Dec. 6, 1927. 1,651,968

C. H. M. ROBERTS

SEPARATING APPARATUS FOR WELLS

Filed March 18. 1926

Fig. 1.

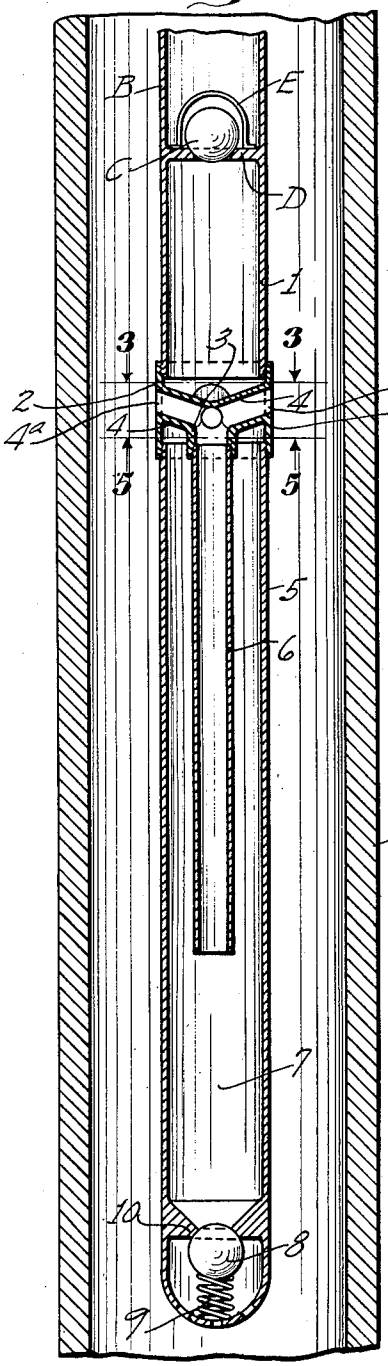


Fig. 3.

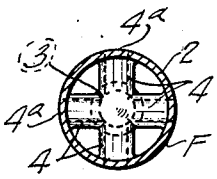


Fig. 4.

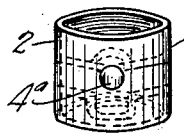


Fig. 5.

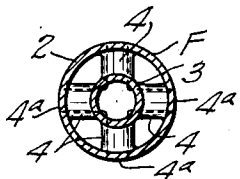
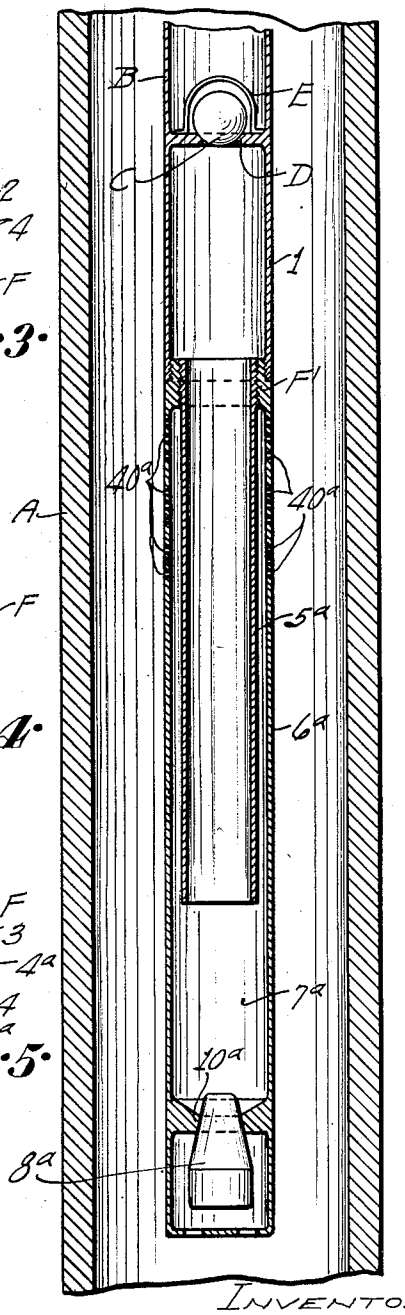


Fig. 2.



