

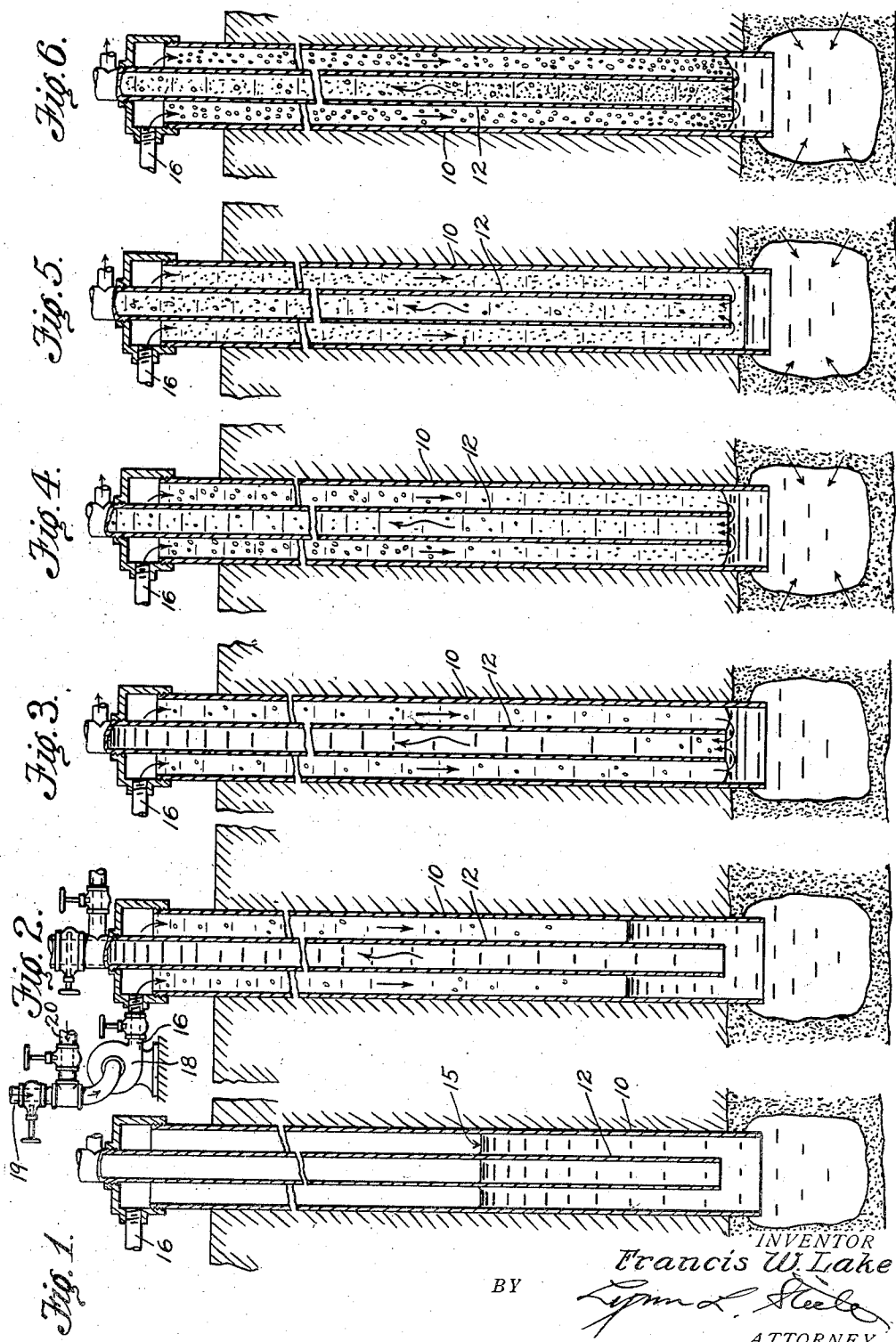
Dec. 17, 1929.

