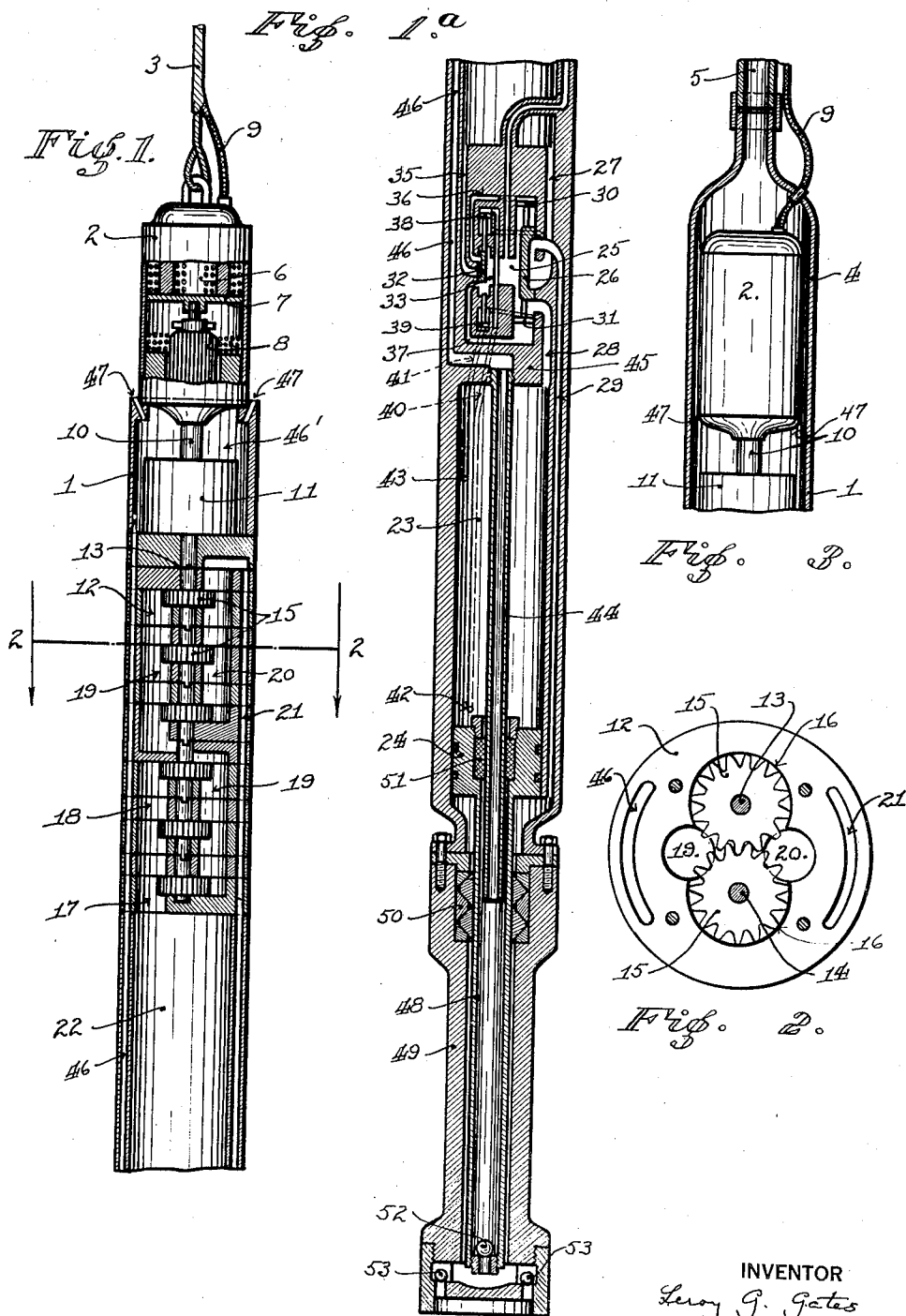


July 27, 1926.

1,593,820

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WELL PUMPING APPARATUS
Filed Feb. 25, 1925



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Patented July 27, 1926.

1,593,820

UNITED STATES PATENT OFFICE.

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WELL-PUMPING APPARATUS.

Application filed February 25, 1925. Serial No. 11,485.

My invention relates to well pumping apparatus especially adapted for deep wells.

The principal object of my invention is to provide a practicable and efficient apparatus in which the power driving means and the well pump are both contained in a single structure of such a size as to enable it to be lowered bodily to any necessary depth in the well. This construction eliminates the use of sucker rods or other mechanical connections between the well pump and the surface, which not only create considerable friction, but are liable to frequent breakage, and also involve a considerable expenditure of time and labor in pulling the well. Other objects and advantages of my invention will become apparent from the following specification.

