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WELL PUMPING APPARATUS

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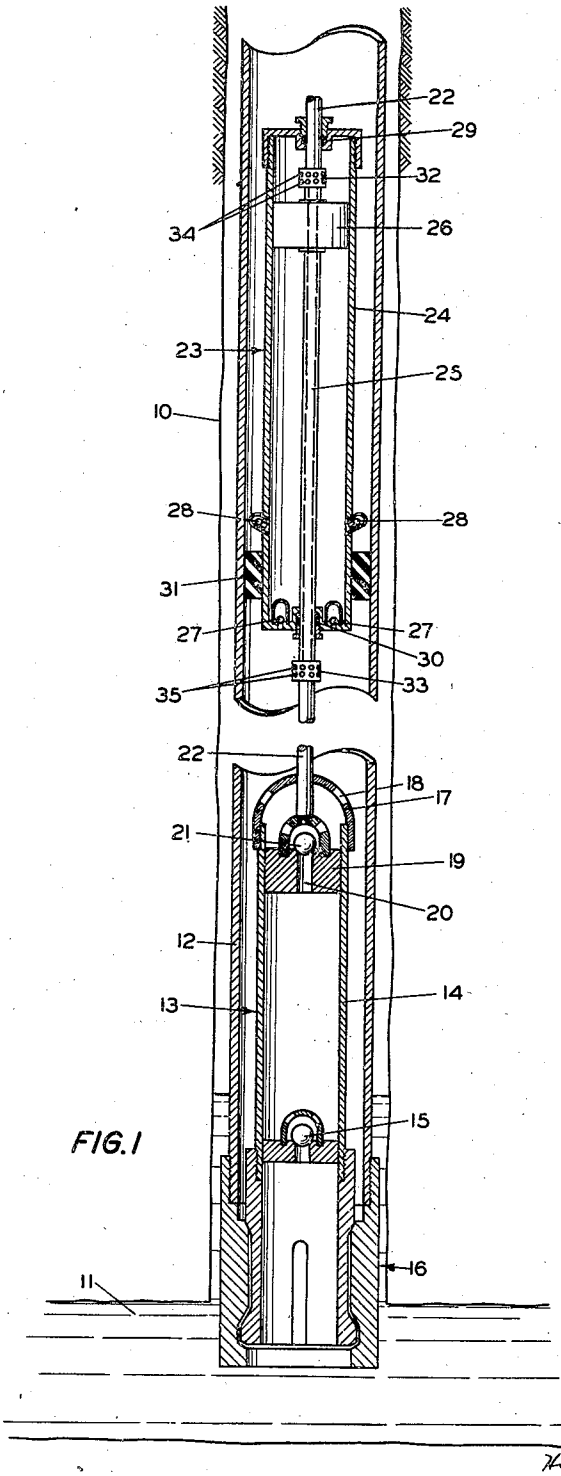


FIG. 1

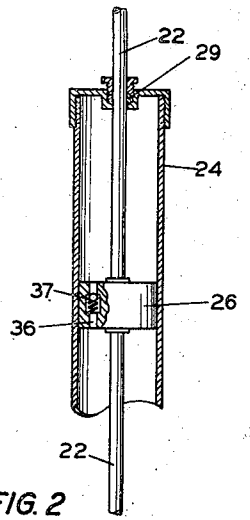


FIG. 2

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WELL PUMPING APPARATUS

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6 Claims. (Cl. 103—5)

This invention relates to pumping, and more particularly to well pumping apparatus of the reciprocating type.

The present practice of pumping fluid from well bores commonly employs a single reciprocating pump which is actuated by a string of sucker rods attached to and reciprocated by a pumping unit or rig front at the surface of the ground. Reciprocating pumps generally lift fluid only on the upstroke of the sucker rods. In order to prevent the occurrence of excessive stresses and extreme shock loads on the sucker rods during the downstroke, the pumping unit is counterbalanced.

My instant invention has a number of advantages which are not inherent with the present types of reciprocating pumps. I employ a pair of pumps, one of which is placed at a considerable distance above the other, on a single sucker rod string and in such a manner that the lower pump lifts fluid on the upstroke of the rods and the upper pump lifts fluid on the downstroke of the rods, thereby utilizing the weight of the sucker rods to assist in lifting well fluid upwardly to the surface of the ground. This greatly reduces or may elminate counterbalancing of the pumping unit. By practicing my invention I can use smaller equipment in lifting subsurface fluids from a known depth than can be used with present types of pumping equipment. Further, I can effect the pumping of deeper wells than is now practical with present-day reciprocating pumps which are actuated by a string of sucker rods.

My invention has for its primary object the provision of reciprocating well pumping apparatus.

Another object of my invention is the provision of a pumping apparatus which lifts fluid on both the upstroke and downstroke of a string of sucker rods.

A further object of my invention is the provision of reciprocating pump apparatus which is capable of lifting from greater depths than is practical with present-day equipment.

These and additional objects and advantages will be apparent to persons skilled in the art by reference to the following description and annexed drawing, wherein:

Figure 1 is an elevation view, partly in cross section of a preferred embodiment of my invention; and

Figure 2 is an elevation view, partly in cross section, of a modified form of the upper pump assembly.

