May 23, 1961 H. E. McCRAY 2,985,432

HYDRAULIC PUMPING APPARATUS

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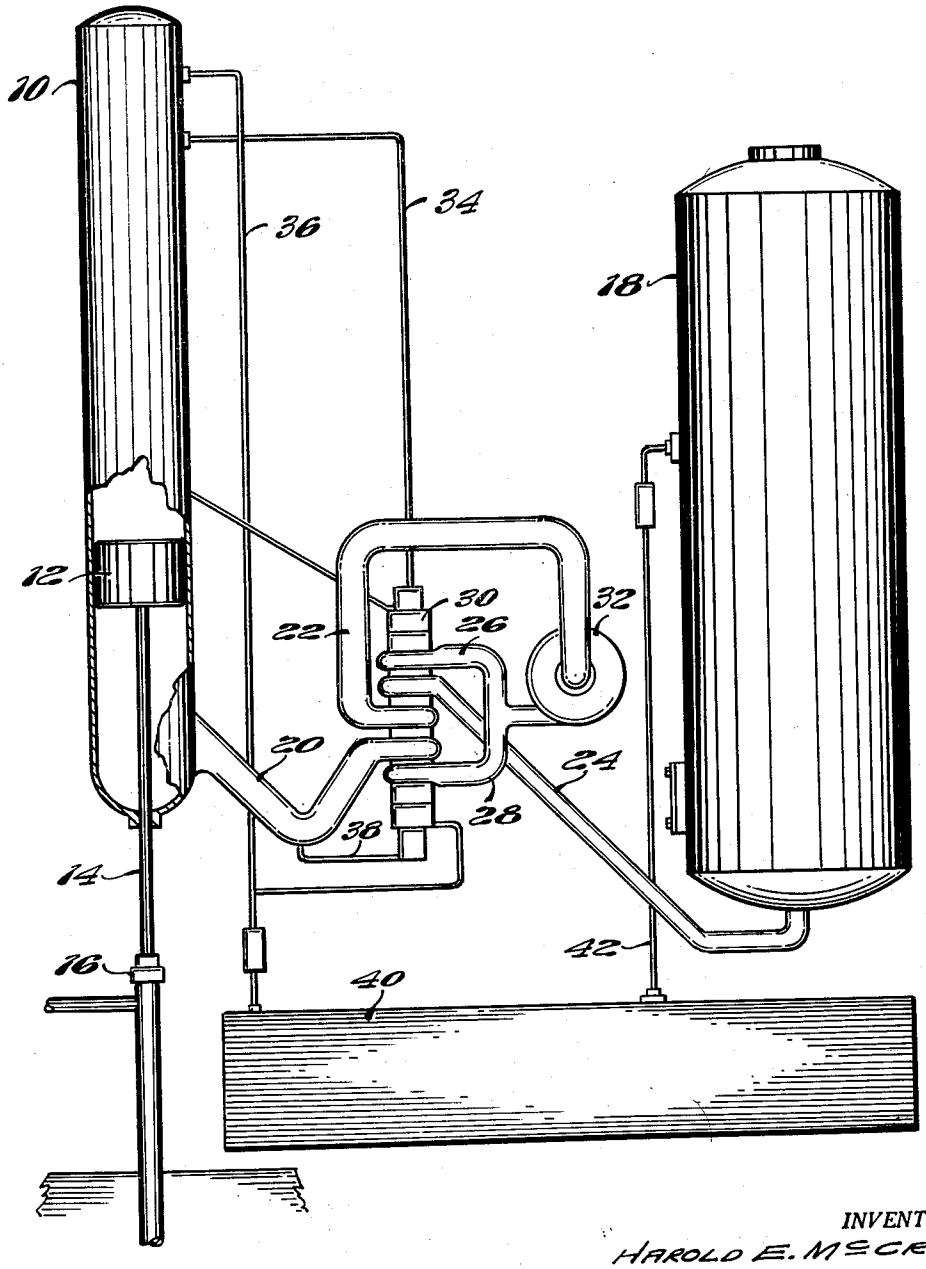



