Feb. 11, 1930. M. T. ARCHER 1,746,811

HYDRAULICALLY ACTUATED PUMP

Filed June 15, 1927

Fig. 1

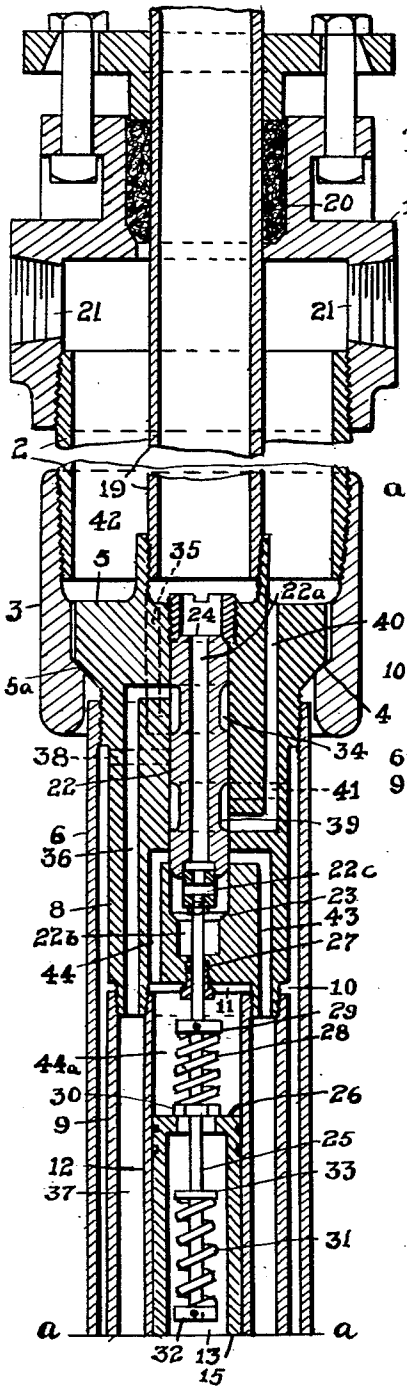


Fig. 1a

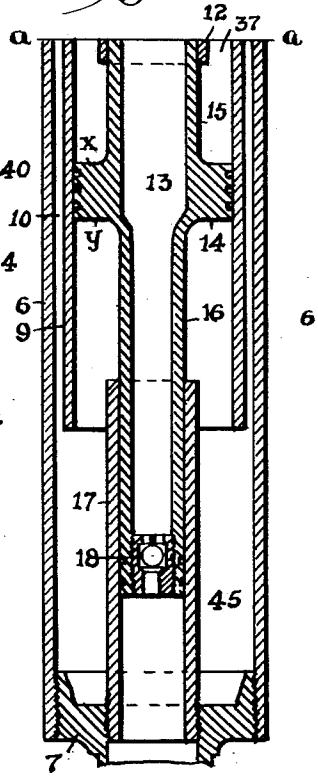
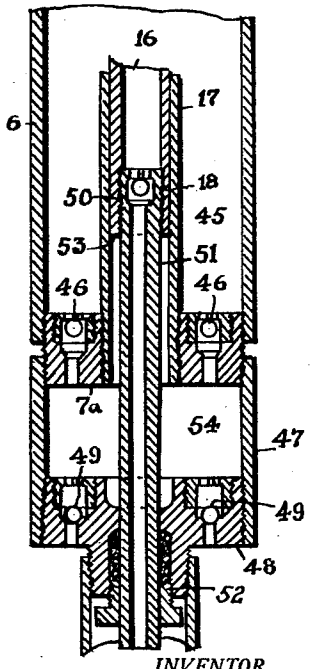


Fig. 2



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UNITED STATES PATENT OFFICE

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HYDRAULICALLY-ACTUATED PUMP

Application filed June 15, 1927. Serial No. 198,934.

My invention relates to pumps operated hydraulically, the pump-plunger being located at any desired depth in the well.