Referring to the drawing, and more particularly to Figure 1, I have denoted therein a well bore by reference numeral 10. The well bore extends downwardly from the surface of the ground to a hydrocarbon oil-bearing formation 11. As illustrated in the drawing, the well bore is partially filled with formation fluid. A tubular member, such as a string of tubing 12, which is suspended in the well bore from the surface of the ground in a well-known manner, conveys the fluid which is pumped from the lower part of the well bore to the surface of the ground. A lower conventional pumping assembly 13, which includes a pump liner or barrel 14 and a standing valve 15, which is provided at the base of the liner, is removably positioned in tubing 12 by a well-known type of hold-down apparatus 16. It will be noted that the hold-down, in addition to holding the pumping assembly in place during pumping operations, also seals the bottom of the tubing so that the formation fluid may enter the tubing only by way of standing valve 15. Liner 14 is threadedly connected to a top or cage 17 which has suitable passages 18 through which fluid may be discharged to tubing 12. A piston or traveling valve 19, having a port 20 and a ball check valve 21, is secured to the lower end of a string of sucker rods 22 which reciprocate in liner 14. It is obvious that port 20 is closed by valve 21 on the upstroke of the piston. During the downstroke, the fluid raises valve 21 off its seat and thence passes through port 20 to the upper side of the piston.

An upper pumping assembly 23 is positioned between the lower pumping assembly and the surface of the ground. This assembly preferably includes a closed pump jacket or cylinder 24; a hollow rod member 25 which reciprocates in the cylinder; and a piston or plunger 26 which is mounted concentrically on the hollow sucker rod. One or more intake ball-check valves 27 are provided on the lower end of the cylinder. One or more discharge ball-check valves 28 are also provided in the cylinder wall. Packing glands 29 and 30 are positioned in the upper and lower ends, respectively, of the closed pump jacket and prevent the movement of fluid past the junctures of the top and bottom of the jacket and the reciprocating rods. The upper pumping assembly is held in place by suitable seating and packing apparatus, such as a slip type packer 31, which seals the annular space formed between pump cylinder 24 and tubing 12. It will be noted that packer 31 is placed intermediate valves 27 and 28. The hollow rod member has

a pair of adapters 32 and 33 with openings 34 and 35, respectively, which are positioned at each end of the hollow rod member. Each adapter is threaded to connect with sucker rods 22. The openings communicate with hollow portion of member 25, forming a by-pass between the part of the pump cylinder which is above piston 26 and the tubing below packer 31. This by-pass arrangement permits the equalization of pressure in the portion of pump cylinder 24 above piston 26 and the region below packer 31.

For the purpose of outlining the mode of operation of my invention, let us assume that the apparatus has been assembled and lowered into well bore 10, as shown in Figure 1. Let us also assume that sucker rods 22 are being reciprocated in the usual manner from the surface of the ground and that well fluid from hydrocarbon oil-bearing formation 11 is being transmitted upwardly through tubing string 12. On each upstroke of the sucker rods, standing valve 15 in lower pump assembly 13 opens, permitting flow of fluid from the formation into barrel 14, check valve 21 being maintained in closed position due to the pressure of the head of fluid acting thereon. At the same time, piston 19 discharges well fluid, previously admitted into the upper portion of barrel 14, upwardly through passages 18 and into tubing string 12. During each upstroke of the rods, check valves 27 in upper pump assembly 23 open, permitting well fluid in the tubing string below packer 31 to be admitted into the lower portion of cylinder 24. Check valves 28 are closed, however, due to the pressure of the head of fluid in the tubing string above packer 31.

Referring back to the lower pump assembly 13, it will be evident that, as the sucker rods move downwardly on each downstroke, valve 15 closes and valve 21 opens, permitting the fluid in the lower portion of pump barrel 14 to flow through port 20 in piston 19 and fill the cylinder above this piston. At the same time, valves 28 open and valves 27 close in the upper pump assembly with the result that piston 26 urges well fluid in cylinder 24 through valves 28 and into tubing string 12. The well fluid thus admitted into the tubing above packer 31 passes upwardly to the surface of the ground. It will be noted from the foregoing that well fluid is raised in the well bore by lower pump assembly 13 on each upstroke of the rods and by upper pump assembly 23 on each downstroke of the rods. The two pump assemblies are spaced apart a predetermined distance, depending on conditions at individual wells, including the depth of the well bore, the size of tubing and sucker rods employed, and the like. By the arrangement outlined above, I am able to utilize the weight of the reciprocating members positioned below the upper pump piston to assist in pumping fluid upwardly therefrom to the surface of the ground.

Referring next to Figure 2 for details of construction of the modification of the upper pump assembly illustrated therein, it will be noted that piston 26 is provided with a port 36 extending therethrough, and containing a spring loaded check valve 37. This check valve is normally maintained in closed position due to the action of its spring. However, in the event well fluid accumulates above piston 26 in cylinder 24, valve 37 will be opened against the action of its spring on the upstroke of the piston, thereby allowing the fluid to flow through port 36 to the lower part of the pump cylinder. This prevents the possibility of damage which might occur in the equipment, if the excessive pressures were permitted to be built up in the upper end of pump cylinder 24. By virtue of the above described construction, the pressure equalizing by-pass arrangement illustrated in Figure 1 may be eliminated and sucker rods may be substituted for hollow rod member 25. The construction and operation of the invention is in all other respects the same as with regard to Figure 1.

