

Aug. 21, 1962

J. S. PAGE

3,050,132

FLUID PRESSURE OPERATED SHUT-OFF VALVE FOR WELLS

Filed July 1, 1957

2 Sheets-Sheet 1

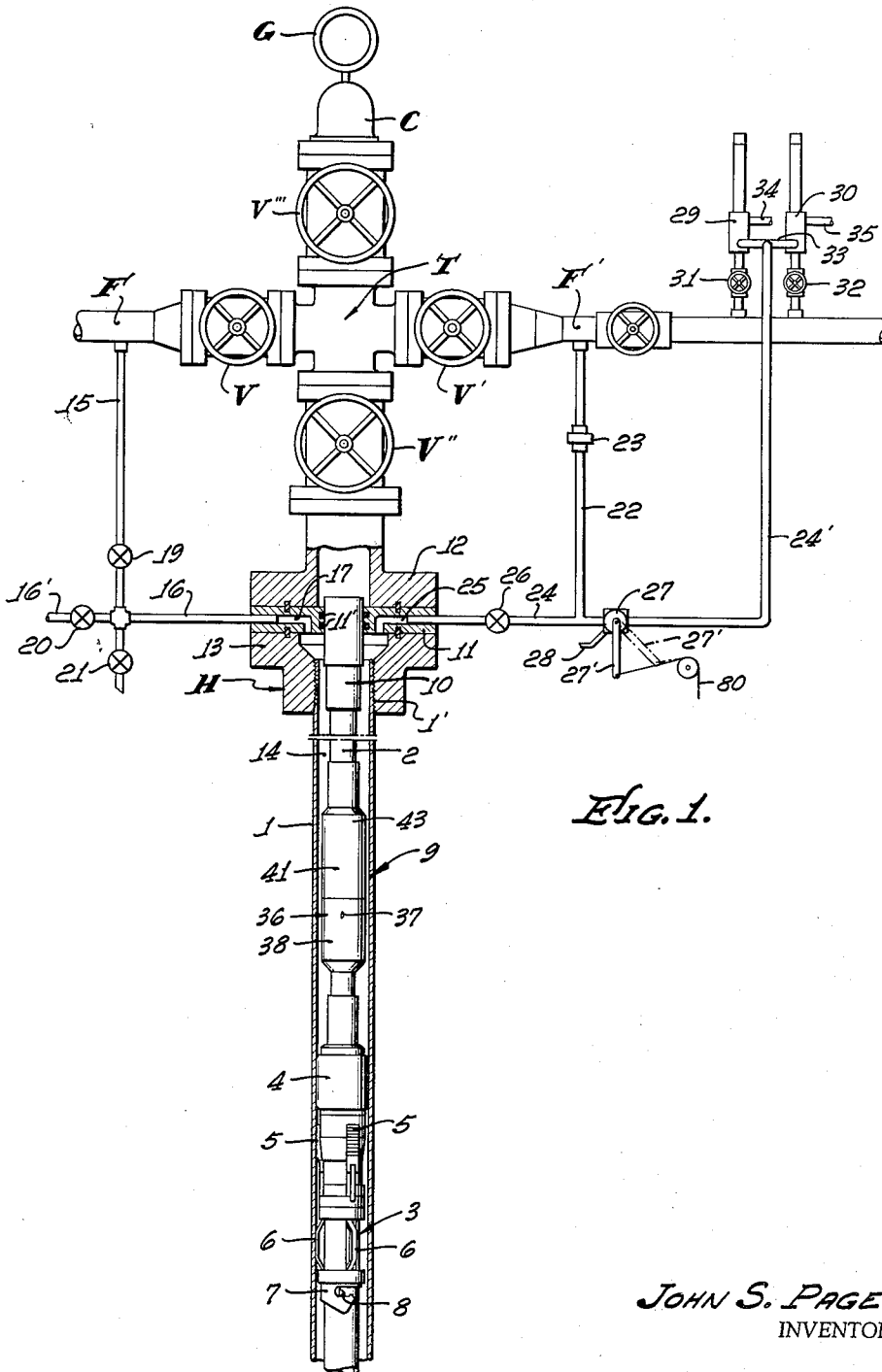


Fig. 1.