The preferred form of power driving means for operating the well pump of my apparatus is an electric motor, current being supplied thereto by a suitable cable extending into the well from the surface; and the preferred form of connection between the motor and the well pump comprises a fluid pump driven continuously by said motor and a reciprocating engine, operated by the fluid supplied by said pump, the reciprocating member of said engine being connected directly with the plunger of the well pump. The fluid employed in this power transmitting mechanism is preferably oil, which may be, and preferably is, kept separate from the well oil, when the apparatus is used in oil wells, so that the power fluid may be kept free from sand, water, or other injurious substances.

It is to be understood, however, that the form and construction of the apparatus as herein described and illustrated may be varied, within the limits of the claims hereunto appended, without departing from the spirit of the invention, as set forth in said claims.

With this in view, my invention will now be fully described with reference to the accompanying drawings, wherein:—

Fig. 1 is a longitudinal section of a preferred form of my well pumping apparatus showing the upper portion of the apparatus.

Fig. 1^a is a longitudinal section showing the lower portion of the apparatus shown in Fig. 1.

Fig. 2 is a transverse section, slightly enlarged, on the line 2—2 of Fig. 1.

Fig. 3 is a part sectional elevation of the upper portion of a modified form of the apparatus.

In the drawings, the reference numeral 1 designates a body or shell within which the greater portion of the apparatus is inclosed, and which is of such diameter that it may be lowered into a well. Secured to the upper end of the body 1 is a motor 2, preferably an electric motor. The entire apparatus is preferably suspended within the well by a cable 3, as shown in Fig. 1, in which case the well casing (not shown) is used as the conduit to convey the pumped well fluid to the surface. Such an arrangement presupposes the use of a suitable packer to pack off the well and separate the portion taken below the pumping apparatus from that above, but as such use of a packer is well known in the art, it has been omitted from the drawings as not essential to a full understanding of the construction of the apparatus.

As an alternative means for suspending the apparatus in the well I have shown, in Fig. 3, the body 1 extended upwardly in the form of a casing 4 surrounding the motor 2, and said casing is secured to the lower end of a tubing string 5. In this case the pumped well fluid passes up through the casing 4 and the tubing string 5, instead of through the well casing itself, as in the form shown in Fig. 1.

I have found it desirable to employ a step-down transformer when the motor is driven by electricity, in order to permit the use of a low-voltage motor, thereby reducing the volume of insulation necessary in its windings, and permitting greater power to be obtained from a motor of necessarily restricted size. The transformer, indicated at 6, in Fig. 1, is preferably inclosed within the upper portion of the shell of the motor 2, and is separated from the motor proper by a fluid-tight partition 7. The armature and field coils of the motor, indicated collectively by the numeral 8, are positioned below said partition. Current is supplied to the transformer 6 by a suitably insulated conducting cable 9, which is preferably incorporated in the suspension cable 3, the two forming in reality one cable with a dual function. If desired, the cable 9 may be separate from the suspending cable 3, but as such construction would be obvious to those skilled in the art,

it has been omitted from the drawings. It is understood that suitable connecting wires, not shown, extend from the transformer 6 to the motor windings 8.

The shaft 10 of the motor 2 extends downwardly and may be provided with any suitable form of speed reducing gearing indicated at 11. Below said gearing and connected thereby with the motor shaft 10, is a fluid pump, designated collectively by the numeral 12, which is housed within the upper portion of the body 1. Said pump 12 may be of any suitable type or form, but for purposes of illustration it is herein shown as a gear pump, having two stages, each stage comprising three pairs of gears working in parallel. 13 is the main shaft of said pump, and 14, Fig. 2, is the side shaft, said shafts carrying six intermeshing pairs of gears 15, operating in close fitting chambers 16 in the usual manner.

The fluid enters the pump 12 through a port 17, Fig. 1, at its lower end, and is distributed to the three lower pairs of gears 15 constituting the first stage, by a vertical passage 18. From this stage the fluid is conducted by passages 19 to the three upper pairs of gears, constituting the second stage, and from them it is discharged through a manifold or connecting passage 20 into a downwardly directed passage 21 formed in the side of the body 1. Below the pump 12 is a reservoir or sump 22 for the pressure fluid, said pump drawing the fluid from said reservoir through the inlet 17.