It is one object of this invention to provide a pump whose plunger, instead of being actuated by rods reaching to the top of a well, is operated in both directions hydraulically. Another object is to alternately actuate two hydraulic columns which move the plunger in opposite directions, by constant pressure applied through a single hydrostatic column under constant pressure, the third column being alternately superimposed on the first two columns. My invention provides a valve automatically operated to apply the pressure of the said third hydrostatic column alternately to the said first two hydraulic columns for reciprocating the plunger. Another object is to adapt the invention for both single and double action. Other objects relate to details described hereinafter.

Referring to the accompanying drawing, Figs. 1 and 1ª show when matched on the lines *a*—*a* a central vertical section of a well-pumping apparatus embodying my invention; and Fig. 2, a central vertical section of a modification of the lower part of Fig. 1ª.

On Figs. 1 and 1ª, 1 is a casing head to which a string of casing 2 is attached, the lower end of the casing having attached thereto the suspension collar or ring 3. The latter has an inturned downwardly tapering annular seat 4, on which the special head 5 is suspended by the annular downwardly tapered shoulder 5ª on the said head. The tube 6 is screwed on the head 5 a short distance below the shoulder 5ª and has its lower end provided with the annular plug or ring 7.

Below the place of attachment of the tube 6 to the head 5, the latter is reduced in cross-section, or provided with the downward extension 8, on whose lower end is screwed the outer pump barrel 9 which terminates above the ring 7, there being an annular space 10 between the tubing 6 on the one side and the barrel 9 and the extension 8 on the other.

The lower end of the head is provided with the large cylindrical cavity 11, to the periphery of which is secured the upper end of the inner pump barrel 12 which extends concentrically down into the barrel 9 and terminates above the lower end of the latter.

The pump plunger which has the axial passage 13 from end to end comprises the cylindrical member 14 which fits the interior wall of the barrel 9 and is reciprocable thereon; the upper member 15 which fits the interior wall of the barrel 12 and slides thereon; and the lower member 16 which fits the interior wall of the tubular member or pipe 17 and slides thereon, the said member 17 being screwed in the central opening in the ring 7. The member 16 has in the passage 13 the check valve 18 which seats downwardly.

The upper end of the head 5 has the tubing 19 axially secured thereto, the upper end of the tubing extending up through the stuffing box 20 in the casing head. 21 represents ports in the casing head.

The head 5 has an axial bore in which the valve 22 is reciprocable. The bottom of the bore has the internal downwardly tapering seat 23 on which the lower end of the valve 22 sits fluid tight when the latter is at its lower limit or position. The upper end of the bore contains a ring seat 24 projecting into the bore and tapering upwardly. The upper end of the valve 22 sits fluid tight on this seat when at its upper limit or position.

To the lower end of the valve 22 is attached the valve-shifting rod 25 which extends down into the member 15, whose upper end has the inturned flange or actuator 26 through which the rod extends. The rod extends through a stuffing box 27 in the lower end of the head 5 and has between the head 5 and the flange 26 the helical spring 28 seated between two disks 29 and 30, all three being strung on the rod. The disk 29 is fastened to the rod but

the disk 30 is loose thereon and is too large to pass below the flanged actuator 26.

Within the barrel 12 and the plunger member 15, the rod 25 has strung thereon the spring 31 between the two disks 32 and 33, the former made fast to the rod and the latter loose thereon. The disk 33 may be engaged by the flange 26 but is too large to pass above it.

The valve 22 has an annular recess 34 which, when the valve is at its upper limit, is in communication with the passage 35 which leads up through the head 5 and into the bottom of the tubing 19 and also in communication with the passage 36 which leads down through the head 5 and into the annular chamber 37 between the two pump barrels 9 and 12. When the valve is at its lower limit, the recess 34 connects the passage 35 with the passage 38 which opens into the chamber 10.

When the valve is at its upper limit, a second annular recess 39 connects the passage 40 to the passage 41, both being in the head 5. The passage 40 opens into the annular chamber 42 between the casing 2 and the tubing 19, and the passage 41 opens into the chamber 10. When the valve is at its lower limit, the recess 39 connects the passage 40 to the passage 43 which goes through the head 5 to the chamber 37, and also connects the passages 40 and 44 in the head 5 to the chamber 44^a in the barrel 12 above the plunger member 15.

