April 17, 1951 J. S. PAGE 2,549,706

BOTTOM HOLE SEPARATOR

Filed Feb. 24, 1948

Fig. 1.

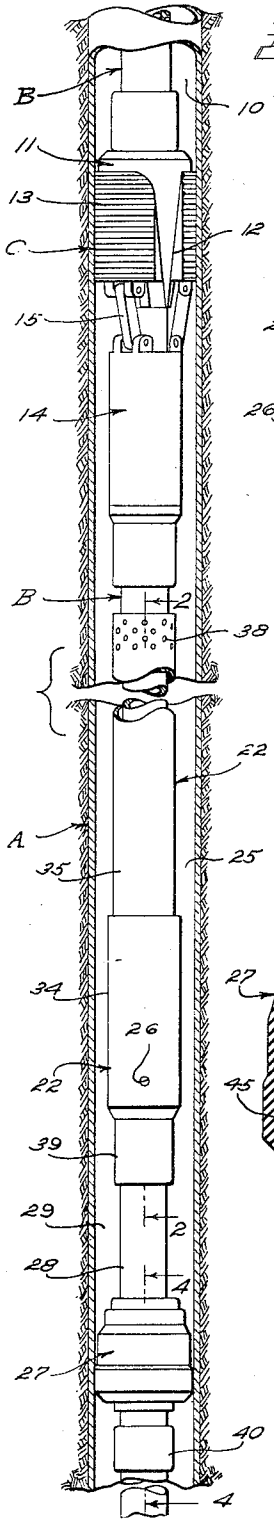


Fig. 2.

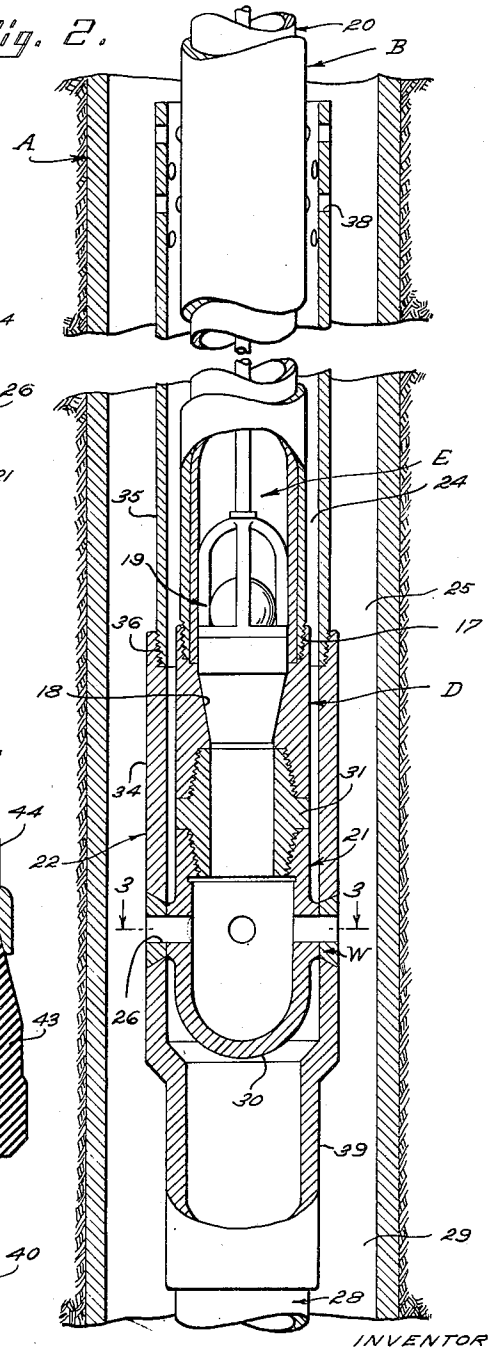


Fig. 3.

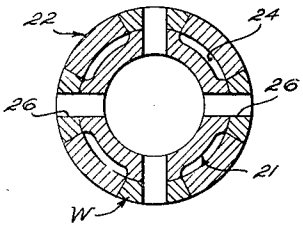
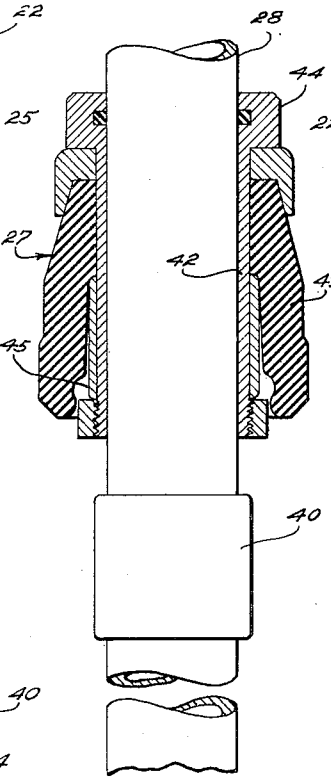


Fig. 4.



