Feb. 26, 1952 K. KELLEY 2,587,333

REVERSE FLOW ADAPTER FOR WELLS

Filed May 15, 1950

Fig. 1

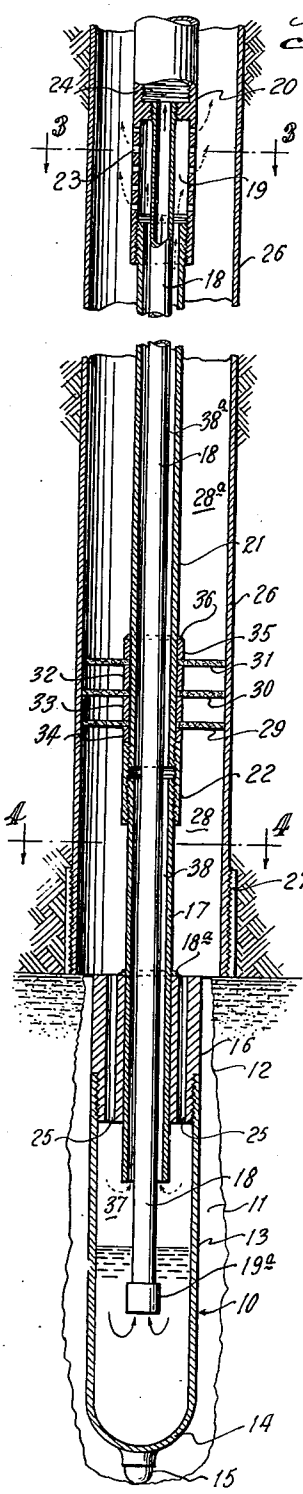


Fig. 2

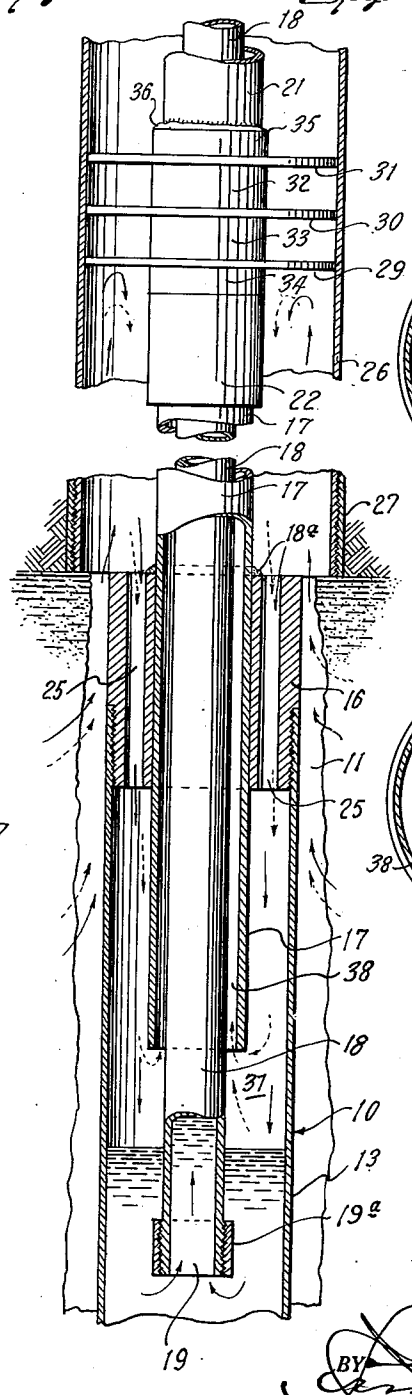


Fig. 3

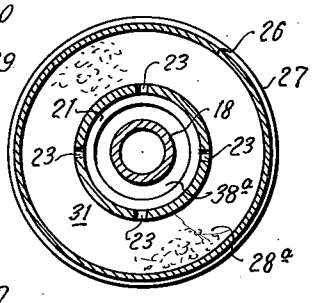
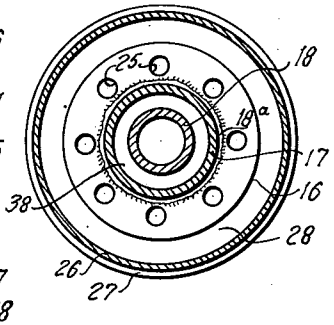


Fig. 4



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2,587,333

REVERSE FLOW ADAPTER FOR WELLS

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9 Claims. (Cl. 183—2.7)

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This invention relates to devices for separating gases from liquids and more particularly to such devices for separating oil from a mixture of oil and gas in a well.

