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MEANS FOR PUMPING LIQUIDS FROM GAS PRODUCING WELLS

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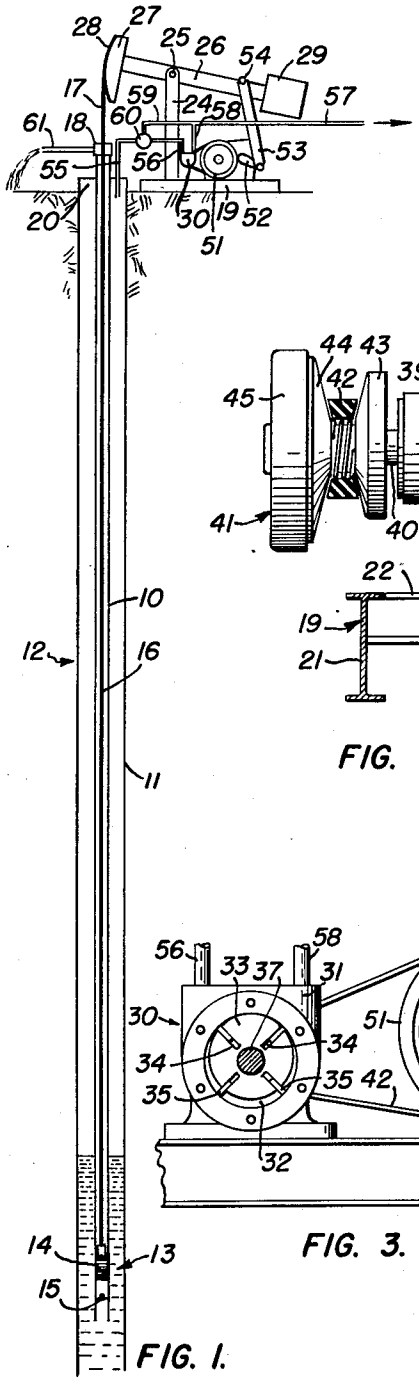


FIG. 1.

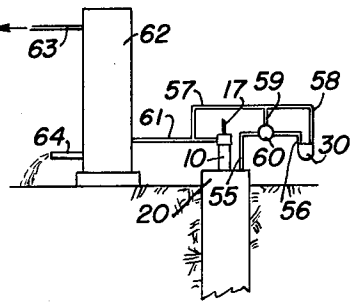


FIG. 2.

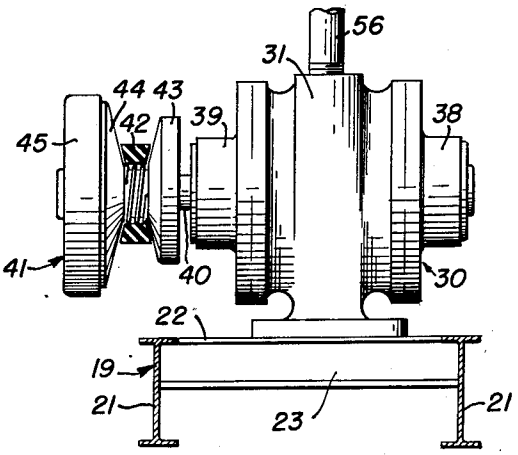


FIG. 4.

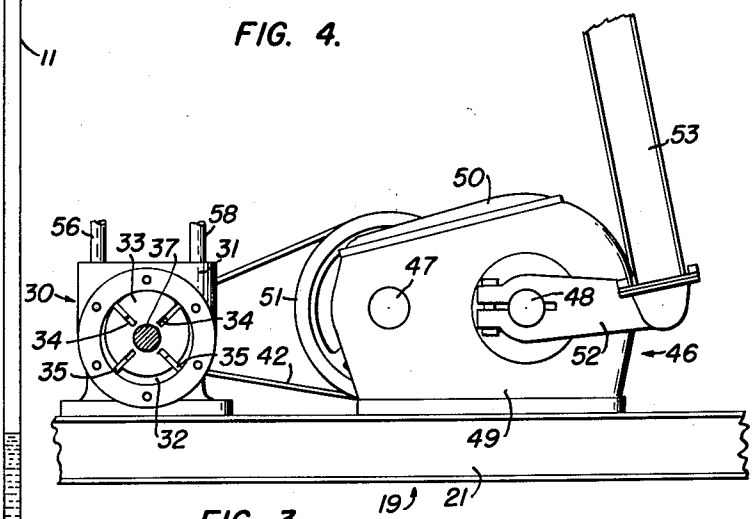


FIG. 3.

