United States Patent

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[54] METHOD AND APPARATUS FOR EFFECTING GAS CONTROL IN OIL WELLS

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[21] Appl. No.: **819,606**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 650,286, June 30, 1967, Pat. No. 3,451,477, which is a continuation-in-part of Ser. No. 433,909, Feb. 19, 1965, abandoned.

[52] **U.S. Cl.** **166/265**, 166/68, 166/105.5, 166/314

[51] **Int. Cl.** **E21b 39/00**, E21b 43/12, F04b 21/00

[58] **Field of Search** 166/250, 314, 54, 75, 91, 97, 166/68, 105, 265, 105.5; 103/203; 138/46; 137/471

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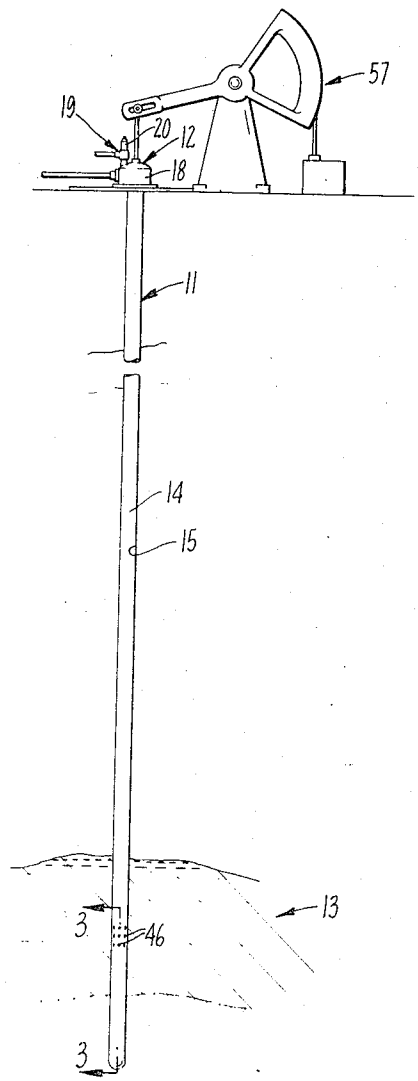
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[57] **ABSTRACT**

A method and apparatus for controlling the rate of production of oil wells including a seal at the casing head, an automatic pressure-responsive valve venting the casing to the atmosphere and a gas anchor to assure separation of oil from gas in the producing zone whereby the producing zone is held under controlled even pressures. The gas anchor includes a bucket vertically reciprocable in a housing, a double-acting lost motion valve member attached to the bucket to be pulled off its seat by the bucket, and a tubing string extending into the bucket and closed off by the seat for the valve member.

