Feb. 24, 1953 C. M. PETERS 2,629,335

GAS LIFT APPARATUS

Filed Oct. 17, 1946 2 SHEETS--SHEET 1

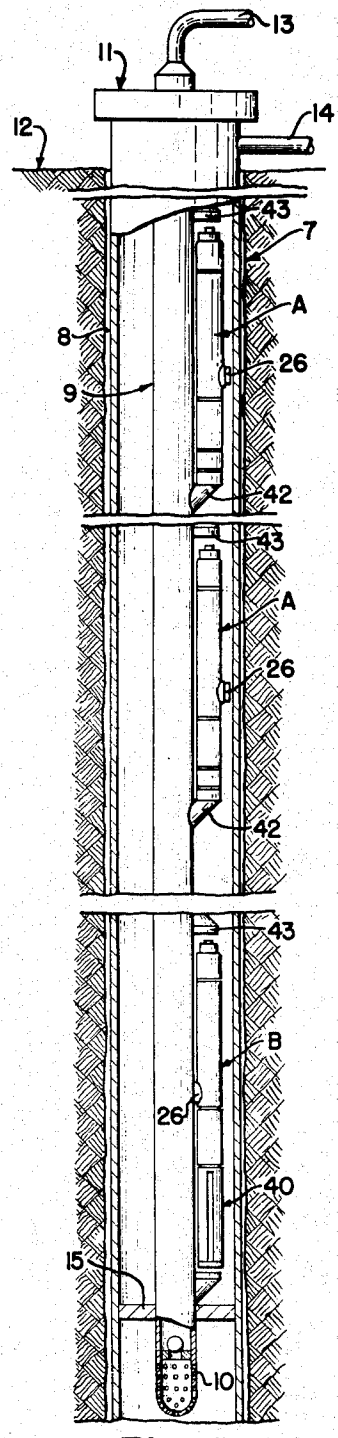

Fig 1

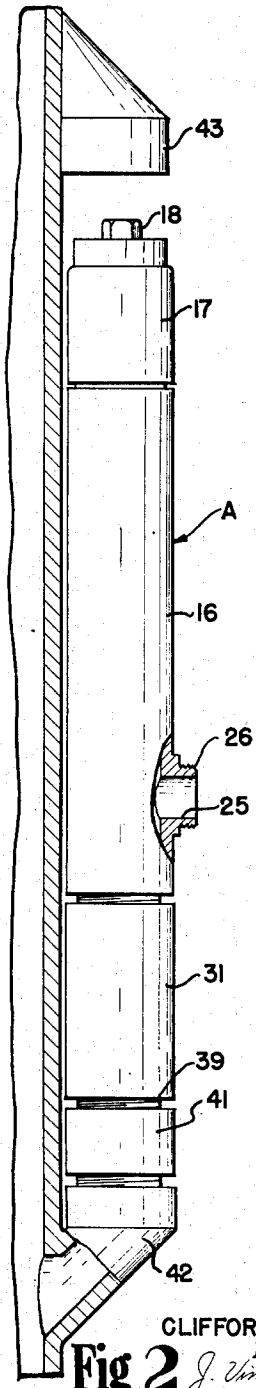

Fig 2

CLIFFORD M. PETERS
INVENTOR.
BY J. Vincent Martin
Ralph R. Browning
James B. Simms
ATTORNEYS

