

May 17, 1938.

G. B. GORDY, JR

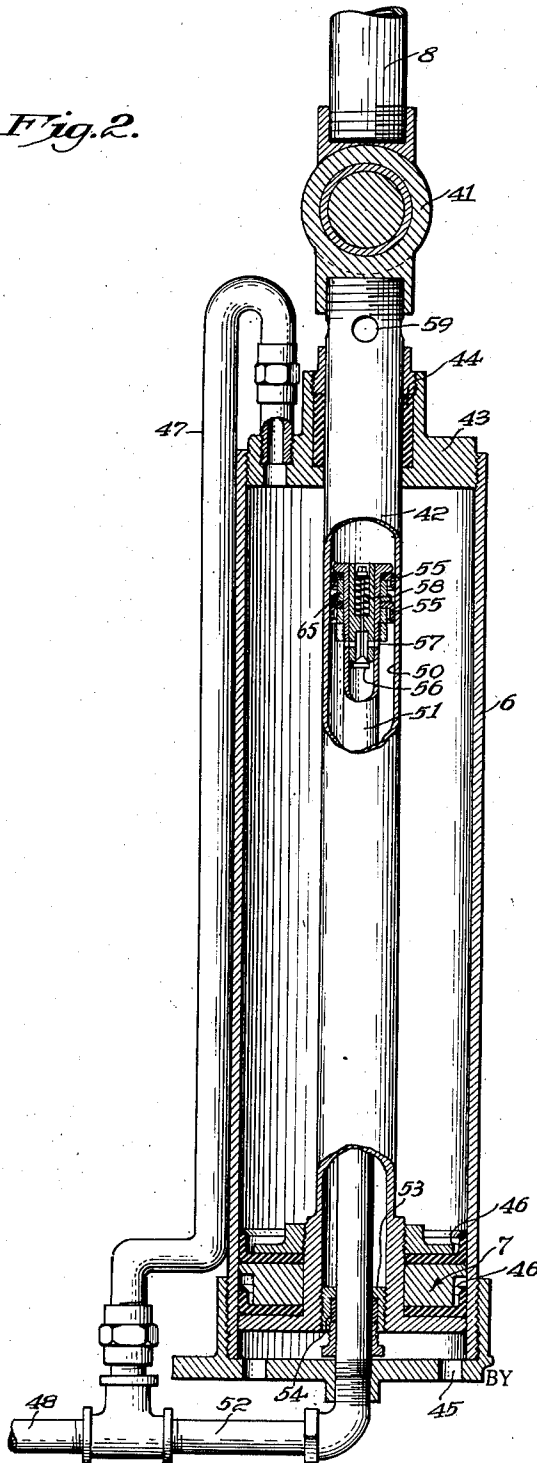
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PUMPING UNIT

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3 Sheets-Sheet 2

Fig. 2.



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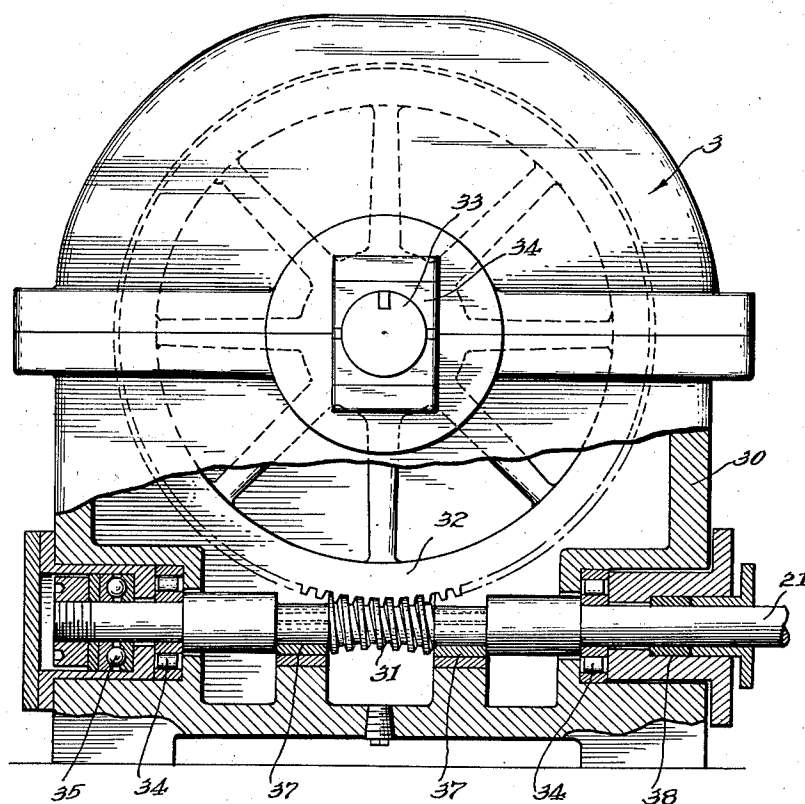
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Fig. 3.