JOHN S. PAGE
INVENTOR.

BY
Paul A. Weiler
ATTORNEY.

Aug. 21, 1962

J. S. PAGE

3,050,132

FLUID PRESSURE OPERATED SHUT-OFF VALVE FOR WELLS

Filed July 1, 1957

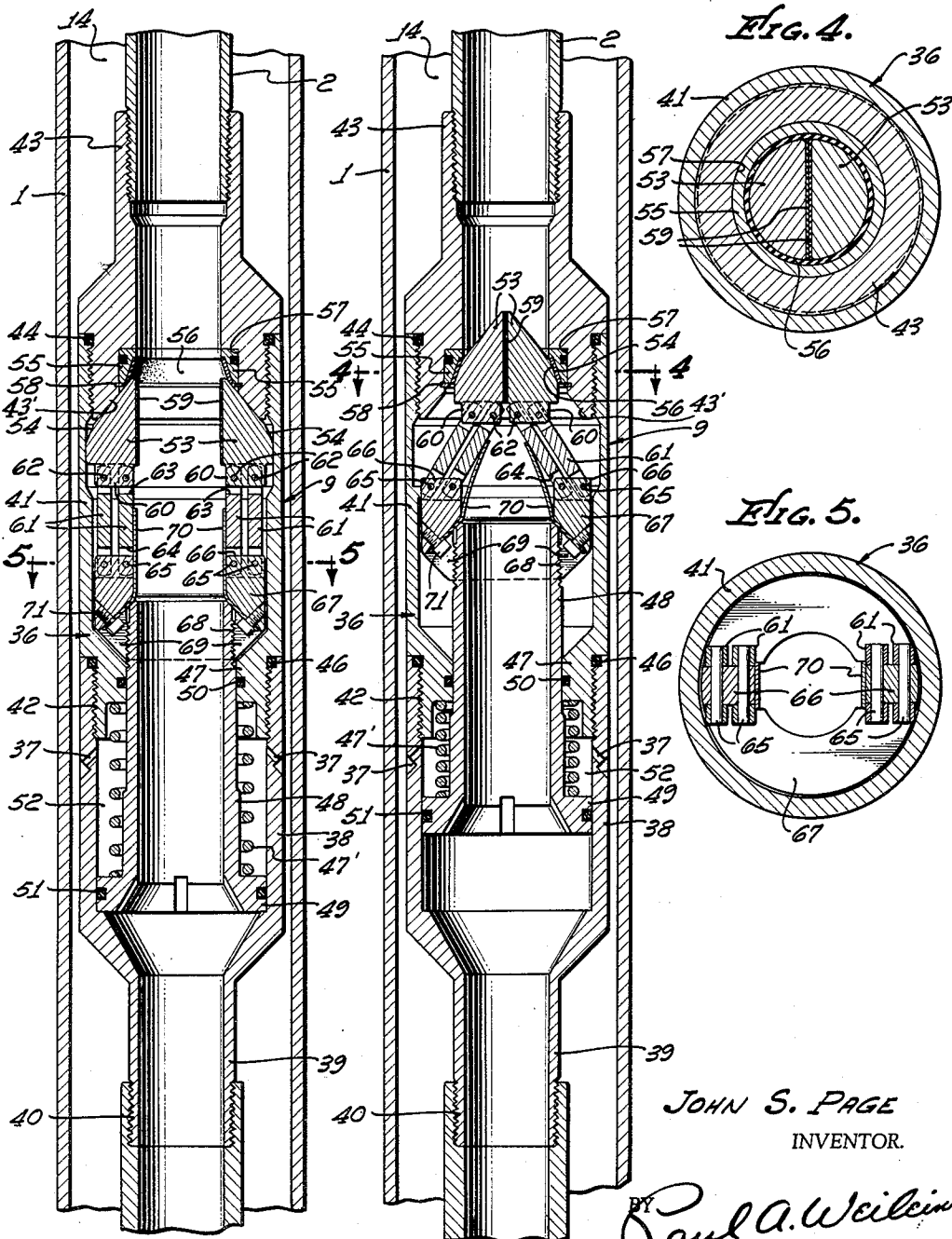
2 Sheets-Sheet 2

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.



