

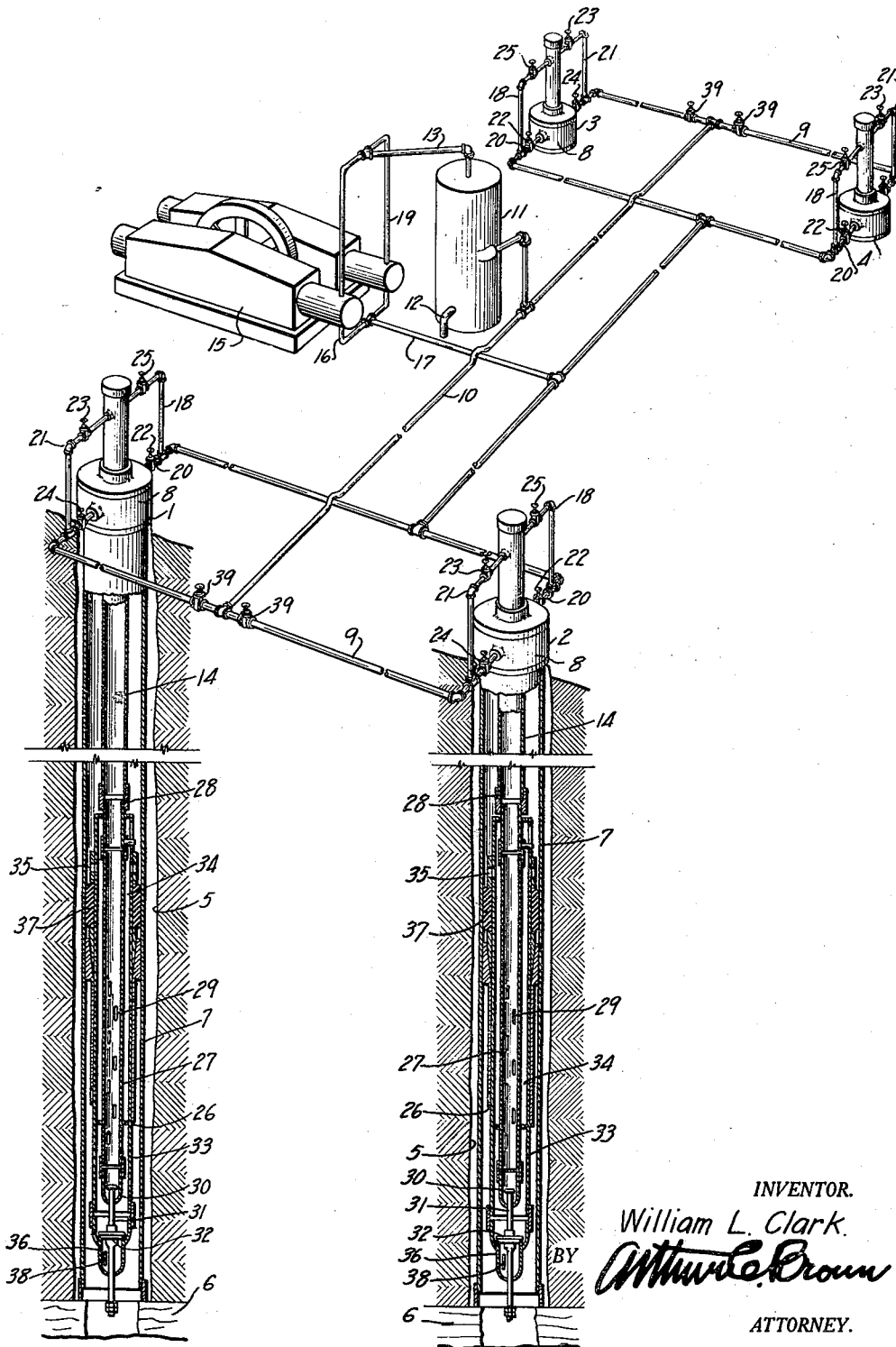
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W. L. CLARK

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METHOD OF FLOWING WELLS

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INVENTOR.

William L. Clark.

BY *Arthur C. Brown*

ATTORNEY.