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MEANS FOR PUMPING LIQUIDS FROM GAS PRODUCING WELLS

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6 Claims. (Cl. 103—44)

This invention relates to well pumps and has reference to a gas operated pumping unit particularly adapted to relieve gas wells of water produced incidently from gas bearing formations.

In a number of gas fields there are wells which have a high gas volume potential but which do not have sufficient shut-in pressure to exhaust intervening water. An accumulation of water within the bore of these wells restricts and impedes gas production because the head of water works against and partially counteracts the available flow pressure of the gas. Generally, the rate of water intrusion is very low in wells of this type, and, despite their inability to lift a head of water to the surface, well head pressures exceed pipe line delivery requirements. Legally prescribed well spacings in Texas and other gas producing States often render the construction and maintenance of electric service lines uneconomical for such intermittent use of low wattage motors as is required to evacuate intrusion water from gas wells. Servicing requirements for gas or gasoline burning internal combustion engines likewise lead to an evacuation cost which is greatly disproportionate to the work actually expended in pumping relatively small quantities of water. Ideally, a pumping means which could operate without fuel cost and with a minimum of attention, would be best suited to the described problem. In connection with this objective it should be noted that excess pressures wasted in delivery represent a normally dissipated source of energy which, if utilized, could provide power to evacuate intrusion water.

Accordingly, an object of the present invention is to provide a pumping unit of limited volume capacity which can derive its power from the flow pressure of a gas well.

Another object of the invention is to provide a gas pressure operated pumping unit which can operate effectively between relatively small pressure differences at its input and exhaust systems.

A further object of the invention is to provide a pumping unit capable of deriving power from such pressure differences as exist between a well head and a pipe line delivery system.

A particular object of the invention is to provide a gas pressure operated pumping unit which may be exhausted into the delivery system of the pipe line.

A related object of the invention is to provide means utilizing the power normally wasted in pressure reduction for pipe line injection and for operating a pumping unit thereby.

A further object of the invention is to provide gas operated means for exhausting intrusion water in a gas well.

An additional object of the invention is to provide a pumping unit for intrusion water and which unit may be operated without manual actuation or other special attention.

These and other objects will become apparent from the following description and the accompanying drawing, wherein:

FIGURE 1 is a side elevational and partially sectional view of a gas well and a pumping unit as defined herein.

FIGURE 2 is a fragmentary side elevational view of the invention shown in operative connection with a gas separation tank.

FIGURE 3 is a fragmentary side elevational view of

the invention illustrating drive and speed reduction components thereof.

FIGURE 4 is a partially sectional front elevational view of the power and driving systems of the invention.

In the drawing, a tubing string 10 is suspended within the casing 11 of a gas well 12 and a tubing pump 13 including a piston 14 and a check valve 15 is positioned within the tubing 10 near the lower end thereof. A string of sucker rods 16 within the tubing string 10 is connected to the piston 14 and extends therefrom to connection with a polish rod 17, the upper end of which projects through a stuffing box 18 on the upper end of the tubing 10. A skid 19 is supported by the surface of the ground adjacent the casing head 20. At opposite sides of the skid 19 runners 21 constructed as spaced I-beam members are disposed in a parallel relationship with respect to one another and each is secured to the lower surface of a horizontally positioned rectangular platform 22. Transverse beams 23 are likewise attached to the lower surface of the platform 22 and extend between the runners 21. The longitudinal center line of the skid 19 is positioned in radial alignment with the casing head 20. Posts 24 project vertically and equidistantly from opposite sides of the skid 19 and a horizontal pivot 25 is journaled at its opposite ends to the respective upper ends of the posts 24. A walking beam 26 is positioned upon and perpendicularly attached to the pivot 25, and opposite ends of the walking beam project perpendicularly and outwardly of the pivot in a vertical plane common with the longitudinal center line of the skid 19. One end of the walking beam 26 is provided with a mulehead 27 in vertical alignment with the axis of the tubing 10; a bridle 28 depending from the mulehead 27 is attached to the upper end of the polish rod 17. The opposite or rearward end of the walking beam 26 carries a counterbalance 29 adapted to offset the polish rod load of the walking beam.