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BOTTOM HOLE SEPARATOR

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8 Claims. (Cl. 103—203)

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This invention relates to a bottom hole separator and it is a general object of the invention to provide a simple, practical, effective structure for use in a well to separate gas and liquids before delivery to the top of the well.

The structure of the present invention is intended primarily for use in an oil well where a tubing enters the well casing and carries a pump which is operated to pump liquids produced by the well. In many cases where the usual arrangement of such elements occurs gas that accompanies the liquid interferes with proper or efficient operation of the pump.

It is a general object of the present invention to provide a structure applicable to or operable in connection with a tubing, casing, and well pump so that gas accompanying solids or liquids as they are produced from the earth's formation is effectively separated from the liquids so that the pump receives only liquids that can be effectively handled thereby.

Another object of the present invention is to provide a gas separator of the general character referred to which involves few simple, effective parts and which is inexpensive of manufacture.

It is a further object of the present invention to provide a separator of the general character referred to including a packer that engages with the well casing and is shiftable relative to the part by which it is supported, so that it may be operated relative to said part to dislodge sand that may settle onto the packer.

The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of a well showing equipment located therein and embodying the present invention. Fig. 2 is an enlarged view of a portion of the structure shown in Fig. 1 with certain of the parts of the equipment embodying the invention shown in section. Fig. 3 is a detailed transverse sectional view taken as indicated by line 3—3 on Fig. 2, and Fig. 4 is an enlarged sectional view taken as indicated by line 4—4 on Fig. 1.

The structure embodying the present invention is shown applied to a well equipped with a liner or casing A. A string of tubing B enters the well from its upper end and fits within the casing A with substantial clearance, leaving an annular space 10 between the casing and the tubing. In the drawings I have shown the tubing

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equipped with a typical anchor C which is located at the lower end portion of the string of tubing and which serves to anchor or fix the tubing in the casing A against movement vertically therein during normal operation of the apparatus. The tubing B is further equipped with a pump seat or shoe D carrying a suitable well pump E which, in accordance with common practice, is located within the tubing and projects upwardly from the seat.

The particular tubing anchor C shown in the drawings is located in or on the tubing B at a point above the pump seat D. The anchor illustrated is of the general type more fully described and claimed in my copending application entitled Hydraulically Operated Anchor for Tubing or the Like, filed April 21, 1947, Serial No. 742,937 now Patent No. 2,532,418, December 5, 1950. This particular anchor involves, generally, a body 11 with inclined faces 12 carrying slips 13. The slips are coupled or linked to an operating means 14 through pivoted links 15. The operating means 14 is hydraulically operated, making it possible for the operator to set the slips at will.

The pump seat or shoe D is shown joined to the lower end portion of the tubing by a suitable threaded connection 17 and has a tapered seat 18 receiving a pump part.

The pump E may be any suitable form or type of well pump operable to receive fluid or liquid in the well and force or circulate it up through the tubing to the top of the well. My present invention is not concerned with details of the pump E and therefore I have only shown certain elements of the pump, such as the foot valve 19, barrel 20, etc.

The parts thus far described may be typical or conventional parts such as are employed in wells for the pumping of liquids, and so far as my present invention is concerned these elements may vary widely in form and construction.

The separator or structure of the present invention includes, generally, an inlet fitting 21 in connection with the pump shoe or seat D, a tubular body 22 extending upwardly from the fitting 21 around the lower end portion of the tubing B to establish an upwardly extending flow passage 24 and a settling chamber 25. The structure further involves liquid inlet ducts 26 that connect the lower end portion of the settling chamber and the interior of the fitting 21, and a packer 27 seals with the casing A of the well, closing the lower end of chamber 25. In the particular form illustrated the invention further involves an extension 28 of the body 22 which

depends below the fitting 21 to carry the packer 27 and to define a catch chamber 29.

The several parts of the separator cooperate with the tubing and the casing and the pump seat so that the body extension 28 forms an inlet duct admitting flow to the structure while the flow passage 24 is an annular passage extending a substantial distance above the fitting 21 and is formed between the exterior of the lower end portion of tubing B and the interior of the body 22.

