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E. R. FRANZ

2,336,083

OIL WELL PUMP CONTROL SYSTEM

Filed Aug. 11, 1941

2 Sheets-Sheet 1

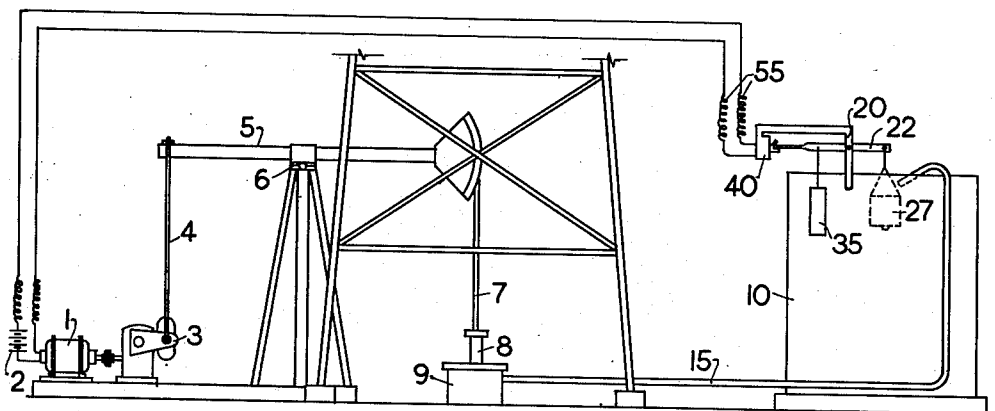


Fig. I

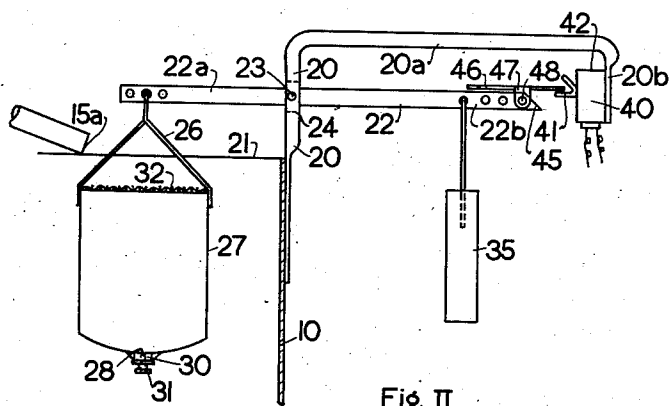


Fig. II

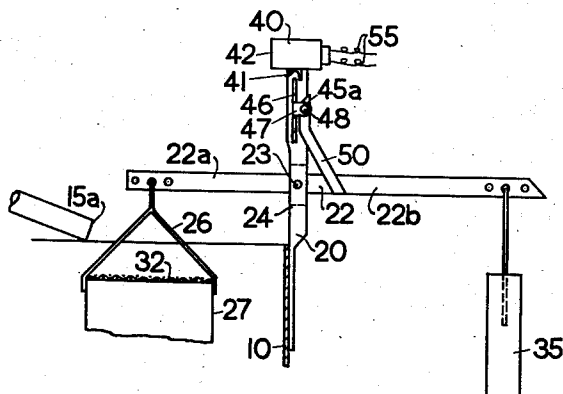


Fig. III

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2 Sheets-Sheet 2

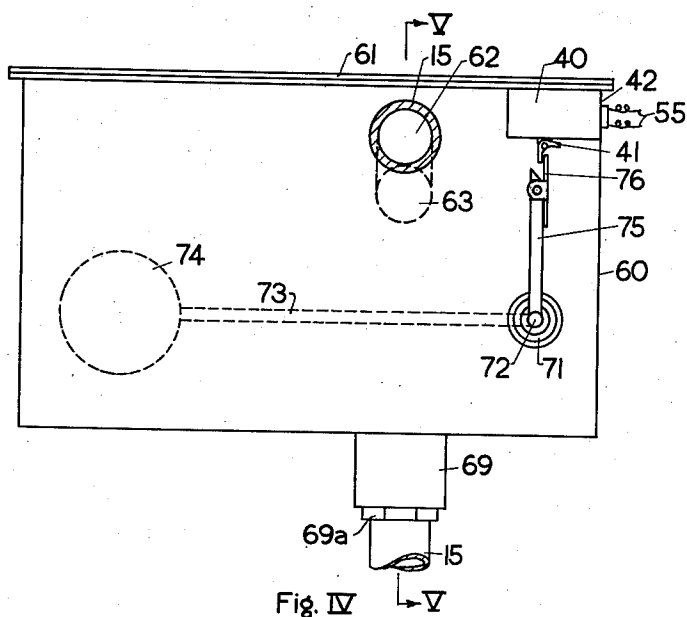


Fig. IV $\rightarrow$ V

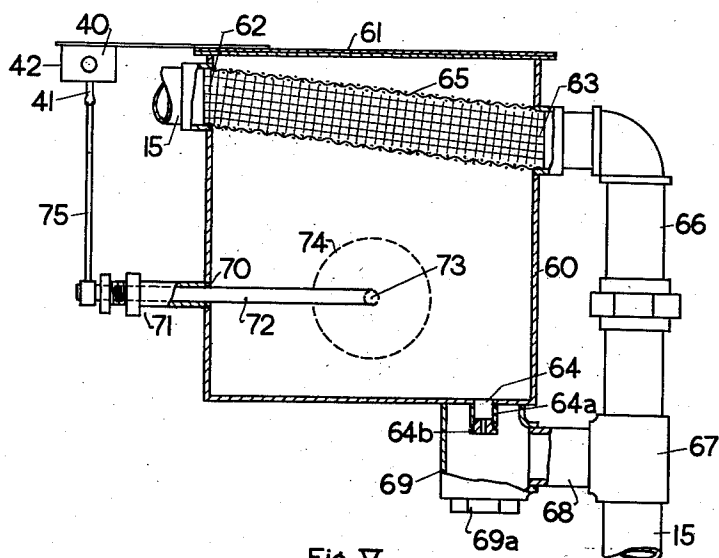


Fig. V

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UNITED STATES PATENT OFFICE

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OIL WELL PUMP CONTROL SYSTEM

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2 Claims. (Cl. 103—26)

The present invention relates to systems for controlling the operation of pumps in oil wells and pertains more particularly to pump control systems for oil wells producing small quantities of fluid.

During the later life of an oil well, the quantity of fluid available for entry into a reservoir at the bottom of the well becomes less than the quantity of fluid which can be mechanically handled by the installed pumping equipment; that is, the capacity of the pumping equipment is such that continued operation thereof causes the well to be pumped off, or dry. When this condition arises in a well, it is the usual procedure to produce the well by intermittent pumping, whereby fluid accumulates in the reservoir during a shut-down period, then the pump is operated until the accumulated fluid is depleted, and thereafter these steps are alternately repeated. Heretofore, this method of operation was generally accomplished by manually starting and stopping of the pumping equipment. While the manual starting operation is easily and conveniently performed due to its non-critical nature, stopping of the pumping operation manually is objectionable since, to obtain optimum efficiency, the pumping must be stopped immediately after the accumulated fluid has been depleted. It is evident that this objective of optimum efficiency can only be accomplished through the use of excessive operating attendance.

