Aug. 27, 1968 | J. B. FOX ET AL | 3,398,760

GAS LIFT VALVES

Filed Feb. 1, 1966 | 3 Sheets-Sheet 1

Fig. 1

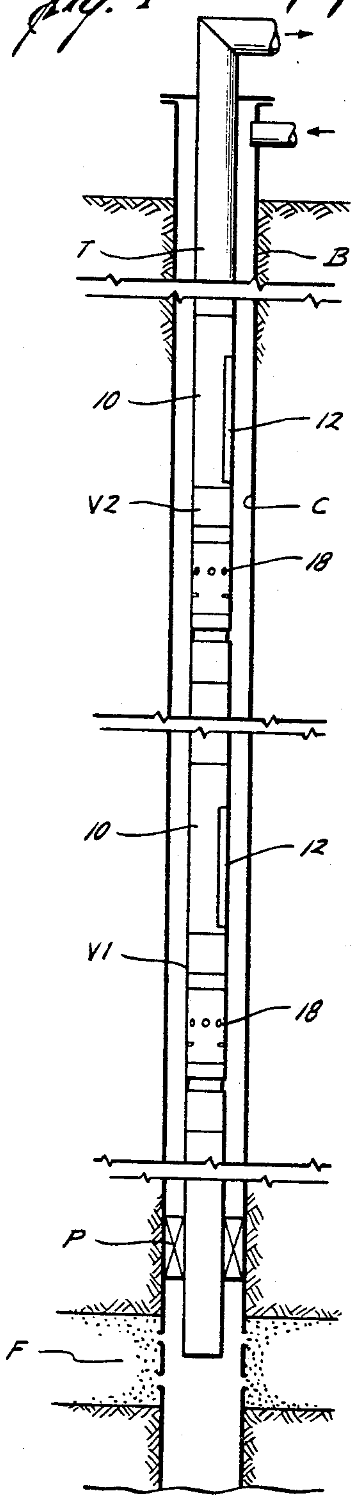


Fig. 5

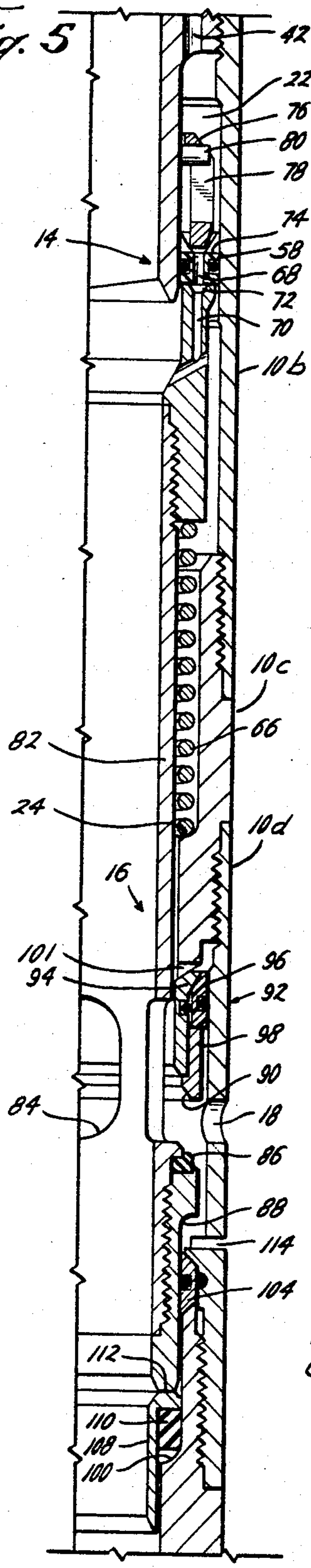
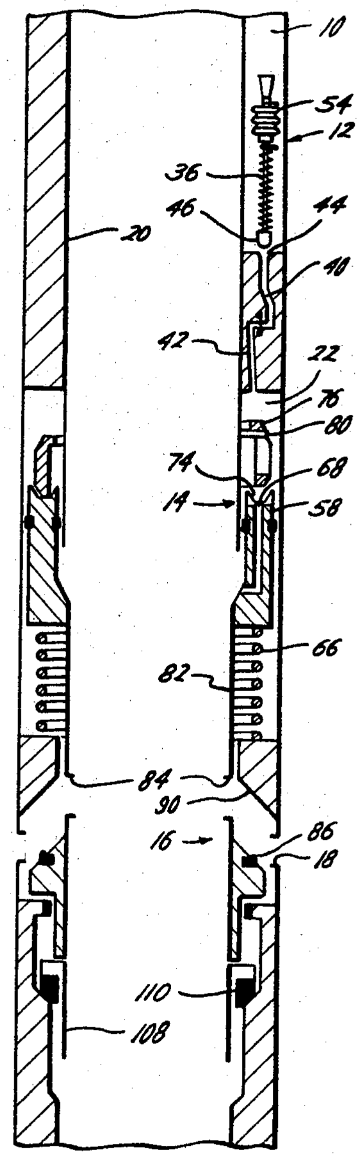