In many oil producing wells the oil from an oil bearing formation which enters into the pocket or shot hole in which is located the intake pipe leading to a pump is not in the form of a liquid but in the form of a foam composed of oil and gas. The pump which is employed to lift the oil to the surface of the earth, however, cannot function properly if air is permitted to enter the pump during the period of its operation. This malfunctioning of the liquid pump is commonly known as an "air lock" or "gas lock." Moreover, if a mixture of gas and oil is discharged by the pump into the tubing string which conducts the oil to the surface, the gas in the mixture causes a turbulence or agitation in the oil in the tubing string which results in the deposition of wax on the walls of the tubing string and also on the rod string that operates the pump. These deposits constrict the operative aperture through which the oil may flow and impede the flow of the oil to the surface.

Gas and liquid separators, commonly called "gas anchors" or "bottom hole separators," are widely employed in such oil wells to separate the gas from the oil before the oil enters the intake pipe of the pump. These devices commonly employ several pipes of various lengths so disposed relative to each other as to create a liquid seal between the pump intake pipe and the source of the gas and oil mixture. In actual operation it is found that the foamy oil and gas mixture does not readily enter these devices. In some wells the foam of oil and gas will flow past these gas anchors or bottom hole separators and up the oil well casing to a height of more than three thousand feet. Applicant has discovered that in order to provide an optimum flow of oil to the surface and to provide efficient operation of the pump, the flow of the foamy gas and oil mixture up the well casing must be prevented.

Accordingly it is an object of applicant's invention to provide a new and improved gas and liquid separator.

It is another object of the invention to provide a new and improved gas and oil separator having a washer preventing the flow of oil and gas mixture up the well casing.

It is another object of the invention to provide a new and improved gas and oil separator having a washer for reversing the flow of an oil and gas mixture up the well casing.

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It is another object of the invention to provide a new and improved adapter for use with gas and oil separators to prevent the flow of the gas and oil mixture up the well casing.

It is still another object of the invention to provide a new and improved adapter for use with gas and oil separators to reverse the upward flow of the gas and oil mixture in a well casing.

Briefly stated, the new and improved gas and liquid separator comprises an adapter provided with a washer or a plurality of washers secured to a portion of the gas anchor or bottom hole separator at a predetermined point above the intake of the gas anchor or bottom hole separator. The washer or washers contact the inner surface of the well casing and form an air and liquid tight seal so that the foamy gas and oil mixture cannot ascend the well casing past the predetermined point. The mixture reverses its direction of flow at the predetermined point and then flows downwardly to enter the intake of the gas anchor or bottom hole separator. Also provided is a new and improved gas anchor especially adapted to be employed with the direction changing washers which includes a separator head secured to a cylindrical vent stack. The separator head is provided with a plurality of apertures spaced about the vent stack. The mixture of gas and oil flows downwardly, after its direction of flow is reversed by the washers, through the apertures of the separator head into the main chamber of the gas anchor. A pipe connected to the intake of a pump extends downwardly through the vent stack and into the main chamber. Since the end of the pipe is lower than the end of the vent stack, the body of oil in the main chamber makes a liquid seal between the intake of the pump and the source of the gas and oil mixture. In passing through the apertures of the separator head, the flow of the mixture of gas and oil is retarded which allows the oil to drop out of the mixture and collect in the main chamber.

The separation of the oil from the gas is further aided by the contact of the mixture with the body of liquid oil in the main chamber, the oil in the mixture entering into the body of liquid oil upon contact with it. The separated gas rises through the vent stack and is discharged into the well casing above the washer or washers. The oil which collects on top of the washer helps seal the cylindrical space between the well casing and the gas anchor. The washer or washers are preferably made of flexible material so that if an excess amount of oil collects on top of the washer

or washers, the washer or washers will give, dumping the oil which will then again enter the gas anchor.

For a better understanding of the invention reference may be had to the following specification taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing,

Figure 1 is a vertical view of a lower portion of a well equipped with a gas and liquid separator embodying the features of the invention, some parts being shown in section;

Figure 2 is an enlarged partly sectional view of a portion of the apparatus shown in Figure 1;

Figure 3 is a cross sectional view taken along line 3—3 of Figure 1; and

Figure 4 is a cross sectional view taken along line 4—4 of Figure 1.

