Oct. 22, 1957 E. D. TUMLISON 2,810,352

OIL AND GAS SEPARATOR FOR WELLS

Filed Jan. 16, 1956 2 Sheets-Sheet 1

Fig. 1

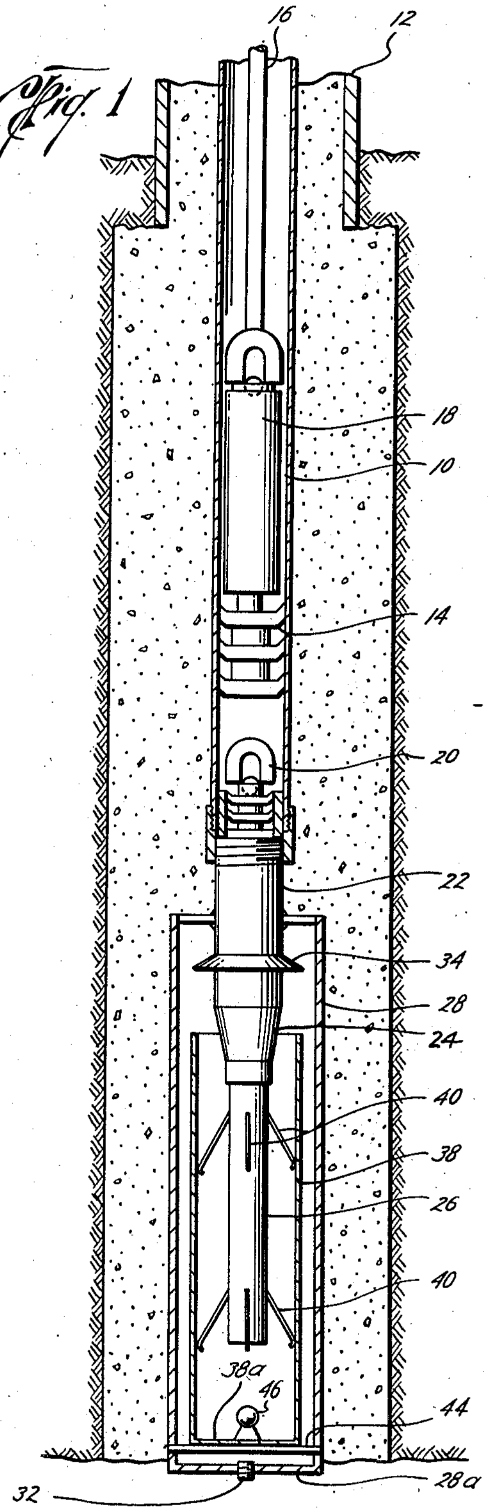
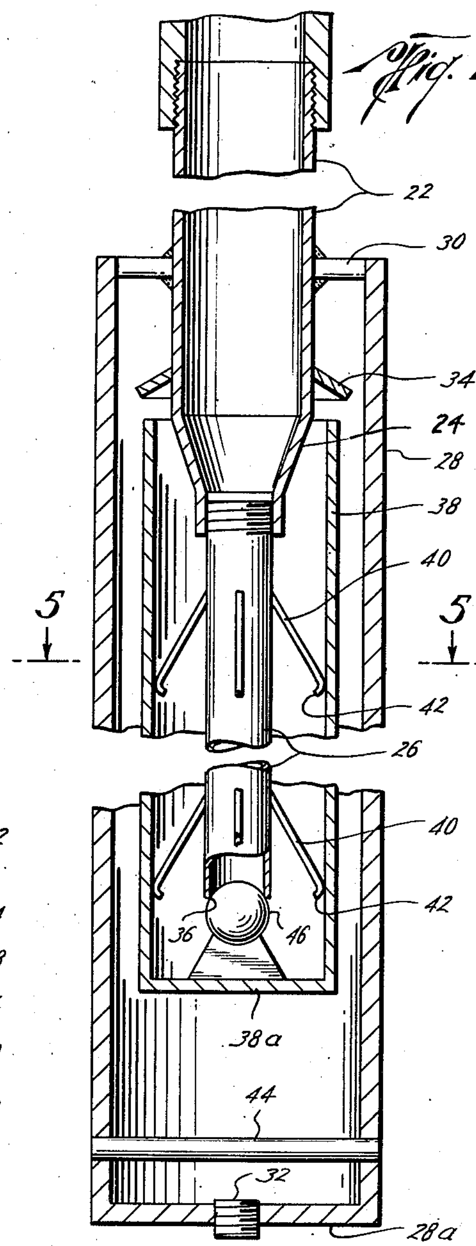