The settling chamber 25 is an annular chamber that occurs between the exterior of the body 22 and the interior of the well casing A and is such that liquid discharged from the flow passage to the upper end of the body 22 settles down in the chamber 25 and finally enters the fitting 21 through the ducts 26. The catch chamber 29 is established between the exterior of body extension 28 and the interior of casing A above the packer 27 forming a chamber below the inlet ducts 26 such as to catch sand or like matter which may settle out of the material handled by the chamber 25.

The inlet fitting 21 is a vertically disposed tubular part with a bottom 30 closing its lower end. The fitting 21 is shown joined to the pump shoe D by a suitable coupling or connection 31. The coupling illustrated is threaded to the shoe and to the fitting so that these parts can be taken apart or separated when necessary.

The tubular body 22 may be formed of a length of tubing or casing larger in diameter than the tubing B and smaller in diameter than the casing A. In the preferred form of the invention the body 22 is joined or attached to the fitting 21 through or by means of the inlet ducts 26, although it will be apparent that other mounting or supporting means may be provided to carry the body 22 or to help in carrying the body 22, if desired. In the particular case illustrated the body has a main or central portion 34 that surrounds the fitting 21 with clearance and it has an upper portion 35 joined to the portion 34 as by a threaded connection 36, or the like, and extending a substantial distance above the fitting 21.

The ducts 26 support the body portion of section 34 concentric with the fitting 21, leaving a flow passage between these parts, as clearly shown in the drawings.

The upper section 35 of the body 22 being threaded to the lower section is supported thereby and is held concentric with the tubing which is joined to the fitting 21 through the coupling 31 and shoe D. In practice the upper section 35 of the body 22 may be of considerable length, so that it defines a long annular flow passage 24 and a long annular settling chamber 25.

In the case illustrated the upper end of the upper section 35 is open and a plurality of side outlet openings 38 are provided in the upper end portion of body section 35. In practice, by perforating the upper end portion of body section 35 to form openings 38 as shown in the drawings, liquid passed up through the passage 24 is allowed to escape or spill into the chamber 25 while gases pass straight up and out through the open top end of the body section 35. It will be understood, of course, that liquids may flow up to the top of the body section 35 to overflow therefrom to the chamber 25.

The extension 28 of the body 22 is, in effect, a lower section of the body and is a tubular part joined to the lower end of the main portion or section 34. In practice the extension 28 may

be considerably smaller in diameter than the upper end portion of body 35, and in the case illustrated the main portion 34 of the body is shown with a reduced lower end part 39 to which the upper end of the extension 28 is joined. It will be noted from the drawings that the reduced portion 39 of section 34 occurs below the fitting 21. Through this construction the extension 28 is open at its lower end to receive flow from the well and it admits the material received from the well to the flow passage 24 around the fitting 21 to flow past the ducts 26.

The inlet ducts 26 may vary in size, arrangement, and construction. The primary function of the ducts 26 is to admit flow or material from the lower portion of settling chamber 25 to the interior of fitting 21 and in accordance with my construction the ducts also serve as the means by which the tubular body is coupled to the fitting 21. I have shown a construction wherein there are several ducts 26 and when several ducts are employed it is preferred that they be circumferentially spaced, as shown in Fig. 3 of the drawings.

The ducts are tubular parts radially disposed with their inner ends joined with or to the fitting 21, while their outer ends are joined with or to the main section 34 of body 22. In the particular case illustrated the ducts 26 are integrally joined with or are in the nature of projections on the exterior of fitting 21 and they are joined to the body 34 by welding W.

The packer 27 is provided primarily as a closure for the lower end of the settling chamber 25. In the preferred arrangement the packer is carried by the body extension 28 and so that it is well below the ducts 26, in which case it is effective in forming a catch chamber 29. The packer 27 is such as to seal between the exterior of body extension 28 and the interior of the well casing A.

In accordance with my invention the extension 28 is of considerable length and the packer 27 is slidable on the extension 28 as between the lower end portion 39 of body section 34 and a coupling or stop 40 on the extension. With this construction relative movement may be obtained between the extension and the packing in the event that sand, or the like, should lodge upon or be deposited above the packer the extension can be worked or reciprocated in the packer in a manner to dislodge or work it loose, enabling it to be pumped out and freeing the packer for removal when desired.

The particular packer illustrated is shown as including a tubular core 42 carrying a body or sleeve 43 of rubber, or the like. The sleeve is confined on the core by flanges or retaining parts 44 and 45.