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1,740,102

DISPLACING DEAD CASING OIL FOR INITIATING GAS LIFT IN OIL WELLS

Filed July 18, 1927



UNITED STATES PATENT OFFICE

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DISPLACING DEAD CASING OIL FOR INITIATING GAS LIFT IN OIL WELLS

Application filed July 18, 1927. Serial No. 206,678.

This invention relates to the so-called "gas lift" method of flowing deep wells, particularly oil wells, and has been designed to overcome the excess hydrostatic head of oil which ordinarily accumulates in such wells prior to starting gas lift and which ordinarily cannot be removed by direct application of a reasonable gas pressure in attempting to initiate gas lift.

Gas lift, as now commonly practiced, consists in passing gas under pressure into a well containing a flow tube, so that the gas passes around the lower end of the flow tube in a stream and in its passage atomizes the oil as fast as it is forced up to said tube end by the natural rock pressure in the well, the atomized oil being carried to the surface in the gas stream. The gas may be introduced either through the flow tube or through the casing, the atomized oil being discharged from the other of the two; however, it is preferred usually to introduce the gas into the casing and discharge the oil from the flow tube.

But, as above indicated, the initiation of gas lift usually offers difficulties, due to the fact that during a preceding period of idleness a relatively great hydrostatic head of oil has accumulated in the well hole, which head usually cannot be overcome by steady application of a moderate pressure to one side of the flow tube. This condition arises for the reason that, as pressure is applied to one side of the tube to depress the oil level therein, the hydrostatic head increases in the other side. While some of the oil is forced back into the formation (depending upon the viscosity of the oil, the friction of the formation, and the like) the effective rock pressure in the vicinity of the well increases until it is sufficient to balance the increased hydrostatic head. Thus, upon any attempt to start gas lift by straight application of pressure to one side in order to force over the entire excess load of accumulated oil and uncover the lower end of the tube for passage of gas thereunder, the hydrostatic head will increase until it reaches the maximum, that is, until it is equal to the entire height of the flow tube, which height may be as much as several thousand

feet. Moreover, the pressure which would be high enough to start gas lift by such steady application, that is, a normal starting pressure, under these conditions, would be excessive for all other purposes, since which the oil level is lowered and gas lift started, normal continuation of gas lift may be and should be carried on with a much lower pressure, this being made possible by a much lower density of the gas-and-oil column in the flow tube during normal gas lift as compared with the oil before gas lift. Thus, it is clear that it is not convenient or desirable to maintain said excessive pressure merely for the purpose of overcoming said hydrostatic head.

Another important consideration is the fact that the oil body found in some wells is so heavy and so free from absorbed gas and other light constituents, that the hydrostatic pressure of a given column is materially greater than that of a less heavy oil. Thus, this reavy gas-free oil, which is commonly termed "dead" oil, offers additional difficulties, especially when very "dead", that is, when containing no material quantities of light elements.

The object of this invention, is to overcome the difficulties described and provide a method whereby the head of accumulated oil, particularly where the oil is very "dead", may be removed with comparative ease so that the available relatively low gas pressure may be employed to initiate and maintain normal gas lift.

This method comprises essentially the introduction of a quantity of relatively light oil into a well casing to raise the level of the oil and decrease the hydrostatic head which would otherwise develop in the flow tube upon application of pressure to the casing. The dead oil is discharged through the flow tube and introduction of light oil into the top of the casing is continued whereby the dead oil is eventually displaced by the light oil. The light oil may be obtained by introducing gas (preferably natural gas) into the casing with a heavy oil whereby the heavy oil is livened up or "rejuvenated", the proportion of the gas so introduced being gradually increased so that said light oil successively becomes very

light, eventually is atomized, and finally is entirely displaced with gas. Meanwhile, discharge through the flow tube is continued so that the light oil which displaces the dead oil is itself displaced by a much lighter oil, and then by the atomized oil and finally by gas, whereupon normal gas lift commences and continues. More briefly stated, the invention may be considered, generically, to be a method for initiating gas lift in a well containing a considerable head of dead oil, by gradually displacing the dead oil with a lighter oil and gradually displacing the light oil with gas.

