

2,246,811

WELL FLOWING DEVICE

Filed May 22, 1937

4 Sheets-Sheet 1

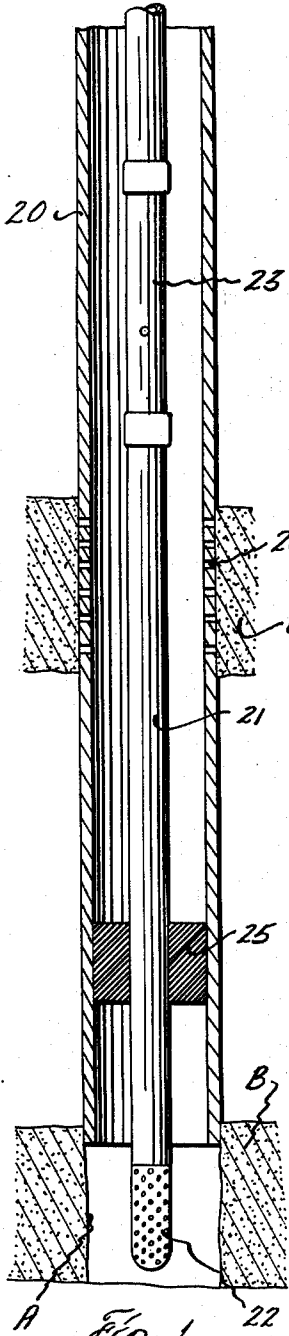


Fig. 1

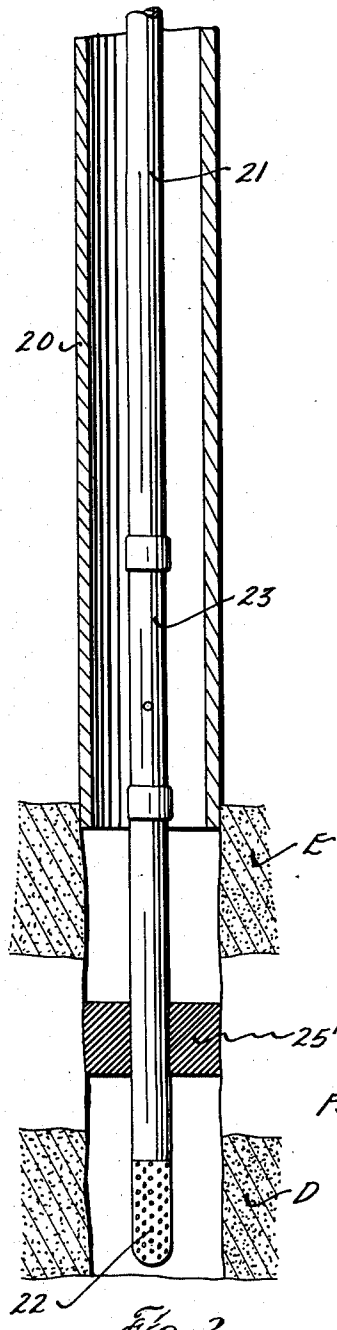


Fig. 2

