

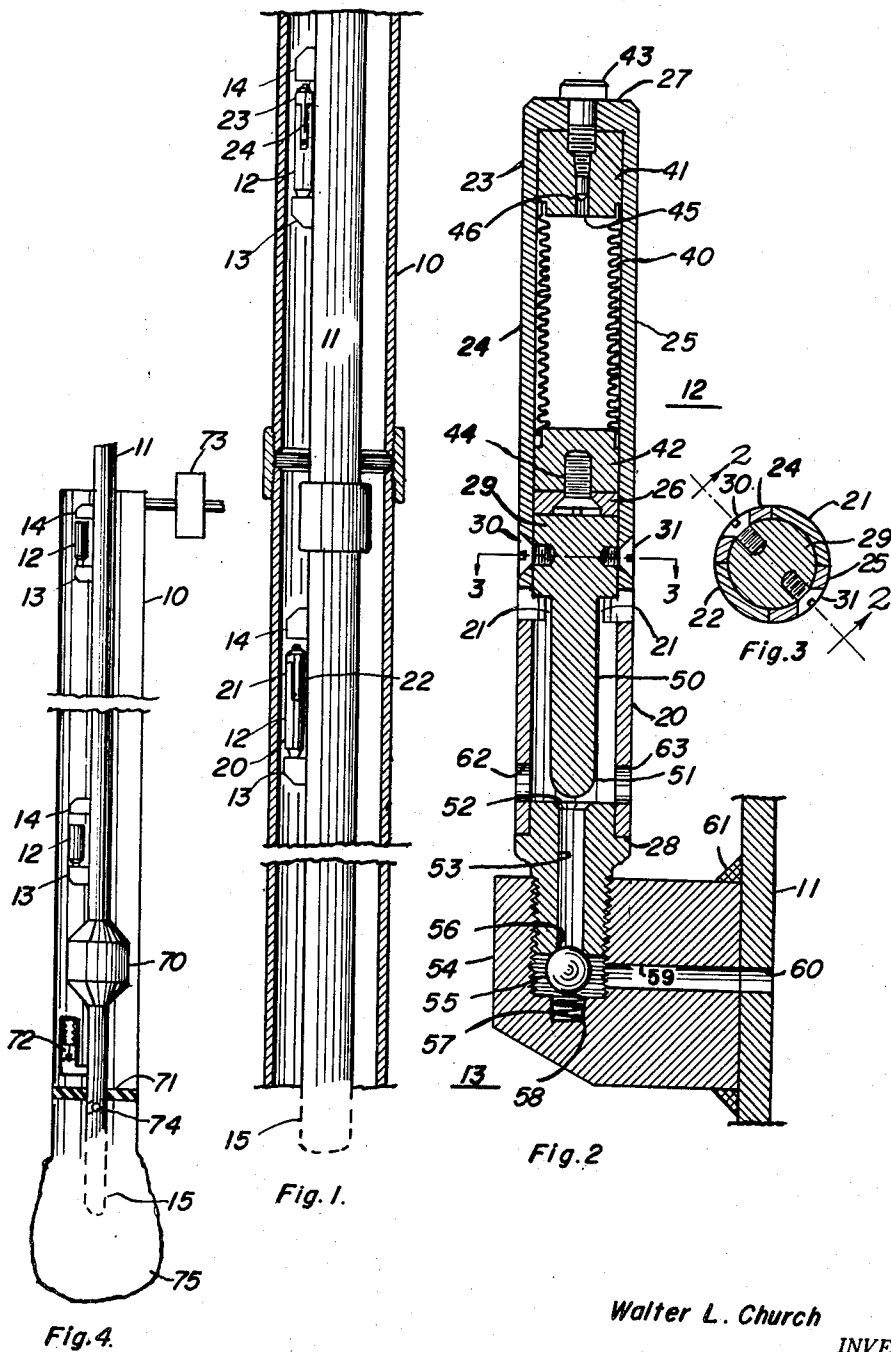
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GAS LIFT VALVE

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GAS LIFT VALVE

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This invention pertains to valves and to a system of valves used for admitting gas to a column of liquid for lifting same. More particularly it pertains to such valves used in conjunction with a system of gas lift for raising petroleum fluids in an oil well whose natural pressure is insufficient to accomplish the purpose satisfactorily. The valve and system are intended to be used to unload the well by admitting gas successively first near the top of the oil column, then lower and lower to the desired depth, removing or lightening the oil above each valve before admitting gas to the next lower valve, so that the gas pressure required for removing the oil will not have to be greater than the hydrostatic pressure of the whole column of that oil standing in the well initially but need only be greater than that of the column of dead oil standing between the two valves spaced farthest apart plus, in the case of continuous operation, the head of light gas-oil emulsion thereabove. This system of unloading a well with a plurality of spaced valves is known as stage lift. After the well has been unloaded the gas can be admitted continuously or intermittently to the bottom of the column depending on the rate of flow of the oil from the sand and the pressure thereof and the depth of the well and other factors.

An object of this invention is to provide a stage lift valve and system which will have a long and satisfactory operating life and to this end it is an object of the invention to provide a valve which will not easily be cut by fluid flow there-through and a system of valves such that the valves will not have to operate in a partially open condition for any great length of time.