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PUMPING UNIT

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12 Claims. (Cl. 103—206)

This invention is an oil well pumping unit, and relates particularly to means for operating a walking beam to which the sucker rods of a pump are attached, so as to counterbalance reciprocation of the rods.

It is an object of the invention to provide a light and compact unit, and more particularly to employ fluid pressure in lieu of cumbersome masses of metal for counterbalancing the pumping operation and reducing the amount of work required to pump a well.

More particularly it is an object of the invention to compress a fluid on the down-stroke of the sucker rods and thus counterbalance this down-stroke, and on the up-stroke to counterbalance the string of rods by means of this compressed fluid.

It is a further object of the invention to actuate the unit by a type of prime mover with which a portion of the compressed fluid may be employed for rendering the prime mover operative and increasing its efficiency.

It is a still further object of the invention to actuate the unit through a reduction gear of simple and compact design, and more particularly to employ worm gearing with the fluid pressure counterbalance maintaining the load on the worm shaft in the same direction throughout the cycle of operation so as to insure efficient operation.

It is a still further object of the invention to utilize the Samson post for the walking beam as a reservoir for the compressed fluid which is employed, thereby conserving space and simplifying the construction.

Further objects of the invention will be readily understood from the following description of the accompanying drawings, in which:

Fig. 1 is a side elevation of the unit.

Fig. 2 is a detail axial section through the counterbalance cylinder.

Fig. 3 is a detail side elevation of the reduction gear, with the casing partly broken away.

In the illustrated embodiment of the invention the operating unit includes a prime mover 1 connected to a crank 2 through a reduction gear 3, with a pitman 4 connected to the crank for operating a walking beam 5. The unit also includes a cylinder 6 and a piston 7 which has a connecting rod 8 connected to the walking beam; and the walking beam is fulcrumed on a Samson post 9 which forms a reservoir for compressed fluid.

The walking beam is medially fulcrumed on the Samson post by means of a trunnion 10 and the pitman 4 is connected to the rear end of

the walking beam by a gudgeon 11. A cable 12 which supports a polish rod saddle 13 is connected to the front end of the walking beam, and a polish rod 14 is suspended from the saddle for reciprocating a usual string of sucker rods which operate a usual deep well pump.

In order that the front end of the walking beam may be swung out of alinement with the well bore when the walking beam is not in use, so as not to obstruct operations at the well, a portion 5a of the front end of the beam is pivotally mounted by means of a hinge 15 which is positioned at the underside of the walking beam, and lugs 16—17 at the upper side of the portions 5—5a of the beam are releasably connected by a bolt 18. When the walking beam is not in use the bolt 18 is removed so that the portion 5a of the beam may swing down to vertical position and thus completely clear the space around the well bore, and when the walking beam is to be used its portion 5a is swung into alinement with the main portion of the beam and is secured in this operative position by the bolt 18.

