

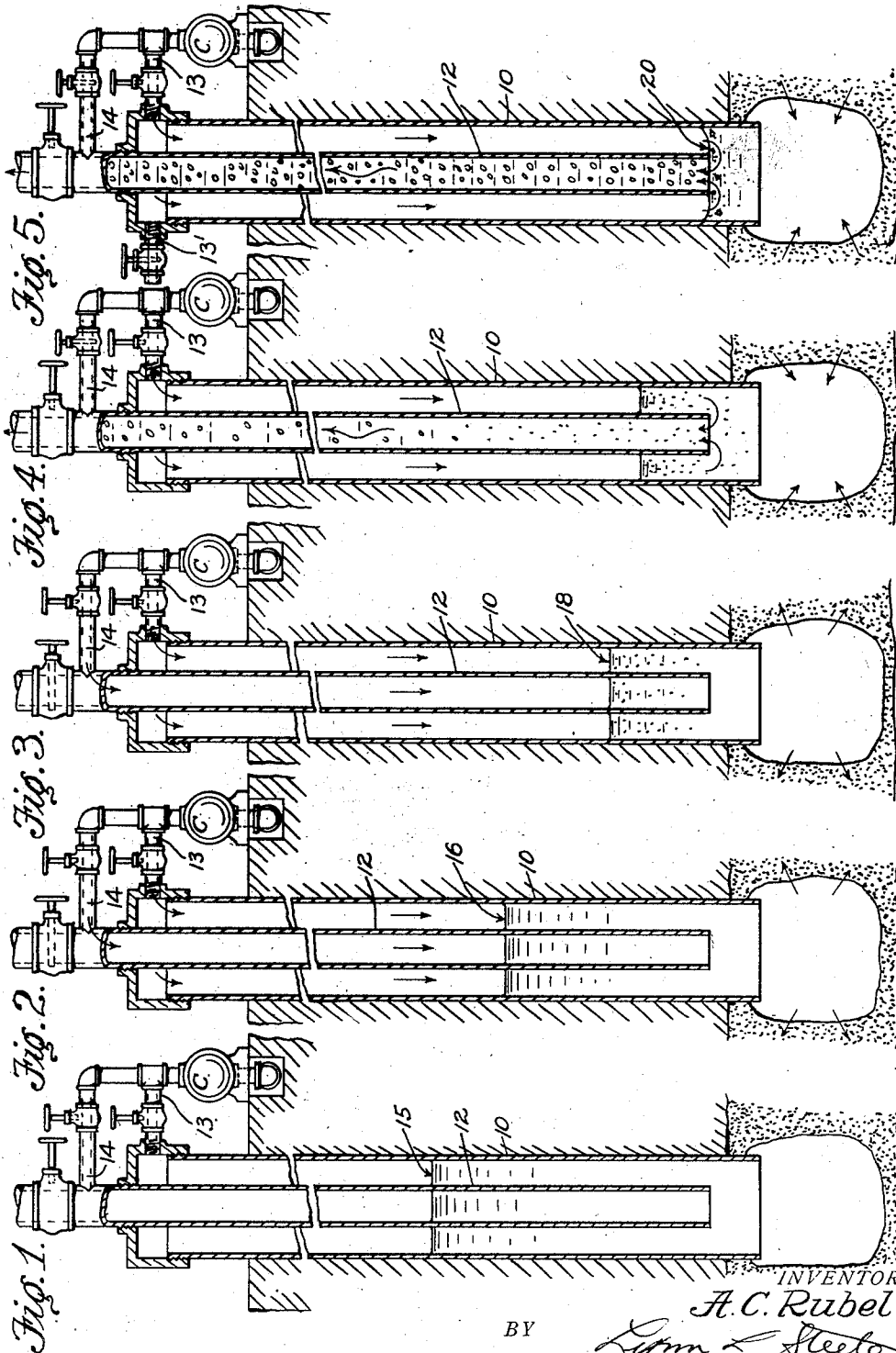
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SOAKING METHOD FOR INITIATING GAS LIFT IN OIL WELLS.

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SOAKING METHOD FOR INITIATING GAS LIFT IN OIL WELLS

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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 sev-

eral 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 when 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 the much lower density of the gas-and-oil volume 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.