From the foregoing description it will be apparent that I have, through my present invention, provided a structure readily applicable to a conventional arrangement of parts and that the separator will serve to handle material produced by the well so that gas is effectively separated from the solid matter, the gas being allowed to escape upwardly in the casing around the tubing after passing from the upper end of the separator body 22 while the solid matter or liquid settles in the chamber 25 to be admitted to the pump through the fitting 21. As above pointed out, sand settling out of the material handled by the chamber 25 and deposited above the packer may be dislodged or worked loose through movement of the extension 28 relative to the packer.

The structure of the present invention involves but few simple parts, all of which are inexpensive of manufacture and do not complicate or encumber the equipment employed in the well.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention, I claim:

1. A separator applicable to a tubing located in a casing including, an inlet fitting for connection with the tubing, the fitting being closed at its lower end and opening upwardly into the tubing, a tubular body carried by the fitting open at its ends and surrounding the tubing with clearance and fitting the casing with clearance, a packer between the body and casing and having a sealing part actuated to seal with the casing by fluid pressure against its lower end, and an inlet duct connecting the exterior of the body with the fitting at a point above the packer, the body having a section depending below the fitting and slidably carrying the packer.

2. A separator applicable to a tubing located in a casing including, an inlet fitting for connection with the tubing, the fitting being closed at its lower end and opening upwardly into the tubing, a tubular body carried by the fitting open at its ends and surrounding the tubing with clearance and fitting the casing with clearance, a packer between the body and casing, and an inlet duct connecting the exterior of the body with the fitting at a point above the packer, the packer having an inner element in sealed sliding engagement with the body for limited movement longitudinally thereof and having an outer fluid pressure actuated element having sealing engagement with the casing.

3. A separator applicable to a tubing located in a casing including, an inlet fitting for connection with the tubing to be carried thereby, the fitting being closed at its lower end and opening upwardly into the tubing, a tubular body fitting the casing with clearance and having an upper end portion surrounding the tubing with clearance, the body being open at its ends, and a packer between the body and casing below the fitting, the fitting having inlet ducts projecting outwardly therefrom and attached to the body, the ducts connecting the exterior of the body with the fitting at a point above the packer and being the sole support for the body.

4. A separator applicable to a tubing located in a casing including an inlet fitting for connection with the tubing, the fitting being closed at its lower end and opening upwardly into the tubing, a tubular body carried by the fitting open at its ends and surrounding the tubing with clearance and fitting the casing with clearance, a packer sealing between the body and casing, and a plurality of circumferentially spaced inlet ducts connecting the exterior of the body with the fitting at a point above the packer, the body being supported by the fitting through the inlet ducts and the packer being freely slidable on a portion of the body depending below the fitting for limited movement relative thereto and having an element sealing with the casing and actuated by fluid pressure against the lower end of the packer.

5. A separator applicable to a tubing located in a casing including, an inlet fitting for connection to the lower end of the tubing to be supported thereby, the fitting being closed at its lower end and opening upwardly into the tubing, an open ended tubular body entirely free of the tubing and having a main section surrounding the fitting, a lower section depending from the main section, and an upper section wholly supported by the main section and projecting upward from the main section and around the tubing without attachment thereto, a packer carried by the lower section to seal between the body and casing, and an inlet duct joining the main section and fitting and connecting the exterior of the body with the interior of the fitting.

6. A separator applicable to a tubing located in a casing including, an inlet fitting for connection with the tubing, the fitting being closed at its lower end and opening upwardly into the tubing, an open ended tubular body having a main section surrounding the fitting, a lower section depending from the main section, and an upper section projecting upward from the main section and around the tubing, a packer carried by the lower section including, a sleeve slidably engaged on the said lower section to have limited movement longitudinally thereof, a seal between the sleeve and said lower section, and a packing element on the sleeve to seal with the casing and being actuated by fluid pressure on the lower end of the packer, and an inlet duct joining the main section and fitting and connecting the exterior of the body with the interior of the fitting.

7. A fitting applicable to a well tubing to support a tubular element around the tubing including, a vertically disposed tubular body closed at its lower end and having a threaded coupling portion at its upper end, and a plurality of circumferentially spaced projections on the exterior of the body for attachment to said element and having openings through them from the exterior of said element to the interior of the body, the said projections being the sole connections between the body and said element.

8. A fitting applicable to a well tubing to support a tubular element around the tubing including, a vertically disposed tubular body closed at its lower end and having a pump connection at its upper end, and a plurality of circumferentially spaced projections on the exterior of the body and having outer ends for the reception of welding material for joining the projections and said element, the projections having openings through them from the exterior of said element to the interior of the body, the said projections being the sole connections between the body and said element.

JOHN S. PAGE.

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