It is therefore an object of the present invention to provide a well-pumping system in which the pumping operation is automatically stopped when the accumulated fluid is depleted.

It is a further object to provide a well-pumping system in which the operation of the pumping equipment is automatically discontinued in response to a substantial decrease or total discontinuance in the flow of fluid from the well.

It is another object to provide a well-pumping system for discontinuously exhausting the fluid accumulating in a well producing small quantities of said fluid, whereby the pumping operation is interrupted by control means when the well fluid is depleted.

It is a further object to provide a well-pumping system comprising a control device for interrupting the operation of the pumping equipment in response to cessation of fluid flow from said well.

It is still another object to provide a simple and economical well-pumping control system for carrying out the foregoing objects.

With the above and other objects in view, the invention has particular relation to certain novel features of construction, operation, and arrangement of parts, examples of which are given in this specification and illustrated in the accompanying drawings, wherein:

Figure I is a schematic view of a pumping well

and field tank with one embodiment of the control device installed on the tank;

Figure II is a side elevation of one embodiment of the control device of the well-pumping system;

Figure III is a side elevation of a variation of the embodiment shown in Figure II;

Figure IV is a side elevation of another embodiment of the control device of the well-pumping system;

Figure V is a vertical cross-sectional view taken along the line V—V of Figure IV.