A further object of the invention is to provide a valve which is inexpensive to manufacture and reliable in operation and to these ends it is an object to provide a valve that is sturdy yet simple in construction.

Other objects and advantages of the invention will become apparent from the following description thereof.

For a detailed description of a preferred embodiment of the invention, reference will now be had to the accompanying drawings in which

Figure 1 is a vertical section through an oil well showing valves according to the invention for continuous gas lift;

Figure 2 is a vertical section through one of the valves, taken on line 2—2 of Figure 3;

Figure 3 is a horizontal section taken on line 3—3 of Figure 2; and

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Figure 4 is a vertical section through an oil well showing the invention applied to intermittent lift.

It is to be noted that the valve shown in Figure 2 is screwed into its support 90 degrees farther than as shown in Figure 1. In Figure 3, to facilitate drafting, the orientation is as though the valve were screwed into its support 45 degrees farther than shown in Figure 2.

Referring to Figure 1, there is shown an oil well casing 10, within which is disposed a string of tubing 11. Along the outside of the tubing in the annulus formed between tubing and casing there are disposed stage lift valves 12, beneath each of which is disposed a check valve 13 and above each of which is disposed a guard 14. To the lower end of the tubing is connected a strainer 15 through which the oil is admitted to the tubing. Gas is admitted to the top of the annulus from a suitable source not shown.

Referring now also to Figures 2 and 3, each valve 12 comprises a lower fixed housing portion 20 in the form of a cylindrical sleeve having two upstanding sleeve sectors 21 and 22, each of 90 degrees width, and an upper movable housing portion 23 in the form of a cylindrical sleeve having two depending sleeve sectors 24 and 25, each of 90 degrees width, the sectors of the upper and lower portions interengaging and being relatively slidable, i. e. reciprocable parallel to the axis of the housing. The top end of the lower housing portion is closed by disc 26 which extends between sectors 21 and 22 and is integral therewith. The top end of the upper housing portion is closed by disc 27 which is integral with the sleeve. The bottom end of the lower housing portion is closed by nipple 28 suitably secured to the sleeve and the bottom of the upper housing portion is closed by cylinder 29 secured between and to sectors or arms 24, 25, by means of screws 30, 31.

A bellows 40 has its ends closed by plugs 41 and 42. Plug 42 is secured to disc 26 by screw 44. The bellows is filled with gas under pressure through opening 45 in the plug 41. A check valve 46 is screwed into the opening to prevent the gas from escaping.

Cylinder 29 carries a valve stem 50, the lower end of which is rounded to form a valve 51. Valve 51 cooperates with valve seat 52 formed at the upper end of passage 53 through the valve body constituted by nipple 28. The nipple 28 is screwed into the top of housing 54 of check valve 13. Within the housing is a ball 55 which cooperates with seat 56 at the lower end of

passage 53. A spring 57 carried in recess 58 urges the ball toward the seat. A passage 59 leads from the interior of housing 54 to a passage 60 through tubing 11 to which the housing is suitably secured, for example by welding as indicated at 61.

Valve 51 controls the admission of gas from the annulus through the valve housing inlet apertures 62, 63, passage 53, 59, and 60, to the inside of the tubing. The valve as shown is open but upon increase of annulus gas pressure above the bellows pressure, the bellows contracts and the valve closes. The check valve 55 prevents oil in the tubing from flowing out into the annulus when the valve 51 is open.

The bellows is initially at such internal pressure that it urges the plug 29 upwards against the disc 26 which serves as a stop to limit the opening movement. By holding the bellows contracted more than its internal pressure alone would dictate, the bellows is kept from moving with every slight change of external pressure, which causes the valve to have a sharply defined closing pressure. By making the bellows fairly long compared to the valve travel from open to closed position the range of pressure between open and closed position is further narrowed. The two part telescoping housing 26—23 provides not only a stop for limiting the valve travel but affords excellent protection for both the bellows and the valve and seat. The valve travel is such that in both open and closed positions there is ample space between the ends of the arms and the bodies of the housing portions to admit gas to the side of the bellows and to the valve. The lower gas ports 52, 63 insure that no sand can collect in the lower part of the housing and there are no pockets in the upper part of the housing for sand to collect in either.

Referring to Figure 1, there will be a plurality of stage lift valves disposed along the side of the tubing at approximately equal intervals, hydrostatic head of oil between each pair of successive valves being somewhat less than the pressure of the gas available for admission to the annulus. The bellows of each valve will be charged to a higher pressure than the valve above. With this arrangement of valves, gas will be initially admitted to the annulus at a pressure below that required to close the uppermost valve but higher than the hydrostatic pressure of the oil thereabove. The oil in the annulus, which initially is at a higher level than the uppermost valve, will be forced down through the valve into the tubing until the valve is exposed. Gas will then enter the tubing through the valve and will emulsify and lighten the oil column so that it will rise to the surface and flow out. As soon as enough oil has thus been removed above the top valve, the annulus pressure will be increased enough to close the top valve and to overcome the hydrostatic head of the oil above the second valve down from the top, including both the emulsion above the first valve and the dead oil therebelow. When this column has been sufficiently lightened the pressure in the annulus will be further increased enough to close the second valve and to overcome the head of the oil above the third valve, including both the light emulsion above the second valve and the heavy dead oil therebelow. This process will be continued until gas is being admitted to the tubing at a point low enough so that the gas does not cut through the oil but all is mixed with the oil as an emulsion. The gas is then said to have sufficient submer-