Feb. 24, 1953 C. M. PETERS 2,629,335

GAS LIFT APPARATUS

Filed Oct. 17, 1946 2 SHEETS—SHEET 2

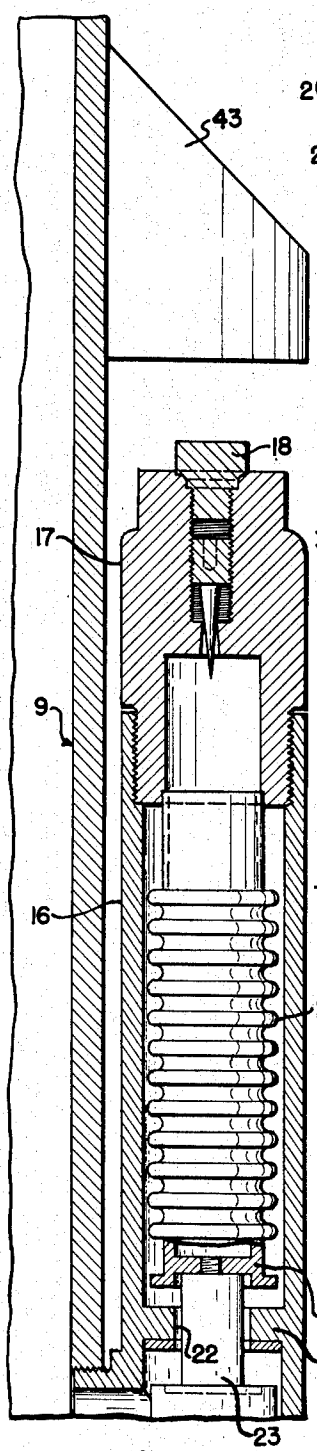

Fig 3

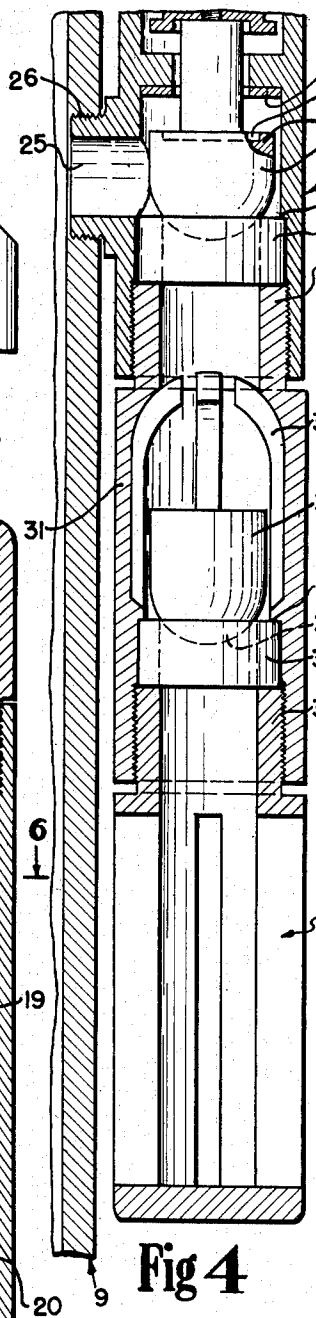

Fig 4

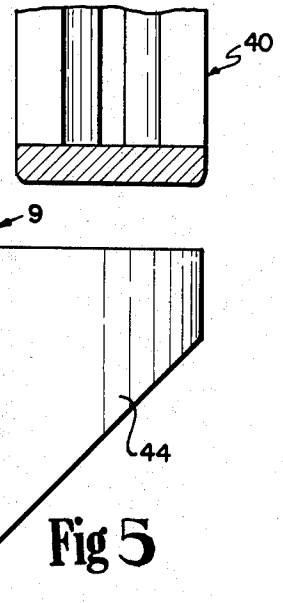

Fig 5

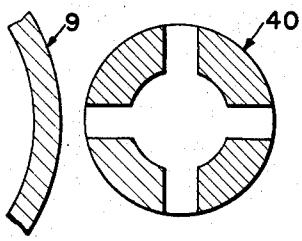

Fig 6

CLIFFORD M. PETERS
INVENTOR.

BY J. Vincent Martin
Ralph R. Browning
James B. Simms
ATTORNEYS

Patented Feb. 24, 1953

2,629,335

UNITED STATES PATENT OFFICE

2,629,335

GAS LIFT APPARATUS

Clifford M. Peters, Longview, Tex., assignor, by mesne assignments, to Garrett Oil Tools, Inc., Houston, Tex., a corporation of Texas

Application October 17, 1946, Serial No. 703,913

1 Claim. (Cl. 103—233)

1

This invention relates to improvements in methods and apparatus for gas lift dumping and producing of oil wells, and more particularly to an improved construction and arrangement of vertically successive dumping and working valves and methods of operating the same. According to this invention the hydrostatic head of oil is dumped either through the tubing or the casing and thereafter the oil is produced through the other of these pipe strings. A novel valve is provided that is especially adaptable for use in conjunction with this type gas lift operation.