Fig. 2



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OIL AND GAS SEPARATOR FOR WELLS

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Fig. 3

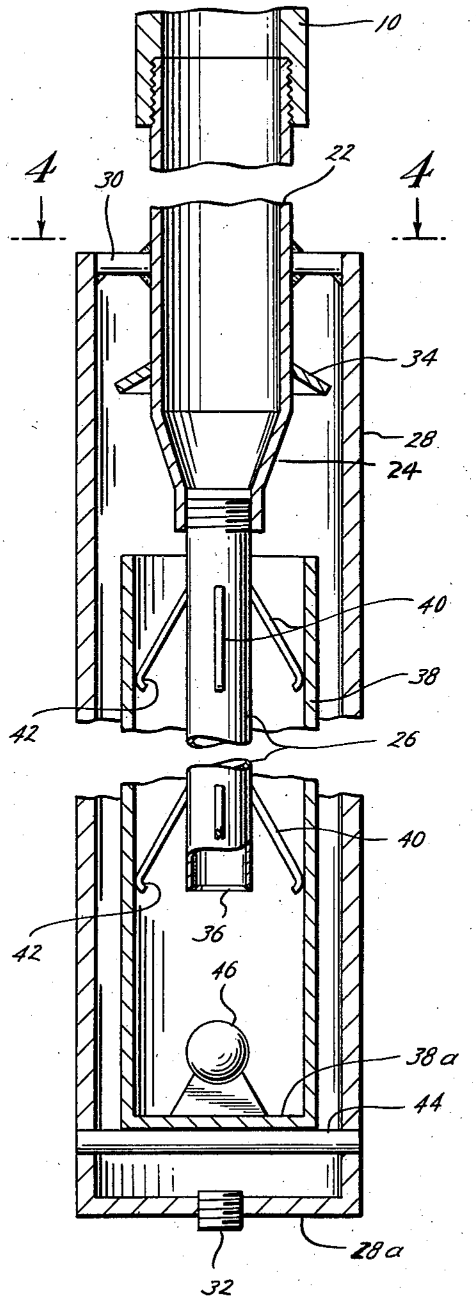


Fig. 4

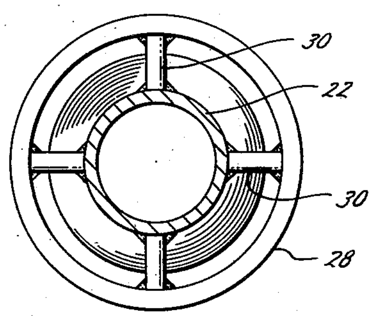
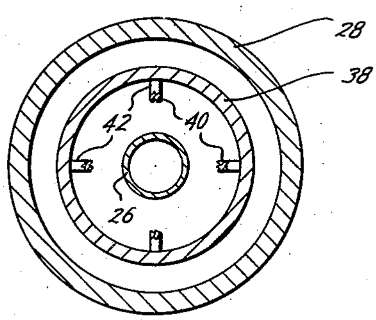


Fig. 5



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OIL AND GAS SEPARATOR FOR WELLS

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7 Claims. (Cl. 103—203)

This invention relates to the production of oil from wells and more particularly to the prevention of the depositing of paraffin or the like in well tubing during the removal of oil from a well.

During the operation of oil wells, one difficulty which is frequently encountered is the gradual depositing from the oil as the same flows through the well tubing of paraffin or other constituents having similar properties, such deposits often accumulating to an extent to prevent further removal of the oil and making it necessary to carry out expensive reconditioning operations before production can be resumed. It has been determined that one of the chief causes of the formation of such deposits in well tubing is the cooling effect of gas in the oil due to the reduction in pressure which occurs as the oil flows upwardly, the gas expanding as the pressure is reduced and causing a reduction in the temperature of the oil sufficient to effect congealing of the paraffin. Thus when the vapor pressure of dissolved gaseous hydrocarbons in the fluid in the bottom of the well exceeds the hydrostatic head of the column of fluid in the well tubing, gas is liberated and the expansion of the gas causes cooling of the oil which results in the formation of paraffin deposits in the tubing.