Fig. 1

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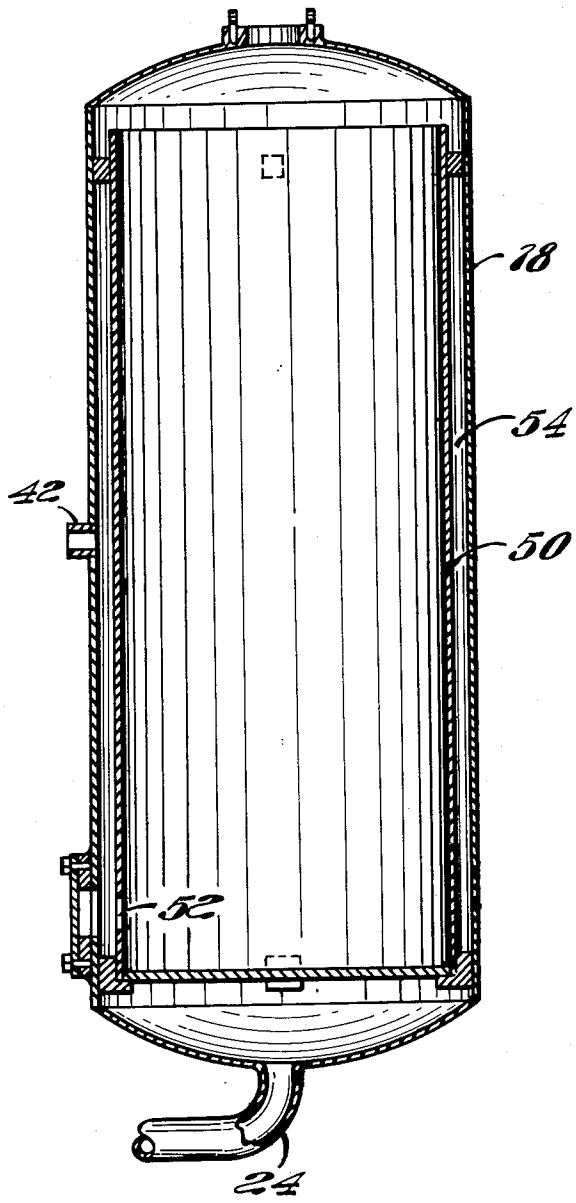



Fig. 2

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United States Patent Office 2,985,432 Patented May 23, 1961



2,985,432

# HYDRAULIC PUMPING APPARATUS

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Filed Sept. 27, 1956, Ser. No. 612,534

2 Claims. (Cl. 257—191)

This invention relates to hydraulic well pumping systems and more particularly to novel apparatus comprising in combination with a hydraulic pump a hydraulic counterbalancing tank particularly adapted to contain the hydraulic fluid employed in the system under pressure and to cool the fluid.

In the pumping of wells, particularly deep oil wells, it has been found desirable to employ pumps at the bottom of the well which have as long a stroke as practicable. The conventional walking beam of the pumping unit has proved to be inadequate to provide a pumping stroke of sufficient length. Consequently, there has been devised a hydraulic pumping unit in which the pumping action is effected by means of a piston moving in a cylinder mounted vertically above the well head. With such apparatus it is possible to achieve a stroke of almost any desired length.

As is customary in the petroleum art the oil pump rests in the bottom of the well and its plunger is connected to the surface by means of sucker rods which in turn are connected to the actuating mechanism. Because of the considerable weight of the sucker rods together with the weight of the column of fluid in the well, considerable hydraulic pressure is required to elevate the piston in the lifting or motor cylinder on the surface of the ground. The conventional walking beam type of pumping unit can be and customarily is counterbalanced mechanically by means of weights attached to the end of the beam and/or to the crank. Such mechanical devices are not adapted to the hydraulic type of lifting apparatus.

Accordingly, the hydraulic pumping system includes a fluid pump and a counterbalancing tank in which the hydraulic fluid is contained under pressure. For reciprocation of the sucker rod the pressure in the counterbalancing tank assists the fluid pump to force hydraulic fluid into the bottom of the lifting cylinder during the upstroke. Thus, depending upon the pressure maintained in the counterbalancing tank, the hydraulic fluid pump will have to lift only about half the weight of oil and sucker rod in the well, the counterbalancing pressure making up the difference.

During pumping the hydraulic fluid naturally becomes quite hot due to friction and also due to the compression of the air in the top of the counterbalancing tank and it becomes necessary to cool the hydraulic fluid.

The principal object of this invention is to provide a novel counterbalancing tank particularly suitable for hydraulic pumping systems in which the hydraulic fluid will be cooled as it flows into the tank.

The apparatus of this invention includes a fluid tight, pressure resistant tank having a conduit connected into the bottom through which the hydraulic fluid flows back and forth in the course of pumping. Within the main tank there is provided a smaller tank open at the top and having its bottom positioned somewhat above the bottom of the main tank. The inner tank is concentrically mounted to provide a narrow annular space between its wall and the wall of the main tank. A small opening,



which may be an orifice or may be equipped with a lift check valve, is provided in the lower area of the inner tank. A body of hydraulic fluid is maintained at all times in the bottom of the tank and by reason of the opening in the inner tank is at a substantially equal level in both tanks while fluid is being withdrawn. When being returned to the tank, hydraulic fluid is forced into the bottom of the main tank and flows upwardly through the narrow passage between the two tanks and then flows over the lip and into the inner tank. In the course of its upward flow the fluid is cooled by contact with the relatively cool wall of the main tank.

The apparatus of this invention is illustrated in the accompanying drawings in which:

Fig. 1 is a side view, partly in cross section, of the complete hydraulic pumping unit, and

Fig. 2 is a side view, partly in cross section, of the counterbalancing tank.