INVENTOR
C. H. M. Roberts.
By Bakewell & Church
ATTORNEYS

Patented Dec. 6, 1927. 1,651,968

UNITED STATES PATENT OFFICE.

CLAUDIUS H. M. ROBERTS, OF ST. LOUIS, MISSOURI, ASSIGNOR TO WM. S. BARNICKEL & COMPANY, OF WEBSTER GROVES, MISSOURI, A CORPORATION OF MISSOURI.

SEPARATING APPARATUS FOR WELLS.

Application filed March 18, 1926. Serial No. 95,693.

This invention relates to an apparatus that is adapted to be used in a well, principally an oil well, for effecting the separation of free gases and solid matter from the liquid produced in the well before said liquid enters the working barrel of the pump that is used to force the liquid upwardly through the well tubing.

In the production of liquid from pumping oil wells there are frequently encountered considerable quantities of sand or other solid impurities in a relatively fine state of subdivision, which solid matter, due to the small size of the particles of same and to the velocity, turbulence of flow and viscosity of the liquid in which it is suspended, fails to separate from the liquid during the time the liquid remains in the well, and accordingly, is drawn into the barrel of the well pump with the liquid and delivered either in whole or in part with the liquid issuing from the well. A portion of the sand or other solid impurities may remain in the barrel or on other parts of the pump, or it may settle from the liquid in the tubing which connects the pump with the surface flow lines, thereby causing considerable difficulty in the efficiency and economical operation of the pumping equipment and resulting in rapid deterioration of said equipment.

Another factor which also frequently operates to reduce the efficiency of the pumping equipment of oil wells and the economical recovery of oil, is the presence of free gases in the liquid produced in the well.

And still another factor which adds to the cost of producing oil is the separating operation that has to be resorted to above the surface of the ground to remove the solid impurities from the oil so as to render it suitable for sale or commercial use.

One object of my invention is to provide an apparatus of novel construction for use in connection with the pumping equipment of wells that will effectively separate the sand or other solid impurities and free gas from the liquid produced in the well prior to said liquid being drawn into the working barrel of the pump, thereby increasing the efficiency of operation of the pumping equipment of wells; preventing or greatly retarding the deterioration of said equipment, due to the action of sand or gas, and overcoming the necessity of subsequently treating the liquid produced from the well to remove suspended solid impurities.

Another object of my invention is to provide an apparatus of the character mentioned which is based upon correct physical principles; is simple in construction, inexpensive to manufacture and of such design that it is reliable and will not clog, highly efficient and economical in operation.

Another object of my invention is to provide an apparatus of the character described, which is of such design that the sand or other suspended solid impurities separated from the liquid will be collected in a chamber from which said impurities may be periodically dumped into the well, without the necessity of removing the apparatus from the well for the purpose of cleaning or removing the collected foreign material. Other objects and desirable features of my invention will be hereinafter pointed out.

To this end I have devised an apparatus that is adapted to be arranged in a well below the well pump and which comprises a passageway of such construction and arrangement that the liquid produced in the well will have to travel through said passageway before entering the barrel of the pump, and in traveling through said passageway, will be subjected to such action as to result in the separation of the free gases and solid impurities and the collection of said solid impurities at a point from which they can be easily discharged, without removing the apparatus from the well. Generally, the passageway above referred to will be of such design that the liquid will flow in opposite directions and at different velocities, in traveling through said passageway, and will remain in a relatively quiescent state in a portion of said passageway, the portion of the passageway through which the liquid first travels being so constructed that the free gases in the liquid can readily separate from the liquid. The apparatus can be constructed in various ways without departing from the spirit of my invention, but in most instances it will comprise a return bend passageway formed by two pipes or tubular members arranged one within the other and spaced apart so as to produce two parallel legs connected together at one end and arranged so that the liquid will pass from the well into the open end of one of said legs, and after flowing in opposite di-