In wells which are being operated by pumping, the reduction in pressure as the oil moves upwardly also results in the separation of the gas from the liquid which sometimes causes the accumulation of gas in the working barrel of the pump in the space between the standing valve and the traveling valve, so that a gas lock is formed which prevents the pumping of the oil.

The present invention has for its chief object the provision of means for causing the separation of gas from the oil at a point in the well such that the depositing of paraffin in the well tubing will be prevented.

Another object of the invention is to provide means for causing the separation of gas from the oil in a well in a location to prevent such gas from interfering with the pumping of the oil from the well.

A further object of the invention is the provision of a gas separator for oil wells which operates to separate gas from the oil in a location to cause the gas to be retained in contact with oil flowing into the well from the surrounding formation while permitting the separated oil to enter the well tubing.

Another object of the invention is to provide gas separating mechanism for use in conjunction with well tubing and which embodies means for closing the tubing against the upward flow of fluid therethrough when the supply of oil in the well falls below a predetermined level and for opening the tubing to such flow when the supply of oil rises above said level.

Another object of the invention is the provision of a flow controlling gas separator assembly for use on well tubing which operates to cause separation of gas from the oil in the well before the oil enters the tubing and which also functions to close the tubing against the upward flow of gas therethrough when the level of oil in the well falls to a point at which gas may enter the tubing.

A further object of the invention is the provision of gas separating mechanism for use in oil wells which embodies an outer tubular housing having a closed bottom and whose upper end is opened positioned in surrounding radially spaced relation to the lower end portion of a well tubing, and an inner tubular member or bucket movably disposed in the housing in radially inwardly spaced relation to the housing and in surrounding radially outwardly spaced relation to the well tubing, said bucket being positioned to permit the flow of fluid in the housing into the bucket when the fluid in the housing rises above a predetermined level to cause the bucket to move downwardly to a position to open the lower end of the tubing, and to be moved upwardly by buoyancy when the fluid in the bucket falls to a predetermined level therein to a position to close the tubing against upward flow of fluid therethrough.

Other important objects and advantages of the invention will be made apparent from the following detailed description, constituting a specification of the same, when considered in conjunction with the annexed drawings, wherein—

Figure 1 is a fragmentary side elevational view, partly in cross-section and on a reduced scale of an oil well illustrating the invention as used in conjunction with well pumping apparatus,

Figure 2 is a vertical, central, cross-sectional view of the invention, showing the same in condition to close the tubing against upward flow of gas therethrough,

Figure 3 is a view similar to that of Figure 2, showing the invention in condition to permit the upward flow of fluid through the tubing;

Figure 4 is a cross-sectional view, taken along the line 4—4 of Figure 3, looking in the direction indicated by the arrows; and,

Figure 5 is a cross-sectional view taken along the line 5—5 of Figure 2.

Referring now to the drawings in greater detail, the invention is illustrated in connection with a well pump having a working barrel **10**, which may form a part of a tubing string of the usual type positioned in a well which is also provided with the usual casing **12**. Within the working barrel a pump plunger **14** is provided which is connected to the lower end of a pump rod **16** and which carries a traveling valve **18** of the usual type, and beneath the plunger the barrel is provided with a standing valve **20**.

The oil and gas separator of the invention is connected in communication with the lower end of the working barrel **10** and includes an inner tubular member **22** adapted to be connected at its upper end to the lower end of the working barrel **10** and whose lower end portion is tapered to form a portion **24** of reduced diameter which is internally threaded for the connection thereto of a pipe **26**. An outer housing or bucket **28** surrounds the lower end portion of the member **22** and pipe **26** in radially outwardly spaced relation thereto and is connected to the member **22** by radial arms **30** welded to the member and housing.

The upper end of the housing **28** is open, and at its lower end the housing is closed by a bottom **28***a*, which may be provided with a screw plug **32**, which may be removed for cleaning purposes. Within the housing the member **22** is provided with an external annular flange or fin **34**, whose outer edge is spaced radially inwardly from the interior of the housing, at a location somewhat above the reduced lower end portion **24** of the member. The lower end of the pipe **26** is provided with a beveled end face **36** for a purpose to be hereinafter explained.

