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WIRE LINE GAS LIFT VALVE

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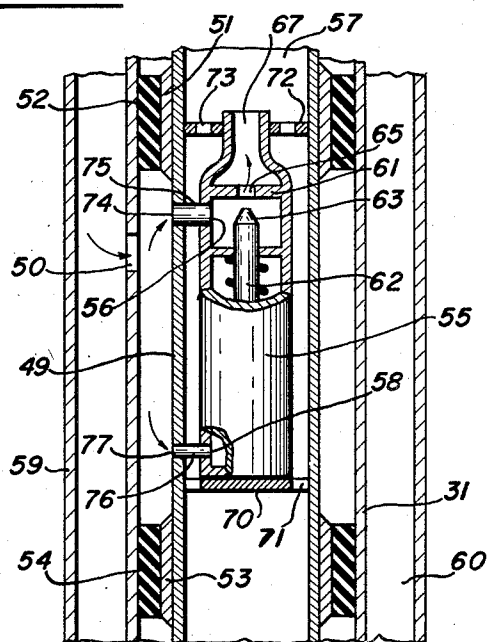
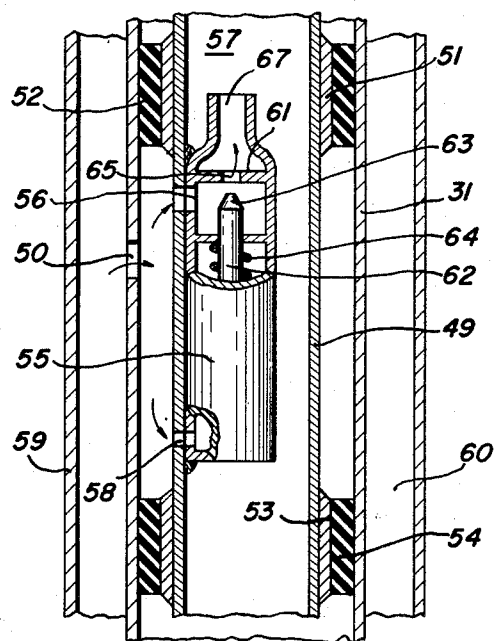
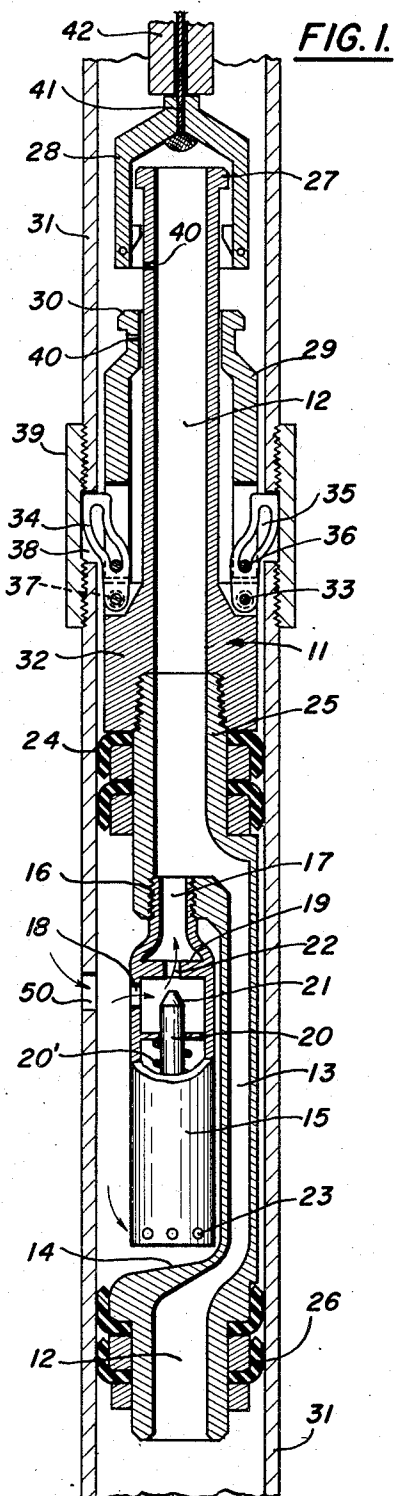


FIG. 3.

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1

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WIRE LINE GAS LIFT VALVE

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The present invention is directed to apparatus for obtaining production from a cased well having a low bottom hole pressure. More particularly, the invention is directed to apparatus for obtaining production from wells having a low bottom hole pressure and which has been previously completed with tubing and packer and with mud or water in the annular space.