The prime mover 1 is shown as an internal combustion engine, preferably a crude oil engine, having its drive shaft 20 connected to a shaft 21 of the reduction gear 3, by means of a coupling 22. The fluid which is compressed by the counterbalancing mechanism of the unit as will be hereafter described, is preferably air, and a portion of this compressed air may be utilized for fuel injection for the engine, and may also be employed for partially supercharging the engine. As an instance of this arrangement a conduit 25 for compressed air may lead to the fuel tank 26 of the engine, so as to maintain pressure on the fuel which is supplied thence via conduit 27 to a usual fuel injection manifold (not shown), and a branch conduit 28 may have an outlet for each of the cylinders of the engine, with said outlets controlled by a sleeve valve 29 which is rotated by timing mechanism 30a so that each outlet supplies compressed air to its corresponding cylinder at the end of the intake stroke.

The reduction gear 3 is preferably an enveloping type worm gearing housed within a casing 30. As an instance of this arrangement the shaft 21 extends into the casing 30 and carries a worm 31 which meshes with a worm gear 32 which is fixed on a shaft 33. The shaft 33 is journaled in the casing 30 as shown at 34a, and the crank 2 is fixed on the outwardly projecting end of the shaft 33. The worm shaft 21 may be journaled in roller bearings 34, and a bearing 35 preferably takes the thrust of the shaft 21 in one direction.

By means of the counterbalance mechanism hereafter described, the load on the worm shaft 21 is maintained in this one direction throughout the cycle of operation so that a bearing to take the thrust in the opposite direction is not required, and by maintaining the load in this one direction most efficient operation of the worm gearing is assured.

The cylinder and piston 6—7 provides means for counterbalancing the string of reciprocating sucker rods. As an instance of this arrangement the connecting rod 8 for the piston 7 is preferably connected to the walking beam 5 between the Samson post 9 and the pitman 4, the connection being shown as a gudgeon 40, and the rod 8 is connected to a cross-head 41 which is in turn connected to a piston rod 42 on which the piston 7 is mounted for reciprocation in the cylinder 6. The upper end of the cylinder is closed as shown at 43, and the piston rod is packed-off at 44 where it projects through the closure 43. The portion of the cylinder 6 which is below the piston 7 is open to the atmosphere via ports 45, and the piston seals against escape of pressure from that portion of the cylinder which is above the piston. For this purpose the piston is preferably provided with cup packing 46 which is operatively expanded by pressure in the cylinder 6 above the piston.

By this arrangement the piston 7 is elevated in the cylinder 6 on the down-stroke of the string of sucker rods, thereby compressing a fluid in the cylinder 6. This compressed fluid is discharged via a conduit 47 which communicates with the cylinder 6 through the closure 43, and the conduit 47 is connected to a pipe 48 which leads to the reservoir which is formed by the Samson post 9. The fluid which is compressed is preferably air, and the reservoir 9 is initially filled with compressed air and the pressure in the reservoir is maintained by the compressed air which is supplied thereto on the down-stroke of the string of sucker rods. This down-stroke is thus counterbalanced by the air which is compressed in the cylinder 6 and which is discharged into the reservoir 9 via the conduits 47 and 48. On the up-stroke of the string of sucker rods compressed air from the reservoir 9 is supplied to the cylinder 6 via the conduits 47—48, and this pressure exerted against the piston 7 thus counterbalances the up-stroke of the string of rods.

Additional means are preferably provided for compressing fluid and counterbalancing the down-stroke of the string of sucker rods, and this compressed fluid may be utilized to maintain the desired pressure in the reservoir 9. For this purpose additional air may be compressed on the down-stroke of the string of sucker rods, with this additional compressed air supplied to the reservoir 9. As an instance of this arrangement the piston rod 42 may be a hollow rod forming a bore 50 which at its lower end opens through the piston 7 and which at its upper end is open to the atmosphere via ports 59; and a pipe 51 which is supported on the base of the cylinder 6 projects upwardly into the bore 50. The lower end of the pipe 51 is connected to the pipe 48 via a branch conduit 52, and a packing head 65 on the upper end of the pipe 51 permits reciprocation of the piston rod 42 relative to the pipe 51 with the packing head sealing that portion of the bore 50 which is below the packing head. The packing head is preferably provided with cup packing 55 which is sealed by pressure in the

bore 50 below the packing head, and the lower end of the bore 50 is sealed, as for example by a plug 53 which is screwed into the bore of the piston 7 and which is provided with packing 54 around the pipe 51.