Within the housing **28** a tubular element or inner bucket **38** is movably positioned, in radially outwardly spaced relation to the pipe **26**, and in inwardly radially spaced relation to the interior of the housing **28**. The element **38** is substantially shorter than the housing **28** and is maintained in substantially concentric relation to the housing and the pipe by radially extending spacer elements **40**, whose inner ends are attached to the exterior of the pipe, and whose outer ends are inturned, as indicated at **42** for sliding contact with the interior of the element. The element **38** is closed at the bottom by the bottom plate **38***a* and open at the top, and suitable means, such as a pin **44** may be provided, extending across the interior of the housing, in spaced relation to bottom **28***a* of the housing, with which the element is engageable, to limit downward movement of the element in the housing.

A valve member **46**, of ball shape, is positioned within the element **38**, and attached centrally to the bottom **38***a* of the element, in position to engage the beveled end face **36** of the pipe **26**, when the element **38** reaches the limit of its upward movement in the housing, to close the pipe **26**.

The dimensions of the parts are such that when the valve member **46** is in closing contact with the beveled end face **36** the upper open end of the element **38** will be spaced downwardly from the exterior flange **34** on the inner tubular member **22**, so that fluid may at all times overflow from the interior of the housing into the element **38**.

In making use of the invention constructed as described above, the tubular member **22** is connected at its upper end to the lower end of the working barrel **10**, or to the lower end of a tubing string, when other means is used for removing oil from the well, and the apparatus is positioned in a well in the manner illustrated in Figure 1. With the apparatus so positioned in the well, well fluid from the surrounding formation may flow into the upper end of the outer housing **28** to fill the housing, and when the fluid in the housing rises to a level to overflow into the inner bucket **38**, the inner bucket will be filled with fluid thereby decreasing or reducing its buoyancy in the well fluid, whereupon the inner bucket will move downwardly to the position shown in Figure 3, to open the lower end of the pipe **26**, so that fluid may be pumped upwardly through the tubing string.

During the flow of oil from the well into the upper end of the housing **28** the flow of oil will be retarded by the baffle **34**, which causes the oil to be agitated, resulting in separation of gas from the oil, such gas then passing upwardly out of the open end of the housing back into the well.

Should the level of the oil in the well fall below the upper end of the housing **28**, then further removal of the oil from the inner bucket **38** will increase its buoyancy so as to cause the inner bucket to float upwardly in the housing until the valve member **46** is moved into closing contact with the beveled end face **36** of the pipe **26**, to close the pipe, thus preventing the entrance of gas from the well into the tubing string. As soon as oil from the formation has accumulated in the well to an extent to permit the flow of oil into the upper end of the housing **28**, oil in the housing will overflow into the inner bucket, to again cause the inner bucket to move downwardly to open the lower end of the pipe **26**, and removal of oil from the well can then be resumed.

It will thus be seen that the invention provides an oil and gas separator of simple design and rugged construction, by which gas may be caused to separate from the oil at a location to prevent the depositing of paraffin in the well tubing, and which also operates to assure the retention of the gas in the well whereby the pressure in the well may be maintained, but which operates automatically to permit the removal of oil from the well as long as the level of oil in the well is above a predetermined level.

To assure effective operation of the device from its initial installation in the well, both the inner and outer buckets, at the time the device is lowered into the well on the tubing string, may be initially filled with a relatively high specific gravity liquid, such as salt water or brine like that commonly produced from oil wells. The valve at the end of the tubing string will then be in the open position shown in Figure 3. A few strokes of the pump will ordinarily be sufficient thereafter to suck the liquid from the outer bucket down to the level of the top of the inner bucket, which will thereby provide a minimum level of relatively heavy liquid in the outer bucket at all times. The inner bucket may be suitably weighted relative to the specific gravity of the heavy liquid, so that introduction of predetermined quantities of oil will cause the inner bucket to sink and open the valve, thereby providing sensitivity for the device.

Each of the buckets, but more particularly the inner bucket, is preferably constructed of any suitable nonmagnetic material, which may be metallic, such as copper, brass, aluminum and the like, or non-metallic material such as an appropriate and known plastic material, in order thereby to obviate magneto-static attraction which, if both buckets were constructed of iron or steel, can occur between the buckets as a result of the relative movement of the inner bucket, and thereby undesirably hinder the necessary free movement of the inner bucket.