Referring now to the drawing, the preferred embodiment of the invention is illustrated as applied to a gas anchor 10 disposed in the pocket or shot hole 11 in a formation 12 from which a mixture of gas and oil flows into the pocket 11. The gas anchor 10 comprises an outer shell 13 having a lower closed end 14 provided with a spacing member 15 which rests on the bottom of the pocket 11. The upper, open end of shell 13 is secured to the lower end of a separator head 16 by means of exterior threads on head 16 which engage the interior threads on shell 13. Separator head 16 is hollow and is secured to a cylindrical vent stack 17 which passes through head 16. Head 16 may be secured to vent stack 17 by a weld 18a, or by any other conventional means, e. g., by exterior threads on stack 17 and interior threads on head 16.

Extending through vent stack 17 is an inner shell 18 whose lower open end 19 is provided with a collar 19a and is disposed near bottom 14 of shell 13 and whose upper end is provided with exterior threads which engage the interior threads provided in the intermediate portion 19 of a head or coupling 20. The upper end of vent stack 17 is secured to a cylindrical shell 21 by means of an internally threaded coupling or collar 22 which engages the exteriorly threaded upper and lower ends of vent stack 17 and shell 21, respectively. The upper end of shell 21 is exteriorly threaded and engages the interiorly threaded lower end of coupling 20. It will be apparent that vent stack 17 and shell 21 in combination constitute a cylindrical shell through which the separated gas may pass. If desired, vent stack 17 and shell 21 could be formed of a single pipe or shell. The lower end of coupling 20 is provided with a plurality of openings 23 while the upper end is provided with interior threads 24 by means of which coupling 20 may be attached to the intake pipe, not shown, of a conventional oil pump employed in oil wells. Separator head 16 is also provided with a plurality of circularly arranged apertures 25.

Gas anchor 10 and its associated structures are centrally disposed in the well casing 26 whose lower end is provided with a collar 27 which is set adjacent pocket 11 above the formation 12. In order to prevent the mixture of gas and oil from formation 12 from rising in the cylindrical space 28 between vent stack 17 and well casing 26 and in the cylindrical space 28a between cylindrical shell 21 and well casing 26, there is provided a plurality of washers 29, 30 and 31, which are maintained in spaced relation on cylindrical shell 21 by spacing collars 32, 33 and 34. The upward movement of washers 31, 30 and 32 and spacing collars 32, 33 and 34 is prevented by a collar 35 which is rigidly secured to cylindrical shell 21 in any suitable manner, e. g., by a weld 36. It will be noted that collar 34 rests on collar 22 so that the washers 34 can be easily assembled on shell 21 and then immobilized by screwing collar 22 on shell 21. Washers 29, 30 and 31 are preferably formed of a strong flexible material such as one inch thick four or five ply rubber belting, so that the washers will bend in one direction when the device is being lowered into position in well casing 26 and in the opposite direction when it is being raised to the surface. In addition to this ease of installation and removal, the flexibility of washers 29, 30 and 31 allows the oil which accumulates above them in cylindrical space 28a to bend washers 29, 30 and 31 and fall into cylindrical space 28 in the event that an excess amount of oil accumulates in space 28a.

When the oil is being pumped from the pocket 11, the mixture of oil and gas from formation 12 flows into pocket 11 and then moves upwardly in the cylindrical space 28 until it reaches the lowermost washer 29. Washer 29 reverses the direction of flow of the mixture as is shown by the arrows in Figure 2 in which the direction of flow of oil is indicated by solid arrows and the direction of flow of gas by arrows having shafts broken in many places. The mixture is then drawn through the apertures 25 in separator head 16. In passing through apertures 16, most of the oil is separated from the gas and falls into the chamber 37 formed by shell 13. The remainder of the mixture contacts the accumulation of oil in chamber 37. The contact with the oil withdraws the oil from the mixture allowing the separated gas to flow upwardly through the cylindrical space 38 between vent stack 17 and shell 18 and the cylindrical space 38a between shell 18 and shell 21 to the coupling 20 where it passes through the apertures 23 into the well casing 26 above the top washer 31. Any droplets of oil carried up through apertures 23 will fall and collect on washers 31, 30 and 29. This accumulated oil aids washers 31, 30 and 29 in sealing cylindrical space 28 from cylindrical space 28a. In the event that an excess amount of oil collects above washers 29, 30 and 31, they will bend and allow the oil to drop into space 28. Once they are relieved of the weight of an excess accumulation of oil, washers 29, 30 and 31 will resume the positions shown in the drawing. In actual operation an accumulation of oil about eighteen inches high is usually present above washer 31 or in cylindrical space 28a.