8 Claims, 7 Drawing Figures



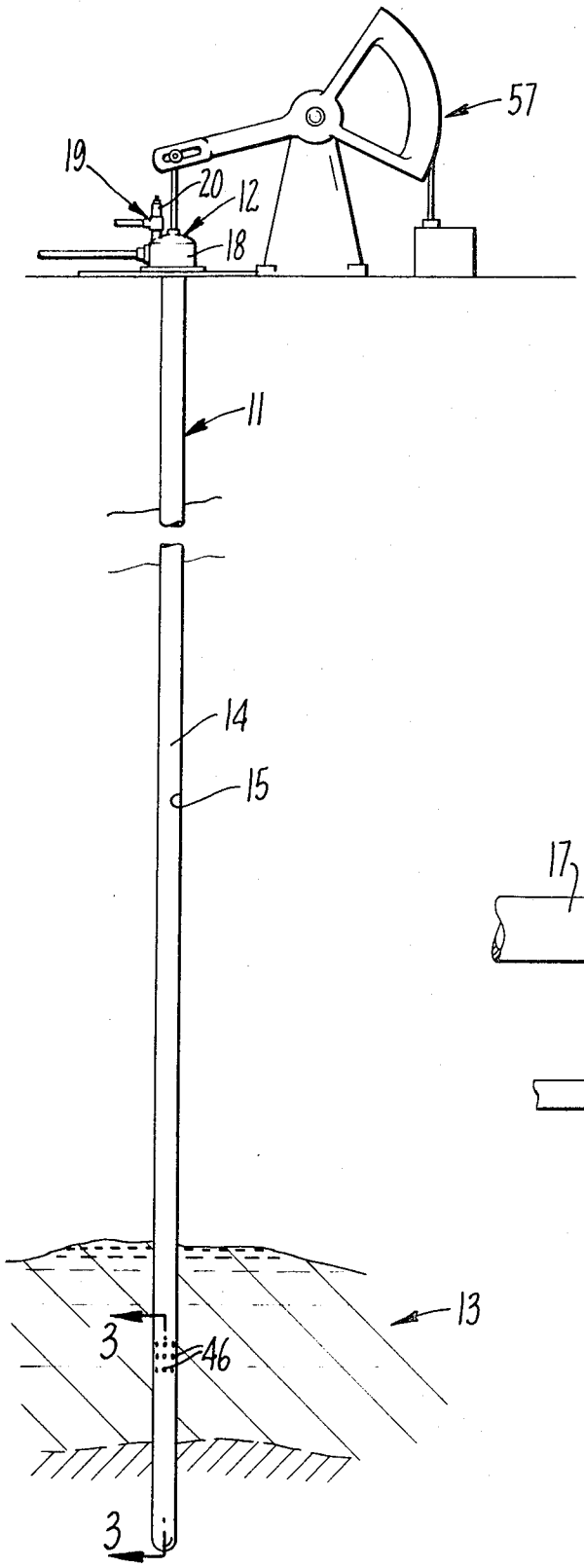


FIG. 1.

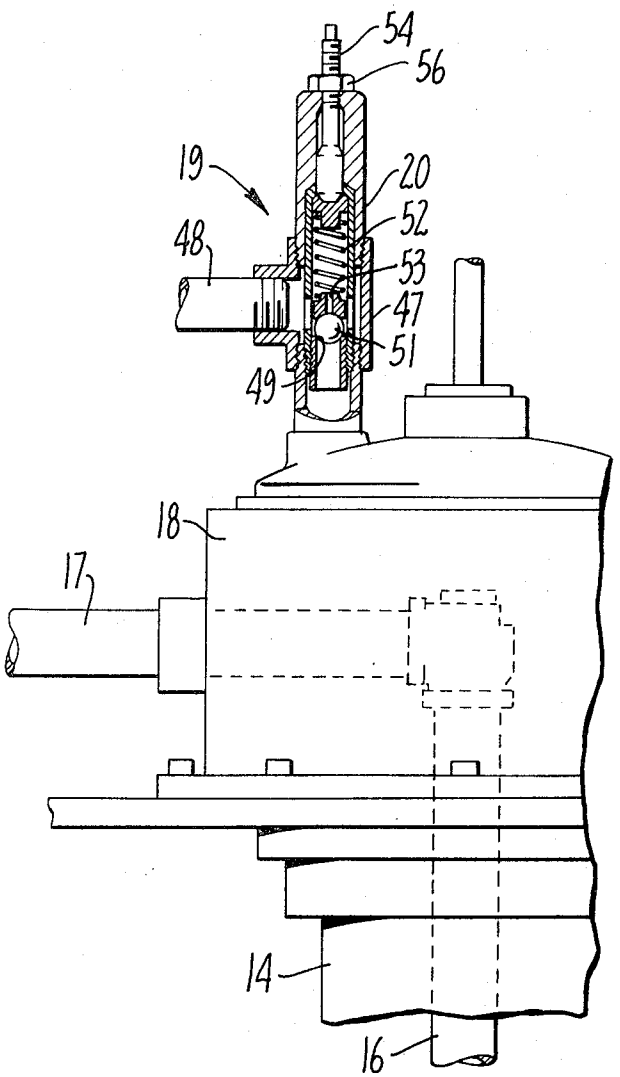


FIG. 2.

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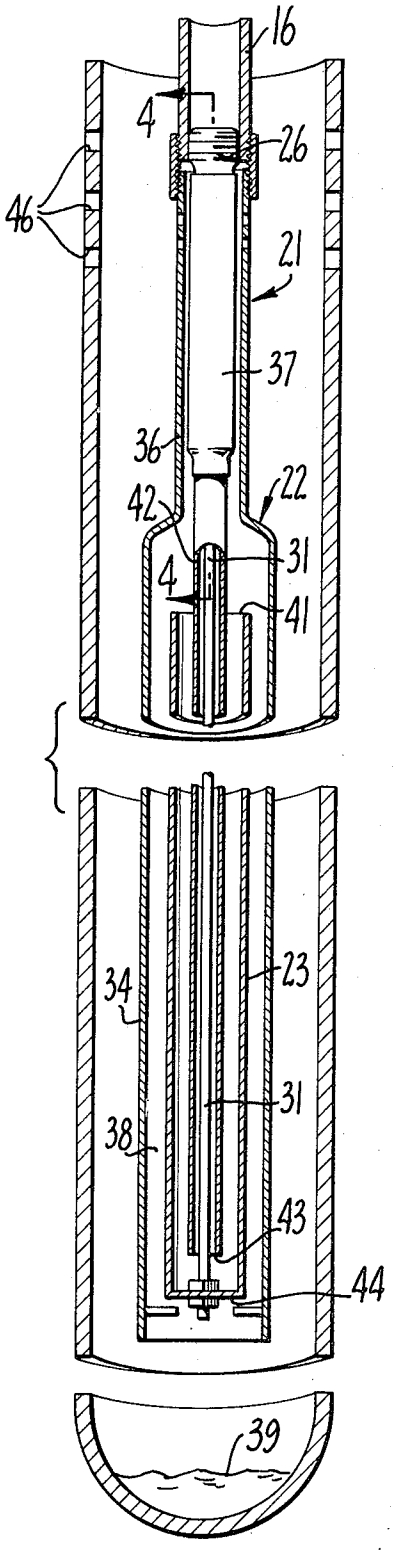


FIG. 3.