JOHN S. PAGE
INVENTOR.

Paul A. Weikert
ATTORNEY.

1

3,050,132

FLUID PRESSURE OPERATED SHUT-OFF VALVE FOR WELLS

John S. Page, Long Beach, Calif., assignor to Page Oil
Tools, Inc., Long Beach, Calif., a corporation of California

Filed July 1, 1957, Ser. No. 669,011
20 Claims. (Cl. 166-224)

The present invention relates to well flow controlling apparatus, and more particularly to novel and improved means for controlling the flow of production fluid from a well responsive to variations in production fluid pressure.

In the oil and gas well field, it is often desirable to shut off the flow of production fluid under certain conditions, for instance to enable the performance of various down hole well operations. In addition, it is sometimes necessary to shut off the flow in the event of certain conditions such as over pressure, under pressure, disruption of the well head equipment or the like.

Conventionally, however, valves for controlling the flow of such wells have been located at the well head, where damage to the well head equipment may cause damage to the flow controlling valve, or to the conventional blow-out preventer at the well head, or they have required certain tubing manipulations or other mandrel control.

In copending application Serial No. 669,043, filed July 1, 1957, there are disclosed an improved method of and apparatus for controlling the flow of production fluid from a well, wherein fluid pressure is imposed upon fluid in the annulus between the casing and the production tubing to operate a valve assembly located in a tubing string down in the well, and wherein a reduction in such pressure for any reason will serve to permit the valve to be closed automatically responsive to the flow of production fluid.

The present invention more particularly concerns a novel valve for use in the method and apparatus of the aforementioned copending application.

An object of the present invention is to provide a valve assembly adapted to be disposed in a string of production tubing at a point spaced downwardly from the well head, said valve assembly including fluid pressure operated valve means adapted to be held open responsive to production fluid pressure, and adapted to be closed at will or as the result of an excessive rise or decline in production pressure, or as the result of the casing head being displaced or damaged for any reason to such an extent as to allow leakage.

Oftentimes flowing wells are left untended for substantial periods of time, especially in the case of offshore wells, and as a consequence should an emergency arise at the well, such as a break in the casing or casing head, rupture of a flow line or the like, shutting off of the well flow is highly desirable, since otherwise the production will be lost and a fire hazard is produced. Countless barrels of oil may be lost, as the fluid runs off on the ground or flows into the water in the case of an offshore well. In the case of the latter type of well the well may be inaccessible because of a storm, and indeed, the entire platform, if a platform be employed, may be destroyed or severely damaged and the tubing and casing ruptured under water

2

thus substantially hampering shutting off or controlling the flow.

A further problem is involved where excessive pressures are produced above the capacity of the well head equipment, whereupon the well head equipment may be blown off or damaged and the well will blow out. In the alternative, flow pressure may be abnormally reduced to a dangerously low point where flow should be temporarily halted. Otherwise the well may cease production, following which swabbing of the well may be required in order to cause resumption of production. The valve hereof, in accordance with the preceding objective, obviates these problems.

A further object is to provide well flow controlling apparatus, including means for packing off the annulus between a string of production tubing and well casing below the valve assembly hereof, and means for imposing production fluid pressure on fluid filling the annulus above the packer, the valve being so constructed as to be held open responsive to pressure in the annulus and being adapted to be closed upon reduction of the annulus fluid pressure, responsive to production fluid pressure.

Another object is to provide a valve assembly and valve for installation in a string of production tubing, said valve being so constructed that the valve offers no obstruction to the flow of fluid through the tubing or to the passage therethrough of any type of tool which may be run into the well on a wire line, such as perforating guns, fracturing tools, cementing tools, testers or the like.