In the accompanying drawings wherein the various steps of this method are represented diagrammatically,

Fig. 1 indicates a well in which a considerable head of heavy oil has accumulated prior to the initiation of gas lift, the flow tube being shown depending into the said oil;

Fig. 2 represents the step of introducing light oil into the casing above the heavy oil to raise the oil level;

Fig. 3 is the condition when the dead oil has been displaced with light oil;

Fig. 4 represents the introduction of large quantities of gas with light oil for gradual displacement of light oil;

Fig. 5 indicates that stage where the light oil being introduced has been almost entirely replaced with gas; and

Fig. 6 represents the final stage wherein the atomized oil has been displaced and gas is passing into the lower end of the flow tube to atomize the dead oil as it flows into the well.

In the drawings the well casing 10 is shown as containing a large quantity of very dead oil into which the flow tube 12 depends, the level of the said oil being indicated at 15 as lying sufficiently high above the lower end of the flow tube as to materially hinder the initiation of gas lift. A casing inlet 16 for oil and gas is connected with a compressor or pump 18 having a gas supply line 19 and an oil supply line 20, whereby light oil may be introduced into the casing above the dead oil. Of course, as the light oil is introduced into the casing and the total hydrostatic head is thereby increased some of the dead oil is thereby forced back into the formation, but since this return of the dead oil to the formation is relatively slow, the casing can be readily filled with the light oil thus causing the head of dead oil to rise in the tube. When the casing has become filled with light oil, the pressure of the pump 18 will then be sufficient to overcome the excess head of the dead oil over the light oil, and discharge of dead oil from the flow tube will commence with consequent lowering of the dead oil in the casing (Fig. 2). The introduction of light oil through inlet 16 is continued until the dead oil has been entirely displaced as indicated in Fig. 3. Then, in order to displace the light oil, gas

in large quantities is introduced into the casing therewith, and the proportion of gas so introduced is gradually increased. Meanwhile, discharge through the flow tube continues so that the light oil is gradually removed and displaced by the oil and gas mixture. This removal of light oil and increase in quantity of gas introduced with the light oil, is continued until all of the head of oil above the lower end of the flow tube is removed and only gas is introduced into the casing as indicated in Fig. 6, gas lift thus being accomplished.

It will be seen that since the circulation from the top of the casing is downward to the lower end of the flow tube and thence upward through the tube to the surface, the head of heavier oil will be gradually displaced by the light oil and the static head in the tube will be gradually reduced correspondingly due to the difference in specific gravity and to the elevating effect of the dissolved gas. Thus, the pressure applied to the casing will always be sufficient to overcome the excess static head of the fluid contained in the flow tube, so that this gradual displacement of a heavier fluid by a lighter fluid is accomplished very readily. Therefore, this method comprises, primarily, two merging steps, namely, gradual displacement of the very heavy, dead oil with light oil and the gradual displacement of the light oil with gas until gas lift is finally established. Moreover, gas lift may in this manner be accomplished with a much lower pressure than would be required by other methods. For example, where a pressure as high as 800 pounds would be insufficient to overcome the hydrostatic head and initiate gas lift by direct application in the usual manner, a pressure of 300 pounds to 400 pounds applied by the oil pump will be sufficient to initiate gas lift by the present method, this pressure being lowered as the amount of introduced gas is increased, until normal gas lift is effected when it may be continued with about 120 pounds.

The above disclosures are to be considered merely as illustrative of the generic invention and not as limiting, since many variations obvious to those skilled in the art may be made within the scope of the following claims.

I claim:

1. A method for removing a head of dead oil from an oil well comprising introducing live oil into the well and simultaneously effecting removal of oil from the well until the dead oil head has been replaced by live oil.

