Sept. 28, 1943. G. J. LANGMYHR ET AL 2,330,781

CONVEYING FLUIDS CONTAINING SOLIDS

Filed May 28, 1941 2 Sheets-Sheet 1

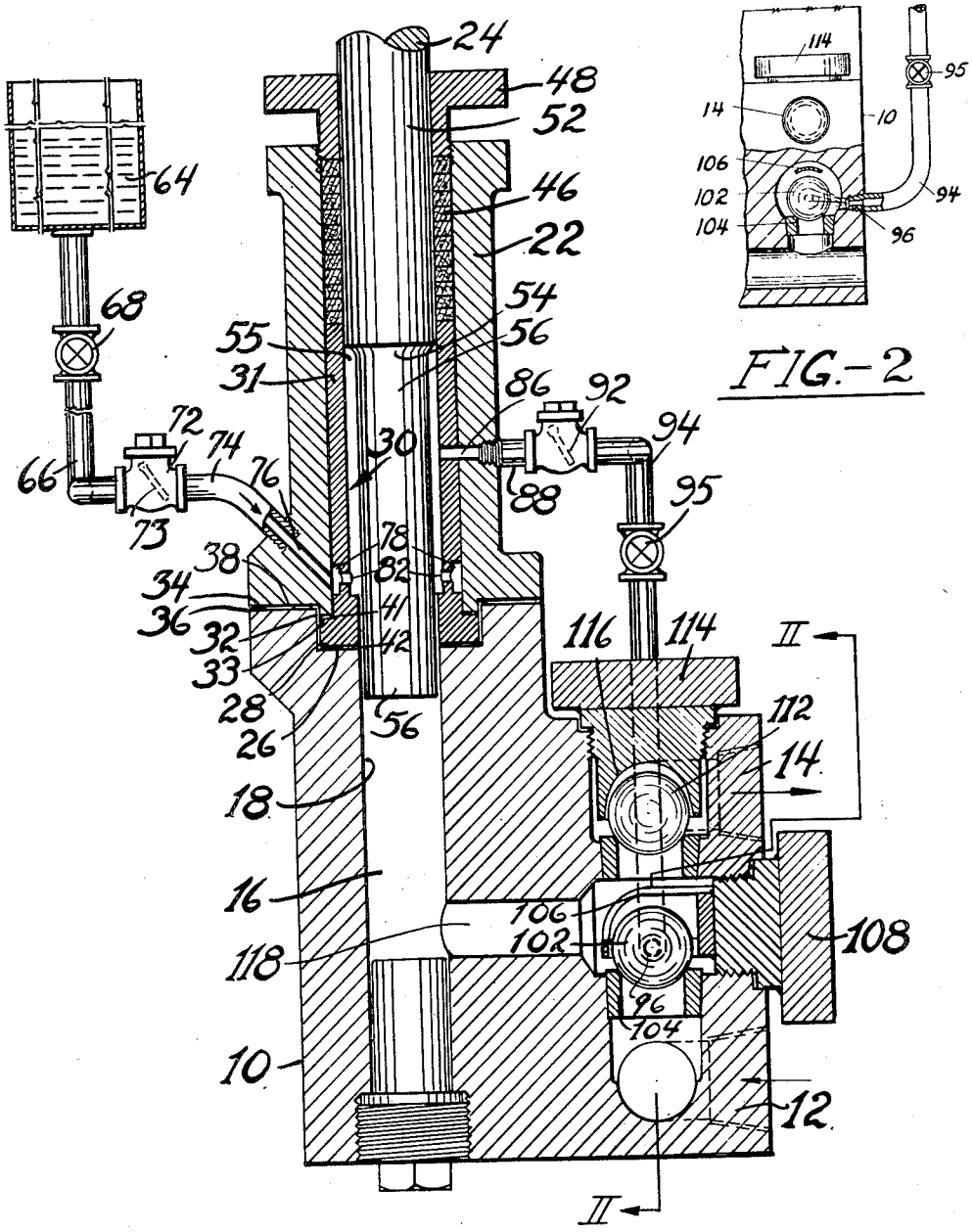


FIG.-1

FIG.-2

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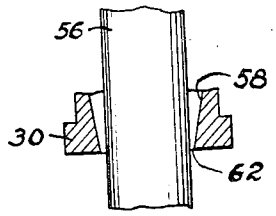


FIG-3

FIG-4

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CONVEYING FLUIDS CONTAINING SOLIDS

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Application May 28, 1941, Serial No. 395,560

5 Claims. (Cl. 103—204)

This invention relates to pumps and more particularly relates to plunger pumps adapted for high pressure pumping and for pumping liquids containing abrasive materials in suspension.