Fig. 6



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GAS LIFT VALVES

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Fig. 2A

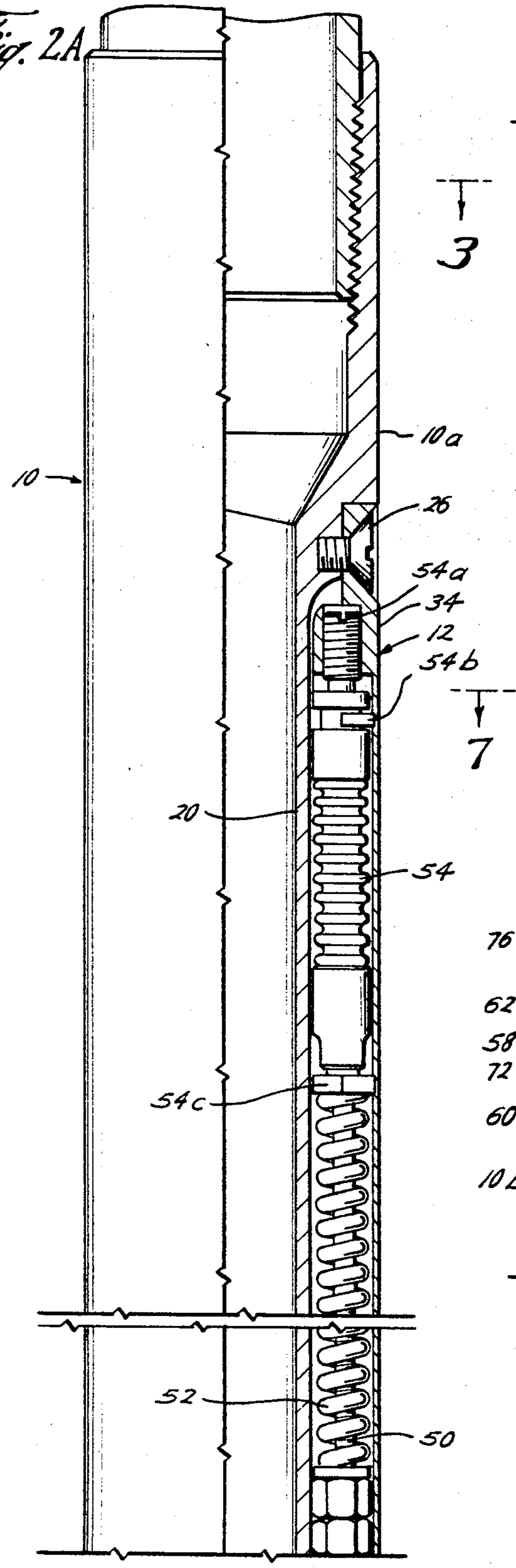

Fig. 2B

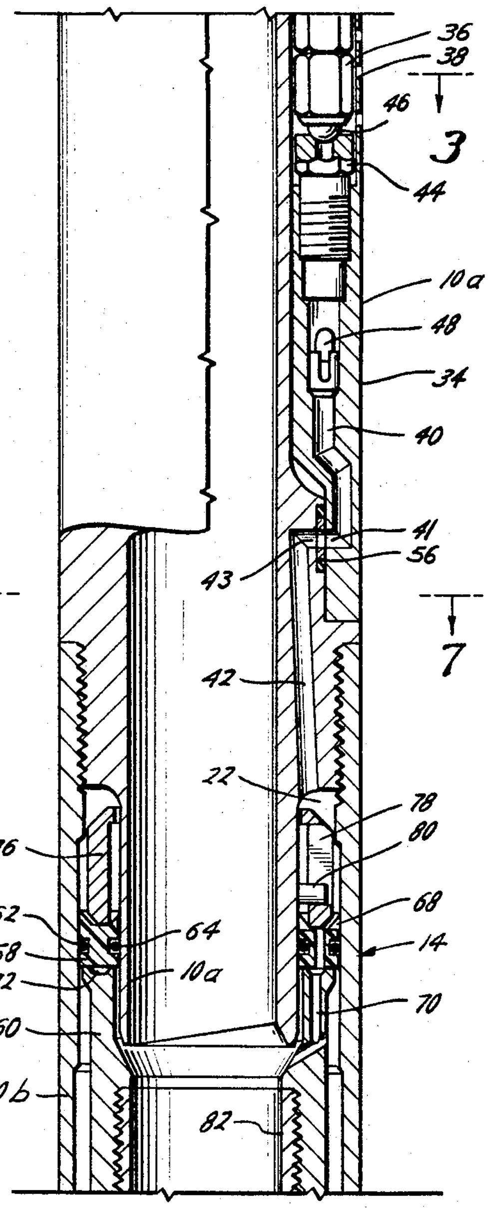

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Fig. 2C

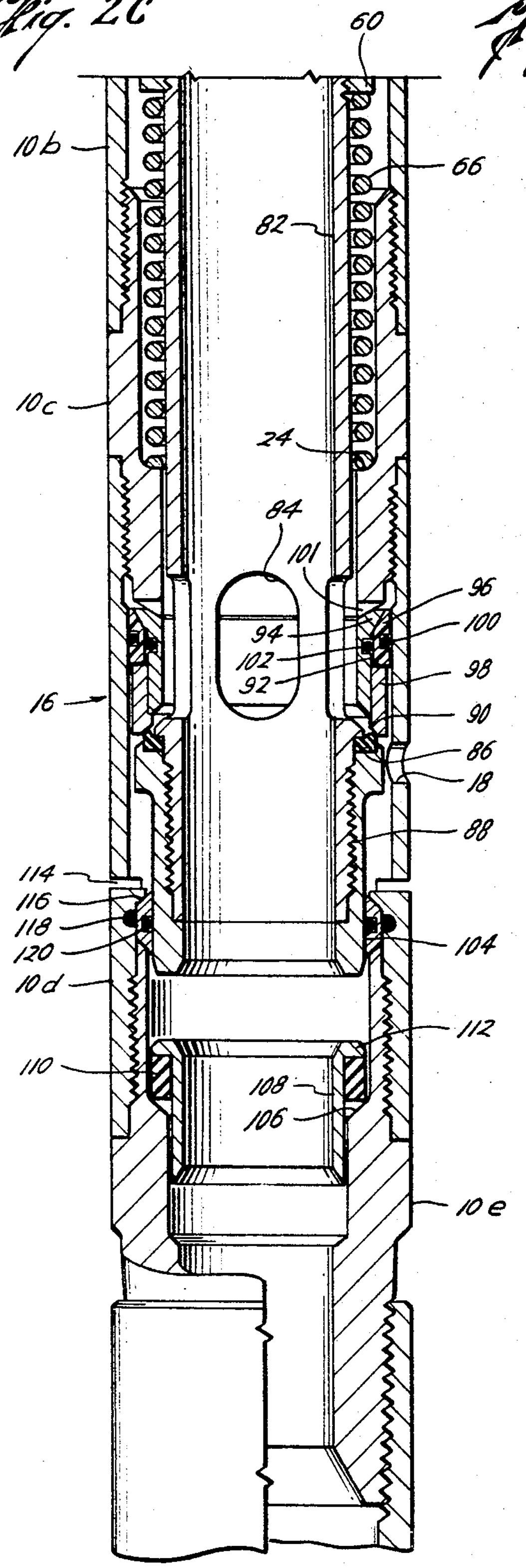
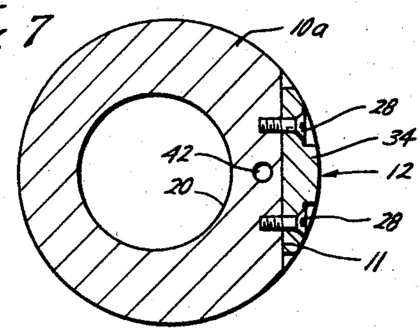


Fig. 7



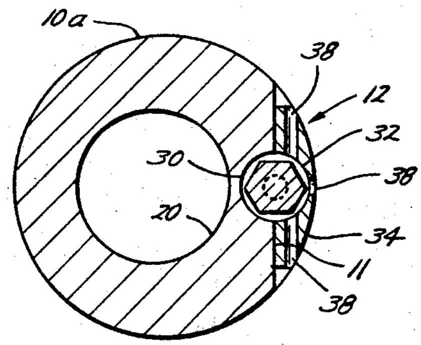
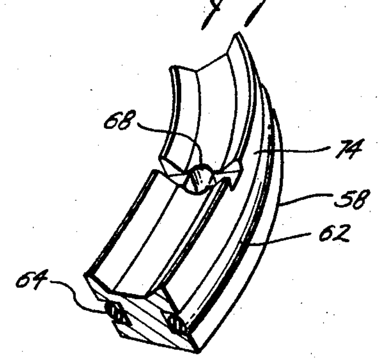


Fig. 3

Fig. 4



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GAS LIFT VALVES

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9 Claims. (Cl. 137—155)

ABSTRACT OF THE DISCLOSURE

A gas lift valve with a tubular mandrel, a sleeve slidably mounted in the mandrel and defining a port and a projection around the exterior of the sleeve below the port, a valve ring slidable between the mandrel and sleeve from a position above a port through the mandrel to a position engaging the sleeve projection to shut off flow between the ports, a pressure responsive annular ring mounted in a chamber in the mandrel and connected to move the sleeve, the pressure responsive ring having a bleed passage therethrough which is partially blocked by a ring in one position and open in another position of the pressure responsive annular ring and a pilot valve controlling fluid pressure delivered to the chamber. This abstract is neither intended to define the invention of the application which, of course, is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

The present invention relates to valves and particularly to gas lift valves of the pilot operated type.