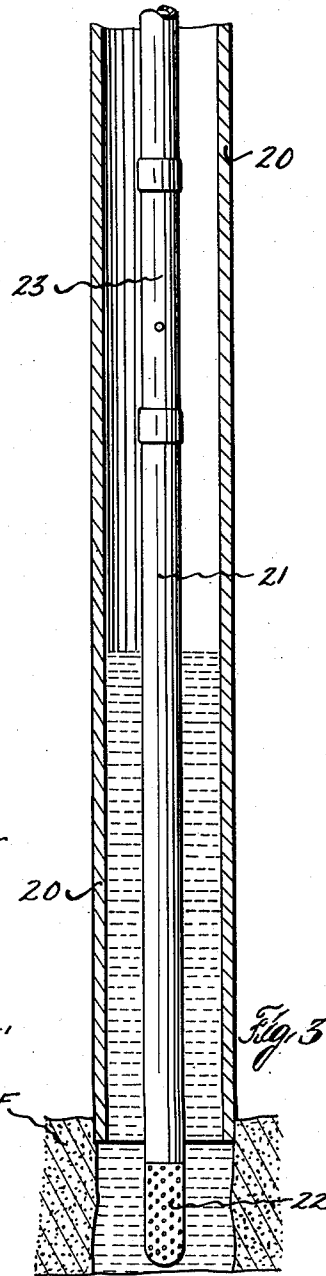


Fig. 3

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4 Sheets-Sheet 2

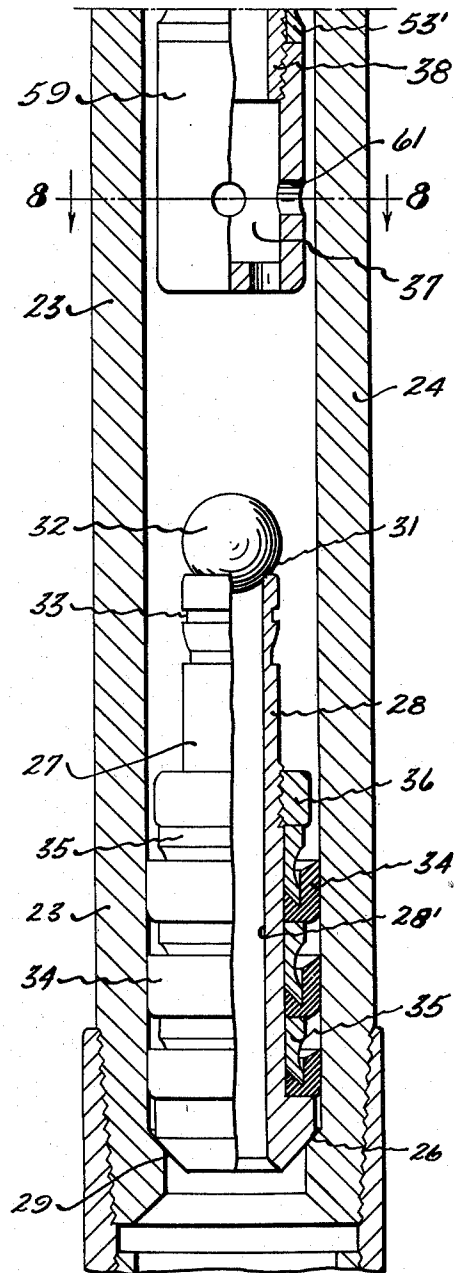
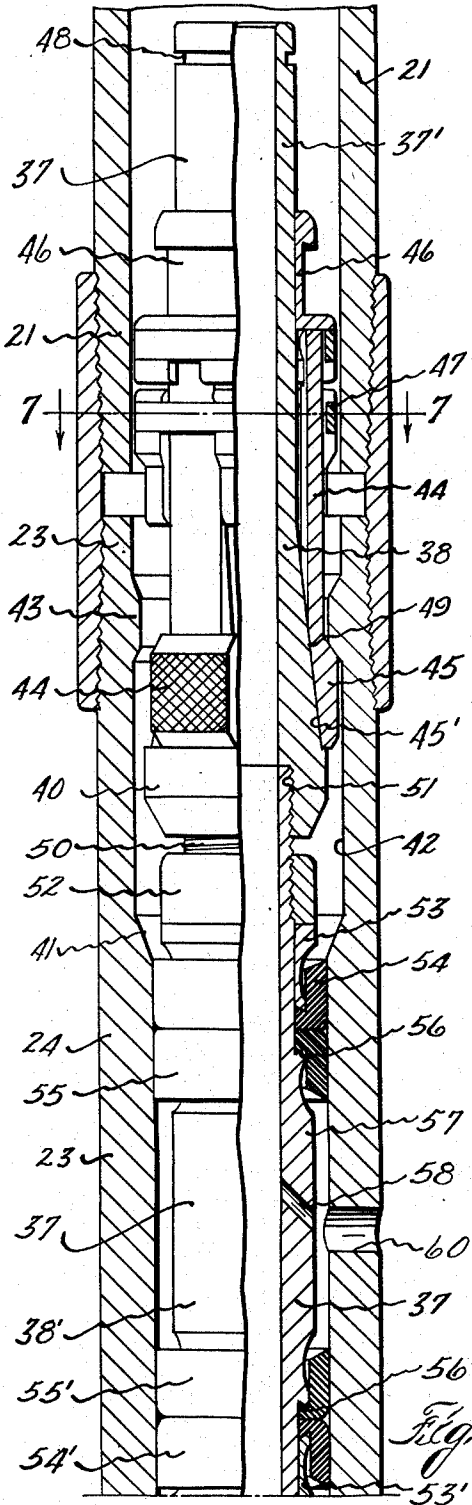