An air motor 30 is attached to and supported by the upper surface of the platform 22 at a position thereon forward of the posts 24. The air motor 30 is comprised of a block 31 including a horizontally disposed cylindrical chamber 32 and a cylindrical rotor 33 so positioned within the chamber that its axis is parallel with but eccentric to the axis of the chamber. A plurality of horizontally and radially disposed slots 34 regularly spaced from one another about the circumference of the rotor 33 each receive a vane 35, the outer edge of which is urged against the surface of the chamber 32 by a spring positioned interiorily of the vane 35 within each slot 34. A shaft 37 coaxially secured to the rotor 33 is journaled at its opposite ends to face plates 38 and 39 respectively bolted to the block 31 at opposite ends of the chamber 32. One end portion 40 of the shaft 37 projects outwardly of its face plate 39, and a speed responsive driving mechanism, herein referred to as a centrifugal clutch 41, mounted on that end of the shaft, is adapted to receive an A-section drive belt 42 and engage the same when the shaft 37 reaches or exceeds a predetermined angular velocity. Although the floating cone type of centrifugal clutch 41 has been found to be satisfactory in the described construction, it is to be understood that any of a variety of commercially available pulleys or centrifugal clutches may be so used without departing from the spirit or scope of the present invention. The illustrated clutch includes a stationary cone 43 coaxially affixed to the end portion 40 of the shaft 37 and a floating cone 44 positioned on the shaft outwardly of the stationary cone in slidably opposed relationship thereto. A housing 45 carried by the shaft 37 outwardly of the floating cone 44 encloses a mechanism (not shown) responsive to rotation of the shaft and adapted to force the floating cone toward the stationary cone 43 when the shaft has attained a predetermined angular velocity. A gear box

type speed reducer 46 is supported by and attached to the upper surface of the platform 22 at a position thereon rearward of the post 24. High speed and low speed shafts 47 and 48 are respectively journaled to opposite sides of the case 49 of the speed reducer 46 and each of the shafts is disposed parallel to the shaft 37 of the air motor 30; as shown in FIGURE 3, the low speed shaft 48 is positioned rearwardly of the high speed shaft 47. The case 49 is provided with an access lid 50 to facilitate inspection and lubrication of internal components (not shown) of the speed reducer 46. A sheave 51 adapted for engagement with the A-section belt 42 is mounted on one end of the high speed shaft 47 exteriorly of the case 49. A split block type crank 52 is attached to one end of the low speed shaft 48 exteriorly of the case 49, and a pitman 53 is pivotally connected at one of its ends to the outer end of the crank and at its other end to a cross head 54 carried by the walking beam 26 at a position thereon between the pivot 25 and the counterbalance 29.

A gas flow line 55 extending through the casing head 20 communicates the annulus between the tubing 10 and the casing 11 with the intake tube 56 of the air motor 30. An injection line 57 communicates the exhaust tube 58 of the air motor 30 with a pipe line delivery system (not shown). A bypass line 59 communicates the injection line 57 with one exhaust port of a three-way valve 60, the other exhaust port and inlet port of which are connected in series to the gas flow line with the inlet port of the three-way valve connected to that portion of the flow line leading to the casing head 20. The three-way valve 60 is adapted to alternately communicate the annulus of the well with the intake tube of the air motor or with the bypass line 59. A drain tube 61 communicating with the interior of the tubing 10 conducts exhausted water to any suitable water disposal system.

In a well where appreciable quantities of gas are exhausted with the water, a separator tank 62 may be utilized with the invention as illustrated in FIGURE 2. In this arrangement, that end of the injection line 57 which would otherwise be connected to a pipe line delivery system, is made to communicate with the drain tube 61 and the drain tube communicates with the interior of the separator tank 62. As is well known in the art, gas will collect in the upper end of the separator tank and may be bled off through a second injection line 63 communicating the upper end of the tank 62 with a pipe line delivery system; water is drained from the lower end of the separator tank by a second drain tube 64, and flow of water through the second drain tube is regulated by a float valve (not shown) within the tank which maintains a level of water therein at a height above the second drain tube.

In operation, part or all of the gas metered into a pipe line may be routed through the air motor 30 by selective adjustment of the three-way valve 60. If gas is to flow continuously from the well into a pipe line, the three-way valve 60 will normally be set so that the intake tube 56 of the air motor 30 is in communication with the annulus of the well. Gas from the well flows through the air motor 30 and causes the rotor 33 and shaft 37 to rotate at a speed such that the A-section belt 42 is constantly engaged by the centrifugal clutch 41. The speed reducer 46 is constructed with a high input to output shaft speed ratio so that a very high angular velocity of the air motor shaft 37 produces a low angular velocity of the crank 52 and pitman 53. A properly selected diameter for the sheave 51 can maintain a pumping rate which slightly exceeds the water intrusion rate of a given well. Since the water exhaustion rate must slightly exceed the intrusion rate in order to assure the prevention of a water accumulation at the base of the well, a considerably volume of gas will be exhausted through the tubing 10 in a continuous flow operation. As has been described and illustrated in FIGURE 2, tubing gas may be captured in a suitable connected separator tank 62.

