July 15, 1941. A. BOYNTON 2,248,949

DIFFERENTIAL TYPE PNEUMATIC PISTON PUMP

Filed Jan. 31, 1939

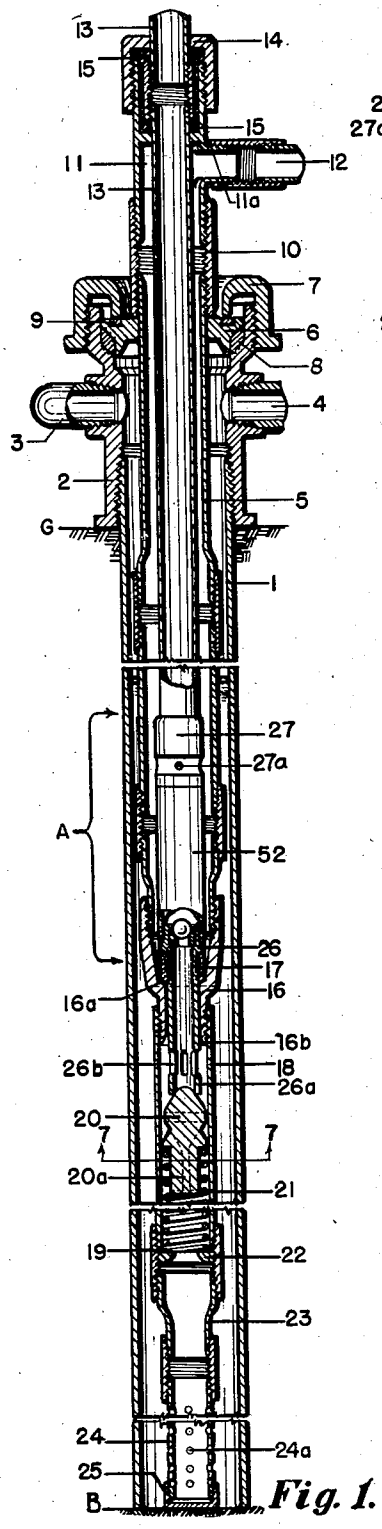


Fig. 1.

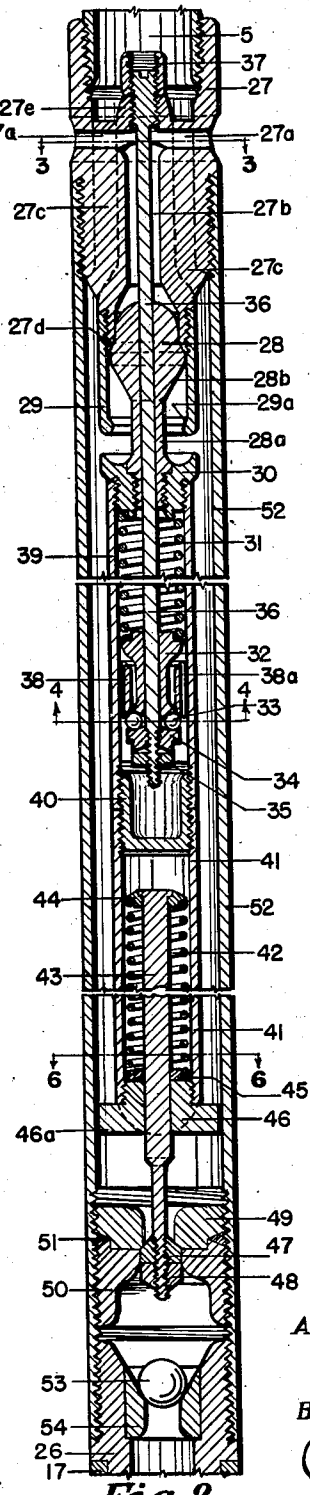


Fig. 2.

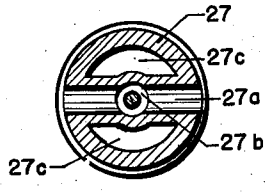


Fig. 3.

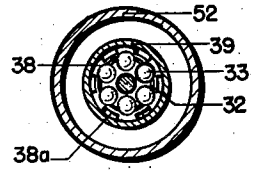


Fig. 4.