In accordance with the preceding objective, it is a further object to provide a valve assembly including an elongated hollow housing, means defining an actuator cylinder including a sleeve in said housing, said housing having a port for admitting fluid into the actuator cylinder to shift the sleeve axially relative to the housing, a valve seat in said housing, and a valve shiftably disposed in the housing and movable towards said seat by said sleeve.

In accordance with the preceding objects, it is a further object to provide a valve assembly including an elongated hollow housing, means defining an actuator cylinder including a sleeve in said housing, said housing having a port for admitting fluid into the actuator cylinder for shifting the sleeve axially relative to the housing, a valve seat in the housing, and a plug valve shiftably disposed in the housing and movable towards said seat by said sleeve, said plug valve including a plurality of individual segments movable towards and away from one another so as to form a plug when engaged with said seat and so as to be spaced from one another upon disengagement from said seat, whereby when the segments are fully separated the clearance therethrough is at least equal to the clearance through the seat.

Another object is to provide a plug valve assembly as aforesaid, wherein the opposed faces of the plug segments are provided with a resilient layer of material such as rubber, neoprene or the like, so that an effective seal is provided, and no fluid can leak between the segments of the plug.

Other objects and advantages of the invention will be hereinafter described, or will become apparent to those skilled in the art, and the novel features of the invention will be defined in the appended claims.

In the accompanying drawing:

3

FIG. 1 is a view showing a well embodying the novel fluid controlling apparatus hereof;

FIG. 2 is an enlarged detail view in section taken longitudinally through a valve assembly made in accordance with the invention, the valve being shown in a full open position;

FIG. 3 is a view similar to FIG. 2, but showing the valve closed;

FIG. 4 is a view in transverse section, as taken on the line 4—4 of FIG. 3; and

FIG. 5 is a view in transverse section, as taken on line 5—5 of FIG. 2.

Like reference characters in the several views of the drawings and in the following detailed description designate corresponding parts.

Referring particularly to FIG. 1, well apparatus is shown, including a casing 1 disposed in a well, with a tubing string 2 concentrically disposed in the casing. The tubing is suspended in the casing at a point spaced substantially downwardly from the top of the casing by suitable means such as a tubing anchor (not shown). Above the anchor is a suitable packer. A hook wall packer assembly 3 may be advantageously used thus eliminating the need for a separate anchor in some cases. The hook-wall packer 3 need not be described in detail in that it is a known type of packer. Generally, however, the packer assembly 3 includes a packer element 4 adapted to seal off the annulus between the casing and the tubing. Means such as a plurality of casing wall engaging slips 5 are employed for securing the packer in place. Operatively connected to the slips 5 is a plurality of friction pads 6 engageable with the casing to set the slips 5 and prevent relative movement of the packer assembly 3 and the tubing 2 in one direction. Depending from the packer assembly is a suitable number of hooks 7 adapted for engagement with a similar number of lugs 8 carried by the tubing 2, whereby relative movement of the packer assembly 3 and the tubing 2 in the other direction, is precluded.

Interposed in the tubing string 2 between the hookwall packer assembly 3 and the upper end of the tubing is a novel fluid pressure operated valve assembly generally designated 9 which will be more specifically described as the description progresses.

As previously noted, the valve assembly is adapted to be subjected to fluid pressure. Such pressure is preferably derived from the production fluid through well head equipment. This well head equipment includes a safety landing sub 10 carried by the upper end of the tubing string 2. Removably mounted on the upper end of the landing sub 10 as by a slip fit is an annular landing flange 11 which is interposed between upper and lower sections 12 and 13, respectively, of casing head means generally designated H. At its inner periphery, the landing flange is provided with suitable seals or packing rings 11', so that the landing flange constitutes an upper barrier between the casing 1 and the tubing 2 for preventing the direct flow of fluid from the tubing into the casing. In addition, the casing head section 13 is sealingly engaged at the upper extremity of the casing 1 as by a threaded connection 1'.