The invention has been disclosed herein in connection with a certain specific embodiment of the same, but it will be understood that this is intended by way of example only, and that numerous changes can be made in the construction and arrangement of the various parts within the spirit of the invention, and the scope of the appended claims.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. An oil and gas separator for wells comprising, an outer tubular housing positioned in fixed, surrounding, spaced relation to a well tubing and having a closed bottom positioned below the lower end of the tubing and whose upper end is open, an inner tubular element whose external diameter is smaller than the internal diameter of the housing and whose internal diameter is larger than the external diameter of the tubing movably positioned in the housing for vertical movement therein in surrounding relation to the tubing and having a closed bottom positioned between the bottom of the housing and the lower end of the tubing and whose upper end is open, means in the element positioned to engage the lower end of the tubing to close the tubing upon movement of the element to an upper position in the housing and to disengage said lower end to open the tubing upon downward movement of the element to a lower position in the housing.

2. An oil and gas separator for wells comprising, an outer tubular housing positioned in fixed, surrounding, spaced relation to a well tubing and having a closed bottom positioned below the lower end of the tubing and whose upper end is open, an inner tubular element whose external diameter is smaller than the internal diameter of the housing and whose internal diameter is larger than the external diameter of the tubing movably positioned in the housing for vertical movement therein in surrounding relation to the tubing and having a closed bottom positioned between the bottom of the housing and the lower end of the tubing and whose upper end is open, means in the element positioned to engage the lower end of the tubing to close the tubing upon movement of the element in an upper position in the housing and to disengage said lower end to open the tubing upon downward movement of the element to a lower position in the housing, said element being movable

vertically relative to the end of the tubing in accordance with changes in its buoyancy in well liquid entering the outer housing from the well.

3. An oil and gas separator for wells comprising, an outer tubular housing positioned in fixed, surrounding, spaced relation to a well tubing and having a closed bottom positioned below the lower end of the tubing and whose upper end is open, an inner tubular element whose external diameter is smaller than the internal diameter of the housing and whose internal diameter is larger than the external diameter of the tubing movably positioned in the housing for vertical movement therein in surrounding relation to the tubing and having a closed bottom positioned between the bottom of the housing and the lower end of the tubing and whose upper end is open, means in the element positioned to engage the lower end of the tubing to close the tubing upon movement of the element to an upper position in the housing and to disengage said lower end to open the tubing upon downward movement of the element to a lower position in the housing, said element being movable vertically relative to the end of the tubing in accordance with changes in the buoyancy in well liquid entering the outer housing from the well, the length of said element being such that the upper end of the element lies below the upper end of said housing when the element is in its lowermost position in the housing.

4. An oil and gas separator for wells, comprising, in combination with a well tubing having an open lower end, a tubular outer casing fixedly secured to the tubing, said outer casing having a closed bottom and an open end into which the lower end of the tubing extends and through which well fluid may flow into the outer casing, a tubular inner casing disposed interiorly of the outer casing to receive the lower end of the tubing, said inner casing having a closed bottom and an open upper end to receive overflow of well fluid from the outer casing, said inner casing being movable longitudinally relative to the lower end of the tubing in response to changes in its buoyancy in the liquid in the outer casing, and valve means mounted in the inner casing and operable by the movements thereof to open and close the lower end of the tubing.

5. An oil and gas separator for wells, comprising, in combination with a well tubing having an open lower end, a tubular outer casing fixedly secured to the tubing, said outer casing having an open upper end into which the lower end of the tubing extends and through which well fluid may flow into the outer casing, a tubular inner casing disposed interiorly of the outer casing to receive the lower end of the tubing, said inner casing having a closed bottom and an open upper end to receive overflow of well fluid from the outer casing, said inner casing being movable longitudinally relative to the lower end of the tubing in response to changes in its buoyancy in liquid contained in the outer casing, and means operable by the movements of the inner casing to open and close the lower end of the tubing.

6. An oil and gas separator for wells according to claim 5 wherein one of said casings is constructed of non-magnetic material.

7. An oil and gas separator for wells, comprising, in combination with a well tubing having an open lower end, a tubular outer casing fixedly secured to the tubing, said outer casing having an open end into which the lower end of the tubing extends and through which well fluid may flow into the outer casing, a tubular inner casing disposed interiorly of the outer casing to receive the lower end of the tubing, said inner casing having a closed bottom and an open upper end to receive overflow of well fluid from the outer casing, said inner casing being movable longitudinally relative to the lower end of the tubing in response to changes in its buoyancy in the liquid in the outer casing, and valve means mounted in the inner casing and operable by the movements thereof to open and close the lower end of the tubing.

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