Our invention is especially adapted for use in pumping clay-oil slurries or slurries of oil and other solid contacting or catalytic agents in the treatment or conversion of hydrocarbons. Our invention is also adapted for use for pumping mud-laden fluid used in connection with oil well drilling operations or the like.

In pumping liquids containing abrasive materials or the like it is known that in some cases the grit or abrasive material is carried into the packing for the plunger due to the movement of the plunger or fluid piston rod moving in the packing and this grit or abrasive material will remain in the packing to wear the plunger or rod. This wear is quite noticeable on rods or plungers in pumps for general service and, obviously, in pumping liquids containing a high percentage in abrasive materials such as clay or mud, the wear on the plunger or rod will be increased and result in excessive maintenance charges.

More specifically the invention includes a pump having an upper chamber and a lower chamber, the chambers being in alignment but being of different diameters. Reciprocating in the chambers is a single plunger provided with portions of different diameters to cooperate with the pumping chambers whereby a positive synchronized pumping action is obtained. A packing is provided for the plunger and means are provided for preventing the abrasive materials from entering the packing material. The lower portion of the larger diameter of the plunger forms a secondary pump for placing oil or other liquid under pressure to prevent abrasive material from moving past the plunger. Oil is introduced into the pump around the smaller portion of the plunger so that as the plunger moves down, the larger portion on the plunger forces the oil or liquid into the smaller pumping chamber thus preventing abrasive materials from entering the oil chamber and getting into the gland packing during the suction stroke of the pump. The oil or liquid is forced out through an annular space formed between the smaller portion on the plunger and the pump housing. More specifically, a liner is provided for the plunger and this liner has tapering sides so as to increase the pressure on the oil as it is forced between the liner and the plunger.

The oil or other liquid under pressure may be used for other purposes. For example, a portion of the oil under pressure from the pump housing around the smaller portion of the plunger is used in part to lubricate the inlet valve of the pump. The oil under pressure may also be piped to a gland packing adjacent the larger portion of the plunger to supply positive lubrication between the upper portion of the plunger and the packing.

In the drawings:

Figure 1 represents a vertical cross-section taken through the preferred form of our invention;

Figure 2 represents a vertical cross-section taken along line II—II of Figure 1 and showing means for lubricating the inlet valve;

Figure 3 represents an enlarged detail showing in slightly exaggerated form the progressively reduced bore of the lower end of the liner for the pump housing; and

Figure 4 represents a vertical cross-section of another form of our invention.

Referring now to the drawings the reference character 10 designates a pump housing having an inlet 12 and an outlet 14. The pump is provided with a suction chamber 16 which is formed as a bore in lower section 18 of the pump. Positioned above the lower section or cylinder 18 is an upper section or cylinder 22 which is provided with a bore in alignment with the suction chamber 16 in the lower section or cylinder 18. Extending through the bores in the cylinders 18 and 22 is a straight single plunger 24 which is preferably solid and which will be described in greater detail hereinafter.

The lower section or plunger cylinder 18 is provided in its upper face with a seat 26 into which fits the bottom portion 28 of a liner 30 having a portion 31 extending into the bore of the upper cylinder 22 and when cylinders 18 and 22 are bolted together the liner 30 is securely held in position as shown in Figure 1. The lower portion of the upper cylinder 22 has a projection 32 which fits into a cut away portion 33 on the lower portion 28 of the liner 30. The lower face of the upper cylinder 22 is provided with a flat annular portion 34 which rests on the flat annular portion 36 of the lower cylinder 18. The projection 32 on cylinder 22 extends below flat portion 34 and is positioned between bottom portion 28 of liner 30 and the upper portion of the lower cylinder 18. The upper and lower cylinders 18 and 22 are preferably connected together in any suitable manner as by bolts or the like. Preferably, packing material is provided between

the meeting faces of the upper and lower cylinders 18 and 22 as at 38, 41 and 42.