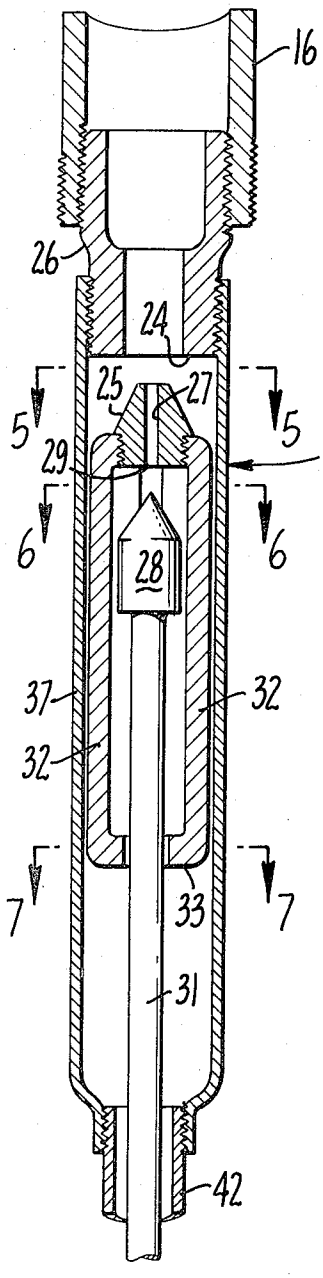


FIG. 4.

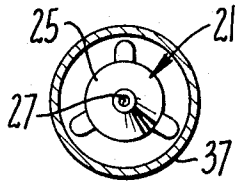


FIG. 5.

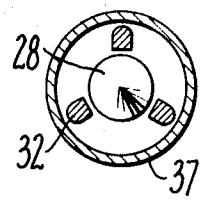


FIG. 6.

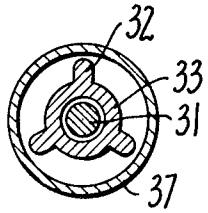


FIG. 7.

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METHOD AND APPARATUS FOR EFFECTING GAS CONTROL IN OIL WELLS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part of my copending application, Ser. No. 650,286, filed June 30, 1967, now U.S. Pat. No. 3,451,477, which in turn is a continuation-in-part of my copending application, Ser. No. 433,909 filed Feb. 19, 1965, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to improvements in A METHOD AND APPARATUS FOR EFFECTING GAS CONTROL IN OIL WELLS, and more particularly to systems for controlling the rate of production of oil wells without wasting gas.

In many localities, the production of liquid oil and gas from wells is strictly regulated. Limited production is difficult to obtain without effective control over internal well pressure. Moreover, it has been demonstrated repeatedly that total production from the average well is very significantly increased where the gas pressure in the formation is retained and utilized instead of being wasted. Efficiency of operation alone is a powerful incentive to accomplish complete gas control, both as to well pressures and as to conservation of gas energy.

Many efforts have been made to accomplish accurate gas control inside the well but these attempts have been only partially successful. This is mainly due to a failure to appreciate all of the interacting conditions present in the producing zone of the well and resulting failure to solve all of the problems created by such conditions. It should be appreciated that the pressures encountered in modern wells, especially those drilled to comparatively great depths, coact with the gas and liquid phases of the hydrocarbons encountered to produce conditions which were either absent or much less important in earlier, shallower wells.

The oil is forced into the well through the rock structure in the producing formation by gas pressure in the formation higher than that present in the well. This often produces turbulence and foaming within the well to such degree that the contents at the producing zone take on many of the characteristics of a fluid composed of a mixture of liquid and gas, the specific gravity of the fluid depending upon the relative proportions of each.

In many localities, oil and gas production is strictly limited by appropriate governmental agencies. Most of these agencies limit the production per well to as low as 15–25 barrels per day. Many of the wells are capable of producing up to 1,000 barrels per day and it has been the policy in most cases to operate the well long enough each day to produce the daily allowance and then shut the well down until the next day. In this procedure, although the flow of oil from the well has been stopped, the gas pressure in the well tends to equalize with the pressure in the surrounding formation. This equalizing of pressures halts the flow of oil through the formation into the well and the oil will not move into the borehole until the gas is vented from the well. The venting of this gas in a relatively short time causes a surging action which drives sand, mud and cut oil into the bore and creates a foamy mixture which is difficult if not possible to pump.