In many gas lift installations for the production of oil, the space available in the well bore for tubing is relatively small. This is necessarily so in slim hole well bores and also in multiple completions in which the separate producing formations of the well are produced through separate tubing strings. The usual gas lift valve which is secured to the side of the tubing mandrel has the disadvantages of requiring excessive space and of possibly being knocked off its mandrel or otherwise damaged in lowering the tubing string into the well bore. In gas lift production of oil, it is desired that the gas lift valve have a large flow capacity and also be sensitive to the gas lift pressures to open and close responsive to small changes in such pressures. Many gas lift valves have been made smaller to accommodate the limited space in slim hole and multiple completion well production, but such valves have either sacrificed the sensitivity of the valve or have reduced the flow capacity. In addition to reducing valve sizes in an attempt to overcome such difficulties, concentric valves have been installed in mandrels, but these valves have been subject to many disadvantages including loss of sensitivity and also leakage across the valve seals because such valves required the seals to pass across a port in opening and closing. This action will rapidly destroy the seals. It is necessary in the design of gas lift valves, as in the design of all commercial equipment, to maintain a reasonable cost of the equipment.

Therefore, it is an important object of the present invention to provide a gas lift valve which is sufficiently small to be used readily in slim hole wells and multiple completion wells without limiting the capacity of the valve.

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Another object is to provide a gas lift valve including a full-size concentric main valve having large flow capacity and long life with a non-concentric side-mounted pilot valve of relatively small size and a high degree of sensitivity.

A further object is to provide an improved pilot-operated concentric gas lift valve having a substantially long service life.

Another object is to provide an improved side mounting of a valve on a mandrel which reduces the space requirements to a minimum.

Still a further object is to provide a concentric gas lift valve with a movable ring-shaped seat to function as a back check valve.

A further object is to provide a pilot-operated gas lift valve in a tubing mandrel with a side-mounted pilot valve in which the mandrel coacts with the pilot valve housing to guide the valve member of the pilot valve.

A still further object is to provide a pilot-operated gas lift valve with a piston as a subcombination having a two-stage bleed configuration.

Still another object is to provide a pilot-operated, concentric gas lift valve with an improved power piston assembly having a standard bleed and a high velocity trash dump bleed when the valve is fully opened.

Still a further object is to provide a pilot-operated gas lift valve with a concentric main valve having a large flow capacity when open and which is not subject to the aforementioned disadvantages of rapid seal destruction.

Other objects, features and advantages of the invention will be apparent from the drawings, the specification and the claims.

In the drawings wherein an illustrative embodiment of this invention is shown and wherein like reference numerals indicate like parts:

FIGURE 1 is a schematic illustration of a section through a well casing in a producing well to which the gas lift valve of the present invention has been applied.

FIGURES 2A through 2C are partial sectional views of the gas lift valve of the present invention; FIGURE 2A being of the upper portion of the device; FIGURE 2B being the intermediate portion of the device; and FIGURE 2C being the lower portion of the device.

FIGURE 3 is a sectional view of the device taken along line 3—3 in FIGURE 2B.

FIGURE 4 is a partial perspective view of the power piston of the present invention.

FIGURE 5 is an elevation view of the lower portion of the device of the present invention in its fully open position.

FIGURE 6 is a schematic line sectional view of the complete gas lift valve of the present invention illustrating the second-stage bleeding or blowdown of the power piston.

FIGURE 7 is a sectional view of the connection of the lower end of the pilot valve assembly to the mandrel taken along lines 7—7 in FIGURE 2B.

In the schematic sectional illustration of FIGURE 1, the well bore B is shown having the casing C extending down to the producing formation F and the tubing string T extending down through the casing C into the area of the producing formation F. The tubing string T includes two gas lift valves V–1 and V–2 of the present invention connected into the tubing string.

As is normal in gas lift production of well liquids, the lift gas is provided to the casing area surrounding the tubing string and the production of fluids is upwardly through the tubing string. The packer P seals the tubing string to the casing at a position above the producing formation F.

The details of structure are more clearly illustrated in the FIGURE 2 series of views. The gas lift valve of the present invention includes a mandrel **10**, a nonconcentric pilot valve assembly **12**, a pressure-responsive means indicated generally at **14**, responsive to pressure from the pilot valve assembly, and a main concentric valve **16** connected to the pressure-responsive means and adapted to close the ports **18** which extend through the lower portion of the mandrel **10**.