The pressure fluid continuously supplied by the pump 12, operates an engine which is connected directly with the well pump in a manner to be described later. Said engine preferably comprises a cylinder 23 positioned longitudinally in the body 1 below the sump 22, a reciprocating piston 24 operable in said cylinder, and suitable valve mechanism for automatically controlling the supply of pressure fluid from the pump 12 to said cylinder and its discharge therefrom. The spent pressure fluid, after giving up its energy to the piston 24, is returned to the sump 22 to be used over again. By this arrangement the pressure fluid is kept separate from the well fluid, and therefore remains clean, and free from sand and other injurious foreign matter.

The preferred form of valve mechanism for controlling the operation of the piston 24 forms the subject matter of a separate application, and is therefore not claimed herein as a part of the present invention. Accordingly, said valve mechanism will be described herein only to an extent necessary to an understanding of its operation in controlling the movements of the piston 24.

The discharge passage 21 from the pump 12 communicates with a chamber 25, in which is mounted a slide valve 26. An

exhaust or return passage 27 leads from said chamber 25 to the sump 22, and passages 28 and 29 lead from said chamber respectively to the upper and lower ends of the cylinder 23. The valve 26 controls the flow of fluid through said passages in the usual manner, so that the piston 24 is reciprocated in its cylinder 23 by said fluid.

The valve 26 is automatically operated by oppositely disposed pistons 30 and 31, which are in turn actuated by the pressure fluid and controlled by a pilot valve 32. Said pilot valve is similar in form to the main valve 26, and operates in a chamber 33, which is in communication with the main valve chamber 25, and has an outlet passage 35 leading to the sump 22, and passages 36 and 37 leading respectively to the pistons 30 and 31 which operate the main valve 26.

The pilot valve 32 is, in turn, operated by oppositely disposed pistons 38 and 39, to which the pressure fluid is supplied through respective passages 40 and 41 from ports 42 and 43 controlled by the movements of the main power piston 24. Thus when the power piston 24 reaches either end of its stroke, it uncovers one of the ports 42 or 43, admitting fluid under pressure to the respective pilot valve piston 38 or 39, and thereby shifting the pilot valve 32. This admits fluid under pressure to the respective piston 30 or 31 of the main valve 26, thereby shifting said main valve and causing the power piston 24 to reverse its movement.

The well pump, which is operated by the power piston 24 may be of any suitable form, but is preferably double acting, so that both strokes of said power piston may be utilized for pumping the well fluid. This provides the maximum efficiency, not only by utilizing the power of the motor 2 in a practically continuous flow, but also by eliminating, practically, the stopping and starting of the entire column of well fluid, extending to the surface of the ground, at each stroke of the pump.

For purposes of illustration, I have shown a particular form of double-acting pump, as being especially well suited for use in the present apparatus, but as the novel features of this form of pump constitute the subject matter of a separate application, it is not claimed herein as a part of the present invention. It will be described, therefore, only to an extent sufficient for a proper understanding of the apparatus as a whole, with the understanding that it is merely an example of any suitable form of pump.

A central tube 44 is fixed in the upper head 45 of the power cylinder 23, and extends downwardly therethrough. The upper end of said tube communicates with a

passage 46, which extends upwardly through the side of the body 1 to a chamber 46' surrounding the speed reducing gearing 11. Said chamber has outlets 47, which serve to conduct the pumped well fluid into the upper portion of the well casing (not shown) or into the tubing string 5, according to whether the form shown in Fig. 1 and that shown in Fig. 3 is used.

The power piston 24 is fixed to the upper end of a tubular well pump plunger 48, which travels up and down upon the fixed tube 44. Below the power cylinder 23 is the pump barrel 49, in which the tubular plunger 48 operates.

The upper portion of the barrel 49 is provided with suitable packing 50 to make a tight fit about the plunger 48, and said plunger, at its upper end, is provided interiorly with suitable packing 51 to make a tight fit about the fixed tube 44. The pump barrel 49 below its packing 50, and the interior of the plunger 48, below its packing 51, are slightly enlarged, to provide clearance spaces between said plunger and both the barrel 49 and the tube 44, to prevent the cutting of said parts by sand. A traveling discharge valve 52 is provided in the lower end of the tubular plunger 48, and a suitable inlet valve is provided at the bottom of the barrel. In practice I prefer to provide a plurality of inlet valves 53, as shown.