SUMMARY OF THE INVENTION

The present invention is adapted to produce oil at a desired rate of flow by controlling gas pressure in the well, so as to produce a desired quantity of oil during a 24-hour period. This is accomplished by bleeding or metering gas from the interior of the well through a valve which is responsive to the casing pressure in such manner that the gas pressure in the well controls production of oil from the formation at the desired rate of flow. The apparatus also provides an environment conductive to the separation of the liquid and gas and removes the liquid from the well either by gas pressure alone or gas pressure in combination with pumping. The configuration of the present apparatus also prevents "frac" sand and other highly abrasive debris from entering the pump string and causing damage to the pump, valves or other parts. The present apparatus is particularly suitable for use with pumping systems of the character disclosed in U.S. Pat. No. 3,324,803 issued June 13, 1967 and entitled "Liquid Control for Gas Wells."

With the use of the gas control system of the present invention, the well is kept pumping 24 hours a day and positive control is exercised over the gas pressure in the well so that the daily allowable production is forced out of the formation into the well during each 24-hour period. This control of pressure in the well provides a stabilized condition which greatly reduces foaming and driving of unwanted debris into the well bore. Under these conditions, the present apparatus is highly effective to permit the pumping of liquid oil out of the well while retaining the gas therein.

In wells that are capable of producing a lot of water along with the oil, the action of the present control system in reducing and controlling the rate of flow into the well from the surrounding formation often helps greatly in reducing the flow of water into the well, probably by reducing surging and allowing natural oil-water separation to take place. In addition, it should be clear that preventing excessive discharge of gas from the well tends to conserve the reservoir energy stored in the highly compressed gas, and this saved energy is available to aid in lifting the oil from the well.

The liquid oil and the gas are separated at the bottom of the well, preferably by a positive-action, bucket-type separator, and the oil is removed from the well through conventional production tubing. The separation of the oil and gas at the bottom of the well, in conjunction with the control of the gas pressure in the well, permits the adjusting of the production rate of flow of oil from the well to the desired amount, without wasting gas on the one hand or allowing the liquid oil to fill up the bore and choke off the well on the other hand.

Broadly speaking, the liquid-gas separator is responsive to the level of liquid oil in the well, although it is recognized that foaming and frothing often occur within wells and it is really a desired differential in density of specific gravity which is utilized to control the action of the separator. The present invention minimizes surging and consequent forcing of sand and other unwanted materials into the well bore. The apparatus is formed in such manner that any sand or other debris which might enter the well bore will be prevented from having deleterious effect on the working mechanism or contaminating the oil being produced.

In the apparatus of the present invention, the valve venting from the sealed casing head is responsive to the casing pressure to vent more when the pressure is high and less when it is lower so that the pressure is held constant without necessity for attendance by an operator or frequent readjustment. The valve opens wider in response to pressure increase, and closes entirely at a preset pressure level to maintain proper gas pressure in the well to assist in its production. Variations in casing pressure can thus be smoothed, resulting in still further improvement of the constancy of the rate of production of the well.

Accordingly, it is a principal object of the present invention to provide a method and apparatus for automatically controlling and conserving gas pressure in oil wells.

Another object of the invention is to provide a method and apparatus for effecting automatic and unattended subsurface gas control in oil wells which will permit continuous production of daily allowances through an entire 24-hour period and which greatly reduces surging and consequent forcing of sand and other unwanted materials into the well bore.

A further object of the invention is to proved an apparatus of the character described which is formed for removing liquid oil from an oil well in a condition substantially free from contamination by sand, mud or other debris.

Yet another object of the present invention is the provision, in apparatus of the character described, of a device responsive to changes in specific gravity of the fluid mixture of liquid oil

and gas normally encountered at the producing zone of an oil well, the device being effective for separating the liquid oil from the gas, supplying the liquid oil to a pump string, and returning the gas to the interior of the well.

Another object of the invention is to provide apparatus of the character described which is adapted to function efficiently in wells of great depth and under a variety of pressure conditions.

