June 24, 1930. R. H. BESS 1,766,974

APPARATUS FOR FLOWING DEEP WELLS BY STAGES

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Fig. 1.

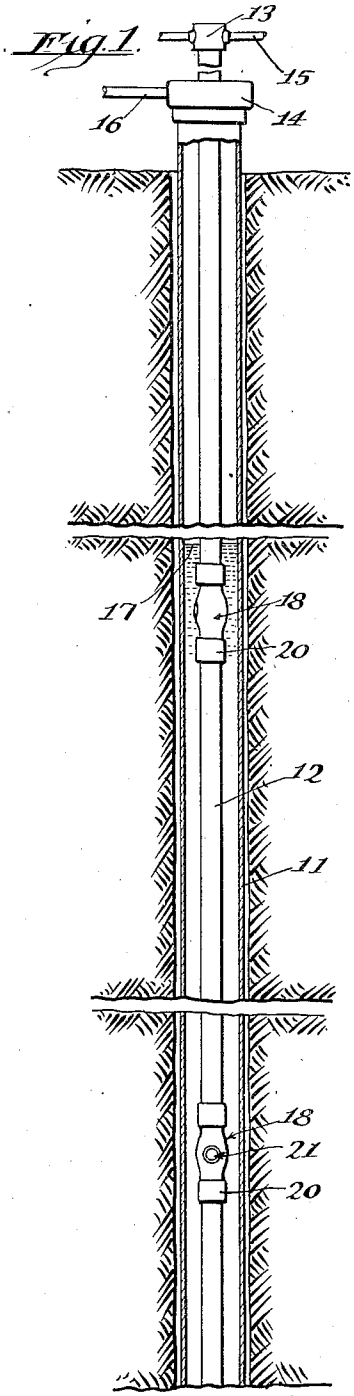


Fig. 2.

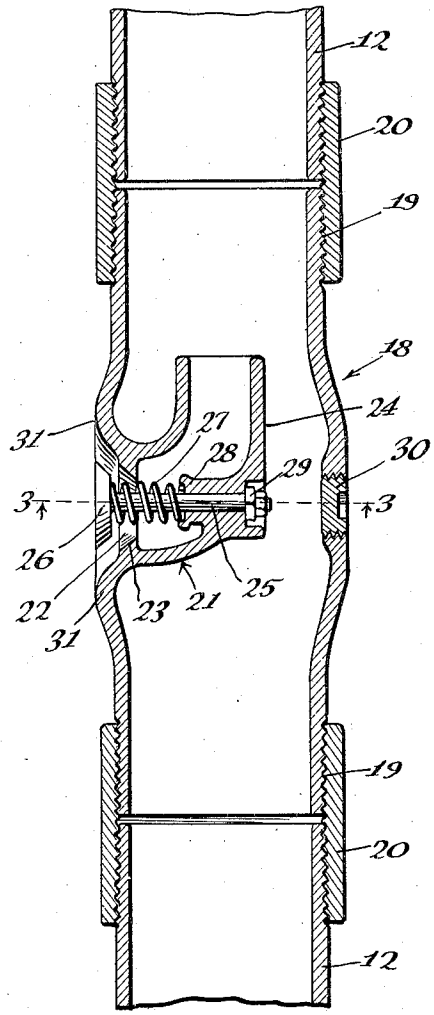
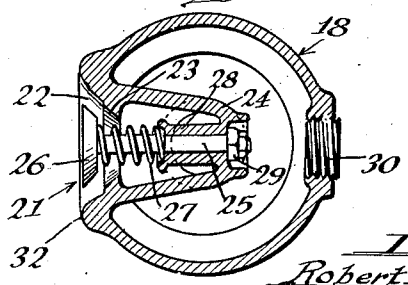


Fig. 3.



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Fig. 4.