The present invention may be briefly described as involving apparatus, for obtaining production from a cased well having a low bottom hole pressure and in which is arranged a tubing string, which includes a mandrel adapted to be run on a wire line in a tubing string, the mandrel having a continuous internal passageway which runs from an upper end to a lower end thereof. The mandrel is provided with or carries a gas lift valve which provides fluid communication between an inlet thereof and the internal continuous passageway of the mandrel. My improved apparatus embodies anchoring means for latching the mandrel to an inner surface of the tubing string and packers which also provide a seal and/or an anchor between the mandrel and the inner surface of the tubing string and which serve to enclose the gas lift valve.

The gas lift valve may be carried by or arranged with in the mandrel either co-axially therewith or positioned against an interior surface of the mandrel, the gas lift valve communicating through ports in the mandrel with the exterior surface thereof to allow operation of the gas lift valve and passage of lifting gas into the valve and thence into the mandrel and up the tubing string. The gas lift valve may also be arranged exteriorly on the mandrel in a recessed or offset portion of the mandrel which is adapted to receive the gas lift valve, the gas lift valve being suitably connected to the mandrel to provide fluid communication with the internal passageway thereof.

It is contemplated that the apparatus of the present invention will be provided, adjacent an upper end, with means for releasing the anchoring means from the tubing string. It is also intended that my apparatus will be provided with means at an upper end for attaching the mandrel to a wire line for lowering the improved apparatus in and pulling the improved apparatus from the tubing.

The invention will be further illustrated by reference to the drawing in which

Fig. 1 is a sectional view of one embodiment;

Fig. 2 is a sectional view of another embodiment of my invention in which the gas lift valve is arranged within the mandrel; and

Fig. 3 is a sectional view of a still further embodiment with the gas lift valve arranged within the mandrel.

Referring now to the drawing and particularly to Fig. 1, numeral 11 designates a mandrel defining a passageway 12. The mandrel 11 is provided with an offset portion 13 through which the passageway 12 runs. The offset portion 13 defines a recessed section 14 in which is arranged a gas lift valve 15 which is connected at an upper end by mating screw threads 16 to the mandrel 11 and provides communication with the passageway 12 through outlet 17.

The gas lift valve 15 is a gas lift valve, such as is described on pages 1380 and 1381 of the Composite Catalogue of Oil Field and Pipe Line Equipment, 16th edition, 1948, published by World Oil, Houston, Texas. Other gas lift valves which may be used in the practice of the present invention are those such as described on pages 1534 and 1535 of the Composite Catalogue of Oil Field and Pipe Line Equipment, supra.

The gas lift valve 15 is provided with a port 18 which

2

serves to allow a lifting gas to be introduced into the passageway 12 as will be described. The gas lift valve 15 is shown in partial section and is provided with a seat 19, a valve stem 20, and a conical seating member 21. The valve stem 20 is embraced by a helical coil spring 20' which serves to urge the seating member 21 into engagement with the seat 19 and to close the port 22. The lower end of gas lift valve 15 is provided with inlets 23 for introduction of gas against a power piston, not shown, connected to the valve stem 20. In any event, although the gas lift valve 15 has been described in some detail, it is considered that any gas lift valve may be employed in the recess 14.

The mandrel 11 is provided with a first packer 24 which is arranged above the valve 15 and is carried by a sleeve 25. Arranged on the mandrel 11 below the gas lift valve 15 is a second packer 26 which is also arranged on sleeve 25, as shown.

The upper end of the mandrel 11 is provided with a protruding shoulder 27 which is adapted to be engaged by an overshot 28 for lowering the mandrel 11 in the well bore. Below the shoulder 27 and slidably arranged on the mandrel 11 is a mandrel recovery and setting carrier 29 which is also provided with an external shoulder 30 for engagement with an overshot larger than the overshot 28 for recovery of the device from the tubing 31. Pivotaly arranged on a section 32 embracing the mandrel 11 by pivot pins 33 are latching dogs 34 which are provided with slots 35. The mandrel recovery and setting carrier 29 is provided with pins 36 which are designed to fit slidably in the slots 35 on raising and lowering of the carrier 29. The latching dogs 34 are biased outwardly by biasing springs 37 which causes the latching dogs 34 to fit within a recess 38 defined by a tubing collar 39 with the tubing 31. A shear pin 40 serves to hold the mandrel recovery and setting carrier 29 in its upper position when running the tool in the tubing string 31.

