level in the reservoir in which gas is alternately compressed and expanded by the rise and fall of the liquid level, a second closed gas space, a check valve between the two which opens when the pressure in the second exceeds that in the first and closes when the pressure difference is reversed, packing between the cylinder and piston rod of the hydraulic motor, a sump to collect any liquid which may leak past the packing, a passageway from the first gas space to the sump, a check valve in the fluid passageway to permit flow of gas to the sump but not in the reverse direction, and a second fluid passageway to return liquid from the sump to the second named gas space and having its opening beneath the liquid level in the sump.

6. In combination with a reciprocating hydraulic motor having a piston rod, a liquid storage reservoir from which liquid is pumped to operate the motor and in which the liquid level rises and falls as the motor piston reciprocates, a closed gas space above the liquid level in the reservoir in which the gas is alternately compressed and expanded by the rise and fall of the liquid level, a second closed gas space in communication with said first gas space, a packing around the piston rod of the hydraulic motor in the wall of the motor cylinder to prevent escape of power liquid past the piston rod, a sump to collect any liquid which may leak past the packing, passages connecting the sump to each of the gas spaces, means restricting the flow between the two gas spaces in the communication referred to to one direction, and means restricting the flow through the passages from one gas space through the sump to the other gas space to a direction opposite to said first named flow, the opening for the outlet passage from the sump being below the liquid level in the sump.

7. In a deep well pumping unit, a reciprocating hydraulic motor driven by liquid under pressure, packing around the piston rod to prevent the leakage of power liquid from the cylinder of the hy-

draulic motor, a sump below the packing to collect any liquid which may leak past the packing, and means responsive to the operation of said motor to restore fluid from the sump to the power liquid circulating system.

8. In a deep well pumping unit having a reciprocating hydraulic motor with a piston rod, means for preventing loss of power fluid for driving said motor, comprising a series of packings surrounding said piston rod and disposed to prevent the leakage of power fluid along the rod from said motor, a take-off for power fluid which may leak past the set of packing nearest the motor, and means operated by said motor to return the power fluid from said take-off to the main body of power fluid.

9. In a deep well pumping unit having a reciprocating hydraulic motor with a piston rod, means for preventing loss of power fluid for driving said motor, comprising a series of packings surrounding said piston rod and disposed to prevent the leakage of power fluid along the rod from said motor, a take-off for power fluid which may leak past the set of packing nearest the motor, and a pump operated in synchronism with the movement of the piston rod for returning fluid from the take-off to the main body of power fluid.

10. In a deep well pumping unit having a reciprocating pump driven by a reciprocating motor by means of a piston rod, means for preventing fluid being pumped from leaking along the piston rod to the motor, comprising a series of packings surrounding said piston rod and disposed to prevent the leakage of fluid therealong from the pump, a take-off for fluid which may leak past the first set of packing nearest the pump, and a pump operated in synchronism with the movement of the piston rod for returning fluid from the take-off to the main body of fluid being pumped.

11. In a deep well pumping unit having a re-

ciprocating pump driven by a reciprocating hydraulic motor by means of a piston rod common to both, means for preventing loss of power fluid for driving said motor and of admixture of crude oil with the power fluid, comprising a series of packings surrounding said piston rod and disposed to prevent the leakage of crude oil along the rod from said pump and the leakage of power fluid along the rod from said motor, a take-off for crude oil which may leak past the set of packing nearest the pump, a similar take-off for power fluid which may leak past the set of packing nearest the motor, there being at least one set of packing between the two take-offs, a pump in at least one of said take-offs operated in synchronism with the movement of said piston rod to return leakage fluid to its source.

12. In a deep well pumping unit having a reciprocating hydraulic motor with a piston rod, means for preventing loss of power fluid for driving said motor, comprising a series of packings surrounding said piston rod and disposed to prevent the leakage of power fluid along the rod from said motor, a take-off for power fluid which may leak past the set of packing nearest the motor, and a scavenger pump operated by the power fluid driving said motor for returning said leakage fluid from the take-off to the main body of power fluid.

13. In combination with a reciprocating rod, a pair of circumferential packing members engaging said rod and spaced apart a distance at least as great as the reciprocating stroke of the rod to prevent any liquid on the surface of the rod passing through both packings during reciprocation of the rod, a pump disposed between the packing members for withdrawing any leakage fluid from therebetween, and means on said rod for engaging the operating member of said pump for operating the latter when the rod is reciprocated.

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