Further objects and advantages of my invention will be apparent as the specification progresses, and the new and useful features of my method and apparatus for effecting gas control in oil wells will be fully defined in the claims attached hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred forms of the invention are illustrated in the accompanying drawings, forming a part of this description, in which:

FIG. 1 is a fragmentary schematic view of an oil well incorporating the apparatus of the present invention;

FIG. 2 is an enlarged fragmentary view of the upper end of the oil well of FIG. 1 showing portions in cross section and portions in phantom;

FIG. 3 is an enlarged vertical cross-sectional view taken substantially on the plane of lines 3—3 of FIG. 1;

FIG. 4 is a further enlarged vertical cross-sectional view taken substantially on the plane of lines 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view taken substantially on the plane of lines 5—5 of FIG. 4;

FIG. 6 is a cross-sectional view taken substantially on the plane of lines 6—6 of FIG. 4; and

FIG. 7 is a cross-sectional view taken substantially on the plane of lines 7—7 of FIG. 4.

While I have shown only the preferred form of my invention, it should be understood that various changes or modifications may be made within the scope of the claims attached hereto without departing from the spirit of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in detail, it will be seen that the gas control system of the present invention operates to control pressure and conserve gas in an oil well **11** and yet produce a desired quantity of liquid oil per day, by sealing the upper end or casing head **12** of the well against unwanted escape of gas, by automatically venting gas through the sealed upper end of the well in response to the pressure in the well to keep the gas pressure within the well at a level just sufficient to cause oil to be forced into the well from the surrounding formation **13** at a desired rate of production, by separating the liquid oil from the gas within the well, and by thereafter removing the liquid oil from the well.

The apparatus for accomplishing this is adapted for use in the conventional well casing **14** positioned in the borehole **15** and the usual pump string **16** mounted in the casing with its lower end in communication with the producing zone of the well and its upper end **17** passing through a gastight sealing device **18** secured to the upper end of the well casing **14**. It should be understood that the casing **14** may be positioned in the well in any of a number of conventional ways, the main essential being that the well bore is normally sealed against the escape of gas and consequent drop in gas pressure.

Venting means **19** is provided for automatically venting gas from the well in response to the pressure therein so as to lower the gas pressure within the well comparatively slowly and keep it at a level just sufficient to accomplish the purposes of the present invention. The slowness of the drop in pressure prevents surging which ordinarily causes excessive foaming and carrying of sand, mud and other debris into the interior of the well casing. The controlled venting of the gas permits the operator to attain a drop in pressure which is just enough to accomplish continuous and relatively nonsurging flow of oil from the surrounding formation into the well casing in amounts equal to the permitted production rate of the well over a 24-hour period.

The means **19** may be located in any suitable place to accomplish the described controlled venting of gas from the well, but preferably is mounted above ground at the casing head, Christmas tree or other structure used to seal the well. As here shown, the venting means **19** consists of a pressure-responsive valve **20** mounted on the seal **18** in communication with the interior of the well casing. The valve **20** is responsive to the pressure within the well casing **14** to open wider at higher pressures and close down at lower pressures, closing entirely at a selected pressure level. In this fashion, excessive gas pressure is vented off to prevent it from stopping oil flow into the bore, and yet the casing pressure is held high enough to impose the desired limit on rate of production from formation into bore and total daily production from the well. In this manner, changes in formation and casing pressures are automatically accommodated without attention of an operator.

In accordance with the present invention, and referring specifically to FIGS. 3–7 of the drawings, it will be seen that the liquid oil is separated from the gas and supplied to the pump string **16** by apparatus positioned within the well casing at the producing zone. As here shown, this apparatus includes valve means **21** positioned at the lower end of the pump string **16** and formed for selectively communicating the interior of the pump string with the interior of the well casing, together with control means **22** responsive to changes in the specific gravity of the fluid mixture, usually liquid oil and gas, encountered at the producing zone of the well, the control means **22** having an operative connection to valve means **21** formed for opening and closing the latter in accordance with the rise and fall of the said specific gravity, so as to supply liquid oil only to the pump suction line.

As here shown, the control means **22** includes an open top cylindrical bucket **23** formed for vertical reciprocation within the well and having a weight sufficient to pull the valve means **21** to open condition against the gas pressure in the well when the bucket is only partly filled. Thus, as liquid oils cascade into the bucket through its open top, the combined weight of oil and the bucket will open the valve means **21** and provide access for the liquid oil to the pump string.

The bucket **23** is formed and proportioned to provide an effective displacement sufficient to float the bucket in the surrounding fluid mixture when the bucket is substantially empty of liquid oil, the floating action being sufficient for urging the valve means **21** to closed condition. Thus, so long as liquid oil is available in the bucket, the valve means **21** will remain open, but as the amount of liquid oil in the bucket is depleted, the bouyancy of the bucket will cause the valve means **21** to close before any gas can enter the pump string. This prevents gas lock and ensures that gas will not be discharged from the well through the pump string even if mistakes are made by the operators above ground level.