Broadly, the present well-pumping system comprises a suitable prime mover which actuates pumping equipment of any desired type in a well, a conduit for the fluid flow from the pump, and control means comprising a reservoir for receiving the total fluid flow from said conduit means, a fluid outlet in the lower portion of said reservoir, which outlet has a predetermined smaller flow capacity than that of the conduit, and means responsive to the amount of liquid in the reservoir, preferably gravity-actuated, adapted to shut off the prime mover when the fluid flow through the conduit has stopped and the liquid has drained out of the reservoir to a predetermined low liquid level through the outlet.

For purposes of illustration, the present well-pumping system will be described in relation to a well having a reciprocating rod-actuated pump. As shown in Figure I, a prime mover, such as an electric motor 1, connected to an electrical current source 2, which is shown for convenience as a battery, but which may in effect take any other form, such as a switch connecting to a system of A. C. or D. C. power supply, actuates the usual crank 3 and pitman 4, which cause the oscillation of a walking beam 5 on its fulcrum 6. The oscillating walking beam 5 reciprocates a string of sucker rods 7 which extend through a packer 8 at the well-head 9 into the well for operating the pump (not shown). The well fluids discharged from the well by the action of the pump are conducted in the usual manner from the well-head 9 to a field storage or surge tank 10 by means of a conduit 15. Suitably arranged, as described hereinafter in relation to the several embodiments, adjacent the discharge end of the fluid conduit 15 is the control device of the present invention, responsive to the stoppage of fluid flow from the conduit for interrupting the electrical current supply to the electric motor 1 or otherwise stopping the prime mover.

Referring to Figure II, one embodiment of the control means of the well-pumping system comprises an upright bracket 20 fastened to and extending above the upper rim 21 of a field tank 10. Adjacent and above the tank rim 21, a normally-horizontal lever 22 is pivotally attached to the upright bracket 20 by means of a pin 23.

The upright bracket 20 is conveniently formed from a section of pipe and may have a horizontal slot 24 therethrough to accommodate the lever 22 in such a manner that one arm 22b of the lever 22 projects outwardly from said tank 10. The slot 24 is formed larger than the lever 22 so that when the lever 22 is pivotably mounted in the center of the slot 24, the ends of the slot 24 form stops to limit the travel of the lever 22. It will be apparent, however, that the bracket 20 and the means for limiting the movement of the lever 22 may be suitably constructed in various other ways.

Suspended from the inner arm 22a of the lever 22 by open support means, such as a frame 26 of rods, is a relatively small liquid reservoir or bucket 27 having a relatively small flow capacity orifice 28 in the bottom or lower portion thereof. The lever arm 22a, the bucket 27, and discharge end 15a of the fluid conduit 15 are so arranged that the total flow of fluid from the well passes from the flow line or conduit 15 into the bucket 27. The orifice 28 in the bottom of the bucket 27 has a predetermined smaller flow capacity than that of the conduit 15. The orifice 28 may be made adjustable, such as by attaching a short coupling 30 to the bucket 27 about the opening 28 and fitting a bushing 31 of the desired size into the coupling 30. The open upper end of the bucket 27 is preferably provided with a wire screen cover 32 or the like to keep debris from entering the bucket and stopping the orifice 28.

To the outer arm 22b of the lever 22 is attached a counterweight 35, which slightly overbalances the bucket 27 when empty or nearly empty. The point of attachment of the counterweight 35 to the outer arm 22b may be varied or additional weights used to provide means for adjusting the overbalancing action to the weight of the bucket.

In the embodiment shown in Figure II, the upper end of the upright bracket 20 is provided with a lateral extension 20a arranged in the same vertical plane as the lever 22. The outer end of this extension 20a is provided with a downwardly-depending portion 20b, to which is fastened a suitable electrical control switch 40, having a switch arm 41 projecting outwardly from the switch housing 42 to a position adjacent the outer end of the outer lever arm 22b. Carried by the outer end of the outer lever arm 22b is a switch-tripping means adapted to contact the switch arm 41 and to actuate the switch 40 into open position when the lever arm 22b moves downward from a horizontal position.