The mandrel **10** is generally tubular in shape and is provided with the central passageway or bore **20** which extends therethrough for the flow of the production fluids from the formation F. At each end of the mandrel suitable means, such as threads, are provided to secure the mandrel **10** into the tubing string T. The upper portion of the mandrel **10*a*** extends downwardly and connects to the central portion of the mandrel **10*b***. The upper section **10*a*** of the mandrel **10** extends downwardly beyond its threaded connection with section **10*b*** and is spaced inwardly from section **10*b*** to define the pressure chamber **22**. The section **10*b*** of the mandrel extends downwardly and is connected to the coupling section **10*c*** which provides an inner upwardly facing shoulder **24**, and the coupling section **10*c*** connects to the lower section **10*d*** of mandrel **10** through which the ports **18** extend. The lowermost section **10*e*** of mandrel **10** connects to section **10*d*** and has an inner shoulder to receive the bumper assembly hereinafter described.

One side of upper section **10*a*** of the mandrel **10** is formed to have a flat surface **11**, as best shown in FIGURE 3, which receives the pilot valve assembly **12**. From FIGURES 2A and FIGURE 7 it can be seen that the connection of the pilot valve assembly to the mandrel is accomplished by the engagement of the upper screw **26** and the two lower screws **28** which extend through the pilot valve housing **34** in mandrel section **10*a***. The surface **11** of the mandrel section **10*a*** is provided with the semicircular recess **30** which cooperates with the semicircular recess **32** in the housing **34** of the pilot valve assembly **12** to provide a guide for the movement of the pilot valve **36**. The housing **34** is provided with apertures **38** extending therethrough as best shown in FIGURES 2B and 3. The lower portion of the housing **34** defines the passage **40** which communicates with the passage **42** in the upper section **10*a*** of the mandrel **10**. The upper end of the passage **40** is surrounded by the valve seat **44** on which the valve member **46** seats. Check valve **48** is provided in the passage **40** allowing flow downwardly therethrough, but preventing flow of fluids upwardly through the passage **40**. Inasmuch as the pilot valve need pass only a small volume of gas, it may be small in size and fit within the mandrel recess and not extend beyond the nominal diameter of the mandrel as shown in FIGURES 3 and 7.

The pilot valve **36** includes the valve member **46**, the stem **50** surrounded by the valve spring **52** and spring stop **54*c*** which is retained by a slot in structural member **34**. The bellows **54** is screwed onto stem **50**. The upper portion of bellows **54** is retained in the structural member **34** by the bellows stop **54*b*** which is positioned in a slot in structural member **34** and the set screw **54*a*** which is tightened against the top of bellows **54**.

As is usual in pilot valves, the bellows section **54** provides a pressure-responsive member for control of the pilot valve. The pilot valve housing **34** is provided with the apertures **38** through which casing pressure passes to expose the exterior of the bellows **54** to such pressure. When the pressure is sufficiently high to overcome the force of the valve spring **52**, the pilot valve **36** opens to admit gas under pressure from the casing-tubing annulus into the passageway **40**. This gas flows through the passage **40**, the passage **42** and into the pressure chamber **22**. It should be noted that the communication between the passage **40** and the passage **42** is through the radially inwardly extending passage **41** in pilot valve housing **34** and the radially outwardly extending passage **43** in mandrel **10**, and sealing means **56** seals between housing **34** and mandrel section **10*a*** around such communication. The pilot valve assembly **12** is readily installed on the mandrel **10**, and, when casing pressure is sufficiently high, the pilot valve admits gas under casing pressure to the pressure chamber **22**. The pilot valve housing **34** only needs to be sufficiently strong to properly position the pilot valve **36** independently of the mandrel **10**. When installed, the recess **30** in the mandrel and the recess **32** in the housing **34** guides the movement of the pilot valve **36**. This method of connecting the pilot valve to the mandrel requires much less space than the conventional threaded boss.

The pressure-responsive means **14**, as shown, is positioned in the pressure chamber **22**. The pressure-responsive means **14** includes the ring shaped power piston **58**, the tubular piston rod **60**, which connects to the main valve **16**, and suitable seals **62** and **64** providing a seal for the piston **58** against the outer and inner surfaces, respectively, of the pressure chamber **22**. The spring **66** is positioned below the piston rod **60** in engagement therewith and is supported by the shoulder **24** of the mandrel coupling section **10*c***. The spring **66** urges the piston rod **60** and the piston **58** upwardly within the pressure chamber **22** and, therefore, urges main valve **16** toward closed position.