As may best be seen in FIG. 4 of the drawings, the valve means **21** is of the valve-on-valve type in order to reduce the bucket weight necessary to open the valve means, thus also reducing the length of bucket necessary to provide the described flotation displacement. Accordingly, valve means **21** includes a main valve member **25** movable vertically toward and away from a valve seat **24** provided by the lower end of a nipple **26** threadably secured to and communicating with the lower end of the pump string **16**. The main valve member **25** is formed with a central opening **27** extending axially therethrough, opening **27** being of considerably smaller cross-sectional area than the opening in nipple **26** surrounded by seat **24**.

The valve means **21** also includes a secondary valve member **28** mounted for vertical movement toward and away from a valve seat **29** formed around the lower end of opening **27** in main valve member **25**. Secondary valve member **28** is operatively connected to bucket **23** by a rod **31** so it will move up and down with the rise and fall of the bucket. This up-and-down movement is guided by a vertically elongated cage **32** which is threadably secured to main valve member **25**. As the secondary valve member **28** moves downwardly away from its seat **29** under the influence of the weight of the bucket **23**, it

encounters a ring member 33 secured to the lower end of cage 32 in closely surrounding relation to rod 31 so that the weight of the partially filled bucket 23 will be transferred to the main valve member 25 as the bucket continues to descend.

The pressure drop across valve means 21 can be very considerable when working with very deep wells or wells having high gas pressures. In order to bodily pull the main valve open under these conditions, the bucket would have to be unnecessarily heavy and, accordingly, unnecessarily long. With the structure described, much less weight is required to pull the secondary valve member from its seat and this permits liquid to flow from the well into the pump string, greatly reducing the amount of pressure drop across the main valve. Thus, when the lost motion connection provided by the secondary valve member 23 engaging ring 33 transfers the weight of the partially filled bucket to the main valve, such weight will be sufficient to pull the main valve member 25 from its seat 24. When the supply of liquid oil in the bucket is substantially depleted, the bucket will float upwardly and urge secondary valve member 28 against its seat. This, in turn, will urge main valve member 25 to closed condition against its seat 24, thus closing off the pump string 16 from the well and preventing the entry of gas from the well into the pump string.

The structure of the valve means 21 and control means 22 thus far described is basically similar to the structure of the oil-gas separator disclosed in my U.S. Pat. No. 2,291,902 issued Aug. 4, 1942 and entitled "GAS ANCHOR." While the device shown in that patent might work effectively in some wells, if substituted for the apparatus illustrated in FIGS. 3–7 of the present drawings, the present apparatus contains several features of novelty which provide foolproof operation in a great variety of wells under a great variety of conditions. Accordingly, it is preferred that the gas-oil bottom hole separating device shown and described herein be used in my gas control system.

In accordance with the present invention, and as a valuable feature thereof, the valve means 21 and control means 22 of the present invention are formed and mounted in such a way as to ensure that substantially uncontaminated liquid oil is the only material allowed to pass through the valve means 21 and enter the pump string 16. The value of this accomplishment should be apparent when it is realized that contaminants and debris such as sand, mud, rock chips and the like normally found in oil wells are all highly abrasive and could cause excessive wear to the valve structures as well as to the pumps usually employed for lifting the oil out of the well.

In the present invention, most of the debris are prevented from entering the bucket 23, and those that do enter are trapped in the bucket and do not pass through the valve means 21 into the pump string 16. Preventing almost all of the debris from entering bucket 23 is accomplished by routing the flow of fluid upwardly through an annular space between the bucket 23 and the bell-shaped skirt 34 mounted in surrounding relation thereto. As here shown, skirt 34 is provided as a downward extension of a tubular member 36 carried on the lower end of pump string 16 in surrounding relation to an elongated cylindrical housing 37, also carried by the lower end of pump string 16. With this construction, the fluid mixture of gas and oil passes downwardly between the skirt 34 and well casing 14, then makes a 180° bend to enter the open bottom of skirt 34 and pass upwardly through the annular space 38 between skirt 34 and bucket 23. Since the bucket 23 and skirt 34 may be as much as 30 or 40 feet long, depending upon weight and flotation characteristics required of the bucket, and because of the abrupt 180° bend required, most of the unwanted debris 39 drop down to the bottom of the well and are not carried up through annular space 38. The latter space also serves to reduce the foaming effect and promote separation of the gas from the liquid oil. Once the liquid oil level reaches the open top 41 of the bucket 23, it cascades down into the bucket. As the bucket fills, its buoyancy is reduced and eventually the combined weight of bucket and oil causes the bucket to sink down and pull the valve means 21 to open condition.