The term "hydrostatic head" except where otherwise defined, is used throughout this case to mean the pressure of that portion of the oil body accumulated in the well hole, which stands as a column in the tube and casing above the lower end of the flow tube. When a well has stood idle for a short time (a few hours or a few days according to the well), the head will have reached substantially its maximum height and will be in substantial equilibrium with the rock pressure in the vicinity of the hole. The term "rock pressure" is used to signify the natural expulsive pressure which forces the oil into the well from the formation, and under the conditions just described approximately equals said hydrostatic head in the well hole. Obviously, then, in a non-flowing well under these conditions the said rock pressure or hydrostatic head is less than the static head represented by the length of the flow tube between its points of intake and discharge.

If gas under pressure be applied to the casing for example, of a well containing an accumulated head of oil, oil will be forced up into the tube, thereby increasing the static head therein, as above indicated. Of course, if the oil level stands sufficiently high in the well, the available gas pressure may elevate the oil in the tubing sufficiently to discharge some oil from the tubing without uncovering the lower end thereof, but discharge will cease as soon as the oil level becomes depressed to such a point that the head in the

tubing above the oil level balances the gas pressure being applied.

In order to initiate gas lift by straight application of pressure, a "starting pressure" must be employed sufficient to depress the oil level low enough to allow the passage of gas under the tubing, this pressure being here termed the "normal starting pressure". Such a pressure must be at least equal to the increased static head thereby developed in the flow tube. This increased head of oil in the tubing is here termed the "normal starting head", and its magnitude is dependent upon the relative size of the tubing and casing, the amount and density and viscosity of the oil in the well, the rock pressure, the friction of the formation, etc. The "normal starting head" as the term is herein employed is defined as the "hydrostatic head" of oil in the flow tube above the point of admission to said flow tube at the time gas would break into the flow tube. In like manner, the "normal starting pressure" is defined as the gas pressure necessary to depress the oil level in the gas admission tube to the point of gas admission to the flow tube and sufficient to start gas lift in the flow tube when said pressure is applied to the surface of the oil in said gas admission tube. It is observed that the definition applies whether discharge flow is from the tube and gas application is through the casing, or vice-versa. If a gas tube is employed and is connected by a jet to the flow tube in a manner common to air or gas lift, the starting head or pressure may be equal to the hydrostatic head of the oil in the flow tube above the jet when gas is first forced into the gas tube, and it may be equal to or slightly greater than the hydrostatic head of oil above the jet when first applied.

The general object of the present invention, is to overcome the hydrostatic head and depress the oil level approximately to the lower end of the flow tube by the application of gas under a pressure less than that required to initiate gas lift by steady application to either the tube or the casing in the usual manner, and less than the hydrostatic head naturally existing in the well prior to gas lift initiation.

The object is attained by promoting the absorption of a large amount of gas (natural gas preferred) by the oil body, coupled with a depression of the oil level to as low a point as possible with the available pressure, whereby the absorbed gas materially reduces the specific gravity of at least the upper portion of the oil body and whereby the available pressure then becomes sufficient to elevate and discharge the column of the so-lightened oil in conjunction with the expansive and lifting properties of the absorbed gas.

In many cases where the available pressure is not sufficient to overcome the hydrostatic head and establish gas lift by employing other measures in the ordinary fashion, I have found that by continuing the application of the maximum available pressure for a prolonged period of time, it is often possible to produce a considerable depression of the oil level together with such a high absorption of gas that gas lift will commence immediately upon the release of pressure in the flow tube. For convenience, this method is termed the "soaking method", and, briefly stated, the novelty therein resides primarily in applying to the surface of a body of oil collected in the well a soluble gas under a pressure less than rock pressure and less than the normal starting pressure, maintaining said pressure for a relatively great length of time to cause absorption of large amounts of gas, and then releasing the pressure on one side of the flow tube while continuing it on the other to initiate gas lift. Thus, a large quantity of gas is caused to be gradually absorbed by the oil, this absorption being desired both for the purpose of lightening the oil body (that is, reducing its specific gravity) and for the expansive and lifting properties of the absorbed gas at higher levels as the oil approaches the top of the well during expulsion, the expansive effects increasing due to static pressure decrease as the top is approached. This step also results in gradually forcing a considerable quantity of the accumulated oil body back into the formation. Preferably, the pressure is applied both to the tubing and the casing, and becomes approximately if not entirely equalized therein. After this soaking, or maintained application of gas under pressure, has been continued for what is deemed to be a sufficient length of time, the pressure on the tube (or the casing, if desired) is suddenly released while pressure on the other side is maintained, whereupon the well begins to flow, if proper conditions have been established. Also, advantage may be taken of "heading" effects in the well, whereby a natural pressure rise due to a natural surge of oil into the well under pressure naturally occurring in the formation may be employed to augment the gas pressure, the pressure on the tube being relieved at a time when a head develops as determined by watching the pressure gauge. Many variations of the invention are possible as will be apparent to those skilled in the art, a preferred embodiment being that generically described above.