The upper end of the pipe 51 communicates with the bore 50 via ports 57, and a valve 56 which is yieldingly closed by a spring 58 closes against escape of pressure from the pipe 51 to the bore 50 via the ports 57, but is adapted to open responsive to pressure in the bore 50 to permit flow from the bore 50 through the ports 57 and past the open valve into the pipe 51.

On the up-stroke of the string of sucker rods, with the piston 7 moving downwardly relative to the stationary head 65, the pressure in reservoir 9 closes the valve 56 so that compressed air from the reservoir is shut-off from the bore 50, and the up-stroke of the string of rods is thus counterbalanced entirely by the compressed air supplied to the cylinder 6 and which is exerted against the piston 7. On this down-stroke of the piston 7 the packing 55 yields responsive to the partial vacuum which is formed in the bore 50 below the head 65, so that air at atmosphere pressure, supplied via ports 59, is drawn into that portion of the bore 50 which is below the head 65.

The air which during the down-stroke of the piston 7 is thus drawn into the bore 50 below the head 65, is compressed on the up-stroke of the piston 7, i. e. on the down-stroke of the string of sucker rods, and this compressed air opens the valve 56 so that the air which is compressed in both the cylinder 6 and the bore 50 is supplied to reservoir 9 during this down-stroke of the string of rods. This compression in bore 50, in addition to the compression in cylinder 6, counterbalances the down-stroke of the string of rods and compresses the air to a degree whereby it may be forced into the reservoir 9 against the pressure therein, to maintain the desired working pressure in the reservoir. The maximum pressure in the reservoir may be controlled by a safety valve 60, and the compression which is thus obtained on the down-stroke of the string of sucker rods being in excess of that required to maintain the desired pressure in the reservoir for counterbalancing the up-stroke of the string of rods, the excess pressure may be supplied to the conduit 25 which furnishes the compressed air for operating and increasing the efficiency of the internal combustion engine 1. For this purpose the conduit 25 may be connected to the branch conduit 52 as shown at Fig. 1.

By this arrangement as thus described, a part of the reduction in load on the down-stroke of the sucker rods and resulting from the string of rods no longer supporting the weight of a column of oil, is compensated for by taking on a compressing load, and the string of rods is thus counterbalanced throughout the cycle of operation, with the load on the reduction gear 3 in the same direction throughout the cycle of operation, and with the excess compressed air available for other uses.

A compact and efficient operating unit is thus provided, particularly applicable for employment of a crude oil internal combustion engine as a source of power, with the excess air which is compressed by the counterbalance mechanism utilized for fuel injection and for supercharging the engine; and the unit being also adapted for employment of efficient gear reduction by using a worm gear, with the compression which is obtained on the down-stroke of the string of sucker

rods maintaining the load on the worm gear in the same direction throughout the cycle of operation to insure most efficient operation of gearing of this type.

5 I claim:

1. An operating unit for use with a walking beam which is connected to and reciprocates a rod, said unit comprising a hollow Samson post for the walking beam, said post forming a reservoir, means for oscillating the walking beam, means for compressing a fluid and conducting it to the reservoir during movement of the walking beam in one direction, and means for utilizing said compressed fluid for assisting in moving the walking beam in the opposite direction.