Trapping of any minor amounts of debris which might have been carried into the bucket is effected by mounting the valve means 21 in spaced relation above the bucket and extending a tubular probe member 42 downwardly from the housing 37 in concentrically spaced relation around the rod 31 and with its lower end 43 terminating a short distance above the bottom 44 of the bucket when the latter is in its uppermost position. From FIG. 3 of the drawing, it may be seen that the probe 42 not only provides a conduit for the liquid oil to pass from the bucket 23 upwardly through the valve means 21 and into pump string 16, but also serves as a guide for the rod 31.

As here shown, the pressure responsive valve 20 includes a housing 47 sealed to the gastight sealing device 18 and communicating between that device and an output line 48. A valve seat 49 is disposed within the housing 47 and receives a ball valve member 51. The valve member 51 is biased toward the seat 49 by a compression spring 52 which bears on the ball member 51 through a bearing member 53. An adjustment screw 54 is threaded in the upper portion of the housing 47 to regulate the force of the spring member 52 on the ball 51. A locknut 56 may be provided to secure this adjustment if desired. It should be appreciated that other pressure-responsive valves could be used in place of the spring-biased valve shown. For instance, a diaphragm type valve might be employed, with one chamber communicating with the casing pressure and the other chamber biased toward valve closure, as by a static reference pressure, spring means, or either of these in combination with atmospheric pressure.

It may be seen that as the pressure in the casing rises, additional pressure is exerted on the underside of the ball 51, and the ball responds by moving farther off the seat 49. As pressure falls, the force of the spring 52 overcomes the force of the gas pressure within the casing, and the valve throttles down and eventually closes. The valve is thus able to hold casing pressure to not more than a selected level by venting gas from the casing when that pressure level is exceeded.

The response of the valve 20 to fluctuations in casing pressure is entirely automatic, shutting off the venting at low casing pressures to prevent further lowering and consequent foaming and surging of the oil and production beyond the desired limits in amount, and venting additional amounts at higher casing pressures, to prevent the choking off of production at high casing pressures. With the automatic pressure responsive valve 20, the well may be left unattended for long periods of time with assurance that the desired limits of production will be adhered to. The output line 48 may vent the gas to the atmosphere, or the gas may be recompressed and sold.

In operation, the adjustment screw 54 is set to allow the valve 20 to bleed off enough gas from the interior of the well to cause a slight pressure drop sufficient for the reservoir gas pressure to urge the desired quantity of oil through the formation and through the usual holes 46 into the well casing 14. As the specific gravity of the fluid mixture in the bucket increases, due to an increasing percentage of liquid oil, the buoyancy of the bucket will be reduced and it will eventually sink down far enough to pull valve means 21 to open condition. So long as liquid oil is being supplied to the bucket as fast or faster than it is being removed through the pump string 16, the apparatus will remain in the described condition. As soon as the specific gravity of the mixture drops, due to the depletion of the amount of liquid oil in the bucket 23, buoyancy will be reestablished and the bucket will rise so as to close the valve means 21 before the probe 42 starves for oil and unwanted gas enters the pump string.

Preferably, the valve 20 is adjusted so that the well will flow only a small proportion of the oil that would otherwise flow with full venting. Generally, this small quantity will be equal to that allowed by appropriate governmental agencies and will be less than, say, 2 or 3 percent of the production which would be possible on full venting. In this way, the pressure within the gas casing is retained at such a steady high degree that volatile components do not come out of the solution in the producing zone at an undue rate. In this way, more produceable liquids

flow into the well and considerably greater overall productivity is achieved from the well.

In conclusion, it should be noted that the method and apparatus of the present invention is effective for use in wells in which gas pressure alone is relied upon to force the liquid from the well. However, in the great majority of wells, some type of pumping means, generally indicated at **57**, is normally employed. Any suitable pumping means may be used which can accommodate closing of the valve means **21** during the periods when no liquid oil is available for pumping. Many such pumping devices are well known in the oil well industry.

From the foregoing, it will be seen that I have provided a novel and efficient gas control system for controlling gas pressures within the well, regulating oil production, and furnishing relatively uncontaminated oil to the pump string.

I claim:

1. The method of producing an oil well having a well casing and producing line and removing a desired quantity of liquid oil therefrom per day comprising sealing the well casing against unwanted escape of gas therefrom, controlling the gas pressure in the well casing by venting gas from the well casing, said venting being varied in direct response to fluctuation of pressure within the well casing and in amounts sufficient to cause the gas pressure within the well to seek and remain at the level just sufficient to cause oil to be forced into the well from the surrounding formation at a desired rate of production to provide a desired quantity of oil per day, effecting a complete separation of the liquid oil from the gas at the bottom of the well in response to the level of the oil in the well attaining at least a specified height, and removing said desired quantity of oil per day from the well through the producing line without wasting of gas from the well.

2. The method as described in claim **1** and wherein said controlling of gas pressure within the well is accomplished by metering gas from the well casing through a pressure-responsive valve at the upper end of the well.