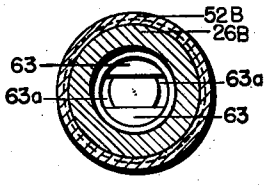


Fig. 5.

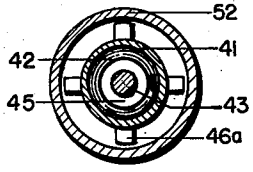


Fig. 6.

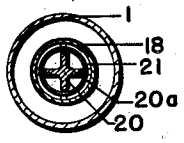


Fig. 7.

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UNITED STATES PATENT OFFICE

2,248,949

DIFFERENTIAL TYPE PNEUMATIC PISTON PUMP

Alexander Boynton, San Antonio, Tex.

Application January 31, 1939, Serial No. 253,875

4 Claims. (Cl. 103—234)

My invention relates to a means for lifting liquids from wells and of propelling liquids through pipe lines by the force of compressed air or gas expanding under or behind a slug of liquid admitted into the eduction tube of a well or into a pipe line by the automatic action of valves which alternately admit a slug of liquid of predetermined weight and then admit under or behind the slug enough compressed air or gas to expel it from the well or pipe line.

One of the objects of this invention is to provide a pump for lifting liquids from wells by means of an expanding pneumatic piston, thereby eliminating the expensive, complicated, and troublesome cups, plungers, working barrels, sucker rods, jacks, and other unnecessary machinery now generally used to lift liquids from wells.

A further object of this invention is to provide a pneumatic piston pump adapted to use either high or low air or gas pressure for expelling either heavy or light slugs from a well without requiring any change in construction or adjustment of parts, the device being adapted to automatically regulate the relation between the weight of slug to be lifted and the air or gas pressure used to lift it. Slugs of different weights or lengths may be expelled from wells by means of simply varying the pressure of the air or gas used to lift the slug. By increasing the air or gas pressure the length or weight of the slug is increased, or vice versa; thereby overcoming the serious difficulty of having to remove the device from the well and of having to change the adjustment so as to expel slugs of different lengths or weights.

A still further object of this invention is to provide means whereby a great number of wells varying widely in depth and production may each be economically and efficiently produced by compressed air or gas from one central compressor plant or by gas from any other source by simply regulating the air or gas pressure supplied to each well for the purpose of expelling oil, water, or mud fluid therefrom.

Another important object of this invention is to provide a means of lifting liquids from wells, regardless of depth, by the use of either greatly or slightly compressed air or gas without allowing any of the air or gas pressure to contact the well liquids so as to transmit pressure against the producing formation at any time.

The slug of liquid is admitted into the eduction tube of a well or into a pipe line by means of a valve that controls the admission of liquid thereto (hereinafter referred to as the liquid intake valve) after a valve that controls the admission of compressed air or gas thereto (hereinafter referred to as the air or gas valve) moves from one seat, referred to as the first seat, and closes upon another seat, referred to as the second seat. The air or gas valve and the liquid intake valve are urged to the only position in which they are both closed by a spring which may work in conjunction with a latch; the latching means tending to hold the air or gas valve and the liquid intake valve closed in the first position, and tending to hold the air or gas valve closed in the second position while the liquid intake valve is open. The force of the air or gas is utilized to hold the air or gas valve seated upon the second seat while the slug of liquid to be expelled is entering the eduction tube or pipe line through the liquid intake valve.

The weight or back pressure of the slug of liquid thus admitted into the eduction tube or pipe line is utilized to unseat the air or gas valve from the said second seat, and to hold the air or gas valve open intermediate its two seats, while, in that position, the liquid intake valve cuts off the admission of more liquid, until the slug has been expelled; whereupon the air or gas valve again assumes the closed position upon its second seat with the liquid intake valve open. This cycle is automatically repeated during the period of operation.

With the above and other objects in view this invention has particular relation to certain novel features of construction, operation, and arrangement of parts which can manifestly be changed and combined in different ways within the scope and purpose of this invention.

Other objects and advantages of this invention will be apparent from the following description as illustrated in the accompanying drawing in which:

Fig. 1 is a vertical section of a well equipped with this device using pressure tubing.

Fig. 2 is a vertical section of a portion of the device.

Fig. 3 is a horizontal section on the line 3—3, Figs. 2, 8 and 9.