Fig. 5

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WELL FLOWING DEVICE

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4 Sheets-Sheet 3

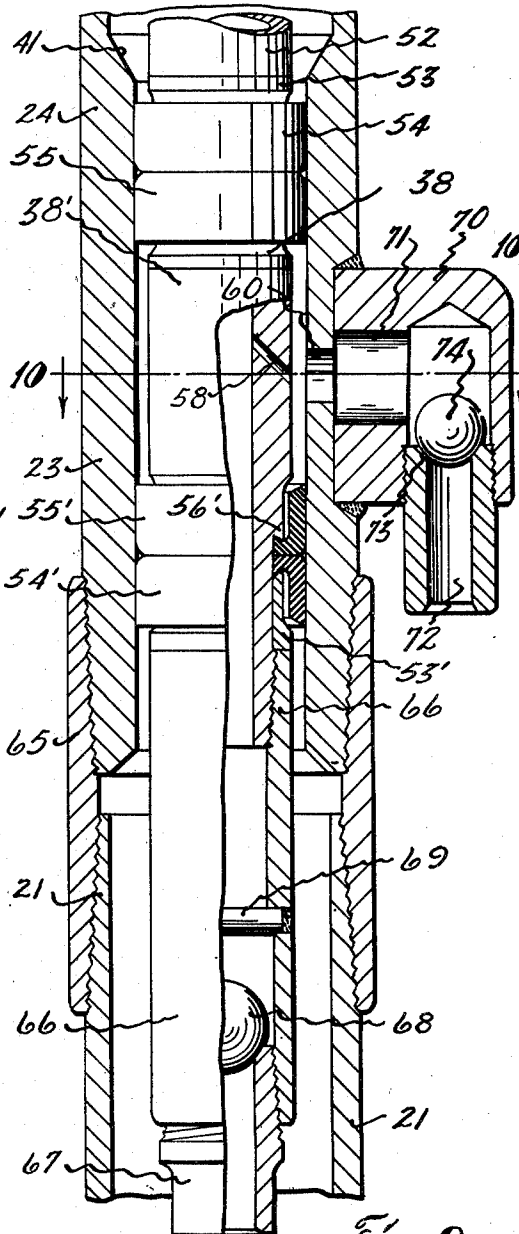
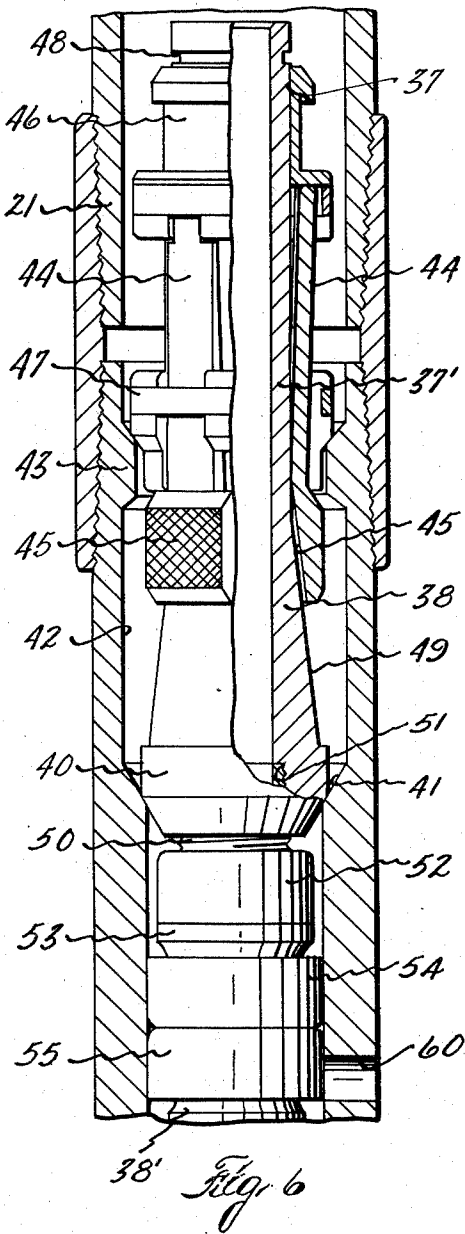