In order to provide selectively for casing or tubing pressure on the upper surface of piston **58**, a bleed passage **68** is provided extending through the piston **58**. The bleed passage **68** provides communication between the pressure chamber **22** above piston **58** to the interior of the mandrel **10** via the passage **70** which extends downwardly through piston rod **60**. The upper end of piston rod **60** is provided with the groove **72** in communication with both passages **68** and **70**. The shallow radial groove **74** extends across the upper surface of piston **58** and intersects with passage **68**. The bottom of groove **74** is only slightly below the bottom of the trough on the upper surface of piston **58** to define a restricted or first-stage bleed passage within the ring **76** when the ring **76** is in its normal position on the bottom surface of the trough of piston **58**. When the ring **76** is lifted off the upper surface of piston **58**, the second-stage bleed passage is defined solely by the passage **68** through piston **58**. The ring **76** has a slot **78** engaging the pin **80** extending outwardly from mandrel section **10*a***. Responsive to extreme downward movement of piston **58**, as hereinafter explained, the pin **80** engages the upper end of slot **78** and lifts one side of ring **76** above the upper surface of piston **58** to allow full flow through passage **68** to clear trash from groove **74**. This cleaning of the restricted passage in groove **74** by the second-stage bleeding is necessary as trash, such as small sand particles, may be caught in the restricted passage through groove **74** below ring **76** after first-stage bleed and ultimately interfere with the valve operation.

The main concentric valving means **16** includes the valve sleeve **82** which is connected at its upper end to the lower end of the piston rod **60** whereby the valve sleeve **82** moves responsive to movement of the pressure-responsive means **14**. The valve sleeve **82** is provided with a plurality of ports **84** which, in closed position, are located slightly above the ports **18** through the lower mandrel section **10*d***. When the concentric valving means **16** is open, the ports **18** communicate with the ports **84**. To close the concentric valving means the resilient valve seat insert **86**, supported on the valve sleeve **82** by the collar **88**, engages the valve seat **90** on the valve seat ring assembly **92** within the annular space surrounding the valve sleeve **82**.

The valve seat ring assembly **92** includes the inner ring member **94**, the outer ring member **96** and the lower ring member **98**. In the valve seating assembly **92**, the ring **96**, which is plastic, such as polytetrafluoroethylene, is slipped onto the ring **94** and is held in this position by pressing ring **98** onto the ring **94**. With the press fit between rings **94** and **98**, the assembly will act as a unit during operation. The outer ring member **96** is provided with the seal **100** to provide a seal against the interior surface of the lower mandrel section **10*d***. The inner ring **94** is provided with a seal **102** to provide a seal between its exterior surface and the interior surface of the outer ring **96**. The upper end of the valve seat ring assembly **92** abuts against the lower end of the mandrel coupling **10*c*** in its uppermost position. The lower end of the coupling **10*c*** is slotted at **101** to allow the pressure from within the central bore **20** to be exerted against the upper surface of the members of the valve seat ring assembly **92**. In this manner, the valve seat ring assembly **92** acts as a back check valve closing communication between the ports **18** and ports **84** when the tubing pressure exceeds the casing pressure by sliding downwardly to cause engagement between the seat insert **86** and the valve seat **90**. A seal **104** is provided surrounding the lower end of the collar **88** and allowing collar **88** to slide back and forth during operation.

As mentioned, the bumper assembly is installed within the lower mandrel section **10*e*** on the shoulder **106**. The bumper ring **108** and resilient bumper **110** coact with seat **106** to form the bumper assembly. The bumper ring **108** is positioned within the bore of the mandrel section **10*e***. The resilient bumper **110** is confined between the flange **112** and the upwardly facing shoulder **106**. Thus, when the valve sleeve **82** moves downwardly in response to movement of the pressure-responsive means **14**, it engages the top of the bumper ring **108** and the resilient bumper **110** is compressed between the flange **112** and the shoulder **106** providing a rebound impetus to the sleeve valve member **82**.

The lower end of the mandrel section **10*d*** is provided with the trash cleaning slots **114** through which any trash collecting in the lower portion of the mandrel above the seal **104** may be discharged. The seal **104** includes the scraper element **116**, which is a plastic, such as polytetrafluoroethylene, and sealing means, such as the O-rings **118** and **120**. Thus, it can be seen as the collar **88** moves downwardly, the upper edge of the scraper element **116** disengages any dirt or trash from the exterior of collar **88** with excess of such dirt or trash being discharged by the flow from the slots **114** through the ports **84**.

The main concentric valving means **16**, as illustrated in 2C, is closed; resilient seat insert **86** being in engagement with the valve seat **90**. FIGURE 5 illustrates the concentric valving means **16** in the open position with the arrows indicating the flow of casing lift gas through the ports **18** and the ports **84** into the bore **20** of the mandrel **10**. FIGURE 6 illustrates the extreme position in the downward travel of the piston **58** and the valve sleeve **82** before rebound from the bumper ring **108** whereby the ring **76** has been lifted by pin **80** from engagement with the part of the upper surface of the piston **58** surrounding passage **68** to place the second-stage or large-flow capacity bleeding through the piston **58** in operation.