As above stated, the liner 30 extends into the bore of the upper cylinder 22 and arranged above the portion 31 of the liner 30 is packing material 46 held securely in place by a screw member 48. The packing construction comprises a packing gland.

The one-piece plunger 24 is provided with a portion having a larger diameter as at 52 which normally reciprocates in the upper cylinder 22 adjacent the portion 31 of liner 30 and the packing material 46. Intermediate its ends the plunger is cut away as at 54 to provide a lower portion 56 on the plunger which has a smaller diameter. The cut away portion 54 immediately below the large diameter portion 52 forms a shoulder which acts to pump oil or liquid from the space 55 between the smaller diameter portion 56 on the plunger 24 and the liner 30 as will be presently described. The larger plunger 52 has a relatively tight fit with liner portion 31 and so prevents any substantial leakage of oil past shoulder 54 and into packing 46. The oil or other liquid in space 55 forms an oil or liquid seal and also provides a lubricating medium for the pump.

Attention is directed to Figure 3 which shows in slightly exaggerated form the tapered bore 58 on the lower portion 28 of the liner 30. The smallest part of the tapered opening is at the bottom and provides a space 62 through which oil or liquid is forced from the space 55 between the liner 30 and the smaller portion 56 of the plunger 24 and in this way increased pressure is applied to the oil or liquid from space 55.

The means for supplying oil or other liquid to the space 55 will now be described. A container 64 is provided having a pipe 66 through which the oil or liquid is withdrawn. The pipe 66 is provided with a valve 68. Where a container of this type is provided, it is necessary to have it at a sufficient height so that the suction head of the oil chamber 55 is greater than the suction head of slurry chamber 16 thus preventing abrasive materials from passing into oil chamber 55 during the suction stroke of the pump. In this way a liquid seal is maintained during the complete cycle of operation. Instead of a gravity feed a pump may be used. The oil or other liquid is passed through the valve housing 72 having a check valve 73 and through line 74 into the space 55 when the plunger 24 moves upwardly when looking at Figure 1. The check valve 73 permits flow only in the direction toward space 55. The upward movement of the plunger 24 creates suction and draws the oil or other liquid from valve housing 72 into the space 55. From the pipe 74, the oil or other liquid passes through the passageway 76 in the upper cylinder 22 and is introduced into an annular space 78 formed in the lower portion of the liner 30. Openings 82 connect the annular space or groove 78 with the space 55 between the plunger and the liner 30.

When plunger 24 moves up on a suction stroke liquid to be pumped is drawn into chamber 16 and then discharged when the plunger 24 moves down as will be hereinafter described in the operation of the device.

As above described, when the plunger 24 goes downward, the shoulder 54 between the smaller and larger portions of the plunger 24 forces the oil or liquid from the space 55 downward past the lower portion 56 of the plunger 24 and prevents grit or abrasive material from passing upward from main pumping chamber 16 to the packing 46. A portion of this oil or liquid under pressure is withdrawn through a separate side line and used for other purposes. For example, a passageway 86 is provided through liner 30 and upper cylinder 22. The passageway 86 communicates with a pipe 88 which is screwed into the passageway. Secured to the pipe 88 is a check valve 92 which only opens outwardly and only permits oil or liquid to pass in one direction. Oil under pressure is passed through the housing of valve 92 and line 94 having a valve 95 and provided at its lower portion with a jet 96 for squirting or spraying oil on the inlet valve 102 for the inlet 12 of main pumping chamber 16. The valve 102 in closed position rests on a valve seat 104. A member 106 extends over the valve 102 to permit opening of the valve but to prevent displacement of the valve 102. This member 106 is secured to a plug member 108 in any suitable manner.

An outlet check valve 112 for main pumping chamber 16 is provided for the outlet 14 to permit discharge of the slurry mixture from the slurry or pumping chamber 16. The outlet valve 112 is prevented from being displaced by a plug member 114 having an arcuate shaped guiding member 116. In passing from the inlet to the pumping chamber 16 and from the pumping chamber 16 to the outlet 14 the pumped liquid passes through a connecting passage 118.