Fig. 9

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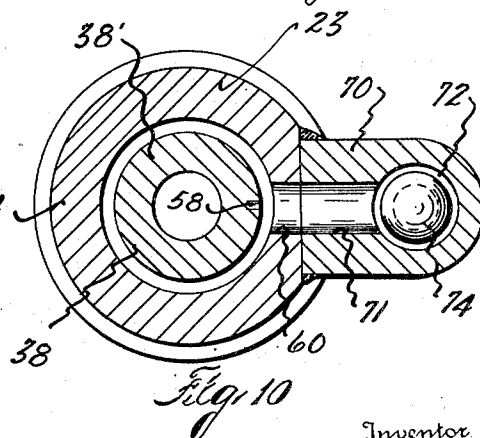
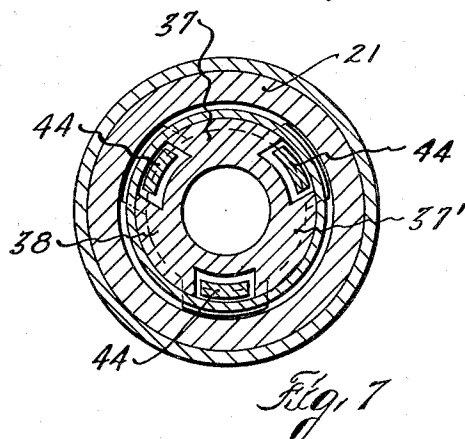
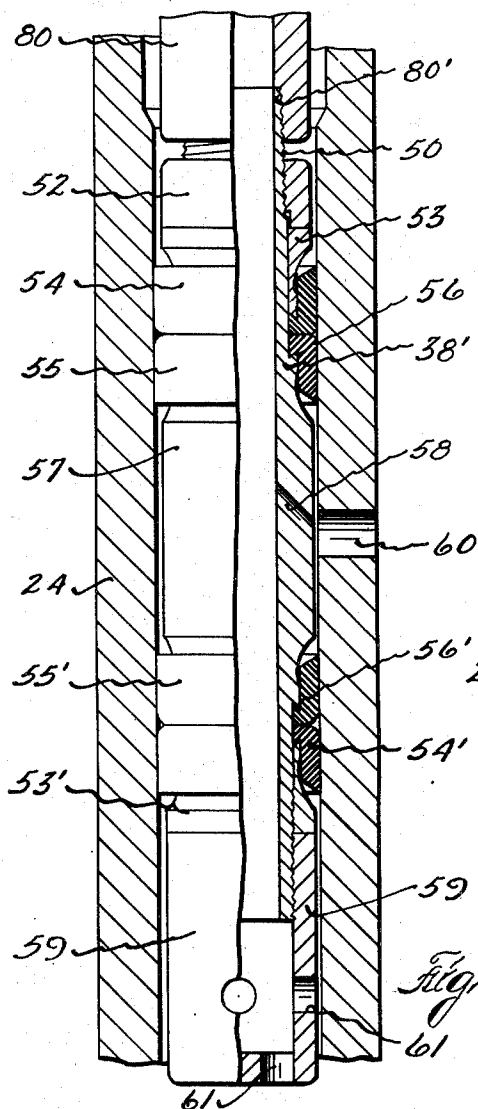
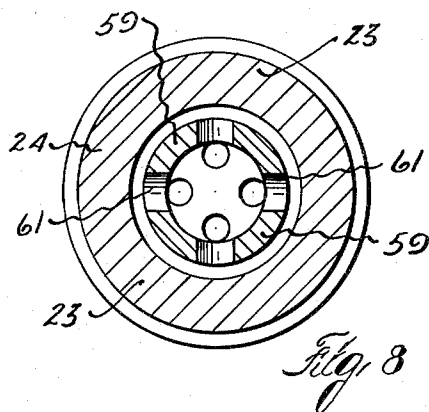
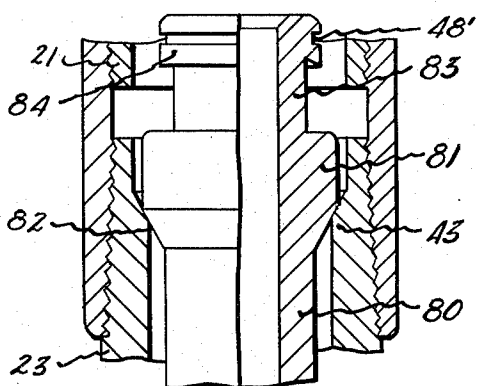
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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,246,811

WELL FLOWING DEVICE

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Application May 22, 1937, Serial No. 144,252

17 Claims. (Cl. 103—232)

This invention relates to new and useful improvements in well flowing devices.

In many cases in the present deep drilling of wells prolific gas horizons are passed up for deeper oil production. Eventually the pressure in these deeper oil horizons declines to the point where the wells will no longer flow, making it necessary to resort to some lifting means to raise the oil. Perforating through the well casing into the upper gas sands may admit into the casing ample gas energy to raise the oil, but unless some means of controlling the gas thus admitted is provided, it is probable that excessive amounts of gas may be produced with the oil; and when the well is closed in, the gas, if under a higher pressure than the oil, will enter the oil sands, driving the oil back from the well bore. If the gas admitted into the well casing through the perforations in the casing is under less pressure than the oil, the oil may enter the gas sands and drive the gas from the well bore. These occurrences cause underground wastage.

There are instances in oil wells, wherein gas from a higher sand being under greater pressure than the gas of the oil producing sand, flows down to the oil producing sands and impairs the oil production. Where such a well casing is closed at the surface, the oil may not be lifted.

One object of the invention is to provide improved means, operable under each of the conditions above set forth, and arranged so that the available gas may be utilized and controlled as a means for lifting the oil.

An important object of this invention is to provide improved means so arranged as to allow the oil and gas to enter the tubing, but to prevent either from escaping into the horizon of the other.

A still further object of the invention is to provide improved means arranged to act either with or without a casing or formation packer, to effectively utilize available gas from sub-surface reservoirs, to lift oil.