Disposed above the casing head H is a conventional Christmas tree T having flow lines F, F' each having a flow valve V and V', respectively. The Christmas tree T also comprises a valve V'' between the casing head H and the flow lines F, F' and a valve V''' disposed above the flow lines F, F'. At the top of the Christmas tree is a cap C which may advantageously be fitted with a gauge G or the like.

In accordance with the invention hereof, the fluid pressure operated valve assembly 9 is adapted to be maintained open, that is, in a condition enabling the well to flow to produce through the tubing 2, responsive to fluid pressure in the annulus 14 between the casing 1 and the tubing 2. Such fluid pressure may be derived from a number of sources.

4

For example, in FIG. 1, fluid communication is established between the flow lines F, F' and the annulus 14. In this connection, a line 15 is tapped into the flow line F. This line 15 is joined with a line 16 which is connected with the landing flange 11, the landing flange having a passage 17 leading to the annulus 14. In addition the line 16 is extended as at 16' for connection to a pump or other source of pressure fluid (not shown), and a vent line 18 is also connected to the line 16. Each of the lines 15, 16' and 18 is provided with a control valve, respectively designated 19, 20 and 21.

At the other side of the Christmas tree T and communicating with the flow line F' is a pressure line 22 preferably having an orifice union 23 therein for limiting the rate of flow of fluid from the flow line F'. The line 22 is connected with a line 24 which establishes fluid communication with the annulus H through a passage 25 in the landing flange 11.

The line 24 has a manual valve 26 and a multiway valve 27 therein. The multiway valve 27 is adapted to selectively establish communication between the line 24 and a vent 28 and between the line 24 and an extension 24' of the latter, the flow from line 24 to extension 24' being interrupted by the valve 27 upon venting of the line 24. Valve 27 may be of any desired construction but is preferably operable by a lever 27' for a purpose which will be hereinafter more fully described.

Also connected to flow line F' is a pair of pilot valves 29 and 30, a manual valve preferably being interposed between each pilot valve 29 and 30 as at 31 and 32, respectively, and the line F'. A cross line 33 establishes communication between line 24' and the pilot valves 29 and 30, and each of said pilot valves is provided with a vent 34 and 35, respectively. The details of the pilot valves are not germane and they may be of any desired construction, whereby one of the pilot valves, say pilot valve 29, is responsive to a drop in pressure in the line F' below a predetermined value to vent line 24' to the atmosphere through vent 34, whereas the other pilot valve 30 is responsive to pressure in line F' above a predetermined value to vent line 24' through vent 35.

As has been previously stated, the valve assembly 9 is adapted to be maintained open responsive to fluid pressure in the annulus 14. Accordingly, the valve assembly 9 has a cylindrical housing 36 having a suitable number of ports 37 leading from the annulus 14 into the housing 36.

Referring particularly to FIGS. 2 and 3, it will be seen that the housing 36 preferably includes a lower section 38 constituting a pressure cylinder and having a reduced coupling portion 39 provided with a threaded pin end 40 adapted to be connected with the depending tubing string. An upper housing section 41 is threaded to the lower section 38 as at 42, and at its upper end the housing section 41 is threaded to an internally threaded box coupling 43 adapted to be connected to the tubing string above the valve 9. Suitable sealing means are employed for preventing the passage of fluid between the coupling 43 and the end of the housing section 41, such as O-ring or other sealing elements 44. Another sealing element 46 or O-ring 46 is interposed between the threaded ends of the housing sections at the connection 42 thereof.

At its lower end the upper housing section 41 is provided with a radially inwardly projecting flange 47 providing a centering and bearing support for an axially movable actuator sleeve 48. At its base, the sleeve 48 has a radially outwardly projecting flange 49 constituting a piston head or pressure head slidably engaged with the inner periphery of the lower housing section 38. The flange 47 and piston head 49 are provided with O-ring or other suitable seals 50 and 51, respectively. It will be noted in FIGS. 2 and 3 that the inlets 37 communicate between the annulus 14 and an annular space or pressure chamber 52 defined between the sleeve 48 and the housing section 38 and the flanges 47 and 49. Thus, the sleeve 48 constitutes fluid pressure responsive actuator means movable

5

downwardly by a build-up of pressure in the chamber 52. In addition, there is preferably a coiled compression spring 47' interposed between flanges 47 and 49 and normally acting to shift the sleeve downwardly. The lower end of the sleeve 48, however, is adapted to be subjected to the pressure of production fluid passing upwardly through the valve assembly 9.