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METHOD OF FLOWING WELLS

William L. Clark, Oklahoma City, Okla.

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This invention relates to a method of flowing wells and more particularly by what is known as the gas lift process. In this method of flowing wells, gas or other pressure medium is compressed to high pressures at a central system and dispatched to the different wells to supplement formation pressure in lifting the well fluid to the top of the well. Upon continued flowing of the wells, the formation pressure gradually diminishes and often becomes so depleted that it cannot move the fluid from the formation into the well as fast as it can be elevated by the induced pressure medium. When this occurs, it becomes necessary to flow the wells intermittently to allow time for sufficient head of fluid to accumulate in the wells to provide the required submergence necessary in effecting lift of the well fluid when the pressure medium is again induced into the wells.

After a well has been shut down, it requires much higher pressure to restart the flow or effect "kick-off" than is required to maintain flow. It also requires considerable time for the compressor units to build up sufficient pressure to break through the static head of oil accumulated in the well. Consequently, the central system must be designed to furnish far greater power than is necessary to normally maintain flow of the well in order to provide the kick-off pressures. Therefore, the cost of the equipment is extremely higher than would be the case if substantially constant pressures are maintained. Furthermore, the larger equipment increases the operation and maintenance costs.

It is, therefore, the principal object of the present invention to provide a more economical method of producing intermittent flow and without placing widely varying loads on the power and compressor system.

It is a further object of the invention to provide a storage of the pressure medium that can be built up during off periods and which is available to kick-off and maintain flow of an intermittent well in a shorter period of time than can be accomplished by compressor units acting alone.

A further object of the invention is to provide a safe, practical and inexpensive method of storing the pressure medium for use in supplementing the compressor unit.

In accomplishing these and other objects of the invention, as hereinafter pointed out, I have provided an improved arrangement of well flowing apparatus as shown in the accompanying drawing, wherein the single figure represents a typical

plan for intermittently flowing a plurality of wells in accordance with the present invention.

Referring more in detail to the drawing:

1, 2, 3 and 4 designate the wells of a typical oil lease wherein the bore holes 5 are drilled into an oil producing formation 6 and from which the oil flows under formation pressure upwardly through the well casings 7, casing heads 8, branch lines 9 and connecting flow line 10 to a separator 11, wherein the oil is separated from the pressure medium as in conventional practice.

After separation of the gaseous and liquid constituents of the flow, the separated liquids are discharged through an off-take line 12 and the gases through a line 13.

Should the formation pressure be insufficient to effect the flow, or in case the formation pressure becomes depleted after continuous flowing of the well, mechanical means is provided for inducing a supplemental pressure medium into the well to assist the natural pressure medium in lifting the well fluid.

This is accomplished by inserting a string of tubing 14 through the casing head of each well so that the lower end thereof extends into the column of fluid contained in the casings 7 sufficiently to provide the proper submergence necessary in effecting lift of the oil by the induced pressure medium.

The pressure medium is supplied to the tubings 14 by a compressor unit 15 having discharge connections 16 connected with a pressure line or manifold 17 having branch lines 18 leading to the upper ends of the respective well tubings so that a high pressure medium is discharged downwardly through the tubings for escape through the lower ends thereof and effects lift of the fluid as in conventional air or gas lift practice. The fluid upon discharge from the wells flows to the separator where the pressure medium is separated and discharged through the pipe 13 and delivered to the intake connections 19 of the compressor unit. The pressure medium is then recycled through the system to provide for continuous flow of the well.

At times it may be desirable to inject the pressure medium through the well casings and to provide for well flow through the tubings 14 and therefore the branches 18 are connected with the casing heads 8 by suitable connections 20 and the discharge lines are connected with the tubings by similar connections 21, the connections being provided with shut off valves 22 and 23, respectively. The branches 9 and 18 are also provided with shut-off valves 24 and 25 whereby

flow therethrough may be shut-off when the valves are opened.

As above pointed out, the formation pressure may become depleted so that it is impossible to deliver the oil into the well as fast as it can be elevated by the induced pressure medium. When this occurs, it is necessary to provide for intermittent flow of the respective wells.