Another object of the invention is to provide improved means co-acting with a casing or formation packer and arranged to be positioned at predetermined locations suitable for efficient gas lifting of the oil.

A further object of the invention is to provide an improved fluid lifting and control choke arranged to be set and removed with a wire line.

A construction designed to carry out the in-

vention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a vertical, sectional view of a device constructed in accordance with the invention and installed in a well, the casing of which is perforated at an upper gas sand and packed off from the lower oil producing sand,

Figure 2 is a similar view showing the casing landed in the gas sands and a formation packer set between the sands,

Figure 3 is a vertical, sectional view illustrating the invention as applied to a well having a low bottom hole pressure, but a large volume of free gas in the casing,

Figures 4 and 5 are vertical, sectional views of a flow device constructed in accordance with the invention showing the removable choke fastened in the nipple,

Figure 6 is a view similar to Figure 4 showing the choke unfastened and ready for removal, the removing tool being omitted,

Figure 7 is a horizontal, cross-sectional view, taken on the line 7—7 of Figure 4,

Figure 8 is a horizontal, sectional view taken on the line 8—8 of Figure 5,

Figure 9 is a view, partly in elevation and partly in section, showing another form of flow device,

Figure 10 is a horizontal, cross-sectional view taken on the line 10—10 of Figure 9, and

Figure 11 is a view similar to Figure 9 showing still another form of the invention.

In the drawings, the numeral 20 designates the well casing, and 21 the well tubing which extends axially of said casing. The tubing may have a suitable screen 22 connected to its lower end and this screen is located at the bottom of the well hole A. At a predetermined location, a flow device 23 is connected in the tubing.

In Figure 1, the casing 20 extends down to the oil sands B. Located below the flow device 23 are the gas sands C, the casing having perforations 20' to allow the gas from the sands C to enter the casing. Located in the casing between the sands B and the sands C is any suitable casing packer 25, packing off around the tubing 21. It will be seen that there may be more or less distance between the two sands. The oil from the oil sands B will enter the tubing through the screen 22; while the gas will flow

into the casing through the perforations 20' and its admission to the tubing will be controlled by the flow device 23, hereinafter described. Figure 2 shows another type of well in which the oil sands D and the gas sands E are usually much closer together. The casing 20 is landed at the top of the gas sands, and the flow device 23 is located just above the bottom of the casing. A formation packer 25' is set in the well hole between the two sands.

Figure 3 shows still another type of well in which the oil and gas are produced from the same sands F. The flow device 23 is placed above the standing level of the liquid in the casing. The gas in solution in the oil entering the tubing 21 through the screen 22 will cause the column of fluid to rise in the said tubing to a point above the flow device 23. The free gas, which in this type of well, would be in volume in the casing, will enter the flow device and lift the liquid within the tubing 21. The packers 25 and 25' are not needed in a well of this type.

The flow device includes a housing or nipple 24 having external screw threads at each end so as to be connected in the tubing 21 by the usual collars. At its lower end the nipple has an internal beveled seat 26 for receiving the beveled flange 29 which is located at the lower end of a check valve assembly 27. This flange is formed on the lower end of a tubular mandrel 28 having an axial bore 28'. The upper end of said mandrel is so constructed as to form a seat 31 for a ball valve 32. Below and adjacent said seat there are provided in the mandrel external annular grooves 33 for receiving tools (not shown) for setting the valve assembly in or removing the same from the nipple 24. Non-metallic packing cups 34 supported and spaced by thimbles 35 surrounding the mandrel, are carried by the flange 29. The cups and thimbles are confined by a retaining nut 36. Thus it will be seen that fluid from the tubing 21 below the check valve assembly 27 may flow up through the bore 28' of the mandrel 28, unseat the ball valve 32 and enter the nipple. However, when the pressure of the fluids above the ball 32 becomes greater than the pressure below said ball, said greater fluid pressure will act upon the ball 32 and reseal it upon the seat 31. Thus it will be seen that fluid will be free to flow upwardly through the valve assembly 27, but no fluid or fluid pressure can escape downwardly through the valve assembly when the ball is seated.

A choke 37 is arranged to be removably fastened in the housing 23. This choke includes a tubular mandrel 38 comprising an upper section 37', and a lower section 38', screwed thereto. At its lower portion the section 37' has a beveled base 40 adapted to come to rest on a beveled seat 41 at the lower end of an annular, vertically elongated recess 42, in the upper portion of the housing 23. The housing has a double beveled stop ring 43 at the upper end of the recess.