Referring now to the modification shown in Figure 4, the general construction is substantially the same as that shown in Figure 1 and the same reference characters have been used to designate the same parts shown in Figure 1. In this form of the invention means are provided for positive lubrication of the gland for the plunger and the plunger is of a somewhat different construction. To form the shoulder intermediate the ends of the plunger 24 a split ring 122 is secured to the plunger in any suitable manner. The lower portion of the ring 122 acts as the shoulder 54 in Figure 1 to force the oil or liquid from the space 55 between the plunger and the liner to prevent abrasive material from entering the packing material.

The split ring construction is cheaper than the construction shown in Figure 1 and in some instances may be preferred for this reason. Instead of a split ring, a threaded sleeve may be screwed on to the plunger.

A side stream is removed through line 86 communicating with the space 55 between the plunger and the liner 30 and a portion of this oil under pressure may be used to lubricate the inlet valve 102, or all or a portion of the oil under pressure may be passed through line 134 having a valve 135 and through passageway 136 in the upper cylinder 22 for introducing the oil under pressure into a lantern gland 138. The lantern gland is provided with an opening 142 which permits communication with the outer annular space 144 and inner annular space 146. The lantern gland is supported on the packing material 148 which surrounds the plunger 34 and rests on the liner 39.

While our invention has been primarily described in connection with the pumping of oil slurries containing clay or other abrasive material, our apparatus may also be used for pumping corrosive liquids, for compounding, blending or mixing oils, gasoline or the like, or in other cases where it is essential to prevent solid material from entering the packing and to pre-

vent wearing of the rod or plunger. The apparatus may be used in horizontal or vertical position. Furthermore, more than one pumping unit may be arranged and combined to form a pump assembly. The diameters of the pistons 52 and 56 may be varied.

The operation of our pump will now be given. When it is desired to pump a clay-oil slurry to a cracking unit, for example, the plunger 24 is reciprocated in the cylinders 18 and 22 in any suitable manner. As the plunger moves upward, the pressure in the suction chamber 16 is lowered and the clay-oil slurry goes past the open valve 102 and is drawn into the pumping chamber 16. When the plunger moves downward, the pressure closes the inlet valve 102 and opens outlet valve 112 to permit the plunger to force the clay-oil slurry through outlet 14 to the desired reaction chamber.

If no provision were made for preventing it, the clay would work its way back past liner 30 and into the packing material 46, and the clay particles would cause abrasion of the plunger 24. According to our invention, the lower portion 56 of the plunger 24 is of a smaller diameter and a shoulder 54 is provided between the two portions of the plunger. As the plunger moves upward, lubricating oil, or the like, is drawn into the space 55 between the smaller diameter piston 56 of the plunger 24 and the liner 30. As the plunger moves downward, the check valve 72 is closed to prevent flowing back of the oil through line 74 and the oil is forced downward between the lower portion 28 of the liner 30 and the smaller diameter portion 56 of the plunger 24. As shown in Figure 3, the lower portion 28 of the liner 30 is formed with a tapered opening 58 which is larger at its top than at its bottom so as to provide a relatively small outlet annular space 62 at the lower portion of the liner. In this way the oil from the space 55 is forced through the smaller opening 62 at a greater velocity and this further helps in keeping abrasive material from working its way back to the packing.

As the piston rod 24 moves downward, the pressure on the oil in the space 55 is increased and a portion of this oil is taken through line 86 and outlet check valve 92 to lubricate the inlet valve 102. This is especially useful in cases where it is necessary to lubricate the valve and prevent corrosive liquids from attacking the valve.

In Figure 4 a portion of this side stream of oil taken through line 86 is used for lubricating the lantern gland 138 of the packing and in this way lubrication under pressure is provided for the upper portion of the plunger rod 24.