The usual mode of gas production involves intermittent flow. For this type of operation a lower input to output shaft speed ratio is required of the speed reducer 46 and selection of a sheave 51 diameter will be governed accordingly. When gas is to be metered into the pipe line the three-way valve 60 is first set so that the annulus is communicated with the intake tube 56 of the air motor 30. Under well pressure the air motor 30 is accelerated and provided with sufficient momentum to overcome the inertia of the pumping unit before the centrifugal clutch 41 engages the A-section belt 42 and starts the pumping operation. If the accumulated head of water at the base of the well has risen sufficiently during the period of inoperation to suppress gas flow pressure to a level where the difference in well pressure and metering pressure is not sufficient to operate the pump, a small volume of gas may be released to the atmosphere from the valve (not shown) customarily provided at the meter. As water is pumped from the well the available gas pressure will rise and injection into the pipe line can be commenced. When the head of water at the base of the well has been exhausted or sufficiently lowered the three-way valve 60 is then set so that gas flows from the valve into the bypass line 59 and thence to the injection line 57 and pumping is discontinued. It will be noted that the tubing 10 remains substantially filled with water at all times and the weight of the water and sucker rods 16 within the tubing is offset by the counterbalance 29 so that the power required of the air motor 30 is only that required to overcome the friction of various components, inertia of the system and energy expanded in displacing intrusion water.

The invention is not limited to the exemplary construction herein shown and described, but may be made in various ways within the scope of the appended claims.

What is claimed is:

1. A gas driven pumping unit for removing liquids from a gas well having a casing and tubing, said pumping unit including a walking beam and a pitman connected therewith: an air motor including a drive shaft, means communicating the input of said air motor with the casing of a gas well, means communicating the exhaust of said air motor with the delivery system of a pipe line, a centrifugal clutch on said drive shaft, a drive member engaging said centrifugal clutch, a speed reducer including a high speed shaft and a low speed shaft, means operatively connecting said drive member to said high speed shaft, a crank on said low speed shaft, means pivotally connecting said crank to the pitman of said pumping unit, a sucker rod depending from the walking beam of said pumping unit and extending into the tubing of said well, and a pump connected to said sucker rod in said tubing.

2. A fluid evacuation system for a gas well comprising: a tubing string in said well, a pump including a piston and a check valve in said tubing string, a sucker rod connected to said piston in said tubing string, a walking beam pivotally supported above the surface of the ground, a mulehead on said walking beam, a bridle connected to said mulehead and supporting said sucker rod, an air motor including a drive shaft and having an intake and an exhaust tube, a centrifugal clutch mounted on said drive shaft, a speed reducer including a high speed shaft and a low speed shaft, a sheave mounted on said high speed shaft, a drive belt connecting said sheave with said clutch, a crank on said low speed shaft, a pitman pivotally attached to and extending between said crank and one end of said walking beam, means communicating said intake tube of said air motor with the casing of said well, means communicating the exhaust tube of said air motor with the delivery system of a pipe line, and bypass means alternately connecting said means communicating said intake

tube of said air motor with said exhaust tube of said air motor.

3. The invention as defined in claim 2 and wherein said bypass means alternately connecting said means communicating said intake tube of said air motor with said exhaust tube of said air motor includes a three-way valve in said intake tube of said air motor and wherein one exhaust port of said three-way valve communicates directly with the exhaust tube of said air motor.

4. In a gas well including a tubing pump and a pumping unit of the walking beam type, an air motor including a drive shaft and having an intake tube communicating with the casing of said well and having exhaust means communicating with a pipe line, a speed reducer including a high speed shaft and a low speed shaft, a speed responsive clutch on said drive shaft, power transmission means coupling said clutch to said high speed shaft, a crank on said low speed shaft, and a pitman pivotally connected to said crank and engaging the walking beam of said pumping unit.

5. The invention as defined in claim 4 and wherein said exhaust means communicating with a pipe line includes: a drain tube communicating with the interior of the tubing of said tubing pump, a separator tank communicating with said drain tube, and an injector line communicating the upper end of said separator tank with said pipe line.

6. A gas driven pumping unit for removing liquids from a gas well having a casing, said pumping unit including a walking beam and a pitman connected therewith, a rotary air motor including a drive shaft, means communicating the input of said motor with the casing of said gas well, means communicating the exhaust of said rotary air motor with the delivery system of a pipe line, a speed reducer including a high speed shaft and a low speed shaft, means operatively connecting said drive shaft to said high speed shaft, a crank on said low speed shaft, means pivotally connecting said crank to said pitman of said pumping unit, a sucker rod depending from the walking beam of said pumping unit and extending into said well and a pump connected to the end of said sucker rod in said well.

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