In the accompanying drawings the various steps are diagrammatically represented for the purpose of illustration, and in these,

Fig. 1 indicates the original condition of the well at the time gas lift is to be initiated;

Fig. 2 indicates the first step wherein gas under the maximum available pressure is applied both to the casing and to the flow tube;

Fig. 3 represents the conditions attending upon the application of said pressure to the surface of the oil for a long period of time which causes portions of the oil body to be forced back into the formation;

Fig. 4 indicates the release of pressure upon the tube whereby the continued pressure on the casing will force a column of gas-containing oil to the top of the well;

Fig. 5 indicates the level to which the oil body is forced upon establishment of normal gas lift.

In these drawings the usual well casing 10 is shown as receiving a flow tube 12 which depends into the oil body, the upper end of the casing being provided with a connection 13 and the tube with a connection 14 into which gas under pressure may be introduced by a compressor C, or from another well flowing gas under sufficiently high pressure. The level of oil which has accumulated in the tube and casing during the preceding period of idleness is indicated at 15, and it is the purpose of this invention to depress this oil level to the lower end of the flow tube 12 and to establish normal gas lift as indicated in Fig. 5.

Ordinarily, the method is employed by applying the maximum available pressure, which, however, is less than the static head of oil, to both the casing and the flow tube. According to Fig. 2, the oil is thereby depressed only to the level 16, this level representing the effect of the pressure upon the oil body after carrying the pressure up to its full value within the casing and the tube, and maintaining the same for the usual short period of time according to the practice followed ordinarily when undertaking to establish gas lift. The pressure thus becomes substantially balanced in the tube and casing.

The feature of the present invention resides in maintaining this pressure for a relatively long period of time, it having been found that by such maintenance of pressure, the body of oil will gradually be forced back into the sands around the well hole, as indicated by the arrows in Figs. 2 and 3, whereby the oil level is eventually brought down to the point indicated at 18 in Fig. 3. It has also been found that under these conditions, a relatively great amount of gas is absorbed by the oil body contained in the casing and the tube. For institution of gas lift by this method, it is necessary that gas absorption be sufficient to so lighten the oil body that the available gas pressure combined with the lifting effects produced by the expansion of the absorbed gas in the oil when the oil column rises toward the top of the flow tube,

will be sufficient to force over the head of oil in the tube, and to cause such absorption it is necessary that the gas pressure be maintained for a relatively long period of time.

For example, if gas pressure to initiate gas lift normally would be maintained for perhaps an hour, it would be necessary according to the present method to maintain such pressure for perhaps six to eight hours, and where such pressure maintenance for one hour would fail entirely to establish flow, the maintenance of pressure for six or eight hours or in some instances thirty hours and more, will so thoroughly saturate the oil with gas that in a great many difficult cases, flow will commence immediately upon release of the pressure in the flow tube, and the excess head of oil will be readily expelled by the pressure maintained in the casing. When the oil level drops to the lower end of the tube as indicated at 20, Fig. 5, normal gas lift commences, at which time the pressure required to continue operation of the well may be dropped down below that employed in starting the well. If the well does not begin to flow or begins but does not continue after release of pressure on the one side, the entire operation may be repeated whereby the resulting surging effect as the oil columns in the tube and casing rise and fall, further increases gas absorption. Absorption will reach a point where a portion of oil will be forced over on release, and if necessary further repetition will eventually reduce the oil level to the lower end of the tube and normal gas lift commences.

The advantages of this method of operation are apparent from the following: In previous attempts to start certain wells, a pressure of 900 pounds had been required, but upon continuously maintaining a pressure of 500 pounds for eight hours, and then releasing the tubing, the well came over without difficulty. Gas lift was thereafter continued at a pressure of 175 pounds on the casing.

It has been found that in wells which "head," (which, however, is true of most wells) gas pressure may be materially augmented by watching the pressure gauge and releasing the flow tube 12 at a time when the maximum effect of a head occurs. In fact, by taking advantage of this effect, it is frequently possible to start a well which could not be started if the pressure were released between heads. To indicate this condition, arrows directed toward the well hole are employed in Fig. 4.