The operation of the gas lift valve may be seen from the schematic illustrations of FIGURES 1 and 6. With the valve members of the present invention positioned on the tubing string T, as illustrated in FIGURE 1, the gas lift production of the well fluids from the producing formation F may be commenced by pressuring of the casing C with lift gas. As soon as casing pressure reaches the opening pressure of the pilot valve **36**, the valve member **46** lifts off the valve seat **44**, and gas under casing pressure is conducted through the apertures **38**, the valve seat **44** past the check valve **48** through the passages **40** and **42** into the pressure chamber **22**. Once pilot valve **36** is cracked open, the pressure on the under side of valve member **46** increases to cause it to move to full open position. With the ring **76** positioned as shown in FIGURE 2B, the increase in gas pressure within the pressure chamber **22** will be exerted against the top of the piston **58**. Only a small portion of such gas will be bled through the groove **74** below the ring **76** into the passage **68**. The passage **68**, the ring **76** and groove **74** are designed to provide a greater restriction to the flow than the restriction through the pilot valve **36**. Thus, casing pressure will be maintained in pressure chamber **22** as long as pilot valve **36** is open. The downward movement of the piston **58** will, by connection of the piston **60** to the valve sleeve **82**, compress the spring **66** and move the valve sleeve **82** downwardly to disengage the resilient seal **86** from the valve seat **90** to provide communication between the ports **18** and **84**, which action is the opening of the main concentric valving means **16**. Once the resilient seal **86** has moved from the valve seat **90**, the casing pressure will be exerted downwardly on a small annular area defined by seal **120** and the exterior of sleeve **82** to assist in the quick opening of the main valve **16**.

The continued downward movement of the piston **58** causes the valve sleeve **82** and its collar **88** to engage the upper surface of the bumper ring **108**. In this position, as illustrated in FIGURE 5, the bleed through the piston **58** is still a first-stage or limited bleed of gas through the power piston **58**. Further, downward movement resulting from the snap opening of main valve **16** compresses the resilient bumper **110** and will move the piston **58** away from the ring **76** in the vicinity of passage **68**, the pin **80** engaging the upper end of the slot **78** on the ring **76**. The movement of the piston **58** below the ring **76** provides the second-stage bleeding of greatly increased capacity through the full open passage **68** to allow any trash in groove **74** to be forced through passage **68** and to be conducted to the bore **20** of mandrel **10** as the components begin their rebound resulting from the contact with the bumper ring **108**. The second-stage or large-capacity flow through the passage **68** of the piston **58**, while only momentary, will provide a sufficient flow to blow down any trash, sand or other particles collecting in groove **74** which might interfere with the operation of the pressure-responsive means **14**.

The ring **76** will again be seated on the upper surface of the piston **58** to re-establish first-stage bleeding therethrough and will, so long as the pilot valve **36** remains open, maintain sufficient pressure within the pressure chamber **22** to maintain the concentric valving means **16** in its open position.

Considerable impact would normally result from the rebound engagement between the ring **76** and the upper surface of the piston **58**. It should be noted from FIGURE 6, however, that the pin **80** is only a single pin and that when second-stage bleeding occurs, the ring **76** maintains its engagement with the upper surface of the piston **58** on the side of such piston away from the pin **80**. This results in the slight cocking or tilting of the ring **76** which is illustrated in FIGURE 6. As the piston **58** rebounds, the ring **76** engages the surface of the piston **58** immediately surrounding the passage **68** and the radial groove **74** as it engages the remainder of the upper surface of the piston **58**. This tilting action of the ring **76** therefore lessens the impact on rebound between the ring **76** and the piston **58** to prevent damage to the critical area of the piston **58**, the radial groove **74**, adjacent the passage **68**.

When the casing pressure is reduced, the pilot valve **36** closes, and the first-stage bleeding through the piston **58** reduces the pressure within the pressure chamber **22** to the extent that spring **66** moves the assembly upwardly thereby closing the concentric valving means **16**. Additionally, an area differential in the main valve **16** will add force tending to close the valve **16** whereby it will close rapidly with a snap action.

As is well-known in the art and taught by the Robinson Patent No. 2,642,812, issued June 23, 1953, the pilot valve may be made responsive to tubing pressure.

With the gas lift valve as described, the sensitivity of the unit to the lift gas pressure is maintained by having a relatively small effective area in the valve seat of the pilot valve as compared to the cross-sectional area of the bellows which is relatively large. With this construction, the gas lift valve has relatively large-flow capacities without sacrificing sensitivity. Further, the valve is economical to manufacture.