rections through said legs, will enter the barrel of the pump. The leg or receiving portion of said passageway through which the liquid first travels is of greater capacity than the working barrel of the well pump, so as to insure the free gases separating from the liquid while it is traveling through said receiving portion, and a collection chamber or sedimentation chamber is arranged below the point where the respective legs of said passageway are joined together, so as to receive and collect the solid matter that settles out of the liquid while it is traveling through said passageway, said collection chamber being preferably equipped with a discharge valve that can be operated either automatically or manually to effect the discharge of the solid matter from said chamber. The other leg or discharge portion of said passageway is so proportioned with relation to the receiving portion of said passageway that the liquid will undergo a change of direction of motion and reduction of velocity in entering said discharge portion to insure settling of any solid matter in the liquid that has failed to settle during the flow of the liquid through the receiving portion or intake portion of the passageway.

Figure 1 of the drawings is a vertical longitudinal sectional view of a separating apparatus constructed in accordance with my invention, illustrating said apparatus arranged in operative position in a well below the well pump.

Figure 2 is a similar view, illustrating another form of my invention.

Figure 3 is a cross-sectional view, taken on the line 3—3 of Figure 1, looking in the direction indicated by the arrows.

Figure 4 is a perspective view of the part of the apparatus shown in Figure 1, which sustains the two coaxially arranged pipes that constitute the return bend passageway through which the liquid travels on its way to the working barrel of the pump; and

Figure 5 is a horizontal sectional view, taken on the line 5—5 of Figure 1, looking in the direction indicated by the arrows.

In Figures 1 and 2 of the drawings, which illustrate two different forms of my invention, A designates the casing of a well, B designates the working barrel of the well pump, C designates the intake valve of said pump, D designates the seat for said valve and E designates the cage that limits the movement of the valve upwardly off its seat. The apparatus shown in Figure 1 comprises a tubular member 1, of substantially the same internal diameter as the working barrel of the well pump, attached to the lower end of said barrel and proportioned so that the liquid capacity of same is approximately twice that of the working barrel. Attached to the lower end of the tubular member 1 is a fitting, designated as an entirety by the reference character F, that is composed of a sleeve 2 and a hollow member 3 arranged inside of said sleeve in coaxial relation with the same and provided at its upper end with a plurality of laterally-projecting, tubular branches 4 whose outer ends terminate in inlet openings 4^a on the exterior of said sleeve 2, the hollow member 3 being closed at its upper end, as shown in Figure 3, and the tubular branches 4 on said member being inclined downwardly from their outer ends or inlet ends, as shown in dotted lines in Figure 1. The branches 4 are so proportioned that they are not liable to become clogged when the apparatus is in use, the combined cross-sectional area of said branches being somewhat greater than the cross-sectional area of the hollow member 3 with which said branches communicate.

Two pipes 5 and 6 are connected to the lower end of the fitting F and project downwardly from same, as shown in Figure 1, the outer pipe 5 being connected at its upper end to the sleeve 2 of said fitting, and the inner pipe 6 being connected at its upper end to the hollow central member 3 of said fitting. The pipes 5 and 6 form a return bend passageway through which the liquid produced in the well has to travel before it enters the barrel B of the well pump, and the inner pipe 6 which constitutes the first leg or receiving portion of said passageway is of such diameter that its cross-sectional area is one-half or less the cross-sectional area of the annular space between the pipes 5 and 6 which constitutes the second leg or discharge portion of said passageway. The inner pipe 6 is of such length that the liquid capacity of same is somewhat greater than the capacity of the working barrel B of the well pump. The outer pipe 5 is considerably longer than the inner pipe 6, so that the lower portion of said pipe 5 will serve as a sedimentation chamber 7 that receives and collects the solid matter that settles out of the liquid while it is flowing to the working barrel of the pump, said sedimentation chamber or collection chamber being provided at its lower end with an outlet through which the collected matter can be discharged from said chamber. Usually the outer pipe 5 will be approximately twice the length of the inner pipe 6.