In order to use constant working pressure in the actuating column 19 and perform equal work on both sides of the plunger I design the plunger according to the following proportion: the area of the annulus x between the barrel 9 and the plunger member 15 is to the area of the annulus y between the barrel 9 and the plunger member 16 as the area of the annulus y is to cross-area of the entire plunger 14. This has been fully described and claimed in my application Serial No. 191,405, filed May 14, 1927, and need not be more fully elaborated here.

It is assumed for the present that the fluid which operates the plunger and the fluid which is pumped is oil and that the system is supplied with oil as it would be during operation.

Oil under pressure is forced down the tubing 19. Some of the oil flows through the passage 35, the recess 34 and the passage 36 into the chamber 37, and forces the plunger downwardly. The oil beneath the plunger member 14 is forced up the chamber 10 and through the passage 41, the recess 39 and the passage 40 into the chamber 42 and out through the ports 21. At the same time the plunger members 15 and 16 descend, tending to form a vacuum in the passage 13 and the chamber 44^a in the barrel 12, since the passage 44 is closed. Oil therefore passes the valve 18 and up the passage 13.

Before the plunger reaches its lower limit, the flange 26 engages the disk 33 and compresses the spring 31 until enough force is stored therein to move the valve 22 from its upper seat 24 to its lower seat 23. It is seen that while the valve 22 is on its seat 24 an annular portion of its upper end is covered and protected from contact with the oil in the tubing 19, while the entire lower end of the valve is in contact with the oil under pressure. Hence there is a resultant upward pressure on the valve which holds the valve in its upper position and which the force stored in the spring must overcome. The lower end of the valve 22 receives pressure through the axial bore 22^a therein, which is connected to the chamber 22^b below the valve by the lateral ports 22^c.

The oil under pressure in the tubing 19 now passes through the passage 35, the recess 34, the passage 38 and the chambers 10 and 45, the latter being bounded laterally by the tubing 6 and the members 16 and 17, below by the ring 7, and above by the annulus y. The excess pressure is now applied to force the plunger upwardly, the annulus x forcing the oil up through the chamber 37, the passage 43, the recess 39, and the passage 40 into the chamber 42 and through the ports 21. At the same time, the oil in the passage 13 and chamber 44^a is forced up by the closed check valve 18, passing up the passage 44 and into the recess 39 where it joins the stream flowing up the passage 40. Before the plunger reaches its upper limit the flange 26 engages the disk 30 and compresses the spring 28 which overcomes the excess downward differential pressure on the valve and moves the valve 22 to its upper limit whereupon the cycle of operations just detailed will be automatically repeated as long as the oil under proper pressure is fed down the tubing 19, provided of course that there is sufficient depth of oil in the well to feed the pump.

The pump described is single acting. Fig. 2 which shows a modification adapting the invention for double acting, will now be described.

The ring 7 of Fig. 1^a is replaced by the ring 7^a which has a suitable number of downwardly seating check valves 46. On the ring 7^a which projects below the barrel 9 is screwed the pipe 47 in whose lower end is screwed the ring 48 provided with a number of downwardly seating check valves 49. The housing 50 for the check valve 18 has the hollow downward extension 51 which passes down through the ring 48 having a stuffing box 52 to make the extension fit fluid tight in the ring.

When the plunger goes up it sucks oil up past the check valves 49 into the chamber 54. When the plunger goes down the annular lower end 53 of the member 16 acts as a piston and forces the oil in the chamber 54

between the rings 7ª and 48, up past the check valves 46 into the chamber 45 whence it flows along with the fluid already therein up the chamber and finally into the chamber 42 and out through the ports 21.

I have described the head 5 as having only one set of passages 35, 36, 38 and 44 and only one set of passages 40, 41 and 43 to cooperate with the recesses 34 and 39, but it will be understood that these sets of passages will be multiplied to meet the conditions present.