A locking device similar to that set forth in my co-pending applications, Serial No. 26,671 and Serial No. 18,788 is mounted on the upper mandrel section 37' and includes swinging and radially moving locking dogs 44 having double beveled heads 45 at their lower ends adapted to engage in the recess 42. These dogs are mounted in a carrier 46 (Figures 4 and 6) slidable on the mandrel. The shanks of the dogs extend loosely through a beveled stop collar 47 integral with the mandrel section 37'. The upper end of the mandrel section has an annular groove 48 for

attaching suitable running tools (not shown). This device is operated as set forth in the aforesaid applications, being lowered by a suitable tool (not shown), until the base 40 rests upon the bevel seat 41 and the collar 47 engages the stop ring 43.

The mandrel section 37' has an inclined enlargement or spreader boss 49 extending upwardly from the base 40. When the choke is being run into the well or removed therefrom the carrier 46 is elevated so that the inner bevels 45' of the dogs are at the upper end of the boss, which permits the heads 45 to move inward and pass through the stop ring 43. However, when the carrier is released and slid downwardly the dogs are spread by the boss so that their heads 45 project into the recess 42. With the dogs so spread the upward movement of the choke is limited by the engagement of the dogs 45 with the stop ring 43.

The lower mandrel section 38' has external screw threads 50 at its upper end engaging in a threaded socket 51 in the base 40, whereby the two sections are united. The extent of the threads 50 is such as to receive an annular nut 52 which fastens in place a thimble 53 (Figure 4) engaging in a packing cup 54 mounted on the mandrel. The cup 54 confines an inverted packing cup 55 on an undercut shoulder 56 on said mandrel. These cups are expanded by upward and downward fluid pressures, into sealing engagement with the smooth bore of the housing 23.

Below the cups 54 and 55 the mandrel has an enlargement 57 provided with a metering port 58, preferably inclined upward to direct the admitted pressure fluid into the upwardly flowing well stream. At the lower end of the enlargement, cups 54' and 55' are held by a thimble 53' and a cap nut 59 against a shoulder 56'. The cups 55 and 55' are opposed so as to confine the pressure fluid therebetween and prevent its escape either upwardly or downwardly in the casing.

The housing 23 has a pressure fluid (gas or air) admitting port 60 located so as to be confined between the packing cups 55 and 55' at all positions of the choke. By changing the lower mandrel section 38', different sizes of metering ports 58 may be had. The cap nut 59 has inlet ports 61 and by changing this nut different sizes of ports may be used. The ports 61 may be of such size as not to restrict the flow or they may be reduced to restrict the flow; or the cap may be omitted entirely if some means is provided to prevent the ball 32 sealing the lower end of the choke.

In operation the housing 23 is connected in the tubing at any desired location while the tubing string 21 is being lowered into the well. When the tubing string has been run the check valve assembly 27 is lowered into position and seated upon the shoulder 26 at the lower end of the housing. The packing cups 34 will seal off around said valve assembly. The choke 37 is then lowered into the tubing, being supported and set as described in said co-pending applications and positioned as shown in Figure 6. While the choke is being lowered the carrier 46 and dogs 44 are free to ride up the mandrel. When the head 40 at the lower end of the upper mandrel section 37' engages the seat 41, the running tool is disconnected and withdrawn from the well.

The choke has been run down the tubing under pressure and when released, will be moved

upwardly from the position shown in Figure 6 to the position shown in Figure 4, by the well pressure. In some instances the pressure below the choke may not be sufficient to move the same upwardly and in such a case the frictional contact of the packing cups 54, 54', 55 and 55', with the wall of the nipple 24, will be adequate to hold the choke in place. After the check valve assembly 27 and choke are set, the liquid will flow up through the check valve assembly and enter the choke through the ports 61 provided in the cap nut 59 located at the bottom of said choke. Lifting fluid provided by a suitable source, such as described in Figures 1, 2 and 3, or some other source, is introduced into casing 20 and admitted to the housing 23 by the port 60. The admitted lifting fluid will then pass through the metering port 58, and into the flow stream in the tubing, thereby aiding in the lifting of the well fluids in the usual way. It is pointed out that if the pressure within the tubing overcomes the pressure of the liquid flowing up through the check valve assembly 27 located at the bottom of the well, the ball 32 will be seated and keep the lifting fluid from flowing down the tubing and reaching lower horizons.

Figures 9 and 10 show another form wherein the housing 23 is shortened and its lower end is secured to the tubing 21 by a collar 65. The choke is substantially the same except that in place of the cap nut 59, a valve case or sleeve 66 is screwed onto the lower end of the lower mandrel section 38' and extends into the tubing 21. A nipple 67 is screwed into the lower end of the sleeve and a valve ball 68 is seated upon the upper end of said tube. The upward movement of the ball is limited by a cross pin 69. This valve controls the back pressure flow in the same manner as the valve 27.