Heretofore it has been a practice to both dump the hydrostatic oil head and produce the well through the same pipe string that is either well tubing or the well casing. In contrast to the procedure heretofore used, the present invention contemplates dumping the head through one of these pipe strings and producing or flowing the well through the other, by which novel procedure substantially greater working pressures can be readily obtained at the bottom of the wells than have heretofore been available. This is especially desirable in producing deep wells by gas lift methods.

The present invention further contemplates the provision of arrangements and construction of valves, for carrying out the novel procedures disclosed herein, in accordance with which the dumping valves and the working valves are essentially the same in construction, differing only in the manner of their connection with the well tubing and with the space between the tubing and the interior of the well casings, and in the pressure settings of the valves. The dumping valves are connected with the well tubing only at their lower ends and are connected with the interior of the well casing only at a point intermediate their ends; whereas the working valves are connected with the well tubing only at a point intermediate their ends and are open to the interior of the well casing only at their lower ends.

In the cases of extremely deep wells it is sometimes desirable to utilize more than one set or series of dumping valves. In this case additional dumping valves may be installed in a similar manner as the working valve and at positions intermediate the first mentioned dumping valves and the working valve. This, however, will not provide the maximum pressures at the working valve.

The simple valves of the present invention avoid the complexity of construction and unreliability of action more or less characteristic of valves which employ a pilot outer element for

2

operating the main valve member, and utilize a construction in which the main valve member is balanced against the bellows so as to cancel out the back pressure of the casing or tubing on the main valve member and provide for operation of the main valve member directly by the bellows.

The effectiveness of the valve construction of the present invention is further enhanced by a check valve element unconnected with either the main valve element or the bellows, which acts as an automatic guard against the back flow of oil through the working valve from the tubing into the well casing in the event of valve failure.

In the ordinary gas lift methods, wherein the working and dumping valves are all connected to dump through the same passage, that is either the tubing or the casing, failure of the bellows of any of the upper valves and consequent leaking thereof causes them to actuate with the working valve, thereby disrupting the entire set up. This can only be remedied by pulling the tubing and repairing or replacing the defective valve or valves and restoring the string in the hole. This is a very expensive undertaking, often costing several thousand dollars. In contrast, in accordance with the present invention, once the well head has been dumped and the well is in production through the working valve, failure of the bellows of any of the dumping valves does not affect operation of the set up, since the pressure within the casing is usually greater than that within the tubing, and maintains the main valve closed. Also, a check valve is provided to prevent flow of gas into the tubing in event the main valve fails.

Thus the primary object of the present invention is to provide for a more efficient and less expensive gas lift production of oil wells, and especially to make practical and economical the operation of wells of greater than usual depth which require operating pressures much greater than are encountered in wells of ordinary depth.

A further important object of this invention is to provide valve construction for carrying out the primary object of the invention, which, besides being characterized by unusual simplicity in construction and reliability in action, eliminates the usual necessity to pull the string in the event of failure of any of the dumping valves while the working valve is intact, once the well has been produced.

Other important objects and advantages of this invention will be apparent from the following description and the drawings appended there-

to, wherein merely for purposes of illustration a specific but non-limiting embodiment of this invention is set forth in detail.

In the drawings:

Fig. 1 is a general view showing a well casing in vertical transverse cross section, and a portion of a well tubing therein in side elevation, with a plurality of valves constructed in accordance with this invention connected thereto, the lowermost valve acting as the working valve and the upper valves as dumping valves.

Fig. 2 is a fragmentary transverse vertical section on an enlarged scale taken through one side of the well tubing, showing in side elevation one of the valves arranged for use as a dumping valve and the manner of its association with the tubing.

Fig. 3 is a fragmentary transverse vertical section on an enlarged scale taken through the upper part of one of the valves arranged for use as a working valve and showing its association with the well tubing.

Fig. 4 is a similar view taken through the lower part thereof.

Fig. 5 is a similar view taken through the lower extremity thereof, and,

Fig. 6 is a horizontal section taken through Fig. 4 on the line 6—6.

Referring in detail to the drawings, the numeral 7 generally designates a well hole containing the pipe string or well casing 8, within which is arranged the inner pipe string or well tubing 9 terminating at its lower end in the perforated element 10 located at the well bottom. The casing has a well head 11 at its upper end above the ground surface 12 including the tubing pipe 13 and the casing pipe 14.