2. An operating unit for use with a walking beam which is connected to and reciprocates a rod, said unit comprising a hollow Samson post for the walking beam, said post forming a reservoir, a cylinder, a hollow piston rod, a piston connected to the hollow piston rod and mounted in the cylinder, means for connecting the hollow piston rod to the walking beam for dependent oscillation of the walking beam and reciprocation of the hollow piston rod, the hollow piston rod forming a second cylinder, a pipe extending into the second cylinder, means surrounding the pipe for closing one end of the second cylinder, a packing head on the pipe expanded by pressure in the second cylinder for sealing the opposite end of the second cylinder, an air inlet communicating with the hollow piston rod beyond the packing head, a valve between the pipe and the second cylinder, said valve closing responsive to pressure in the pipe and opening responsive to pressure in the second cylinder, the parts being arranged whereby movement of the piston in one direction compresses air in the cylinders, and movement of the piston in the opposite direction draws air through the air inlet and thence through the hollow piston rod and past the packing head into the second cylinder, means for conducting compressed air from the cylinders to the reservoir during movement of the piston in the first mentioned direction, said means supplying compressed air from the reservoir to the first mentioned cylinder during movement of the piston in the opposite direction, a pitman for the walking beam, a crank for the pitman, a worm gear fixed for rotation with the crank, a shaft having a worm meshing with the worm gear, an internal combustion engine for rotating the shaft, and means for conducting compressed air from the reservoir to the engine for injecting fuel and supercharging the engine.

3. An operating unit for use with a walking beam which is connected to and reciprocates a rod, said unit comprising a reservoir, a cylinder, a hollow piston rod, a piston connected to the hollow piston rod and mounted in the cylinder, means for connecting the hollow piston rod to the walking beam for dependent oscillation of the walking beam and reciprocation of the hollow piston rod, the hollow piston rod forming a second cylinder, a pipe extending into the second cylinder, means surrounding the pipe for closing one end of the second cylinder, a packing head on the pipe expanded by pressure in the second cylinder for sealing the opposite end of the second cylinder, a fluid inlet communicating with the hollow piston rod beyond the packing head, a valve between the pipe and the second cylinder, said valve closing responsive to pressure in the pipe and opening responsive to pressure in the second cylinder, the parts being ar-

ranged whereby movement of the piston in one direction compresses fluid in the cylinders, and movement of the piston in the opposite direction draws fluid through the fluid inlet and thence through the hollow piston rod and past the packing head into the second cylinder, means for conducting compressed fluid from the cylinders to the reservoir during movement of the piston in the first mentioned direction, said means supplying compressed fluid from the reservoir to the first mentioned cylinder during movement of the piston in the opposite direction, and means for oscillating the walking beam.

4. An operating unit for use with a walking beam which is connected to and reciprocates a rod, said unit comprising means for compressing air by movement of the walking beam, an internal combustion engine for oscillating the walking beam, and means for utilizing air compressed by the air compressing means in the operation of the engine.

5. An operating unit for use with a vertical string of rods, said unit comprising a reservoir, a cylinder, a piston in the cylinder, a hollow piston rod for the piston, means for connecting the hollow piston rod to the string of rods for dependent reciprocation of said string of rods and said hollow piston rod, the parts being arranged whereby movement of the hollow piston rod responsive to downward movement of the string of rods operates the piston for compressing air in the cylinder, means in the hollow piston rod for compressing air therein by said movement of the hollow piston rod, means for conducting compressed air to the reservoir from the cylinder and from the hollow piston rod, said conducting means supplying compressed air from the reservoir to the cylinder and against the piston for moving the hollow piston rod in the opposite direction during upward movement of the string of rods, means for shutting off compressed air from the hollow piston rod during said upward movement of the string of rods, an internal combustion engine for reciprocating the string of rods, and means for conducting compressed air from the reservoir to the engine for use in the operation of the engine.