2. A method for removing a head of dead oil from a well comprising introducing a light oil into the well to displace the head of dead oil by effecting removal of said dead oil from the well until such displacement occurs and introducing gas into the light oil and

gradually increasing the quantity of gas until the light oil has been displaced by gas.

3. A method for establishing gas lift in an oil well in which a head of dead oil exists and into which a flow tube depends, comprising introducing a relatively light oil into the well to raise the head, and simultaneously removing oil through the flow tube, introducing gas into the well with said light oil in gradually increasing quantities while continuing to remove oil through the flow tube, until the gas displaces the live oil and gas lift upward through the flow tube is established.

4. A method for establishing gas lift in an oil well comprising a casing and flow tube elements containing a head of dead oil, comprising displacing the head of dead oil in at least one of said elements with lighter oil and displacing the light oil with gas until normal gas lift commences.

5. A method for removing a quantity of dead oil in an oil well in which a flow tube depends into the oil, comprising introducing lighter oil into the well above the dead oil to displace the dead oil and to reduce the hydrostatic head in the flow tube, removal of the dead oil being effected through said tube while introducing the light oil above said dead oil, removing the light oil, and then flowing the well by gas lift.

6. A method for establishing gas lift in an oil well containing a head of dead oil comprising introducing a lighter oil to displace the dead oil head, the dead oil head being removed until displaced by light oil, then introducing gas into the well with the light oil and gradually increasing the gas while effecting removal of light oil and gas until the light oil is displaced by gas.

7. A method for establishing gas lift in an oil well containing a head of dead oil comprising displacing said head of dead oil with a lighter oil, then displacing the light oil by the introduction of gas, and continuing the introduction of gas to produce gas lift of oil which then flows into the well.

8. A method for removing a head of dead oil from an oil well which comprises introducing light oil into the well and thereby displacing the dead oil head, continuing the introduction of light oil and then introducing gas with the light oil in gradually increasing quantities whereby the light oil head is gradually displaced by the gas.

9. A method for establishing gas lift in an oil well containing a head of dead oil comprising introducing a lighter oil into the well in sufficient quantity to displace the dead oil head, continuing the introduction of light oil and introducing gas with the light oil so introduced, gradually increasing the quantities of gas introduced with the light oil until the light oil head is displaced by the gas, and then continuing the introduction of the gas

to produce elevation of oil naturally flowing into the well.

10. A method of establishing gas lift which comprises introducing gas and oil into a well containing oil to displace the oil head therein, then discontinuing the introduction of the oil and continuing the introduction of the gas to cause gas lift.

11. A method of establishing gas lift which comprises displacing an oil in a well by a gas charged oil and then introducing gas into the well to cause gas lift.

12. A method for removing a quantity of dead oil from a well containing a casing into which a flow tube depends and in which casing and tube a head of dead oil stands, comprising introducing a quantity of lighter oil on top of the dead oil on one side of the tube to reduce the hydrostatic head on the other side of the tube, removal of the dead oil from said other side being effected while introducing said lighter oil on the one side, thereby displacing the dead oil with said lighter oil.

13. A method according to claim 12 wherein displacement of dead oil is followed by removal of light oil, and the well is then flowed by gas lift.

14. A method for removing a quantity of relatively heavy oil from a well containing a casing into which a flow tube depends and in which casing and tube a head of the heavy oil stands, comprising introducing a quantity of relatively light oil on one side of the tube to reduce the hydrostatic head on the other side of the tube, effecting removal of heavy oil head while introducing light oil until the heavy oil head is displaced, then introducing gas with the light oil to displace the light oil head with a still lighter oil.

15. A method for establishing gas lift according to the method of claim 14 wherein the displacement of the light oil head is followed by successively increasing the gas proportions until the lighter oil head is entirely displaced by gas, and the introduction of gas is then continued to flow the well by gas lift.

Signed at Los Angeles, in the county of Los Angeles, and State of California, this 12th day of July A. D. 1927.

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