The pumping unit as shown in Fig. 1 includes a motor or lifting cylinder **10** containing a piston **12** attached to polish rod **14** running in the stuffing box **16** at the well head. Hydraulic fluid is contained under pressure in the counterbalancing reservoir **18** of my invention. Flow of hydraulic fluid between motor cylinder **10** and reservoir **18** is provided for by conduits **20**, **22**, **24**, **26** and **28**, reversing valve **30** and pump **32**. Reversing valve **30** is actuated by pressure changes in pressure transmission lines **34** and **36** working against a constant pressure in line **38**. Hydraulic fluid leaked from the system is recovered in drain tank **40** and returned to the reservoir through conduit **42**.

The apparatus functions as follows. To commence upstroke of polish rod **14**, hydraulic fluid flows through conduit **24**, valve **30**, conduit **22**, pump **32**, conduit **28**, valve **30** and conduit **20**, in that order, into the bottom of motor cylinder **10**. When the piston **12** has been elevated to the top of the cylinder, thereby also opening fluid pressure transmission lines **34** and **36** to the full cylinder pressure and causing actuation of reversing valve **30**, hydraulic fluid is diverted from cylinder **10** through pump **32** back into reservoir **18**. The hydraulic fluid thus flows through conduit **20**, valve **30**, conduit **22**, pump **32**, conduit **26**, valve **30** and conduit **24**, in that order, into reservoir **18**. In other words, on upstroke pump **32** pulls fluid from the reservoir and discharges it through the valve into motor cylinder **12** while on downstroke pump **32** pulls fluid from the motor cylinder and discharges it into the reservoir.

If hydraulic fluid were merely flowed in and out of the supply of fluid in the bottom of reservoir **18** it would become hotter and hotter as pumping progressed until an equilibrium temperature was reached. Such temperature, as is well known, may be sufficiently high to cause rapid deterioration and loss of the fluid. It is for the purpose of increasing hydraulic fluid life that the apparatus of this invention has particular utility.

The counter balance reservoir is shown in more detail in Fig. 2. It comprises an outer tank **18** containing a smaller tank **50** concentrically mounted within. Inner tank **50** is open at the top but closed at the bottom except for a small orifice **52** in the side wall. The two tanks are closely spaced on the side to provide a narrow annular passageway **54** between the two while the bottom of the inner tank is raised somewhat above the bottom of the outer. Thus when fluid is returned to reservoir **18** through conduit **24** it flows rapidly upward through passageway **54**, spills over the lip of the inner tank and falls to the bottom. During upflow of the fluid in contact with the wall of the outer tank it is sufficiently cooled to maintain overall temperature at a satisfactory level.

In operation, sufficient hydraulic fluid is charged to reservoir **18** to fill the motor cylinder and hydraulic con-

duits and to maintain a slight fluid head in the reservoir. Orifice **52** is of adequate size to accommodate the required flow of fluid from the inner to the outer tank on withdrawal of fluid. With a minimum pressure of 200 lbs./sq. in. or more prevailing in the reservoir fluid is always available to the intake of conduit **24**.

In one apparatus constructed according to this invention the following dimensions and conditions were provided.

Tank **18**: height—15′ 5″; ID—41″.
Tank **50**: height—14′; OD—39″.
Passageway **54**: capacity—91.4 gals.
Motor cylinder **12** @27′ stroke: capacity—110.45 gals.
Fluid flow velocity in passageway **54**—3.38 ft./sec.
Fluid flow volume through passageway **54**—6.625 lbs./sec.
Cooling effect—14.1° F. avg. reduction in temp. of fluid.
Fluid reserve in reservoir—34.3 gals.
Counterbalance effect: top of stroke—200 p.s.i.; bottom of stroke—228 p.s.i.

Having thus described my invention, I claim:

1. A counterbalancing hydraulic fluid reservoir comprising a fluid-tight, pressure-resistant outer container, a smaller, open-top, closed-bottom container disposed therein with side walls disposed parallel to the side walls of said pressure-resistant outer container having as the only direct opening between the lower parts of the said inner and outer container an orifice type opening in the lower side wall of the inner container, and a conduit connected into the bottom of said pressure-resistant outer container, whereby fluid entering through said conduit is propelled upwardly between the parallel side walls of the said two



containers and thereby cooled by contact with the side wall of the outer container.

2. A combined hydraulic fluid reservoir, counterbalance and radiant cooler particularly adapted for incorporation in hydraulic well pumping apparatus comprising a pair of concentrically disposed containers providing a narrow passageway between the side walls thereof, the outer container being closed at the top and adapted to be maintained under pressure, the inner container having a closed bottom elevated above the bottom of the outer container and being open at the top and having as the only opening between the lower part of said inner container and said narrow passageway between the side walls of the concentrically disposed containers an orifice in the lower side wall of the inner container, and a fluid conduit connected into the bottom of the outer container.

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