Value means are operatively connected to the upper end of the sleeve 48 so as to be closed upon upward movement of the sleeve 48 and opened upon downward movement of such sleeve. In accordance with one of the salient features of the invention the valve means is in the form of a segmental plug valve having a plurality of complemental segments 53. A pair of such segments are shown illustratively, but in practice any desired plurality may be employed. Each segment 53 constitutes one half of an upwardly tapered plug having an inclined sealing face 54 adapted to engage a correspondingly tapered valve seat 55, this seat preferably having a sealing lining material such as rubber or neoprene thereon as at 56. The seat 55 may be formed integrally with the coupling 43, but is preferably replaceable, as shown, and includes a tapered ring removably retained in a counterbore 57 in the inner end of the coupling 43, as by means of a snap ring 58, so as to circumscribe the passage through the housing. The opposing faces of the segments 53, 53 are preferably provided with a lining or facing of compressible sealing material such as rubber or neoprene, as at 59, 59, so that upon seating of the segments, the sealing faces will be engaged with one another, as seen in FIGS. 3 and 4, so as to effectively preclude the passage of fluid therebetween.

Means are provided for operatively connecting the plug segments 53, 53, to the sleeve 48, whereby the segments will be shifted into and out of engagement with the seat 55. In this connection, each of the segments 53 is provided with downwardly projecting ears or lugs 60 to which is connected one or more links 61 as by means of a like number of pivot pins 62. The links are bifurcated as at 63 so as to span the ears 60 for connection thereto. At its opposite end, each link is also bifurcated as at 64 for connection as by pins 65 to an upstanding lug or ear 66 carried on an actuator ring 67 which is threaded or otherwise removably secured adjacent to the upper end of the sleeve 48 as at 68.

The basal section of the ring 67 is slotted as at 69, 69 to accommodate one terminal end of a leaf spring 70 in each slot, such terminal end preferably being secured to the ring as by a screw 71 or the like. Each leaf spring 70 extends upwardly for engagement with the links 61 connecting the respective plug segments 53 to the ring 67. These leaf springs normally bias the links 61 to a position where the plug segments are in a retracted position engaged with the housing section 41, as shown in FIG. 2, when, responsive to fluid pressure in the annulus 14, the sleeve 48 is urged downwardly to the position shown in FIG. 2. It should be noted that in such retracted position of the segments 53, the valve is full open and offers no obstruction to the flow of fluid therethrough or to the passage of any desired wire line tool or instrument through the valve.

In operation, assuming the well to be producing under flow pressure and the valve to be open, as shown in FIG. 2, responsive to production fluid pressure being imposed upon sweet oil or the like with which the annulus 14 has been previously filled, a reduction or cut off in production pressure applied to the oil in the annulus through the well head equipment will permit further flow of production fluid to compress spring 47', acting on the lower end of the sleeve 43 to shift the sleeve axially. Accordingly, the actuator ring 67 and links 61 will shift the valve segments 53 upwardly, the segments being cammed laterally, towards the axis of the assembly into engagement with one another by engagement of the outer,

6

tapered walls of the segments 53 with inclined end surface 43' of the coupling 43.

Once the valve is closed, fluid pressure will act upon the valve segments tending to wedge them tightly into contact with one another, and the flexible facings 59 will be tightly pressed against one another, and a portion of this material will be forced to flow radially into tight sealing contact with the seat facing 56.

While the specific details have been herein shown and described, changes and alterations may be resorted to without departing from the spirit of the invention, as defined in the appended claims.

I claim:

1. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly having means for admitting annulus pressure to actuate the valve assembly; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means on said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a member having opposed fluid pressure responsive surfaces subjected to annulus pressure in said assembly and to production fluid pressure in said passage, respectively.

2. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly having means for admitting annulus pressure to actuate the valve assembly; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means on said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a member having opposed fluid pressure responsive surfaces subjected to annulus pressure in said assembly and to production fluid pressure in said passage, respectively; said plug segments having opposed faces engageable with one another upon seating of the segments; said faces being lined with resilient material.

3. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly having means for admitting annulus pressure to actuate the valve assembly; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a

7

plurality of axially and laterally movable plug segments; means in said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a member disposed in said housing and movable axially thereof; said member having opposed fluid pressure responsive surfaces subjected to annulus pressure in said assembly and to production fluid pressure in said passage, respectively; and means pivotally interconnecting said segments to said member.

4. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly having means for admitting annulus pressure to actuate the valve assembly; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means in said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a member disposed in said housing and movable axially thereof; said member having opposed fluid pressure responsive surfaces subjected to annulus pressure in said assembly and to production fluid pressure in said passage, respectively; and link means connected to said segments at one end and to said member at the other end.

5. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly having means for admitting annulus pressure to actuate the valve assembly; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means in said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a member having opposed fluid pressure responsive surfaces subjected to annulus pressure in said assembly and to said production fluid pressure in said passage, respectively; and means for biasing said segments laterally out of the path of flow through the passage upon unseating of the segments.

6. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly having means for admitting annulus pressure to actuate the valve assembly; said valve assembly including a housing having a production fluid passage therethrough

8

communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means on said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a member disposed in said housing and movable axially thereof; said member having opposed fluid pressure responsive surfaces subjected to annulus pressure in said assembly and to production fluid pressure in said passage, respectively; means pivotally interconnecting said segments to said member; and means for biasing said interconnecting means and said segments laterally out of the path of flow through the passage upon unseating of said segments.

7. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means in said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a sleeve disposed in said housing; means defining a pressure chamber intermediate said sleeve and housing; said housing having means for admitting annulus pressure to said chamber; said sleeve having a portion subjected to pressure in said chamber; and said sleeve having a further portion subjected to pressure of production fluid in said passage for shifting said sleeve responsive to fluid pressure to shift said segments as aforesaid.

8. In well flow control apparatus including: tubing extending into the well and forming an annulus between the tubing and the well wall; means packing off the annulus about the tubing; a fluid pressure operated valve assembly in said tubing above the packing means; and means at the well head for directing fluid under pressure into the annulus outside the tubing; said valve assembly including a housing having a production fluid passage therethrough communicating with said tubing; means in said housing defining a seat circumscribing said passage; a plug valve shiftably mounted in said passage and comprising a plurality of axially and laterally movable plug segments; means in said housing for shifting said segments into sealing engagement with one another upon movement of the segments toward engagement with said seat; and fluid pressure responsive actuator means in said housing and connected to said segments for shifting the segments into and out of engagement with said seat; said actuator means including a sleeve disposed in said housing; means defining a pressure chamber intermediate said sleeve and housing; said housing having means for admitting annulus pressure to said chamber; said sleeve having a portion subjected to pressure in said chamber and an opposing portion subjected to pressure of production fluid in said passage for shifting said sleeve and shift said segments as aforesaid; and means resiliently biasing said sleeve in one direction.

9. In a flow control valve for wells: an elongated housing having a flow passage extending centrally there-
through; a valve seat circumscribing said passage; a plug

9

valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said flow passage; and actuator member in said housing shiftable axially thereof in opposite directions; and means operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions.

10. In a flow control valve for wells: an elongated housing having a flow passage extending centrally therethrough; a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said flow passage; and actuator member in said housing shiftable axially thereof in opposite directions; and means operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions; said segments having opposing faces provided with resilient facing material.

11. In a flow control valve for wells: an elongated housing having a flow passage extending centrally therethrough; a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said flow passage; an actuator member in said housing shiftable axially thereof in opposite directions; and means operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions; said segments each being tapered and having camming surfaces engageable with said housing for moving the segments laterally towards one another upon movement of the segments towards said seat.