6. An operating unit for use with a vertical string of rods, said unit comprising a reservoir, a cylinder, a piston in the cylinder, a hollow piston rod for the piston, means for connecting the hollow piston rod to the string of rods for dependent reciprocation of said string of rods and said hollow piston rod, the parts being arranged whereby movement of the hollow piston rod responsive to downward movement of the string of rods operates the piston for compressing fluid in the cylinder, means in the hollow piston rod for compressing fluid therein by said movement of the hollow piston rod, means for conducting compressed fluid to the reservoir from the cylinder and from the hollow piston rod, said conducting means supplying compressed fluid from the reservoir to the cylinder and against the piston for moving the hollow piston rod in the opposite direction during upward movement of the string of rods, means for shutting off compressed fluid from the hollow piston rod during said upward movement, of the string of rods, and means for reciprocating the string of rods.

7. In combination, a driven element, means for driving the driven element, a reservoir, a cylinder, a piston in the cylinder, a hollow piston rod for the piston, means for connecting the hollow piston rod to the driven element for dependent

movement of said driven element and said hollow piston rod, the parts being arranged whereby movement of the hollow piston rod responsive to movement of the driven element in one direction operates the piston for compressing fluid in the cylinder, means in the hollow piston rod for compressing fluid therein by said movement of the hollow piston rod, means for conducting compressed fluid to the reservoir from the cylinder and from the hollow piston rod, said conducting means supplying compressed fluid from the reservoir to the cylinder and against the piston for moving the hollow piston rod in the opposite direction during movement of the driven element in the opposite direction, and means for shutting off compressed fluid from the hollow piston rod during said last mentioned movement of the driven element.

8. In combination, a driven element, means for driving the driven element, a reservoir, a cylinder, a piston in the cylinder, a hollow piston rod for the piston, means for connecting the hollow piston rod to the driven element for dependent movement of said driven element and said hollow piston rod, the parts being arranged whereby movement of the hollow piston rod responsive to movement of the driven element in one direction operates the piston for compressing fluid in the cylinder, means in the hollow piston rod for compressing fluid therein by said movement of the hollow piston rod, and means for conducting compressed fluid to the reservoir from the cylinder and from the hollow piston rod, said conducting means supplying compressed fluid from the reservoir to the cylinder and against the piston for moving the hollow piston rod in the opposite direction during movement of the driven element in the opposite direction.

9. In combination, a driven element, means for driving the driven element, a cylinder, a piston in the cylinder, a hollow piston rod for the piston, and means for connecting the hollow piston rod to the driven element for dependent movement of the driven element and reciprocation of the piston and its hollow rod in the cylinder, the parts being arranged whereby movement of the

piston and its hollow piston rod in one direction compresses fluid in the cylinder and in the hollow piston rod, and during movement of the piston in the opposite direction pressure of said compressed fluid is exerted against the piston.

10. In combination, a reservoir, a pump cylinder, a piston, a hollow piston rod, the piston and its hollow piston rod being adapted for reciprocation in the cylinder, and means whereby movement of the piston and its hollow piston rod in one direction compresses fluid in the cylinder and in the hollow piston rod with said compressed fluid supplied thence to the reservoir, said means being arranged so that during movement of the piston and its hollow piston rod in the opposite direction said compressed fluid is shut off from flow from the reservoir to the hollow piston rod but is supplied from the reservoir to the cylinder for exerting pressure against the piston in said opposite direction.

11. In combination, a reservoir, a pump cylinder, a piston, a hollow piston rod, the piston and its hollow piston rod being adapted for reciprocation in the cylinder, and means whereby movement of the piston and its hollow piston rod in one direction compresses fluid in the cylinder and in the hollow piston rod with said compressed fluid supplied thence to the reservoir, said means being arranged so that during movement of the piston and its hollow piston rod in the opposite direction said compressed fluid is supplied from the reservoir to the cylinder for exerting pressure against the piston in said opposite direction.

12. In combination, a pump cylinder, a piston, a hollow piston rod, the piston and its hollow piston rod being adapted for reciprocation in the cylinder, and means whereby movement of the piston and its hollow piston rod in one direction compresses fluid in the cylinder and in the hollow piston rod, said means being arranged so that during movement of the piston and its hollow piston rod in the opposite direction said compressed fluid is supplied to the cylinder for exerting pressure against the piston in said opposite direction.

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