Referring now to Fig. 2, mandrel 49 is shown in the tubing string 31. The mandrel 49 is provided with a first sleeve 51 on which is arranged a packer 52. The mandrel 51 is provided with a second sleeve 53 carrying a packer 54 to isolate a zone in the tubing 31 and to provide a chamber therein. Arranged in or carried interiorly by the mandrel 49 is a gas lift valve 55 which may be similar to the gas lift valve 15. This gas lift valve 15 is attached to an internal surface of the mandrel 49 against an internal wall thereof and is provided with a port 56 in the mandrel 49 which allows communication of lifting fluid to the gas lift valve 55 and to internal passageway 57 of the mandrel 49. The mandrel 49 is also provided with anchoring means similar to that of mandrel 11. The gas lift valve 55 is provided with a second port 58 through the wall of the mandrel 49 which allows communication with the outer surface of the mandrel 49 and also provides the means for the lifting gas to work against a power piston, not shown, of the gas lift valve 55. The tubing 31 is shown arranged in a casing 59 which defines annulus 60 with the tubing 31.

Like the gas lift valve 15 the gas lift valve 55 is provided with a seat 61, a valve stem 62 and a conical seating member 63. The valve stem 62 is embraced by helical coil spring 64 which serves to urge the seating member 63 into engagement with the seat 61 and to close the port 65. The lower end of the gas lift valve 55 is provided with an inlet 58, as described, for introduction of gas against a power piston, not shown, connected to the valve stem 62. An outlet 67 communicates valve 55 with passageway 57. Although the gas lift valve 55 has been described in some detail, it is considered that any gas lift valve may be employed in the passageway 57 which is provided with inlets to the gas lift valve for operation thereof through the mandrel 49.

In Fig. 3 a slightly different modification of the apparatus of Fig. 2 is described. The embodiment of Fig. 3 is similar to the embodiment of Fig. 2 and similar numerals will be employed to designate identical parts. In this embodiment of my invention the gas lift valve 55 is arranged coaxially in the central passageway 57 of the mandrel 49. The gas lift valve 55 is arranged on a lower plate member 70 provided with a plurality of perforations

or slots 71 to allow passage of fluid up the continuous passageway 57. The upper end of the gas lift valve 55 is held centrally in the passageway 57 by a second perforated plate 72 provided with a plurality of passageways or ports 73 to allow passage of fluid upwardly in the passageway 57 and the tubing 31. In this embodiment of my invention, the inlet to the gas lift valve 55 through which the lifting gas passes is through a port 74 in the mandrel 49 which is connected by a conduit 75 to inlet 56 of the gas lift valve 55. Like the gas lift valve in Fig. 2 a valve stem 62 is provided with a conical seating member 63 which is adapted to seat against the seat 61 and close the port 65. In this particular embodiment of my invention the inlet 58 of the gas lift 55 communicates with the exterior surface of the mandrel through a conduit 76 which terminates in port 77 on the exterior surface of the mandrel 50, as shown.

Like the embodiment of Fig. 2, the latching means or anchoring means of this embodiment of my invention is similar to the latching means of Fig. 1 and, for simplicity, has been omitted from this embodiment of my invention.

In employing my apparatus with particular reference to the embodiment of Fig. 1, the mandrel 11 carrying the gas lift valve 15 is lowered in the tubing string 31 by means of a wire line 41 attached to the overshot 28, the mandrel recovery and setting carrier 29 being held in an upper position by the shear pin 40. The mandrel 11 is then lowered past a tubing collar 39 to a point where it is desired to set the mandrel and a go-devil 42 is dropped on the wire line 41 which strikes the overshot 42 and shears the shear pin 40. After being released, the mandrel recovery and setting carrier 29 slides downwardly and the pins 36 press the latching dogs 34 against the walls of the tubing 31. The mandrel 11 is then slowly pulled up the tubing 31 until the latching dogs 34 expand into the tubing collar recess 38. As the latching dogs 34 expand outwardly, the mandrel recovery and setting carrier 29 slips further downward and locks the dogs in the expanded position by means of the vector forces about the pins 36; with the latching dogs held expanded, the mandrel 11 is thus prevented from moving either upwardly or downwardly. The packers 24 and 26 are then set anchoring the device and sealing off the gas lift valve 15 from the tubing 31 and, in effect, enclosing the valve 15 in a chamber thus defined in the tubing.