12. In a flow control valve for wells: an elongated housing having a flow passage extending centrally therethrough; a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said flow passage; an actuator member in said housing shiftable axially thereof in opposite directions; and means operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions; said segments each being tapered and having camming surfaces engageable with said housing for moving the segments laterally towards one another upon movement of the segments towards said seat; and resilient means biasing said segments laterally away from one another.

13. In a flow control valve for wells: an elongated housing having a flow passage extending centrally therethrough; a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said flow passage; an actuator member in said housing shiftable axially thereof in opposite directions; and means including a link operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions.

14. In a flow control valve for wells: an elongated housing having a flow passage extending centrally therethrough; a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said

10

passage; an actuator member in said housing shiftable axially thereof in opposite directions; means including a link operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions; and resilient means engaged with said link and normally biasing said segments away from each other.

15. In a flow control valve for wells: an elongated housing having a flow passage therethrough; a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another; and actuator member in said housing shiftable axially in opposite directions; means including a link operatively connecting each of said segments to said actuator member for movement into and out of engagement with said seat and with one another upon movement of said actuator member in said opposite directions; said actuator member comprising a ring; and a leaf spring carried by said ring and engaged with each link for normally biasing said segments away from each other.

16. A flow control valve for wells, comprising: an elongated housing having a flow passage therethrough; an actuator member in said housing; fluid pressure responsive means for shifting said member axially in said housing; means in said housing defining a valve seat circumscribing said passage; a plug valve in said housing; said plug valve comprising a plurality of individual segments having complemental sealing surfaces engageable with one another; means operatively connecting said segments to said actuator member for movement into and out of engagement with said seat and with each other upon movement of said actuator member in opposite directions; and means in said housing for moving said sealing surfaces of said segments into engagement with one another upon movement of the segments toward engagement with said seat.

17. A valve as defined in claim 16, wherein said fluid pressure responsive means includes a sleeve shiftable mounted in said housing; means including a pressure head on said sleeve defining a pressure chamber between said housing and said sleeve; and said housing having means for admitting pressure fluid into said chamber.

18. In a valve including a housing having a flow passage extending centrally therethrough; means in said housing defining a seat circumscribing said passage; a plug valve shiftable disposed in said housing for movement into and out of engagement with said seat; said plug valve including a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said passage; means shiftable supporting said segments for movement towards and away from one another upon movement towards and away from said seat; fluid pressure responsive means in said housing for shifting said segments towards and away from said seat; and means in said housing for moving said sealing surfaces of said segments into engagement with one another upon movement of the segments toward engagement with said seat.

19. In a valve including a housing having a flow passage extending centrally therethrough; means in said housing defining a seat circumscribing said passage; a plug valve shiftable disposed in said housing for movement into and out of engagement with said seat; said plug valve including a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said passage; an actuator member shiftable disposed in said housing; link means supporting each segment on said actuator member for movement towards and away from each other upon movement towards and away from said seat.

20. In a valve: a housing having a flow passage extending centrally therethrough; means in said housing defining a seat circumscribing said passage; said housing

11

having a section spaced longitudinally of said housing from said seat and provided with a circumferentially enlarged bore; a plug valve shiftably disposed in said housing for movement into and out of engagement with said seat; said plug valve including a plurality of individual segments having complemental sealing surfaces engageable with one another centrally of said flow passage and movable from a first position disposed in the enlarged bore in said housing section to a second position in engagement with said seat and with one another centrally of said flow passage; an actuator member shiftably disposed in said housing; means supporting each segment

12

on said actuator member for movements from said first position to said second position and from said second position to said first position upon movement of said actuator member toward and away from said seat.

References Cited in the file of this patent

UNITED STATES PATENTS

1,968,297	Hild	July 31, 1934
2,757,741	O'Reilly	Aug. 7, 1956
2,812,822	O'Reilly	Nov. 12, 1957
2,813,588	O'Reilly	Nov. 19, 1957