It will be noted that the lower end 19 of inner shell 18 is located below the surface of the oil in chamber 37 so that the oil in chamber 37 acts as a liquid seal between the pump intake (not shown), which is engaged by the threads 24 of coupling 20, and the pocket 11. The oil is drawn by the oil well pump upwardly through inner shell 18 and to the surface through a tubing string connected to the outlet of the pump.

Since the effect of the washers 29, 30 and 31 in reversing the flow of the gas and oil mixture and the effect of gas anchor 10 result in the very efficient separation of oil and gas, the oil drawn into inner shell 18 and then to the pump and the tubing string is substantially free of gas. The pump will therefore not be subject to "gas lock," and the deposition of wax on the tubing string and the rod string will be minimized.

It will be noted that a plurality of washers 29, 30 and 31 has been provided in order to have a very good seal between spaces 28 and 28a. If desired, however, only one washer could be employed. It has been found that in order to obtain optimum results, washer 29 should be located about ten inches above the top of separator head 16.

While there has been shown and described a preferred embodiment of the invention, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What applicant claims as new and desires to secure by Letters Patent of the United States is:

1. A gas-liquid separating device for wells, comprising in combination, an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having a lower closed end and an upper open end communicating with said pocket and said lower end of said well casing; an outer cylindrical shell having its open lower end disposed within said outer shell; means connecting said outer cylindrical shell to said outer shell, said outer shell being of greater diameter than said outer cylindrical shell and spaced therefrom; an inner cylindrical shell disposed in said outer cylindrical shell and having its open lower end disposed in said outer shell below said lower end of said outer cylindrical shell, said inner cylindrical shell being spaced from said outer cylindrical shell to provide a cylindrical gas passage, said outer and inner shells extending upwardly through said well casing, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a flexible sealing member secured to said outer cylindrical shell disposed above said upper open end of said outer shell, said sealing member sealing said cylindrical space, said inner cylindrical shell being adapted to conduct oil from said outer shell member, said gas passage being adapted to conduct gas from said outer shell, said flexible sealing member flexing downwardly to allow accumulations of liquid on said sealing member to descend past said sealing members when said accumulations exceed a predetermined volume.

2. A gas-liquid separating device for wells, comprising in combination, an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having a lower closed end and an open upper end communicating with said pocket and said open lower end of said casing; an outer cylindrical shell having its open lower end disposed within said outer shell; means connecting said outer shell to said outer cylindrical shell, said outer shell being of greater diameter than said outer cylindrical shell and spaced therefrom; an inner cylindrical shell disposed in said outer cylindrical shell and having its open lower end disposed in said outer shell below said lower end of said outer cylindrical shell, said outer and inner cylindrical shells extending upwardly through said well casing, said inner cylindrical shell being spaced from said outer cylindrical shell to provide a cylindrical gas passage, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a plurality of vertically spaced flexible washers disposed above said upper open end of said outer shell, said washers sealing said cylindrical space, said cylindrical gas passage communicationg with said cylindrical space above said washers.

3. A gas-liquid separating device for wells, comprising in combination, an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having a lower closed end and an open upper end, said outer shell forming an oil collecting chamber; a separator head on said open upper end provided with a central opening and a plurality of apertures concentrically arranged about said central opening, said apertures communicating with said pocket, said well casing and said oil collecting chamber; an outer cylindrical shell extending through said well casing and said central opening into said chamber, said outer cylindrical shell having its lower open end within said chamber; an inner cylindrical shell in said outer cylindrical shell and having its open lower end in said chamber below said open lower end of said outer cylindrical shell, said inner shell being spaced from said outer shell to provide a cylindrical gas passage, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a washer vertically spaced above said separator head, said washer sealing said cylindrical space.

4. An oil and gas separator for use with a well, comprising in combination, an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having an open upper end and a lower closed end, said outer shell forming an oil collecting chamber; a separator head on said open upper end provided with a central opening and a plurality of apertures concentrically arranged about said central opening, said apertures communicating with said pocket, said well casing and said oil collecting chamber; an outer cylindrical shell extending through said well casing and said central opening into said chamber, said cylindrical shell having its lower open end within said chamber; an inner cylindrical shell in said outer cylindrical shell and having its open lower end in said chamber below said open lower end of said outer cylindrical shell, said inner shell being spaced from said outer cylindrical shell to provide a cylindrical gas passage, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a plurality of vertically spaced washers disposed above said separator head, said washers sealing said cylindrical space.