The flow capacity of the concentric valving means **16** through the ports **18** and the ports **84** may be made to be as great as or greater than the flow capacity through the bore **20** of the mandrel. This large-capacity concentric valving means is controlled by the movement of the pressure-responsive means **14** in response to the opening and closing of a side-mounted pilot valve. The concentric main valve means achieves the large-capacity flow with a valve and seat structure which assures sealing of the valving means and avoids the usual high rate of destruction of the seals on prior concentric valves. The main valve structure also includes a valve seat acting as a check valve to close the main valve even though the main valve member has been actuated. The side-mounted pilot alve is readily installed as an assembly and the structural member of the assembly cooperates with the recess in the mandrel into which a portion of the valve is received to provide a guide for the movement of the pilot valve to assure that it will always return to seating engagement with the pilot valve seat. The particular structure of the piston **58** of the pressure-responsive means **14** is such as to cooperate with the ring **76** to provide the desired first-stage bleed capacity during normal operation of the device and to provide a larger capacity second-stage bleeding at the extreme downward movement of the piston to clear the restricted or first-stage bleeding passage of all trash. Further, this large-capacity concentric valve and nonconcentric pilot valve are contained within a tubing mandrel, and the pilot valve is side-mounted thereon so as to be wholly within the general circular contour of the mandrel thereby allowing the gas lift valve of the present invention to be readily lowered into a slim hole producing well on a tubing string. The sensitivity of the gas lift valve is maintained in the device by the use of the pilot valve which controls the large-capacity operation of the main concentric valve.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A gas lift valve, comprising

a mandrel having a central bore therethrough and at least one port communicating between the central bore and the exterior of said mandrel,

an annular valve sleeve positioned for longitudinal movement within said mandrel and defining at least one port communicating through said valve sleeve and having a projection surrounding the exterior of said sleeve spaced longitudinally from said port through said sleeve,

said mandrel also defining an annular pressure chamber and a flow passageway communicating into said chamber,

an annular pressure responsive ring positioned for reciprocation in said chamber responsive to pressures in said chamber and connected to said annular sleeve member whereby movement of said pressure responsive ring moves said sleeve, and

said mandrel defining a bleed passage communicating with said chamber on the opposite side of said pressure responsive ring from said flow passageway, said pressure responsive ring having a passageway longitudinally therethrough,

an annular ring adapted to be positioned on one face of said pressure responsive ring,

means retaining said annular ring from movement with said pressure responsive ring,

said annular ring restricting the flow through the passageway in said pressure responsive ring in one position of said pressure responsive ring and being positioned away from said passageway in said pressure responsive ring in another position of said pressure responsive ring to allow full flow therethrough whereby trash and sand collecting in said chamber are discharged through said bleed passage, and

an annular valve ring movably positioned within said mandrel in surrounding relation to said valve sleeve and adapted to engage said projection on said valve sleeve to close communication between the port through said mandrel and the port through said sleeve.

2. A gas lift valve according to claim **1**, wherein

said pressure responsive ring has opposing pressure surfaces,

one of said pressure surfaces defines an annular recess,

said passageway defined by said pressure responsive ring communicating between said opposing pressure surfaces, and

a radial groove defined in said one of said surfaces and intersecting with said passageway,

said groove being slightly deeper than said recess whereby restricted flow is provided through said groove to said passageway when said annular ring is seated in said annular recess.

3. A gas lift valve according to claim **1**, including

a pilot valve mounted on said mandrel,

said pilot valve controlling flow through said flow passageway into said chamber.

4. A gas lift valve according to claim **3**, wherein

a portion of the exterior of said mandrel includes a surface on which said pilot valve is mounted and a longitudinal recess in said exterior surface of said mandrel,

said pilot valve includes a housing and a valve member,

said housing being secured to said surface with said recess coacting with said housing to guide movement of the valve member of said pilot valve.

5. A gas lift valve according to claim **3**, wherein

said pilot valve includes a housing secured to said mandrel,

a passage extending radially inward in said housing and communicating from said pilot valve,

a passage extending radially outward in said mandrel and communicating to said annular pressure chamber,

said passages being connected in radial alignment when said housing is secured to said mandrel to provide communication from said pilot valve to said pressure chamber, and

means sealing between said housing and said mandrel around the connection of said passageways.

6. A gas lift valve according to claim **1**, including

an internal shoulder defined by said mandrel,

a resilient annular bumper positioned within the bore of said mandrel and supported on said shoulder,

said bumper being spaced below the lower end of said valve sleeve in its upper position and adapted to be engaged by said valve sleeve when it moves to full open position to provide a rebound impetus to the valve sleeve.

7. A gas lift valve according to claim **1**, wherein

said mandrel defines a transverse slot extending into the space between the mandrel and said sleeve at a position in the lower end of said space whereby trash collecting therein may be discharged through said slot to the exterior of said mandrel.

8. A gas lift valve according to claim 1, including a resilient insert positioned in said projection on the exterior of said sleeve and adapted to be engaged by said annular valve ring to provide a seal closing communication from the exterior of said mandrel to the interior of said sleeve valve.

9. A gas lift valve according to claim 8, wherein said projection is positioned on said sleeve below the port extending through said sleeve so that said insert is positioned out of the flow path of fluids flowing through said ports.

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