A preferred arrangement for the switch-tripping means comprises a downwardly slanting beveled outer end 45 on the outer lever arm 22 and a trip bar 46 pivotably attached by means of depending ears 47 and pin 48 to the outer end of the outer lever arm 22b. The trip bar 46 normally lies along the lever arm 22b and extends out beyond the outer end of said arm 22b for contacting the switch arm 41 and operating the switch 40 upon downward movement of the lever arm 22b. The trip bar 46 is pivoted off-center with the greater portion of its weight on the inner side of the pivot pin 48, so that the trip bar 46 normally rests on the lever arm 22b and parallel thereto, but is capable of tipping, the beveled end of the lever arm 22b allowing this, when the lever arm 22b is returned from a position below the switch arm 41 and the horizontal to a well-flowing position as shown in Figure II, above the switch arm 41.

In a variation of the above embodiment and as shown in Figure III, the switch 40 may be positioned on the upper end of the upright bracket 20, vertically above the pivoting pin 23 and arranged with the switch arm 41 depending downwardly below the switch housing 42. An inclined trip-carrying arm 50 is attached to the outer lever arm 22b and extends therefrom towards the switch 40. The upper end of said arm 50 is beveled as at 45a and provided with a pivotable trip bar 46.

The switch 40 in either of the above-described arrangements serves as control means responsive to the liquid level in the reservoir or bucket 27 and thereby to the liquid flow in the conduit 15, for stopping the prime mover which actuates the pumping equipment in the well. The control may be accomplished by operating the switch 40 to open or closed position, said switch 40 being preferably placed in the electrical circuit of the prime mover such as the electric motor 1, by means of electrical conductors 55, whereby the switch 40 acts as an interrupter for stopping the prime mover.

In both the above-described arrangements, the operation of the well-pumping system is the same. Thus, as shown in Figures I and II, when the pumping equipment is actuated by the electric motor 1 and the bucket 27 is maintained full of liquid by the liquid flow thereinto from the conduit 15, the lever arm 22a remains at or below the horizontal and the switch 40 remains closed. The liquid issuing from the conduit 15 into the bucket 27 in excess of the amount draining through the orifice 28 overflows into the tank 10 together with the liquid flowing from the outlet orifice 28. However, when the accumulated liquids in the reservoir at the bottom of the well become depleted and the flow of liquid from the well through the conduit 15 to the bucket 27 ceases, the liquid in the reservoir or bucket 27 drains out through the small outlet or orifice 28. As the bucket 27 on the inner arm 22a of the lever 22 becomes empty, the counterweight 35 on the other and outer arm 22b of the lever 22 overbalances the bucket 27 and the outer arm 22b together with the trip bar 46 carried thereby, is caused by gravity to move downward. As the outer arm 22b moves downward, the trip bar 46 carried thereby strikes the switch arm 41 and moves the switch 40 into open position, thereby interrupting the electrical circuit to the electric motor 1, which stops the operation of the well-pumping equipment. Thus, without the attendance of an operator, the pumping operation is stopped at the optimum and most efficient time; namely, when the accumulated liquid in the well has been depleted and liquid flow from the well has ceased.

At a desired time thereafter, when sufficient liquid has accumulated in the bottom of the well, the switch 40 is reset to closed position for restarting the pumping equipment, which may be done manually by the operator or gauger on his rounds by moving the switch arm 41 to closed position of the switch 40. If desired, however, a suitable automatic timing regulator can be used to reset the switch 40 at some predetermined time.

Figures IV and V show another and preferred embodiment of the present invention which does not require the use of a storage or surge tank, but may be installed directly on a pipe line leading from a well and is therefore of particular advantage for controlling the pumping of wells lo-

cated at a considerable distance from their storage tanks. This embodiment comprises a reservoir or chamber 60 having a cover 61, a liquid inlet port 62, a liquid outlet port 63, and a drain outlet or orifice 64 in the bottom portion of the chamber 60. The inlet and outlet ports 62 and 63 are preferably positioned in the upper portion of the chamber 60 with the inlet port 62 higher than the outlet port 63. A tubular wire screen 65 or the like is preferably provided between the inlet and outlet ports 62 and 63 to keep clogging matter from accumulating in the chamber 60. The well flow line or conduit 15, on which this controller is installed, is connected to the inlet port 62 and a downwardly-depending conduit 66 is connected to the outlet port 63. Connected to the conduit 66 by means of a T 67 therein is a conduit 68 attached to the chamber 60 about the drain outlet or orifice 64 by means of second T 69, as shown in Figure V. The drain orifice 64 may be provided with means for adjusting its flow capacity in a manner similar to that described above for the orifice 28 of the first embodiment. For example, a removal plug 69a fitted into the lower opening of the T 69 allows access to the outlet 64, which may be provided with a downwardly-extending nipple 64a, adapted to receive a bushing 64b with an opening of the desired size.