5. A gas-liquid separating device for wells, comprising in combination, an upright well casing in an oil well adjacent a source of oil, a lower member providing an oil collecting chamber in communication with said source, a pair of spaced telescoped cylindrical shells extending through said well and having lower ends terminating in said chamber, said shells having open lower ends, the lower end of the outer of said pair of shells being disposed above the lower end of the inner of said pair of shells; means connecting said outer shell to said lower member; said lower member being of greater diameter than said outer shell and spaced therefrom; said inner shell having an upper end adapted to be connected to a liquid pump, said outer shell and said well casing forming a cylindrical space; and a flexible sealing

member for closing said cylindrical space above said collecting chamber, said sealing member flexing downwardly to allow accumulations of oil on said sealing member to descend when the accumulations exceed a predetermined value.

6. A gas-liquid separating device for wells, comprising in combination, an upright well casing in an oil well adjacent a source of oil, said separating device comprising a lower member providing an oil collecting chamber having an upper end in communication with said source, a pair of spaced telescoped cylindrical shells extending through said well and having lower ends terminating in said chamber, said shells having open lower ends, the lower end of the outer of said pair of shells being disposed above the lower end of the inner of said pair of shells; means connecting said lower member to said outer shell, said lower member being of greater diameter than said outer shell and spaced therefrom; said inner shell having an upper end adapted to be connected to a liquid pump, said outer shell and said well casing forming a cylindrical space; and a sealing member for closing said cylindrical space above said collecting chamber, said pair of shells forming a cylindrical gas passage, said gas passage communicating with said cylindrical space above said sealing means.

7. A gas-liquid separating device for wells, comprising in combination, an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having a lower closed end and an upper open end communicating with said pocket and said lower end of said well casing; an outer cylindrical shell having its open lower end disposed within said tubular member, means connecting said outer shell to said outer cylindrical shell; an inner cylindrical shell disposed in said outer cylindrical shell and having its open lower end disposed in said outer shell below said lower end of said outer cylindrical shell, said inner cylindrical shell being spaced from said outer cylindrical shell to provide a cylindrical gas passage, said outer and inner cylindrical shells extending upwardly through said well casing, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a sealing member secured to said outer cylindrical shell disposed above said upper open end of said outer shell, said sealing member sealing said cylindrical space, said inner cylindrical shell being adapted to conduct oil from said outer shell, said gas passage being adapted to conduct gas from said tubular member, said outer shell being provided with means connecting said gas passage with said cylindrical space above said washer.

8. An oil and gas separator for wells, comprising in combination with an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having a lower closed end, said outer shell forming an oil collecting chamber; a separator head on said open upper end provided with a central opening and a plurality of apertures concentrically arranged about said central opening, said apertures communicating with said pocket, said well casing and said oil collecting chamber; an outer cylindrical shell extending through said well casing and said central opening into said chamber, said outer cylindrical shell having its lower open end within said chamber; an inner cylindrical shell in said outer cylindrical shell and having its open lower end in said chamber below said open lower end of said outer cylindrical shell, said inner shell being spaced from said outer shell to provide a cylindrical gas passage, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a sealing member vertically spaced above said separator head, said sealing member sealing said cylindrical space.

9. A gas-liquid separating device for wells, comprising in combination, an upright well casing having an open lower end communicating with a pocket in an oil bearing formation, an outer shell adapted to be disposed in said pocket and having a lower closed end, said outer shell forming an oil collecting chamber; a separator head on said open upper end provided with a central opening and a plurality of apertures concentrically arranged about said central opening, said apertures communicating with said pocket, said well casing and said oil collecting chamber; an outer cylindrical shell extending through said well casing and said central opening into said chamber, said outer cylindrical shell having its lower open end within said chamber; an inner cylindrical shell in said outer cylindrical shell and having its open lower end in said chamber below said open lower end of said outer cylindrical shell, said inner shell being spaced from said outer shell to provide a cylindrical gas passage, said outer cylindrical shell and said well casing being spaced from one another to provide a cylindrical space; and a flexible washer vertically spaced above said separator head, said flexible washer sealing said cylindrical space, said washer flexing downwardly to allow accumulations of liquid to descend past said washer when the weight of said accumulations exceed a predetermined limit.

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