A vertically successive plurality of dumping valves A connected with and mounted on the well tubing 9 at intervals above the working valve B located near the lower end of the tubing above the packer 15, constitutes a set or series of valves. In an ordinary deep well a single set or series of dumping valves may suffice, whereas in the case of a well of extreme depth several valves connected as B may be required, as pointed out hereinabove, in which event a portion of the hydrostatic head is dumped through the tubing 9 down to the bottom working valve B and produced therethrough.

The valves A and B are substantially the same in construction, and, as shown in Figs. 2 to 6 of the drawings, comprises a cylindrical housing 16 closed at its upper end by a plug 17 containing a needle valve device 18 for adjusting a response of the bellows 19 which is held in place in the upper part of the housing by the plug 17.

The lower end 20 of the bellows is adjacent to a partition 21 provided with a bore 22 in which works loosely the stem 23 of the main valve element 24 located below the partition 21, so that pressure can act through the bore 25 of a nipple 26 opening through the side of the housing 16 at a point slightly below the partition, on both the lower end 20 of the bellows and the upper end 27 of the main valve element 24, while the hemispherical lower part of the main valve element is seated in the seat 28 whose top is level with the lower side of the nipple bore 25.

The main valve element 24 loosely fits the bore of the housing but has a rim 29 on its upper end to form a seal with a soft metal sealing ring 30 affixed to the lower side of the partition 21 when the main valve element is in its raised position.

In order that the tubing back pressure will not have any effect on the seating or unseating of the main valve element 24, the areas of the bellows bottom and valve element exposed to this pressure are adjusted so the resultant forces thereon are equal and opposite in direction, and this may be accomplished by forming the valve seat area equal to the effective area of the bellows exposed to the pressure surrounding the bellows. This provision is made so that the main valve element 24 is operated only by the bellows 19 through the connection of its stem 23 with the bellows bottom 20 in response to the casing pressure exerted against the portion of the valve encircled by the seat.

The valve housing 16 further comprises a lower section 31 having a reduced upper part 32 threaded into the housing 16 to hold the main valve seat 28 up in place against a shoulder 33. The housing section 31 is provided internally with a cage 34 confining to axial movement therein a cylindrical check valve 35 having a hemispherical lower end 36 adapted to engage the seat 37 only while the check valve is in a depressed position, as shown in Fig. 4.

The check valve seat 37 is held up in place against a shoulder 38 by a reduced portion 39 threaded into the lower end of the housing section 31, said reduced portion 39 forming a part of the slotted cage 40 in the case of the working valve B shown in Fig. 4, or of the union 41, in the case of the dumping valve A shown in Fig. 2.

The slotted cage 40 is open to the space between the interior of the casing 8 and the exterior of the well tubing 9 for working valve operation, with the nipple 26 connected with the interior of the well tubing as shown in Fig. 4.

For dumping valve assembly the nipple 26 is in communication with the space between the well tubing 9 and the interior of the well casing 8, as shown in Fig. 2, and a fitting 42 is employed to connect the union 41 with the well tubing 9, so as to establish communication of the lower end of the valve with the interior of the well tubing 9 instead of with the interior of the casing 8 as in the case of the working valve.

The fittings 42 are angulated to act as shields for the lower ends of the dumping valves A when lowering the string into the casing. Upper shields 43 are provided on the well tubing for the upper ends of the valves to protect them in pulling the string, while similar reversed shields 44 are employed on the well tubing below the working valves, as shown in Fig. 5.

Since, as already mentioned, the bellows bottom 20 and main valve top 27 have similar areas exposed, the back pressure from the well through the nipple 26, with the main valve element 24 seated, exerts the same pressure downwardly on the main valve member 24 as upwardly against the lower end 20 of the bellows 19, so that there is no tendency for the main valve element 24 to be unseated or opened by this back pressure. Therefore, the only well pressure which can open or unseat the main valve 24 is pressure coming through the lower housing section 31 of the valve, either through the slotted nipple 40, in the case of a working valve B, or through the fitting 42, in the case of a dumping valve A, and unseating the check valve 35.

The check valve 35 serves only as such in the event of failure of the main valve element 24, in which event the check valve acts to prevent back flow from the well tubing 9 into the well casing 8 in the working valve hook up. In the dumping

valve hook up the check valve prevents back flow of fluid from the casing into the tubing.