gence. The oil-gas emulsion flows to the surface continuously at a minimum gas-oil ratio. The pressure may be increased further to admit the oil at a still lower point if it is desired to further lighten the column to increase the rate of flow. Since the pressure is increased as the gas admission point is lowered, all valves above that through which gas is being admitted are positively closed. This prevents cutting of the valve as would be the case if it were cracked partly open. At the same time the valve through which gas is admitted, being normally open is fully open and is not cut either.

The valve and stage lift system according to the invention can also be used with an intermittent lift operation as shown in Figure 4. In addition to the apparatus of Figure 1 there is also shown an accumulation chamber 70, a packer 71 between the tubing and annulus, and a normally closed bellows actuated valve 72. The stage lift valves have sufficiently large openings so that a large quantity of gas flows through each when it is open. This causes the oil above it to rise as a slug instead of emulsifying and the tubing above is left completely dry. After the oil is kicked off in slugs down to the level of the lowermost valve, the gas pressure is raised enough to open valve 72 and raise the oil in the accumulation chamber 70. Thereafter the intermitter control device 73 at the surface lowers the annulus gas pressure to close valve 72 until the accumulation chamber has filled again whereupon the pressure is increased to again empty the chamber. Ball check valve 74 keeps the gas pressure off the formation 75 during the lifting of the oil to the surface from the chamber.

Valve 72 may be of any conventional type such as that shown in U. S. Patent 2,339,487, granted January 18, 1944, to W. R. King.

While preferred embodiments of the invention have been shown and described, it is obvious that many modifications thereof could be made by one skilled in the art without departing from the spirit of the invention and it is intended to protect by letters patent all forms of the invention falling within the scope of the following claims.

I claim:

1. A stage lift valve comprising a threaded nipple having a valve seat formed at one end, a first sleeve secured to the nipple and extending beyond said seat, a pair of oppositely disposed arms extending from said sleeve away from said seat, a closed bellows having one end secured to said arms, the body of the bellows extending away from said seat, a second sleeve having one end secured to the other end of said bellows, said sleeve extending back around said bellows toward said seat, a pair of oppositely disposed arms extending from the other end of said bellows toward said seat and reciprocatingly slidably interengaging with the first said arms, and a valve secured to the ends of the arms of the second sleeve and adapted to engage said seat, said bellows containing gas at a pressure above atmospheric so as to normally hold said valve in open position away from its seat.

2. A stage lift valve comprising a sealed bellows containing gas under pressure, a first cylindrical housing portion surrounding the bellows and secured thereto at one end, said housing having a plurality of slots in its other end, leaving arms of arcuate cross section therebetween, a cylindrical plug received between the ends of said arms and secured thereto, a valve stem carried by said plug extending away from said bellows,

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a valve member formed on the end of said stem, a nipple having a valve seat formed therein adapted to cooperate with said valve member, a second cylindrical housing portion surrounding said valve member and seat, said second housing portion being secured to said nipple, said second housing portion having apertures therethrough adjacent said seat and having a plurality of slots in its other end leaving arms of arcuate cross section therebetween, the last said arms fitting in the first said slots and the first said arms fitting in the last said slots so that the two housing portions together form a single extensible and retractable housing, and a disc integral with the ends of the second said arms secured to the other end of said bellows between said bellows and said plug.

3. A stage lift device comprising a sealed bellows containing gas under pressure, a first cylindrical housing portion surrounding the bellows and secured thereto at one end, said housing having a plurality of slots in its other end leaving arms of arcuate cross section therebetween, a cylindrical plug received between the ends of said arms and secured thereto, a valve stem carried by said plug extending away from said bellows, a valve member formed on the end of said stem, a nipple having a valve seat formed therein adapted to cooperate with said valve member, a second cylindrical housing portion surrounding said valve member and seat, said second housing portion being secured to said nipple, said second housing portion having apertures therethrough adjacent said seat and having a plurality of slots

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in its other end leaving arms of arcuate cross section therebetween, the last said arms fitting in the first said slots and the first said arms fitting in the last said slots so that the two housing portions together form a single extensible and retractable housing, a disc integral with the ends of the second said arms secured to the other end of said bellows between said bellows and said plug, an opening through the first said end of the bellows and an opening through the end of the housing portion connected thereto, a check valve secured in the first said opening, a screw through the second said opening engaging a thread in the second said opening to close the openings and secure the bellows to said housing portion as aforesaid, a support adapted to be secured to the side of a well tubing, a passage through said support having openings disposed at an angle to each other, one of said openings receiving therein and being secured to the end of said nipple away from said valve member, and a ball check valve disposed in said one of said openings between said support and nipple.

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