Mounted on the housing is a fluid check valve 70 having the bore 71 of its case communicating with the port 60. A nipple 72 is screwed into the valve case to provide a seat 73 at its upper end for a valve ball 74 in the bore 71. In operation, the lifting fluid from the casing enters through the nipple 72, whereby the ball valve 74 is unseated, and the fluid passes through the bore 71 and the port 60 into the housing 23, and then into the choke through the port 58, thereby lifting the liquid which has entered through the nipple 67 located at the lower end of the choke. If the fluids in the tubing set up a back pressure which overcomes the lifting fluid pressure in the casing, said fluid pressure from the tubing will act upon the ball valve 74 thereby closing said valve, and preventing the fluid in the tubing from escaping into the casing. It is pointed out that the check valve 70 may be used upon the form (Figures 1 to 8) first described and will act in the same manner as herein described.

In Figure 11 there is shown another form of the invention in which the locking dogs 44 and the recess 42 are eliminated. Instead of the complete mandrel 37 an upper tubular mandrel section 80 is employed. This mandrel section has an internally screw-threaded socket 80' at its lower end arranged to receive the upper screw-threaded end 50 of the lower mandrel section 38', heretofore described. While it would be possible to use the nipple 24 with the recess 42, such recess is not required, and therefore, may be omitted, as shown.

At the upper end of the nipple the bevelled stop ring 43 is employed. The mandrel section 80 is provided with a stop collar 81 having an

undercut bevelled shoulder 82 adapted to rest on the stop ring 43 and limit the downward movement of the choke. Above the collar the mandrel is provided with a fishing neck 83 and an annular flange 84 which has a groove 48' similar to the groove 48 and for the same purpose.

The form illustrated in Figure 11 is particularly adapted for installations where there is little or slight pressure below the choke or when the pressure differential across the choke is low; and which is not sufficient to force the choke upwardly. In this installation, the frictional contact of the packing cups of the choke with the bore of the nipple are depended upon to hold the choke in position. In some formations the gas producing sands may be below the oil sands and in such an event the oil and gas inlets would be reversed; that is, oil would enter through the ports 58 and 60, while gas would be admitted through the valve assembly 27.

What I claim and desire to secure by Letters Patent is:

1. Well flowing and controlling means including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, a removable choke mounted in the nipple and having a gas inlet to admit gas into the choke from the nipple and also having an oil inlet, and means removably mounted in the nipple below the choke for preventing fluids from the nipple back flowing down the tubing to the oil producing sand, the choke being removable independently of said latter means.

2. Well flowing and controlling means including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, a removable choke mounted in the nipple and having a gas inlet to admit gas into the choke from the nipple and also having an oil inlet, an internal annular seat within the nipple below the choke, and a valve assembly supported on said seat for preventing fluids from the nipple back flowing down the tubing to the oil producing sand, the choke being removable independently of said valve assembly.

3. Well flowing and controlling means including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, a removable choke mounted in the nipple and having a gas inlet to admit gas into the choke from the nipple and also having an oil inlet, an internal annular seat within the nipple below the choke, a valve assembly supported on said seat and comprising a tubular mandrel having means for packing off the space between the mandrel and nipple whereby flow of fluid is through the mandrel, and a valve for closing the upper end of the valve mandrel to prevent fluid from the nipple back flowing down the tubing to the oil producing sand, the choke being removable from the nipple without disturbing the valve assembly.

4. Well flowing and controlling means for controlling the flow of fluids from upper and lower horizons of tubed wells including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, means for packing off the well outside of the tubing between the upper and lower horizons and below the gas inlet of the nipple, a removable choke mounted in the nipple having a well liquid inlet and a gas inlet for metering the admitted gas to the flow stream, and means removable independently of said choke within the nipple below the choke for shutting off the flow of gas through the tub-

ing to the lower producing horizon, the choke being removable from the nipple without disturbing said latter means to thus maintain a mechanical separation of the pressure fluids with respect to upper and lower horizons.

5. Well flowing and controlling means including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, a removable choke mounted in the nipple and having a gas inlet and an oil inlet, means removable independently of the choke for preventing fluids from the nipple back flowing down the tubing to the oil producing sand, and valve means connected with the gas inlet of the nipple for preventing back flow of fluid from the tubing, into the casing in the event back pressure in the tubing overcomes lifting fluid pressure in the casing.

6. Well flowing and controlling means including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, means connected with the gas inlet of the nipple for preventing back flow of fluid from the tubing, a removable choke mounted in the nipple and having a gas inlet to admit gas into the choke from the nipple and also having an oil inlet, and means removably mounted in the nipple below the choke and independently of the latter for preventing fluids from the nipple back flowing down the tubing to the oil producing sand, the choke being thus rendered removable without disturbing said latter means.

7. Well flowing and controlling means including, a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, a valve connected with the gas inlet of the nipple arranged to close when subjected to a back pressure, a removable choke mounted in the nipple and having a gas inlet to admit gas into the choke from the nipple and also having an oil inlet, an internal annular seat within the nipple below the choke, and a valve assembly supported on said seat independently of said choke for preventing fluids from the nipple back flowing down the tubing to the oil producing sand, the choke being removable from the nipple without disturbing the valve assembly.