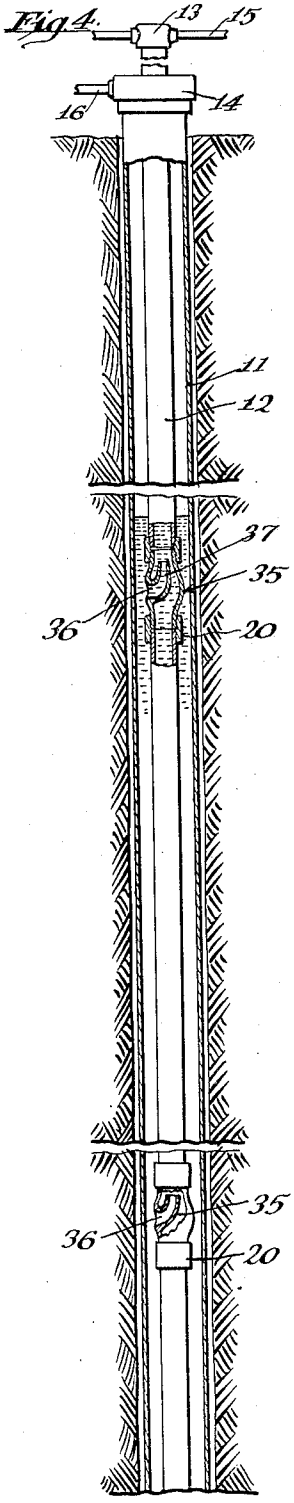


Fig. 5.

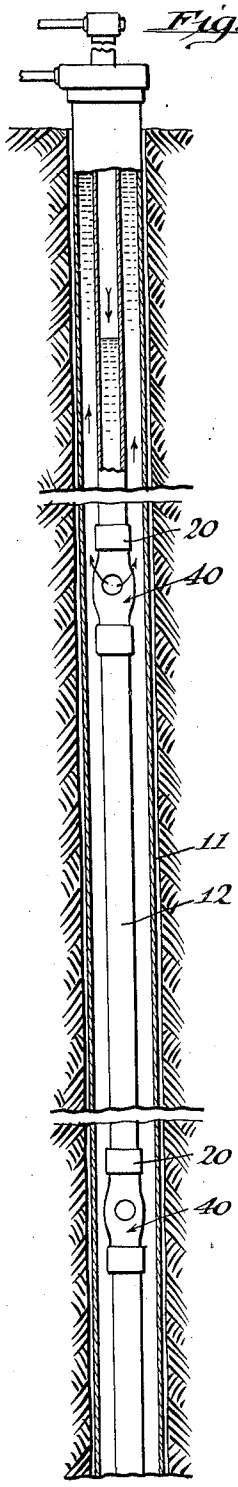
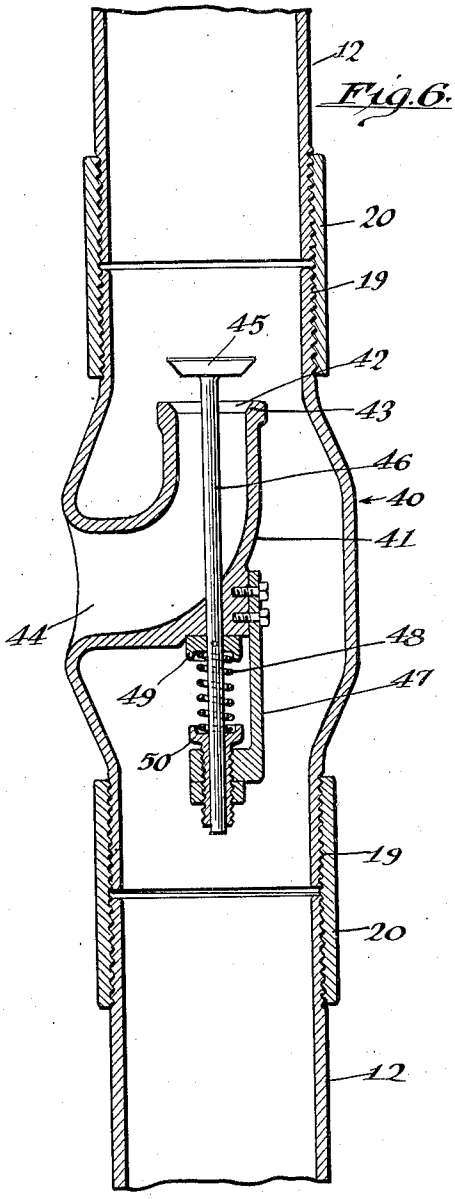


Fig. 6.