Fig. 4 is a horizontal section on the line 4—4, Figs. 2 and 8.

Fig. 5 is a horizontal section on the line 5—5, Fig. 9.

Fig. 6 is a horizontal section on the line 6—6, Fig. 2.

Fig. 7 is a horizontal section on the line 7—7, Fig. 1.

Identical numerals of reference are used to indicate corresponding parts throughout the drawing.

Fig. 1 shows a well equipped with this device in which outer casing 1 is sealed above ground surface G by casing head 2 having two openings one of which is closed by bull plug 3 the other being connected with a pipe line 4 for the purpose of conveying away gas produced by the well. The pressure tube 5 is suspended centrally within casing 1 and proximate its upper end rests upon a plate 6 to which it may be welded or otherwise joined in leakproof contact therewith. Cap 7 is then screwed down upon lead ring 8, at the same time compressing lead ring 8, to form a seal against the escape of formation gas from the well. Any other casing head arrangement that will afford a seal between the well casing and the pressure tubing may be used; many such casing heads being well known to the art.

Pressure tube 5 extends above the casing head and is connected by means of a coupling 10 with a T 11 having a lateral branch 11*a* connected to the air or gas line 12. The upper end of said T is formed to support the eduction tube 13 which is closed about by packing gland 14 which clamps packing 15 producing an hermetical seal between pressure tube 5 and eduction tube 13. The pressure tube 5 may be of one diameter throughout its length or it may be swaged to a different diameter for part of its length as shown.

The pressure tube is connected at its lower end to a swaged coupling 16 which has a tapered seat 16*a* to be engaged by lead seal 17 poured on or otherwise secured upon the eduction tube proximate the lower end thereof. The lower end of the swaged coupling 16 is connected to a tubular housing 18 connected at its lower end to coupling 19.

Within the housing 18 is a valve 20 held resiliently upon upper end of spring 21 to normally engage a seat 16*b* at the lower end of the swaged coupling 16. Said spring 21 rests upon an annular plate 22 in the coupling 19. Below the valve 20 the tubing may be extended downwardly as far as is desired, and I have shown the same as connected through a nipple 23 to a perforated pipe 24 having openings 24*a* therein and closed at its lower end by a cap 25.

The tubing may be extended to rest on bottom of the well B as shown in Fig. 1, or it may be allowed to hang from the casing head with its lower end anywhere below annular plate 22.

While the pressure tubing 5 is being lowered into the well, seal valve 20 contacts seat 16*b* upon which it is held by the force of seal valve spring 21 plus the fluid pressure in the well. When the flow tubing is lowered into the position shown in Fig. 1, the slotted extension 26*a* forces the seal valve down to the position shown in Fig. 1 whereupon well liquid can enter the device via ports 24*a* of intake nipple 24, passing through plate 22, seal valve spring 21, passing between fins 20*a*, around seal valve 20, and through slots 26*b* of the pressure tubing extension 26*a*. This action of valve 20 which keeps well liquid out of the pressure tubing while flow tubing is being lowered or withdrawn is very important in that high flow starting pressures are thereby avoided as is explained in my prior Patent 2,104,008.

The device shown in Fig. 2 being installed within the bracketed space A as shown in Fig. 1, compressed air or gas is supplied into the pressure tubing from pipe line 12 if the well does not produce enough gas to flow it, as illustrated in my prior Patents 2,042,583 and 2,104,008. The air or gas in the pressure tubing can enter the flow tubing 5 only through ports 27*a* of the air or gas intake connection member 27 via passage 27*b*, through the clearance between double air or gas valve 28 and valve seat carrier nipple 29, then upwardly around nipple 29, and through cored ports 27*c* of intake connection member 27.

Double air or gas valve 28 is interposed in the path of the air or gas flow from the pressure tubing into the flow tubing. The valve shank 28*a* is connected at its lower end to deflector 30 against the lower end of which spring 31, under some compression, normally forces double valve 28 to engage its upper seat 27*d* upon lower end of member 27. The cupped upper surface of deflector 30 is formed as shown in order to reverse the direction of the compressed air or gas with a minimum of resistance.