In the form of my invention illustrated in Figure 1 the discharge opening at the lower end of the sedimentation chamber 7 is normally closed by a valve of any suitable form, such, for example, as a ball valve 8, that is acted upon by a spring 9 which holds it seated against a valve seat 10 at the lower end of the collection chamber 7, said valve being so arranged that downward movement of same uncovers the discharge opening of the chamber 7 and permits the collected solid material in said chamber to escape from same and

drop into the well. If desired, a valve 8ª of the kind shown in Figure 2, hereafter described, can be used in place of the valve 8.

The operation of the apparatus is as follows: On each upward stroke of the piston in the working barrel B of the well pump, liquid will be drawn from the well into the upper end of the pipe 6 through the inlet openings 4ª of the radially-disposed, tubular branches 4 of the fitting F. On the succeeding downward stroke of said piston this liquid remains in the pipe 6 in a state of relative quiescence, thus permitting the free gases in the liquid to rise in the pipe 6 and escape through the inlet openings 4ª of the fitting F into the well casing. During this time the sand and other solid impurities in the liquid begin to settle out or travel downwardly through the pipe 6, due to their greater density and inertia of motion. On the next succeeding upward stroke of the piston of the well pump the liquid in the pipe 6 is drawn downwardly and enters the pipe 5. At this moment the liquid undergoes an abrupt change in direction from downward to upward motion. The upward velocity, moreover, is only one-half or less the downward velocity, due to the relative sizes of the pipes 5 and 6. The change of direction and decrease of velocity combine to afford the maximum sedimentation effect on the sand or other suspended material which settles through the quiescent liquid in the collection chamber 7. During the succeeding upward strokes of the piston of the well pump the liquid is gradually drawn upward through the annular space between pipes 5ª and 6ª through the spaces between the radially-disposed branches 4 of the fitting F, through the tubular member 1 to which said fitting is connected and thence past the inlet valve C into the working barrel B of the pump. The upward motion of the liquid from the time it enters the pipe 5 is relatively slow and quiet, since its velocity has been greatly reduced and since the capacity of the separator, from the lower end of the pipe 6 to the inlet valve of the well pump, is at least four times the capacity of the working barrel of said pump.

When sufficient sand or other solid material has settled on top of the valve 8 that closes the discharge opening of the sedimentation chamber 7 to overcome the strength of the spring 9, said valve moves downwardly from its seat and permits the collected material in the chamber 7 to escape from same and drop into the well, and after sufficient material has escaped from the chamber 7 to reduce the overload on the valve 8, the spring 9 of said valve will seat said valve, and thus automatically close the discharge opening of said chamber.

If the conditions of deposition or the character of the deposited material are such that it packs too solidly in the collection chamber 7 to permit the valve 8 to open automatically, said material may be easily discharged from said chamber and dumped into the well by "bumping" the well tubing on the casing head, which operation will jar said valve open and set the sedimented material in the chamber 7 in motion. The "bumping" of the well tubing to which the working barrel of the pump and my improved separating apparatus are attached can be easily accomplished by attaching the handling tackle commonly used in oil well operations and alternately raising and lowering the well tubing, allowing it to strike against the casing head at the end of each downward motion. If this manual operation of discharging the sedimented material from the collection chamber 7 should become necessary, it should be repeated, at suitable intervals, dependent upon the rate of deposition and the capacity of the sedimentation chamber, in order that said chamber will not become filled, for filling of said chamber with sedimented material would prevent the apparatus from functioning properly.