In ordinary practice, this is accomplished by shutting off the valves 25 in the branches 18 of selected wells so that the pressure medium is diverted to the other wells while the required submergence is being reestablished in the shut off wells. Then when the flowing wells have delivered their charges, the shut off valves 25 for those wells are closed and the valves 22 for the shut off wells are reopened to allow admission of pressure medium which effects removal of the oil that has accumulated therein. Thus, the wells are operated intermittently, but to start the shut off wells, much greater pressure and velocity is required to elevate the oil than is normally required to maintain flow. This necessitates designing the power unit so that it will have ample power and capacity to furnish the required pressure and volume to effect kick-off or start the wells.

As above pointed out, it is the purpose of the present invention to provide a more economical operation by providing a supplemental storage whereby the pressure medium may be stored under pressure of the compressor unit for discharge into the wells in cooperation with the discharge from the compressors to effect the kick-off.

By using the gas under storage for supplementing that furnished by the compressor unit, the compressor unit can be operated under substantially constant load so that a smaller unit may be employed to not only reduce the expense of initial installation, but also the maintenance and operating cost of the system.

Owing to the large volume of high pressure gas required, forms of external storages are out of the question because they cannot be practicably constructed for holding high pressure in the volume required.

To overcome this difficulty, I have found that a well, for example, a 6500 foot well in the Oklahoma field containing 6000 linear feet of casing provides an annular space exteriorly of the tubing plus space within the tubing to hold approximately 511,000 cubic feet of gas at approximately 500 pounds pressure which with approximately 66,000 cubic feet in the discharge system of the plant provides ample storage for the reserve gas supply. Such a storage chamber is always available due to the fact that the wells are ordinarily flowed in intermittent rotation and one of them can be used for storage purposes while the other wells are being flowed and then one of the intermittent wells may be shut down to serve as storage to assist flow of the well which has been previously shut down and used for storage purposes.

This type of storage is not only capable of handling the required amount of gas, but is far safer than the above surface storage and has the advantage of maintaining velocity of the gas flowed therefrom at a more nearly constant value. This is, of course, due to the extremely great length and relatively small diameter of the storage space which causes the flow therein to take the characteristics of flow through an ordinary pipe line. Consequently, the storage

gas is dispatched into the delivery system at substantially uniform high velocity which, of course, is essential in kicking-off one of the wells.

In using this type of storage, means must be provided for retaining the gas under storage from acting against the formation pressures which cause movement of the oil into the well.

In the illustrated instance, this is accomplished by an intermitter 26 which is attached to the lower end of the tubing 14 and includes a tubular section 27 conforming in diameter to the tubing and has its upper end coupled thereto by a coupling 28. The lower end of the section is provided with a plurality of gas outlet ports or perforations 29 and is closed by a cap 30 forming a guide for the stem 31 of a valve 32 later described. Carried by the perforated section is an outer tubular section 33 of larger diameter to form an annular space 34 about the perforated section.

The upper end of the outer tubular section has openings 35 therein for the outlet of oil and the lower end thereof has a valve cage 36 connected thereto and provided with a valve seat for seating the valve 32 previously mentioned. The outer tubular section carries a suitable packing 37 which is located below the outlet openings 35 to sealingly engage with the wall of the casing and provide a closed bottom for cooperating with the valve in supporting the hydrostatic head of oil in the casing when the well is flowing, and to withhold the storage pressure from the formation when that well is being used for storage purposes.

The valve also has a depending stem extending through a bearing opening in the bottom of the valve cage to guide the valve to and from its seat incidental to flow of well fluid into the annular space or tubing or to the pressure exerted thereagainst by the pressure medium when the well is under flow or being used for storage purposes. The valve cage 36 is provided with inlet openings 38 through which the well fluid flows to lift the valve for flow into the annular chamber and upwardly therethrough to the ports 35, where it is discharged into the well casing to stand at a level where the hydrostatic head balances the formation pressure.

When this occurs, the valve seats to trap the column of oil therein. Then when the pressure medium is turned on, it is delivered through the tubing for discharge through the plurality of ports to cause blowing of the oil to the top of the well from where it is delivered to the separator as above described.