It will be evident that while the form of lower pump assembly 13 that is illustrated and described herein may be advantageously employed in the practice of this invention, various other types of well-known reciprocating pumps may be substituted therefor with equally satisfactory results.

It is to be understood that the form of my invention, herewith shown and described, is to be taken as a preferred example of the same, and that various changes in shape, size and arrangement of parts may be resorted to without departing from the spirit of my invention, or the scope of the subjoined claims.

I claim:

1. In well pumping apparatus, the combination comprising a conduit adapted to be disposed in a well bore, a pair of reciprocating pumps positioned at different levels in the conduit, the upper pump forming an annular space with the conduit and including a fluid inlet in its lower portion and a fluid outlet above the fluid inlet discharging into the annular space, a packer in the annular space intermediate the fluid inlet and the fluid outlet of the upper pump, reciprocable means for actuating both pumps, means for transmitting well fluid from the lower pump into the upper pump on movement of the reciprocable means in one direction, and means for discharging well fluid from the upper pump on movement of the reciprocable means in the opposite direction.

2. In well pumping apparatus, the combination comprising a conduit adapted to be suspended in a well bore, a pair of reciprocating pumps removably disposed at different levels in the conduit, the upper pump being spaced from the conduit to form an annular passage therewith and including a fluid inlet and a fluid outlet above said inlet discharging into the annular space, a packer in the annular passage intermediate the fluid inlet and the fluid outlet of the upper pump, reciprocable means for actuating both pumps simultaneously, means for transmitting well fluid into the upper pump on each upstroke of the reciprocable means, and means for discharging well fluid from the upper pump on each downstroke of the reciprocable means.

3. In well pumping apparatus, the combination comprising a conduit adapted to be disposed in a well bore, a pair of reciprocating pumps positioned one above the other in the conduit, reciprocable means for actuating both pumps, said reciprocable means coacting with one pump to discharge fluid therefrom upon movement in one direction and coacting with the other pump to discharge fluid therefrom upon movement in the opposite direction, said upper pump including a cylinder forming an annular space with the conduit, a closure at each end of the cylinder, a piston reciprocable in the cylinder and connected to the reciprocable means, a fluid inlet and a fluid outlet, said fluid inlet and fluid outlet both communicating with the annular space, and packer means in the annular space intermediate the fluid inlet and the fluid outlet.

4. In well pumping apparatus, the combination comprising a conduit adapted to be disposed in a well bore, a pair of reciprocating pumps positioned one above the other in the conduit, the upper pump forming an annular space with the conduit and including a cylinder, a closure at each end of the cylinder, a piston reciprocable in the cylinder, a fluid inlet for transmitting fluid discharged from the lower pump into the cylinder, and a fluid outlet communicating with the annular space, packer means in the annular space intermediate the fluid inlet and the fluid outlet, and reciprocable means for actuating both pumps, said reciprocable means coacting with the lower pump to transmit well fluid upwardly through the conduit upon movement in one direction and coacting with the upper pump for transmitting well fluid upwardly through the conduit upon movement in the opposite direction.

5. In well pumping apparatus, the combination comprising a conduit adapted to be disposed in a well bore, a pair of reciprocating pumps positioned one above the other in the conduit, the upper pump forming an annular space with the conduit and including a cylinder, a closure at each end of the cylinder, a piston reciprocable in the cylinder, a fluid inlet for transmitting fluid discharged from the lower pump into the cylinder, and a fluid outlet communicating with the annular space, packer means in the annular space intermediate the fluid inlet and the fluid outlet, and reciprocable means for actuating both pumps, said reciprocable means coacting with the lower pump to transmit well fluid upwardly through the conduit upon movement in one direction and coacting with the upper pump for transmitting well fluid upwardly through the conduit upon movement in the opposite direction, said reciprocable means including means for maintaining the pressure in the cylinder above the piston of the upper pump substantially equal to the pressure in the conduit below the packer means.

6. In well pumping apparatus, the combination comprising a conduit adapted to be disposed in a well bore, a pair of reciprocating pumps positioned one above the other in the conduit, the upper pump forming an annular space with the conduit and including a cylinder, a closure at each end of the cylinder, a piston reciprocable in the cylinder, a fluid inlet for transmitting fluid discharged from the lower pump into the cylinder, and a fluid outlet communicating with the annular space, packer means in the annular space intermediate the fluid inlet and the fluid outlet, and reciprocable means for actuating both pumps, said reciprocable means coacting with the lower pump to transmit well fluid upwardly through the conduit upon movement in one direction and coacting with the upper pump for transmitting well fluid upwardly through the conduit upon movement in the opposite direction, said reciprocable means including a pressure equalizing tubular member communicating with the cylinder above the piston in the upper pump and with the conduit below the packer means.

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