While we have shown the draw-off stream passing through line 86 in Figure 1 at some distance above the bottom of the liner 30, it is to be understood that the position of this draw-off line or passageway 86 may be varied. For example, if only a small amount of oil under pressure is desired for lubricating the valve 102, the passageway 86 is preferably raised to a point near the shoulder 54 at its highest point. That is, with the plunger rod 24 at its uppermost position, the passageway 86 would then be positioned slightly below the shoulder 54. If a larger pressure or more oil is desired for lubricating the valve 102, the passageway or draw-off line 86 is placed near the bottom of the liner 30 adjacent the annular space 78. In this way more oil will be supplied to the inlet valve 102. This latter positioning would be especially useful in a form of the invention such as shown in Figure 4 where a portion of the oil under pressure from space 55 is desired for lubricating the inlet valve 102 and another portion is desired for lubricating the lantern gland 138.

While we have shown two forms of our invention, it is to be understood that this showing is by way of example only and that we are not to be restricted thereto as changes and modifications may be made without departing from the spirit of the invention.

We claim:

1. A pump including an elongated cylinder provided with two sections of different diameter, the smaller diameter cylinder section forming a pumping chamber having an inlet and an outlet, an elongated single plunger having corresponding piston portions of different diameters and adapted to reciprocate in said cylinder, a liner for the larger diameter cylinder section, said liner being spaced from the smaller diameter piston portion during reciprocation of said plunger, means for supplying liquid to the space between said liner and said smaller diameter piston portion, said space communicating with said pumping chamber and means whereby liquid in said space is positively maintained both on the intake and discharge strokes at a pressure higher than that in the pumping chamber.

2. A pump including in combination an elongated cylinder having two sections of different diameters, an elongated single plunger adapted to reciprocate in said cylinder and having portions of different diameters to cooperate with said cylinder sections, the smaller diameter cylinder portion forming a pumping chamber having an inlet and an outlet, said smaller diameter piston portion cooperating with said pumping chamber for pumping fluid, a liner for the larger diameter section of said cylinder and having an internal diameter about the same as the large diameter piston portion, said liner being spaced from said small diameter piston portion during a suction stroke of said plunger, means for supplying a liquid to said space between said liner and said smaller piston portion, one end of said liner being arranged intermediate the ends of said cylinder and having a tapered bore to leave a restricted opening around the smaller piston portion, whereby on a discharge stroke of said plunger the liquid in said space will be forced through said restricted opening around said smaller piston portion to prevent flow of pumped fluid from said pumping chamber in the opposite direction into said cylinder beyond said liner.

3. A pump including an elongated cylinder provided with two sections of different diameter, the smaller diameter cylinder section forming a pumping chamber having an inlet and an outlet, an elongated single plunger adapted to reciprocate in said cylinder and having an abutment intermediate its ends to form a smaller piston portion at one end, said smaller piston portion being spaced from the larger diameter cylinder section, means for supplying liquid to said space, said space at one end having a restricted portion for communicating with said pumping chamber, said abutment forcing the liquid from said space through said restricted opening into said pumping chamber when said plunger moves on a discharge stroke, said means for supplying liquid to said space being so constructed that the suction head of the liquid in said space is greater than the suction head of said pumping chamber.

4. A pump including an elongated cylinder provided with two sections of different diameter, the smaller diameter cylinder section forming a pumping chamber, an elongated single plunger adapted to reciprocate in said cylinder and having an abutment intermediate its ends to form a smaller piston portion at its lower end for reciprocation in said pumping chamber, packing for said plunger at the opposite end of said cylinder, inlet and outlet valves associated with said pumping chamber, said cylinder being spaced from said smaller piston portion, means for supplying liquid to said space between said cylinder and smaller piston portion during a suction stroke, means whereby the liquid is forced from said space during a discharge stroke of said plunger, and means communicating with said space for jetting liquid under pressure to said inlet valve.

5. A pump including an elongated cylinder provided with two sections of different diameter, the smaller diameter cylinder section forming a pumping chamber having an inlet and an outlet, an elongated single plunger adapted to reciprocate in said cylinder and having an abutment intermediate its ends to form a smaller piston portion, means for supplying liquid to the space between the larger diameter cylinder section and the smaller diameter piston portion, means whereby liquid supplied to said space is positively maintained both on the intake and discharge strokes at a pressure higher than that in the pumping chamber, a tapered cylinder portion at the junction of said different cylinder diameters and spaced slightly from said smaller diameter piston portion for increasing the velocity of the liquid as it is forced from said space into said pumping chamber during the reciprocation of the plunger.

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