While I prefer to construct the apparatus in the manner illustrated in Figure 1, this is not essential, for various changes could be made in the construction of the apparatus without departing from the spirit of my invention, so long as the apparatus is of such design that the liquid from the well will enter the upper end of a return bend passageway, will travel downwardly through the receiving portion of said passageway in such a manner that the free gases can separate and escape preferably back into the well casing, said liquid will then change its direction flow and move upwardly at a decreased velocity through the discharge portion of the passageway to the working barrel of the pump, and the solid matter in the liquid that settles out or separates during the flow of the liquid through the return bend passageway will collect at a point, to wit, the sedimentation chamber 7, from which it can be easily discharged, without removing the apparatus from the well. While I have stated that the apparatus illustrated in Figure 1 is provided with a tubular member 1 that is used to join the fitting F to the working barrel of the well pump, it is not absolutely necessary that the apparatus be equipped with such a tubular member 1, although it is preferable to construct the apparatus in this way, in order to insure sufficient liquid capacity above the sedimentation chamber 7 to decrease the turbulence of bow in the separator, due to surging action of the working barrel of the well pump.

The apparatus illustrated in Figure 2 operates on the same principle as the apparatus shown in Figure 1 and is provided with a return bend passageway formed by a

pipe 5^a arranged inside of a pipe 6^a. The receiving portion of said passageway, however, is formed by the annular space between the pipes 5^a and 6^a and the discharge portion of said passageway is formed by the inner pipe 5^a, and said pipes are joined together at their upper ends by a fitting F' connected to the lower end of a tubular member 1 whose upper end is attached to the lower end of the working barrel of the well pump. The cross-sectional area of the inner pipe 5^a is twice or more the cross-sectional area of the annular space between the pipes 5^a and 6^a, and said inner pipe 5^a is of such length that the liquid capacity of said annular space is somewhat greater than the capacity of the working barrel of the well pump. In the apparatus shown in Figure 2 the liquid passes from the well into the receiving portion of the return bend passageway through inlet ports 40^a in the upper end portion of the pipe 6^a, the aggregate area of said inlet ports being somewhat greater than the cross-sectional area of the annular space between the pipes 5^a and 6^a. Another slight difference in the construction of the apparatus shown in Figure 2 is that the sedimentation chamber or collection chamber 7^a is provided with a discharge valve 8^a that consists of a hollow metal float arranged so that it normally closes a discharge opening in a valve seat 10^a at the lower end of the chamber 7^a, said float or valve 8^a being of sufficient volume that its buoyancy serves to keep it in contact with its co-operating seat. It will be understood, of course, that the types of valves shown in the two forms of separator are not peculiar to the design with which they are associated.

When the well pump is in operation the liquid passes from the well into the separator through the inlet ports 40^a in the pipe 6^a and then passes downwardly through the annular space between said pipe and the pipe 5^a. The free gas is separated at this time and rises to the top of said annular space where it passes back into the well through the upper row of inlet ports 40^a. The liquid, upon reaching the bottom of the annular space between the pipes 5^a and 6^a, reverses and flows upwardly through the pipe 5^a at a reduced velocity, thereby insuring the suspended solid material in the liquid settling in the collection chamber 7^a, and remaining therein until it is discharged by opening of the discharge valve 8^a.

From the foregoing it will be understood that my separating apparatus comprises two novel features:

(1st) A return bend passageway of such design that the liquid, after traveling through the receiving portion of said passageway, will reverse and flow pwardly at a decreased velocity through the discharge portion of said passageway; and

(2nd) A collection chamber that is equipped with a means for enabling the sedimented material to be discharged therefrom without withdrawing the apparatus from the well. Said features are capable of use independently of each other, and accordingly, I wish it to be understood that my invention contemplates equipping existing types of separators for wells with a discharge valve, by means of which the sedimented material that collects in the separator can be discharged therefrom without removing the separator from the well.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

A separating apparatus adapted to be arranged in a well below the well pump and comprising a passageway disposed so that the liquid produced in the well will have to travel through said passageway before entering the barrel of the well pump, said passageway being constructed so as to cause the liquid to remain in a substantially quiescent state after entering said passageway, then flow downwardly through said passageway and thereafter flow upwardly at a reduced velocity towards the well pump, a collection chamber or sedimentation chamber combined with said passageway in such a manner as to receive the solid impurities that settle out of the liquid while it is flowing through said passageway, a discharge opening for said collection chamber, and a float valve for closing said discharge opening designed so that its buoyancy keeps it seated.

CLAUDIUS H. M. ROBERTS.