8. Well flowing and controlling means including a well tubing, a nipple arranged to be connected in the well tubing and having a gas inlet, a choke removably mounted in the nipple and having a gas inlet to admit gas into the choke from the nipple and also having an oil inlet, valve means removably mounted in the nipple below the choke for preventing fluids from the nipple back flowing down the tube to the oil producing sand, the choke being removable independently of and without disturbing said valve means, and means for positively locking the choke in position within the nipple against movement in either direction.

9. In combination in a well, a well tubing set to admit oil at its lower end, a nipple arranged to be connected in said tubing and having an inlet opening for gas only located intermediate its ends, a choke removably mounted in the nipple provided with a flow passage extending longitudinally therethrough and open at its lower end for admitting oil flowing up the tubing, said choke having a side gas inlet communicating with the gas inlet opening of the nipple, packers on the choke above and below the gas inlet for packing off the tubing, and means within the nipple and co-acting with the flow passage of the choke

for preventing liquids back flowing to the tubing below the nipple.

10. In combination in a well, a well tubing set to admit oil at its lower end, a nipple arranged to be connected in said tubing above the oil level outside of the tubing and having an inlet opening for gas only located intermediate its ends, a choke removably mounted in the nipple provided with a flow passage extending longitudinally therethrough and open at its lower end for admitting oil flowing up the tubing, said choke having a side gas inlet communicating with the gas inlet opening of the nipple, packers on the choke above and below the gas inlet for packing off the tubing, and means within the nipple and co-acting with the flow passage of the choke for preventing liquids back flowing to the tubing below the nipple.

11. In a well, the combination with an underlying oil stratum and an overlying gas stratum separated therefrom, of a tubing extending through the gas stratum into the oil stratum, a packer in the well between the strata for packing off the tubing, a nipple connected in the tubing above the packer and having a gas inlet intermediate its ends for admitting gas from the gas stratum, a removable choke mounted in the nipple having an inlet for receiving oil from the tubing below said packer and provided with a side gas inlet for receiving gas from the inlet of the nipple, and means in the nipple for preventing both oil and gas back flowing to the oil stratum.

12. In combination in a well, a tubing set to admit oil at its lower end, a nipple arranged to be connected in said tubing and having an inlet opening for gas only located intermediate its ends, a choke removably mounted in the nipple and provided with a flow passage extending longitudinally therethrough open at its lower end for admitting oil flowing up the tubing, said choke having a side gas inlet communicating with the gas inlet opening of the nipple, packers on the choke above and below the gas inlet for packing off the tubing, and means mounted in the nipple below the choke for preventing liquids back flowing from the nipple.

13. In combination in a well, a well tubing set to admit oil at its lower end, a nipple arranged to be connected in said tubing and having an inlet opening for gas only located intermediate its ends, a choke removably mounted in the nipple and provided with a flow passage extending longitudinally therethrough open at its lower end for admitting oil flowing up the tubing, said choke having a side gas inlet communicating with the gas inlet opening of the nipple, packers on the choke above and below the gas inlet for packing off the tubing, and a valve assembly removably mounted in the nipple below the choke for preventing liquids back flowing from said nipple.

14. A well flowing and controlling device for tubed wells wherein is provided a well tubing for conducting well fluids to the surface and having a housing connected therein with its bore communicating with the tubing, said housing having therein a lateral inlet from the well, in combination with a removable element having a lateral flow inlet and a flow passage establishing communication between the well through the flow inlets and the tubing above said element, said element having means for preventing flow down the passage thereof, and valve check means for

preventing back flow of fluids from the well tubing above the passage of the said element and by way of said passage through the flow inlets to the well.

15. A well flowing and controlling device as set forth in claim 14 and sealing means interposed between the housing and said element adjacent the flow inlets thereof for directing the flow of fluids entering the housing into the flow inlet of said removable element.

16. A well flowing and controlling device for tubed wells wherein is provided a well tubing for conducting well fluids to the surface and having a housing connected therein with its bore communicating with the tubing, said housing having therein a lateral inlet from the well, in combination with a removable element having a lateral flow inlet and a flow passage establishing com-

munication between the well through the flow inlets and the tubing above said element, means removable independently of the said element located below the flow inlets for preventing flow from the passage of the removable element and the tubing thereabove back flowing down the tubing, and sealing means between the housing and the removable element adjacent the flow inlets for directing the flow of fluids entering the housing into the flow inlet of said removable element.

17. A well flowing and controlling device as set forth in claim 16 and valve check means for preventing back flow of fluids from the well tubing above the passage of said element and by way of said passage through the flow inlets to the well.

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