Prior to running the apparatus of my invention in a tubing string 31 a tubing perforating device, such as is well known to the art, had previously been run in the well and had formed a perforation 50. This perforation 50 had been formed at a predetermined distance from the recess 38 and may be accomplished by catching the tubing gun on the tubing collar 39. In any event, the perforation 50 had been formed at a predetermined distance from the tubing collar 39 such that the inlet port 18 of the gas lift valve 15 will be opposite or adjacent the inlet 50.

After the apparatus of the present invention has been anchored as described, the wire line 41 and overshot 28 and the go-devil 42 are removed from the tubing by means well known to the art.

The mandrel 11 may be recovered by running an overshot, not shown, larger than the setting overshot 28. This second overshot is designed to engage with the shoulder 30 on mandrel recovery and setting carrier 29. When the larger overshot engages with the shoulder 30 a pull upon the wire line 41 moves the pins 36 upwardly which pulls the latching dogs 34 inwardly and releases the mandrel from the tubing collar. The apparatus is then returned up the tubing string by reeling in the wire line 41.

The apparatus of Fig. 1 of the present invention may be used in the following manner: For example, it may be employed in an oil well which has previously been completed with a tubing and packer and with mud in the annular space between the tubing and the casing. It is assumed that the well has gone dead because of a low bottom hole pressure. The tubing is then perforated near the bottom of the tubing at a predetermined liquid working level. The mud in the annular space is circulated through the tubing port, such as 50, and displaced by clean water. Additional perforations at various intervals up the hole may then be made, each of which is a definite distance from a preselected tubing collar. The apparatus of the present invention embodying gas lift valves, as described, is then run into the tubing and set opposite or adjacent the tubing perforation, the gas lift valve, as has been described, being set first opposite the lower of the

perforations and then sequentially up the tubing. The well is then unloaded and placed on production by injecting into the annulus a suitable lifting gas to pressurize the casing and to allow production.

The operation of the gas lift valve per se is well known and will not be described specifically since each design varies somewhat in operation. In this particular instance, however, lifting gas pressure is exerted against the power piston, not shown, through inlets 23 which holds the seating member 21 on seat 22 closing off the passage from port 18 to outlet 17 and thence to passageway 12. When the pressure head of the fluid in the passageway 12 and tubing 31 exceeds the pressure on the power piston and the spring 20' the seating member 21 is forced downward off the seat 19 and gas passes from the annulus through port 50 into the valve 15 by port 18 and thence through outlet 17 into passageway 12 causing the liquid in the tubing 31 to be brought to the well head. Thereafter since the pressure head on the tubing is decreased, the valve 15 is again closed and the cycle repeated.

The apparatus of Figs. 2 and 3 of the present invention may be used in a manner similar to that of the apparatus of Fig. 1. It is assumed that the well has been previously completed with a tubing and packer and with mud or water in the annular space between the tubing and casing. The well may have gone dead because of a low bottom hole pressure. The tubing is then perforated, as shown at 50, at a predetermined liquid working level. The mud or water in the annular space, such as 60, is circulated through the tubing port 50 and is displaced by clean water. Additional perforations at various intervals in the hole may be made, each of which is a definite distance from a predetermined tubing collar. The apparatus of the present invention, such as illustrated in Figs. 2 and 3, is then run into the tubing and set opposite or adjacent the tubing perforation so that the gas lift valve, such as has been described, is arranged within a zone or chamber which encloses the tubing perforation. The well is then unloaded and placed on production by injecting into the annulus 60 a lifting gas to pressurize the casing and to allow production.

As mentioned with respect to Fig. 1, the gas lift valve 55 of Figs. 2 and 3 may be any type of gas lift valve. In the instance of Figs. 2 and 3 lifting gas pressure is exerted on the power piston, not shown, through the inlet 58; in the instance of Fig. 2, the gas lift valve 55 communicates directly with the annulus between the tubing 31 and the mandrel 49 by inlets 56 and 58; and in the instance of Fig. 3 the gas lift valve 55 communicates through the conduit 76 and the port 77. The gas lift pressure and spring 64 hold the seating member 63 against the seat 61 and closes off the passageway from inlet 56 by closing off port 65 and prevents passage of lifting gas from the gas lift valve through outlet 67 into the passageway 57. When the pressure head in the passageway 57 and the tubing 31 exceeds the pressure of the power piston and the spring 64 the seating member 63 is forced off the seat 61 and gas passes from the annulus 60 through the port 50 into the valve 55 by inlet 56 and thence through port 65 and through outlet 67 into passageway 57 causing the liquid in the tubing 31 to be lifted to the well head. Thereafter since the pressure head on the tubing is decreased the valve 55 closes and the cycle of lifting is repeated.