A rotatable shaft 72 passes through a small lateral opening 70, preferably located about halfway up the side wall of the chamber, and through a bearing and packer combination 71 attached to the outer wall of the chamber 60 about the opening 70. To the inner end of the shaft 72 and at a right angle thereto is attached a float arm 73, to the other end of which is attached a float 74. To the other and outer end of the rotatable shaft 72, and at a right angle thereto, is fastened a trip-carrying arm 75. Pivotably attached to the outer end of said arm 75 is a trip bar 76, which is arranged to strike the switch arm 41, projecting from the switch housing 42 of switch 40.

In practice, when using the last-described embodiment of the control means in the well-pumping system, the operation of the pumping equipment 1 to 7 causes well liquids to flow through the conduit 15 into the chamber 60 by way of inlet port 62. Since the amount of liquid entering the chamber is greater than that draining from the chamber 60 by way of the drain outlet or orifice 64, the chamber 60 remains full or filled to a relatively constant high level, the excess liquid overflowing through the outlet port 63 in the upper portion of the chamber into the down-pipe or conduit 66 and on, into a field tank or collecting system, through a continuation of the pipe 15. The liquid draining through the orifice 64 passes by means of T 69, conduit 68, and thence, by means of T 67, into the conduit 66. With the liquid level in the chamber 60 remaining constant, the float 74, which buoyantly rests on said liquid, and its appendages; namely, the float arm 73, the rotatable shaft 72, and trip-carrying arm 75, remain stationary.

However, when liquid ceases to flow from the well into the chamber 60 due to the depletion of the accumulated liquid in the bottom of the well, the liquid drains from the chamber 60 through the drain outlet or orifice 64, causing the liquid level, together with the float 74, to fall. The downward movement of the float 74 and

the float arm 73 rotates the shaft 72 in its bearing 71, causing the trip-carrying arm 75 to swing through an arc so that the trip-bar 76, carried by said arm 75, strikes the switch arm 41 and thereby actuates the switch 40. The operation of the pumping equipment is thus stopped by the actuation of the switch 40. After a predetermined period of time, which allows another accumulation of liquid in the borehole, the pumping equipment may be again operated by resetting the switch in any suitable manner.

It will be readily apparent that many modifications of the present well-pumping system, and particularly of the control means therein, can be made without departing from the basic concept of the invention, which includes a reservoir or chamber for receiving the total fluid flow from the well, a liquid outlet having a smaller flow capacity than the output of the pump, and gravity-actuated means responsive to the liquid level in the reservoir for stopping the operation of the pumping equipment.

I claim as my invention:

1. In a well-pumping system for discontinuously depleting the liquid accumulating in a well producing small quantities of said liquid, said system comprising a pump in a well, a prime mover for actuating said pump, and a tubular conduit for the liquid flow from said pump, control means for intermittently interrupting the operation of the pump when the liquid accumulated in the well has been depleted, said control means comprising a tubular screen member forming said conduit throughout a portion of the length thereof, a closed reservoir enclosing the screened portion of the conduit, a drain outlet in communication between the lower portion of said reservoir and said conduit at a point downstream of its screened portion, said drain outlet having a smaller capacity than the normal output of the pump, and float means buoyant in the liquid of said reservoir for shutting off the prime-mover when the liquid flow through said conduit has stopped and the liquid delivered to said reservoir through said screen portion has drained to a predetermined level through said drain outlet.

2. In a well-pumping system for discontinuously depleting the liquid accumulating in a well producing small quantities of said liquid, said system comprising a pump in a well, a prime mover for actuating said pump, and a tubular conduit for the liquid flow from said pump, control means for intermittently interrupting the operation of the pump when the liquid accumulated in the well has been depleted, said control means comprising a tubular screen member forming said conduit throughout a portion of the length thereof, said tubular screen member being inclined downwards in the direction of the fluid flow, a closed reservoir enclosing the screened portion of the conduit, a drain outlet in communication between the lower portion of said reservoir and said conduit at a point downstream of its screened portion, said drain outlet having a smaller capacity than the normal output of the pump, and float means buoyant in the liquid of said reservoir for shutting off the prime-mover when the liquid flow through said conduit has stopped and the liquid delivered to said reservoir through said screen portion has drained to a predetermined level through said drain outlet.

ERNEST ROBERT FRANZ.