The operation of the pump described above will be apparent. When the power piston 24 and the tubular plunger 48 move down, the latter displaces a quantity of well fluid equal to its own volume, and a portion of such fluid, equal in amount to the difference in displacement between the tubular plunger and the fixed tube 44, is forced up through said plunger, said tube, and the passage 46, and when said piston and plunger move up, the amount of fluid contained within said plunger is forced up through the same path. The pump is thus double acting, forcing the well fluid up on both strokes, and utilizing both strokes of the power piston for pumping. By properly proportioning the effective displacement of the plunger 48 within the barrel 49 to that of the fixed tube 44 within said plunger, that is, by properly proportioning the inside and outside diameters of said plunger and said tube, the pump can be made to deliver a practically continuous flow.

The operation of the entire apparatus will be apparent. As long as the electric current is supplied to the motor 2 through the cable 9 and the transformer 6, the clean oil or power pump 12 will operate, and the fluid continuously supplied thereby will be automatically controlled by the valve 26 and its associated mechanism in a manner to cause the power piston 24 and the well pump plunger 48 to reciprocate.

The use of the electric motor 2 enables the power to be supplied to the apparatus by the cable 9, instead of by the usual troublesome sucker rods; the clean oil or power pump 12 and the cylinder 23 with its piston 24 constitute the most efficient form of driving connection for converting the rotary motion of the motor 2 into reciprocating motion suitable for operating the well pump plunger 48; and the employment of a double acting pump, by utilizing the power of the motor 2 in a practically continuous flow, permits the largest possible output of pumped well fluid for an apparatus of necessarily restricted size.

I claim:—

1. A well pumping apparatus adapted to be lowered bodily into a well and comprising a motor; a well pump; and a fluid power transmitting connection therebetween.

2. A well pumping apparatus adapted to be lowered bodily into a well and comprising a rotary motor; a reciprocating well pump; and a fluid power transmitting connection therebetween.

3. A well pumping apparatus adapted to be lowered bodily into a well and comprising an electric motor; a well pump; and a fluid power transmitting connection therebetween.

4. A well pumping apparatus adapted to be lowered bodily into a well and comprising a motor; a fluid pump driven thereby; a well pump; and means actuated by the fluid supplied by said fluid pump for operating said well pump.

5. A well pumping apparatus adapted to be lowered bodily into a well and comprising a motor; a fluid pump associated therewith and driven thereby; a reciprocating well pump; and means actuated by the fluid supplied by said fluid pump for operating said well pump.

6. A well pumping apparatus adapted to be lowered bodily into a well and comprising a motor; a rotary fluid pump driven thereby; a reciprocating well pump; and means actuated by the fluid supplied by said rotary pump for operating said well pump.

7. A well pumping apparatus adapted to be lowered bodily into a well and comprising a well pump; a fluid actuated reciprocating engine for operating said well pump; and a power driven pump for supplying fluid under pressure to said engine.

8. A well pumping apparatus adapted to be lowered bodily into a well and comprising a reciprocating double acting well pump; a fluid actuated reciprocating engine for operating said well pump; and a power driven pump for supplying fluid under continuous pressure to said engine.

9. A well pumping apparatus comprising a body adapted to be lowered into a well; a fluid actuated well pump carried thereby;

a power driven pump associated with said body for supplying the actuating fluid to said well pump; and a reservoir within said body for containing a supply of said actuating fluid.

10. A well pumping apparatus comprising a body adapted to be lowered into a well; a well pump carried thereby; fluid actuated means for operating said well pump; a power driven pump associated with said body for supplying the actuating fluid under pressure to said well pump operating means; and a reservoir within said body for receiving the spent actuating fluid from said well pump operating means and delivering it to said power driven pump.

11. A well pumping apparatus comprising a body adapted to be lowered into a well; a motor associated with the upper end portion of said body; a fluid pump positioned below said motor and driven thereby; an engine positioned below said fluid pump and actuated by the fluid supplied thereby; and a well pump carried by the lower end portion of said body and operated by said engine.

12. A well pumping apparatus adapted to be lowered bodily into a well and comprising

an electric motor; a transformer associated therewith; means for supplying electric power to said transformer; a well pump; and a fluid power transmitting connection between said motor and said well pump.

13. A well pumping apparatus adapted to be lowered bodily into a well and comprising an electric motor; a well pump; a fluid power transmitting connection therebetween; and a cable for supplying electric power to said motor and for suspending the apparatus within the well,

14. A well pumping apparatus comprising a body adapted to be lowered into a well and having a fluid passage formed in its wall, said passage having an outlet in the upper end region of said body; a well pump carried by the lower end portion of said body and adapted to discharge the well fluid into said passage; an electric motor associated with said body; and fluid power transmitting means within said body for connecting said motor with said well pump.

In testimony whereof I have signed my name to this specification.

LEROY G. GATES.