The present invention allows numerous advantages over the prior art. For example, my apparatus provides a retrievable mandrel employing a gas lift valve which may be run in a tubing string. Thus, with my invention a well may be placed on artificial lift employing gas lift valves without pulling the tubing, as is conventionally done. When a gas lift valve in an apparatus as described fails, the valve can be removed and a new valve reinstalled by wire line without pulling the tubing. As pointed out before, a plurality of removable gas lift valves may be installed in the tubing string in accordance with my invention. My invention also allows the apparatus of the present invention to be run in a tubing string in which gas lift valves, as conventionally employed, are installed on the outside of the tubing string; thus, if one of the conventionally employed gas lift valves arranged exteriorly to a tubing string should fail, it is possible to rectify this failure by perforating the tubing and setting an apparatus embodying my invention with a removable mandrel and valve. If the valve should fail such that gas is passing freely through the port of the failed valve, perforation of the tubing may be dispensed with.

5

While the several embodiments of my invention show packers 24 and 26 and 52 and 54 straddling the valves 15 and 55 to enclose same in a chamber in a tubing string 31, it is possible to employ other packing means, such as rubber cups, an O-ring seal or chevron packing, as is well known. Likewise, it is contemplated that other latching means besides the latching dogs 34 may be used to secure or to anchor my apparatus inside a tubing string.

The nature and objects of the present invention having been completely described and illustrated, what I wish to claim as new and useful and to secure by Letters Patent is:

1. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel, a gas lift valve carried by said mandrel in said recess and fluidly connected to said mandrel to provide fluid communication with said passageway, anchoring means mounted on said mandrel for anchoring said mandrel in said string, and packing means carried by said mandrel to form a seal between the mandrel and the tubing string and to provide a chamber in said tubing string enclosing said valve.

2. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel, a gas lift valve carried by said mandrel in said recess and fluidly connected to said mandrel to provide fluid communication with said passageway, anchoring means mounted on said mandrel for anchoring said mandrel in said string, packing means carried by said mandrel to form a seal between the mandrel and the tubing string and to provide a chamber in said tubing string enclosing said valve, and means for releasing said anchoring means.

3. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel, a gas lift valve carried by said mandrel in said recess and fluidly connected to said mandrel to provide fluid communication with said passageway, latching dogs mounted on said mandrel for anchoring said mandrel to a tubing collar in said string, a first packer mounted on said mandrel above said valve, a second packer mounted on said mandrel below said valve, and means for releasing said latching dogs.

4. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, mandrel adapted to be run on a wire line in said tubing string, by said mandrel being provided with a continuous open internal passageway and having an intermediate offset section providing a recess on the exterior surface of said mandrel, a gas lift valve carried by said mandrel in said recess and fluidly connected to said mandrel to provide fluid communication with said passageway, latching dogs

6

mounted on said mandrel for anchoring said mandrel to a tubing collar in said string, a first packing means mounted on said mandrel above said valve, a second packing means mounted on said mandrel below said valve, releasing means for releasing said latching dogs, and attaching means on said mandrel for attaching said mandrel to a wire line.

5. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel adapted to carry a gas lift valve in said recess, and anchoring means mounted on said mandrel for anchoring said mandrel in said string.

6. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel adapted to carry a gas lift valve in said recess, anchoring means mounted on said mandrel for anchoring said mandrel in said string and packing means carried by said mandrel to form a seal between the mandrel and the tubing string and to provide a chamber in said tubing string enclosing said recess.

7. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel adapted to carry a gas lift valve in said recess, anchoring means mounted on said mandrel for anchoring said mandrel in said tubing string, a first packer mounted on said mandrel above said recess, and a second packer mounted on said mandrel below said recess, said packers being adapted to enclose and seal said recess and to provide a chamber in said string.

8. In an apparatus for obtaining production from a cased well in which is arranged a tubing string open to passage of fluid from the casing annulus to the interior of the tubing string which comprises, in combination, a mandrel adapted to be run on a wire line in said tubing string, said mandrel being provided with a continuous open internal passageway and having a section providing on its exterior surface a recess intermediate the ends of said mandrel adapted to carry a gas lift valve in said recess, anchoring means mounted on said mandrel for anchoring said mandrel in said tubing string, a first packer mounted on said mandrel above said recess, a second packer mounted on said mandrel below said recess, said packers being adapted to enclose and seal said recess and to provide a chamber in said string, and means mounted on said mandrel for releasing said anchoring means.

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