When the well is to be used for storage purposes, the air pressure carried within the casing seats the valve to hold the pressure and prevent its acting against the formation pressures.

In operating a system constructed as described and assuming that the well 1 is to be used for storage while the wells 2, 3 and 4 are being flowed, the valve 39 in the branch line 9 is closed. Gas then discharged from the compressor is delivered through the pipe 17 and discharged into the casing and tubing. When the compressor has built up the required storage pressure in the well 1, the air and flow valves of the other wells are opened in rotation to cause successive flow of gas from the well storage and compressor into the respective wells to be flowed.

As soon as the pressure preponderates over the pressure of the hydrostatic head of fluid in the first well to be flowed, the gas will start bubbling therethrough to start elevation of the oil to the

top of the well from where it is delivered through the branch lines 9 into the flow line 10 and to the separator 11 where the oil is separated from the gas and discharged through the offtake pipe 12.

The separated gas is delivered through the pipe 13 to the intake of the compressor unit for recycling through the system and for restorage.

With a well having a storage capacity above noted and with compression intake and discharge pressures of 10 and 500 pounds, respectively, the wells 2, 3 and 4 can be flowed intermittently at 55 minute intervals with gas being introduced into the respective tubings for 5 minute periods per well. This takes essentially 10,000 cubic feet for each well or 30,000 cubic feet for all three wells which would not exceed one-half of the plant capacity while reserve storage is being used to maintain the discharge pressures. After the wells 2, 3 and 4 have been successively flowed in intermittent periods over a space of time, one of these wells may be shut down and used for storage purposes while the well 1 is placed under intermittent flow along with the other two wells.

It is thus obvious that the wells can be used in rotation for storage purpose so that all of the wells are flowed in regular turn.

From the foregoing it is obvious that I have provided an efficient and adequate storage for intermittently operating a plurality of wells with a relatively small compressor unit and that by providing the intermitter the pressure of the stored gas is not lost into the formation, nor does it act against the pressure therein when the well is being used as a reservoir or storage chamber.

What I claim and desire to secure by Letters Patent is:

1. The method of flowing a plurality of wells including supplying a pressure medium to one of a group of wells to be flowed, storing the compressed pressure medium in said well, intermittently delivering pressure medium from the storage well to other wells in the group to effect flow of fluid from said wells, periodically diverting supply of pressure medium to and building up storage of said medium in a previously flowed well in the group, and delivering stored pressure medium from storage in the last named well to the well first used for storage for flowing that well.

2. The method of flowing wells including storing a compressed pressure medium selectively in one of a group of wells to be flowed, delivering pressure medium from such storage selectively to the other wells in the group, and periodically reversing connection between the storage and a flowed well.

3. The method of flowing wells including storing a pressure medium in one well, delivering the pressure medium from said well to another well for effecting flow of said last named well, and reversing said operations whereby the wells are alternately flowed and used for storage.

4. The method of flowing wells including supplying a pressure medium, storing a portion of said supply of pressure medium in one well, delivering the pressure medium supply in supplement with the stored pressure medium to another well for effecting flow of said last named well, and reversing said operations whereby the wells are alternately flowed and used for storage.

5. The method of flowing wells including storing a pressure medium in one well, delivering the pressure medium from said well to another well for effecting flow from said last named well, retaining said pressure medium from acting on the producing formation into which the wells are drilled, and reversing said operations whereby the wells are alternately flowed and used for storage.

6. The method of flowing wells including supplying a pressure medium, storing a portion of said supply in one well, delivering the pressure medium supply in supplement with the stored pressure medium to another well for effecting flow of said last named well, retaining said pressure medium from acting on the producing formation into which the wells are drilled, and reversing said operations whereby the wells are intermittently flowed and used for storage.

7. The method of flowing a group of wells including storing a pressure medium in one well periodically and successively, delivering the pressure medium to the other wells in the group to effect successive flow of said wells, collecting and compressing said pressure medium from the flowing wells, and delivering said pressure medium for storage in one of the previously flowed wells for effecting flow of said other wells including the well previously used for storage.

WILLIAM L. CLARK.