When normal gas lift has once been initiated by depression of the oil level to the point 20, indicated in Fig. 5, the flow of gas under the lower end of the flow tube 12, will be sufficient to elevate the incoming oil as rapidly as supplied by the natural well pressure. Obviously, in the operation of this method, it will

be possible to release pressure upon the casing and maintain the pressure on the flow tube whereby the oil will be flowed out through a connection 13', and it is intended that this variation shall be considered throughout to be the same invention as flowing out through the tube. Also, it might be possible in some instances to close the flow tube and apply gas to the casing only, or vice versa, when the well is being allowed to soak, although the advantages of this modification will not be so marked as when pressure is applied both to the casing and to the tube.

From the foregoing, it will be seen that this process appears to depend upon three factors, each of which varies according to the conditions of the individual well. These factors are:

(a) Forcing a part of the oil back into the sands.

(b) The absorption of relatively large quantities of gas under pressure to lighten the oil and reduce the effective head.

(c) Heading effects in the well.

It can be seen that the function of the absorbed gas is considerable when it is considered that approximately 160 cubic feet of natural gas will be absorbed per barrel of oil when the gas is under pressure of five hundred pounds. The expansion of this amount of gas and oil as the well approaches the upper portion of the tubing has a lifting effect of approximately thirty atmospheres, which constitutes an enormous aid to the pressure of the gas on the casing. Also, it should be noted that the successful accomplishment under this process, is due largely to the factor of time.

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

I claim:

1. In a method for initiating gas lift in oil wells comprising a casing element and a tubing element dependent therein wherein the hydrostatic head of an oil body collected in the well is greater than the available gas pressure, the steps comprising applying said gas pressure to the oil surface to force as much as possible of the oil back into the formation and maintaining the pressure of the gas on the oil to increase absorption of the gas by the oil, said pressure being maintained for a considerable time, and then releasing the pressure in one of said elements.

2. In a method for initiating gas lift in a well having a casing containing an accumulated body of oil into which a flow tube depends, the steps comprising applying a soluble gas to both sides of the tube under a pressure less than the normal starting pressure, maintaining said pressure for a relatively long period of time to cause absorption of relatively large amounts of gas by the oil

and then releasing the pressure upon one side of the tube while maintaining it upon the other side.

3. In a method according to claim 2 wherein the release of pressure is timed to take place when a heading effect occurs in the well.

4. In a method for establishing gas lift operations in oil wells, wherein a flow tube depends into a body of oil within a well casing, the steps comprising applying a soluble gas to the oil in the tube and in the casing simultaneously under a pressure less than the hydrostatic head in the tube until the pressure is balanced on both sides of the tube, releasing the pressure on one side while maintaining it on the other, and repeating the operation to cause the oil to surge for further charging the same with gas until a portion of oil is carried over on the released side and until the oil level in the well has been lowered to the lower end of the tube to bare the same and normal flow by gas lift is established.

5. In a method for initiating gas lift in an oil well containing a casing into which a flow tube depends and in which oil has accumulated, the steps comprising applying a soluble gas under pressure less than sufficient to overcome the hydrostatic head, said pressure being applied to at least one side of said tube, maintaining said pressure for a relatively long period of time to depress the oil level, releasing the pressure on said one side and applying it on the other side.

6. In a method for initiating gas lift in an oil well containing a body of oil the steps which comprise applying a soluble gas to the surface of said oil under a pressure insufficient for normally initiating gas lift of oil to the surface of the well, and continuing said application for a prolonged period of time until conditions suitable for gas lift are developed.

7. In a method for initiating gas lift in an oil well containing a body of oil into which a flow tube depends the steps which comprise applying a soluble gas to the surface of the oil under a pressure insufficient to start gas lift of oil up and out through said tube, continuing said application for a prolonged period of time until conditions suitable for gas lift have been developed, and then releasing pressure on one side of said tube.

8. In a method of initiating gas lift in an oil well containing a body of oil into which a flow tube depends, the steps which comprise applying a soluble gas to one side of the tube under a pressure insufficient to cause gas lift up and out from the other side of said tube, maintaining said pressure for a prolonged period of time until gas lift of oil to the surface is accomplished.

9. In a method of initiating gas lift in an oil well containing a body of oil into which a flow tube depends, the steps which comprise applying a soluble gas to one side of the tube under a pressure insufficient to cause gas lift

up and out from the other side of said tube,
maintaining said pressure for a prolonged
period of time while maintaining an approxi-
mately balanced pressure on the other side
5 of the flow tube, and releasing the pressure
on one side of the flow tube while maintaining
pressure on the other side to obtain gas lift.

Signed at Los Angeles, in the county of
Los Angeles and State of California, this
10 11th day of July, A. D. 1927.

ALBERT C. RUBEL.

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