It is noted that the entire assembly supported by the head 5 is suspended on the seat 4, but, in case the assembly is supported otherwise, as from above by the tubing 19, the head 5 or equivalent may be packed off from the casing 2 in any suitable or well known manner.

I claim:—

1. In a pump, a well casing, a head packed off therefrom, a tubing attached to the head, two pump barrels attached to the head and within the tubing, a hollow plunger having a piston member in each barrel, a downwardly seating check valve for the plunger, a ring carried by the tubing below the barrels, an upstanding tube carried by the ring, a hollow plunger member slidable in the tube, a tubing connected to the head and within the casing, a valve slidable in the head, and means whereby, when the valve is in one position, the interior of the second tubing is in communication with the upper face of one piston member, and the space between the casing and the second tubing is in communication with the lower face of the said piston member, and, when the valve is in another position, the said communications are reversed.

2. In a pump, a well casing, a head packed off therefrom, a tubing attached to the head, two pump barrels attached to the head and within the tubing, a hollow plunger having a piston member in each barrel, a downwardly seating check valve for the plunger, a ring carried by the tubing below the barrels, an upstanding tube carried by the ring, a hollow plunger member slidable in the tube, a tubing connected to the head and within the casing, a valve slidable in the head, and means whereby, when the valve is in one position, the interior of the second tubing is in communication with the upper face of one piston member, and the space between the casing and the second tubing is in communication with the lower face of the said piston member, and, when the valve is in another position, the said communications are reversed and the hollow in the plunger is connected to the said space.

3. In a pump, a well casing, a head packed off therefrom, a tubing attached to the head, two pump barrels attached to the head and within the tubing, a hollow plunger having a piston member in each barrel, a downwardly seating check valve for the plunger, a ring carried by the tubing below the barrels, an upstanding tube carried by the ring, a hollow plunger member slidable in the tube, a tubing connected to the head and within the casing, a valve slidable in the head, means whereby, when the valve is in one position, the interior of the second tubing is in communication with the upper face of one piston member, and the space between the casing and the second tubing is in communication with the lower face of the said piston member, and, when the valve is in another position, the said communications are reversed, and means controlled by the plunger for causing the valve to move from each position to the other.

4. In a pump, a well casing, a head packed off therefrom, a tubing attached to the head, two pump barrels attached to the head and within the tubing, a hollow plunger having a piston member in each barrel, a downwardly seating check valve for the plunger, a ring carried by the tubing below the barrels, an upstanding tube carried by the ring, a hollow plunger member slidable in the tube, a tubing connected to the head and within the casing, a valve slidable in the head, means whereby, when the valve is in one position, the interior of the second tubing is in communication with the upper face of one piston member, and the space between the casing and the second tubing is in communication with the lower face of the said piston member, and, when the valve is in another position, the said communications are reversed, a downwardly seating check valve in the ring, a pipe extending below and connected to the ring and having therein a ring provided with a downwardly seating check valve, and a tube having a smaller diameter than the plunger member in the said upstanding pipe and connected thereto and projecting through the second ring.

5. In a pump, a hollow plunger carrying an operating piston and a pumping piston, means confining a hydraulic column in communication with the upper side of the operating piston, means including a tube surrounding the plunger and the said means, confining a hydraulic column and conveying pressure therefrom to the lower side of the operating piston, means confining a third hydraulic column, means automatically operated by the movements of the plunger to superimpose the third column on the other two columns alternately, and a pump barrel containing the pumping piston.

6. In a pump, a well casing and a pump mechanism suspended from the casing and insertable through the casing and withdrawable therefrom, the pump mechanism comprising the following, a head suspended from the casing, a well tubing coaxially connected to and pendent from the head, concentric pump barrels within the tubing, a pump plunger having an operating piston and a

pumping piston, the operating piston working in the larger barrel, means including the tubing and the larger barrel for confining two hydraulic columns one communicating pressure to the lower side of the operating piston and the other to the upper side thereof, means confining a third hydraulic column, and a valve automatically operated to superimpose the third column upon the other two columns alternately, the pumping piston working in the smaller barrel.

In testimony whereof I hereunto affix my signature.

MERTON T. ARCHER.