The lower end of spring 31 rests upon the upper end of ball roof 32 which urges latch balls 33 downwardly upon ball floor 34 which is secured in place by lock nut 35 upon lower end of latch shaft 36 having an enlarged externally threaded upper end engaging with the internally threaded annular boss 27*e* of member 27, affording means for vertical adjustment of shaft 36. Lock ring 37 is provided to lock shaft 36 in position to hold the latch balls 33 in proper place within latch sleeve 38, so that the outward movement of the balls at either end of the sleeve may be thus controlled to provide the proper latching force at each end of the valve travel. Ball roof 32 and ball floor 34 are beveled as shown for the obvious purpose of urging the latch balls outward by the force of spring 31. Latch sleeve 38 may, as shown, be pressed into latch housing nipple 39 which is closed at its lower end by externally threaded plug 40. This plug is also connected to nipple 41 that houses coiled spring 42, the upper extension of liquid intake valve shaft 43, and rings 44 and 45. The plug 40 therefore serves the function of interconnecting the nipples 39 and 41 and also serves as a partition to form separate chambers in these nipples.

The lower end of nipple 41 is closed by winged plug 46, the wings 46*a* of which have an easy sliding fit within case nipple 52 and serve as guide to hold the liquid intake valve in the central position shown. Upper ring 44 slips over the upper end of valve shaft 43, is held engaged with the upper end of said shaft by the enlarged top section thereof and provides the upper seat for spring 42 as shown. Lower ring 45 provides the lower seat for spring 42 and at the same time becomes a bearing upon the upper end of plug 46. This bearing is desirable because coiled springs in changing length under compression tend to twist.

The purpose of spring 42 is to urge liquid intake valve 47 toward its seat and to normally hold this valve closed. Liquid intake valve 47 is threadedly engaged upon the lower end of shaft 43 where it is locked in place by nut 48. The liquid intake valve seats upon member 49 which is locked in place by lock ring 50, both of which members are threadedly engaged within the lower end of case nipple 52 that joins together the air or gas intake nipple 27 and the lead seal carrier nipple 26. Packing 51 is obviously locked between members 49 and 50 to prevent leakage along the threads. Check valve 53 and seat 54

are provided in the upper end of member 26 upon the lower end of which lead seal 17 is secured as appears in Figs. 1 and 8.

The chamber housing the latch may be filled with a lubricant to insure smooth working of the latch, slots 38a being to provide for circulation of the lubricant. Slight clearance is provided between shaft 36 and the central bore through valve 28 as breather space in order that the latch action may not be impeded. Likewise the chamber in nipple 41 may be provided with a lubricant to insure easy working of the moving parts therein.

It is apparent that the length of the latch sleeve 38 is determined by the valve travel and by the force of spring 31 in arriving at a certain latching force at either end of the valve travel.

A latching means similar to the one described herein is shown in each of my prior Patents Nos. 2,042,583 and 2,104,008.

When enough force is exerted upon the upper end of valve 28 by the compressed air or gas in the pressure tubing the force of the latch will be overcome and valve 28 will be driven from its first position to engage its lower surface 28b upon the seat 29a. The inflow of air or gas from the pressure tubing to the flow tubing will still be cut off by valve 28 but this change of seats by the air valve opens the liquid intake valve 47 by driving it down into the central enlarged opening through member 50. This opening of the liquid intake valve is caused by a blow struck by plug 40 upon top end of shaft 43, the blow being caused by release of the latch which is set to hold with somewhat more force than would be required to compress spring 31 the full distance of the air or gas valve travel and to compress spring 42 the full distance of the liquid intake valve travel which latter distance is the full distance of the air or gas valve travel minus the distance between the bottom of plug 40 and the top of shaft 43 in the position shown in Fig. 2. The latch must be set to hold with somewhat more force than would be required to compress both springs the stated distance because the well liquid will be pressing up on the liquid intake valve urging it to remain seated. This seating force also must be overcome by energy which the latch releases.

The check valve 53 is not of the yielding type because the liquid intake valve shown in this application does not tend to become impinged upon the liquid under it in the opening operation due to the fact that upward movement of the liquid between the check valve and the liquid intake valve may begin the instant the latter valve breaks its seal. The purpose of the check valve is to prevent the possibility of compressed air or gas escaping into the lower regions of the well if valve 28 should leak upon either of its two seats or if the liquid intake valve should not have a gas tight seat while the slug is being expelled through the flow tubing.