3. Apparatus for producing an oil well while controlling pressure and conserving gas therein, comprising a well casing positioned in the bore of the oil well and having a gastight seal at the upper end thereof, venting means in the gastight seal for venting gas from said casing in response to the pressure therein so as to prevent excessive increase of pressure in the casing and maintain the casing pressure at a desired level, said venting means being formed to vent only when the pressure in the well casing exceeds said desired level and to stop venting when the pressure in the well casing falls below said desired level, a pump string mounted in said casing and having a lower end in communication with the producing zone of the well and an upper end passing through said gas tight seal in the upper end of said casing, pump means connected to said pump string and formed for producing a lowered pressure therein for drawing liquid oil out of said well, valve means at said lower end of said pump string formed for selectively communicating the interior of said pump string with the interior of said casing, and control means inside said casing at the producing zone of the well and responsive to changes in specific gravity of the fluid mixture encountered thereat, said control means having an operative connection to said valve means formed for opening and closing the latter in accordance with the rise and fall of the said specific gravity so as to communicate the interior of the pump string with the interior of the casing to supply liquid oil to the pump suction line when the specific gravity exceeds an amount providing liquid only to said valve means and to close said valve means when the specific gravity is below said amount to prevent passage of gas through said valve means from the casing into the pump suction line, whereby a desired quantity per day of oil is produced into the casing and removed therefrom through the pump string without wasting gas.

4. Apparatus for producing an oil well having a pump and pump suction line while effecting gas control therein, comprising a well casing positioned in the bore of an oil well, a gastight seal at the upper end of said casing, a control valve in the gastight seal from venting gas from said casing in response to the pressure therein so as to maintain the pressure in the casing at a desired level, said venting means being formed to vent only when the pressure in the well casing exceeds said desired level and to stop venting when the pressure in the well casing falls below said desired level, and separating means for separating oil and gas in the producing zone of the well; said separating means comprising valve means adapted for connection to the intake end of the pump suction line, and control means adapted for positioning at the producing zone of the oil well and responsive to changes in specific gravity of the fluid mixture encountered thereat, said control means having an operative connection to said valve means formed for opening and closing the latter in accordance with the rise and fall of the said specific gravity so as to communicate the interior of the pump suction line with the interior of the casing to supply liquid oil to the pump suction line when the specific gravity exceeds an amount providing liquid only to said valve means and to close said valve means when the specific gravity is below said amount to prevent passage of gas through said valve means from the casing into the pump suction line, whereby a desired quantity per day of oil is produced into the casing and removed therefrom through the pump suction line without wasting gas.

5. Apparatus as described in claim **4**, in which the control valve in the gas tight seal is a pressure-responsive valve responsive to the pressure in said casing.

6. Apparatus for producing an oil well having a pump and pump suction line while effecting gas control therein, comprising a well casing positioned in the bore of an oil well, a gastight seal at the upper end of said casing, a pressure-responsive control valve in the gastight seal for venting gas from said casing in response to a selected pressure level therein so as to reduce the pressure in the casing to said selected pressure level, and separating means for separating oil and gas in the producing zone of the well; said separating means comprising valve means adapted for connection to the intake end of the pump suction line, and control means adapted for positioning at the producing zone of the oil well and responsive to changes in specific gravity of the fluid mixture encountered thereat, said control means having an operative connection to said valve means formed for opening and closing the latter in accordance with the rise and fall of the said specific gravity so as to communicate the interior of the pump suction line with the interior of the casing to supply liquid oil to the pump suction line when the specific gravity exceeds an amount providing liquid only to said valve means and to close said valve means when the specific gravity is below said amount to prevent passage of gas through said valve means from the casing into the pump suction line, whereby a desired quantity per day of oil is produced into the casing and removed therefrom through the pump suction line without wasting gas, said control means also having an open-top bucket formed for vertical reciprocation within the well, said bucket having a weight sufficient to pull said valve means open against the gas pressure in the well when said bucket is partially filled and having an effective displacement sufficient to float said bucket in the surrounding fluid mixture when said bucket is substantially empty for urging said valve means closed.

7. An apparatus as described in claim **6** and wherein a tubular member having an elongated bell-shaped skirt open at the bottom is mounted in concentrically spaced relation around said bucket in such manner that the fluid mixture from the well enters the open bottom of the skirt and passes upwardly through the annular space between said bucket and bell-shaped skirt and into the open top of the bucket whereby sand and other unwanted debris will drop into the bottom of the well and will not be carried into the bucket with said fluid mixture.

8. An apparatus as described in claim **7** and wherein said tubular member extends vertically above the open top of said bucket and is formed with an opening therethrough for venting gas trapped in the upper part of said tubular member back into the well.