As already herein explained, failure of any of the dumping valves A above the working valve B, after producing of the well has started, will not disrupt the system and require pulling of the string for repair or replacement of the defective dumping valve A while the working valve B is in operative condition, because the pressure within the casing **8** being greater than that within the tubing **9** while the well is being operated seats the check valve as well as the main valve.

It is believed that the operation of this invention is obvious from the foregoing description. In dumping the hydrostatic head of a well equipped as described hereinabove, the oil within the tubing **9** is forced outwardly therefrom through the dumping valves A into the casing **8** by applying gas pressure to the pipe **13**. The uppermost valve A may have its bellows set to operate at the highest desired pressure, such as 1000 p. s. i. with the next lower valves A set to operate at gradiently lower pressures, such as 800 p. s. i., the pressure settings of the valves A being progressively lower to the lowest dumping valve A. The working valve B, below the lowermost dumping valve A, is set to operate at a relatively high pressure, such as 1000 p. s. i.

Sufficient gas pressure is applied downwardly through the tubing pipe **9** to open all of the dumping valves A with the oil accumulated above the upper dumping valve A. When the oil head, now in the casing, has been lowered below the uppermost valve A, the gas pressure is successively reduced so as to open only the successive valves A therebelow and not the valve A next above. During this time the working valve B remains closed as will be understood.

When the oil head has been dumped through the casing **8**, the gas pressure is switched to the casing pipe **14**, from which it enters the working valve B upwardly through the slotted nipple **40** and displaces the working valve check valve **35**.

When the pressure in the space between tubing **9** and the inner wall of casing **8** is sufficient to overcome the setting of the bellows **19** of working valve B, the main valve element **24** is raised to open position away from its seat **28** and the gas under pressure passes through the nipple bore **25** into the well tubing **9** in a big slug which serves as a piston to elevate the accumulated oil therein to the tubing head and out of the tubing pipe **13**. In its raised position the rim **29** on the upper end **27** of the main valve element **24** engages the soft metal ring **30** to seal off the bellows **19** and prevent its being damaged by possible excess pressure in casing **8** and to confine the flow of high pressure fluid through the working valve to the space below the valve housing partition **21**, and through outlet **25**.

When it is desired to stop production of the well through working valve B, the pressure in casing **8** is lowered until it is less than the setting in bellows **19** of the working valve. Main valve member **24** is then forced downwardly by the bellows until it again seats upon seat member **28**, closing off the flow of fluid under pressure from casing **8** to the bore **25** of nipple **26**. Obviously a time controlled intermitter may be employed to control the introduction of actuating pressure to the tubing and casing in the conventional manner.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein described or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described my invention, I claim:

In an oil well system including a well hole, a well tubing and a casing spacedly surrounding said well tubing in the well hole, a gas lift valve system comprising a plurality of upper pressure actuated dumping valves and a lower pressure actuated working valve mounted in the space between the casing and the tubing, said valves each providing communication means between the tubing and casing, said dumping valves being of the fluid pressure loaded type and vertically spaced along said tubing with downwardly succeeding dumping valves charged with successively lower pressures so as to close at successively lower gas pressure and dump successively lower portions of the oil head into and through said casing, means communicating with the tubing for introducing gas under pressure into said tubing to effect dumping of the oil head through the dumping valves and the casing, said working valve being of the fluid pressure loaded type and spaced below the lowermost dumping valve, said working valve having a main valve element exposed to casing pressure which is charged to open in response to casing pressure when such pressure exceeds a predetermined amount, a check valve in said working valve preventing flow of fluids from the tubing into the casing through the working valve, and pipe means communicating with said casing for introducing gas into said casing under pressure sufficiently great to open said working valve and force upwardly through the tubing accumulated oil head standing above the working valve.

CLIFFORD M. PETERS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,981,965	Morgan	Nov. 27, 1934
2,265,835	Godsey	Dec. 9, 1941
2,314,869	Boynton	Mar. 30, 1943
2,331,503	Ray	Oct. 12, 1943
2,339,487	King	Jan. 18, 1944
2,342,301	Peters	Feb. 22, 1944
2,366,146	Martin-Hurst	Dec. 26, 1944
2,377,981	Taylor	June 12, 1945
2,437,187	Eshbaugh	Mar. 2, 1948
2,465,060	Carlisle	Mar. 22, 1949

FOREIGN PATENTS

Number	Country	Date
373,583	Italy	July 28, 1939