Air or gas valve 28 being now securely seated in its second position upon seat 29a and held there by the force of the compressed air or gas that drove it from the upper seat will break away from seat 29a as soon as enough well liquid enters the flow tubing through the open liquid intake valve to balance the air or gas pressure with aid of the expansive force of both springs. From this expansive force of both springs must, of course, be subtracted the force, if any, stored up by the latch in this lower position of the valves.

In this connection it should be stated that the latch is not wholly essential to satisfactory working of this device but will improve the action thereof under many of the varying conditions found in wells, particularly oil wells in some of which it will be best to adjust the latch to operate downward only or generally with greater force downward than upward.

The difference between the weight of the slug and the air or gas pressure used to expel it equals, and is determined by, the force required to compress spring 31 far enough to allow valve 28 to contact seat 29a plus whatever force the latch employs in the lowermost position of the valves. The weight of the slug may, therefore, be increased by increasing the air or gas pressure, and vice versa. Increasing the air or gas pressure decreases the percentage of difference between the air or gas pressure and the weight of the slug, while the actual difference between them remains constant, and vice versa. Consequently the flowing cycle consists of simultaneously moving the air or gas valve from one closed position to another closed position and opening the liquid intake valve until the slug has entered the eduction tube, then simultaneously closing the liquid intake valve and opening the air or gas intake valve intermediate its two seats 27d and 29a until the slug is expelled, whereupon the air or gas valve again closes while the liquid intake valve opens, and so on during the operating period.

It is to be understood that all references to positions such as "upper" and "lower," "upward" and "downward," etc., apply to the device as illustrated in the drawing wherein the normally upper portion of the device is shown uppermost.

While I have shown and described the preferred embodiment of my invention, it will be understood that the same is illustrated as an example only and is not intended to limit minor variations in the construction and apparent uses thereof.

I claim:

1. In a fluid lift device, an intake connector having a downwardly extending intake passage for a gaseous fluid, spaced upper and lower valve seats in said passage, a valve member movable within the passage to engage said seats, a valve stem extending downwardly from the valve member, a casing attached to said connector and surrounding said stem, a valve seat in said casing, a valve connected to said stem and resiliently held in sealing engagement with said seat to close the casing to the entrance of fluid from below when the valve member is in engagement with the upper valve seat, and means for forcing the valve from its seat when the valve member approaches the lower seat.

2. In a fluid lift device, an intake connector having a downwardly extending intake passage for a gaseous fluid, spaced upper and lower valve seats in said passage, a valve member movable within the passage to engage said seats, a valve stem extending downwardly from the valve member, a casing attached to said connector and surrounding said stem, a valve seat in said casing, a valve connected to said stem and resiliently held in sealing engagement with said seat to close the casing to the entrance of fluid from below when the valve member is in engagement with the upper valve seat, means for forcing the valve from its seat when the valve member approaches the lower seat, and means for releasably latching said stem to hold the valve member upon one of said spaced seats.

3. In a fluid lift device, a flow tube, an intake connector therein having a downwardly opening intake passage, additional passages longitudinally of the connector, spaced valve seats in said intake passage, a valve member intermediate said seats adapted to engage either of the seats, a valve seat in the flow tube below said connector, a valve on said seat, a valve stem on said valve, and a resilient connection between said valve member and said valve stem to resiliently hold the valve upon its seat when said valve member is upon its uppermost seat, and means movable with the valve member and adapted to engage said valve stem to positively open the last mentioned valve as said valve member approaches the lowermost of the spaced seats.

4. In a fluid lift device, a flow tube, an intake connector therein having a downwardly opening intake passage, additional passages longitudinally of the connector, spaced valve seats in said intake passage, a valve member intermediate said seats adapted to engage either of the seats, a valve seat in the flow tube below said connector, a valve on said seat, and a loose connection between said valve member and valve whereby the valve may remain closed during initial downward movement of the valve member, and means movable with the valve member to positively engage and open the valve and admit fluid upwardly within the flow tube as the valve member approaches its lowermost seat, said connection including means normally holding said valve member upon one of said spaced valve seats and means for opening said valve when the valve member moves to the lowermost seat.

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