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Patented June 24, 1930

1,766,974

UNITED STATES PATENT OFFICE

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APPARATUS FOR FLOWING DEEP WELLS BY STAGES

Application filed October 24, 1928. Serial No. 314,818.

My invention is an apparatus for flowing deep wells by stages.

My invention is adapted principally for flowing oil wells using gas or air pressure and drawing first from a higher level and then from successive lower levels as the oil level in the well drops in relation to the oil pipe.

In operating deep oil wells it is sometimes very difficult to start the flow of oil upwardly through the oil pipe. It quite frequently happens in deep wells that the oil will rise to a considerable height above the oil sand in the well casing and that it is very difficult to bring sufficient pressure on the top of the oil column to start the oil flowing in the oil pipe which is immersed to a considerable extent in the oil column. Although gas pressure either derived from compressors or compressor wells or possibly air pressure is exerted on the top of the column of oil, it is difficult to obtain a downward movement of this column sufficient to start the oil flowing upwardly in the oil pipe.

An object of my invention is, in a gas pressure system of flowing wells, in which gas pressure is exerted on the top of a column of oil to cause the oil to flow upwardly in the oil pipe first at a higher level and when the oil drops to or adjacent this level then at succeeding lower levels. In this procedure the oil pipe is provided with intakes at different depths and as soon as the oil level reaches or approaches the highest inlet the flow through such inlet stops and the next lowest inlet functions. As the oil rises in the oil pipe to the same level that it occupies outside of the pipe and in the well casing the pressures outside and inside the pipe are therefore balanced. Hence when gas pressure is brought to bear on the top of the oil column outside of the pipe by using my intakes the oil may flow upwardly in the highest intake and start an upward flow of the oil already in the oil pipe. Then, when the flow of oil or oil and gas exceeds a certain amount, that is brings an external pressure to bear on the upper intake greater than that of the inside column of oil, the intake is closed and the next intake therebelow begins to function in flowing the internal column of oil in the oil pipe.

Another object of my invention is the construction of an intake port and valve in an oil pipe, this valve being normally held open by a comparatively light spring pressure and is designed so that when the oil level inside and outside of the oil pipe is the same and above any particular intake, that the valve will remain open. Therefore, considering an upper intake in a string of oil pipes, the external pressure due to the gas pressure on top of the outside column causes this outside oil to flow through the upper valve and by means of the port is started in an upward direction. The continuous pressure carries on the flow of oil through this upper inlet with the valve open. Then, as the oil level approaches or reaches the upper valve and gas begins to flow with the oil through the intake, the increased rate of flow closes the valve. Then, as no oil can enter the upper intake, the external gas pressure on the external column causes the intake next below to function in flowing the oil upwardly.

In constructing my invention I have a series of valve pipe sections which may be coupled in a string of tubing or pipe separated by a considerable number of lengths of such pipe. Each of these sections has a valve formed of an intake port and a valve block adapted to seat thereon, this block being mounted on a slidable stem the stem extending inwardly of the valve pipe section and being mounted in an upwardly directed jet like nozzle structure. A comparatively light pressure spring coiled on the stem and bearing against the nozzle structure thrusts the valve plug outwardly thus maintaining the seat at the port opening. A closure plug is positioned in the valve pipe section directly opposite the stem for the purpose of adjusting the stem.

This construction as above mentioned having the series of intakes is such that the oil may flow between the valve plug and the seat of the port and upwardly through the jet type of nozzle, carrying with it the head of oil in the oil pipe above such intake. While the oil flows comparatively slowly,

the valve plug remains open, but when this starts to flow fast as the level in the outside column approaches the upper intake or the gas under pressure flows down and through the upper intake, this closes the upper valve by bringing sufficient pressure to bear on the valve plug to seat it against the internal pressure of the spring and the internal column of oil. The next lower intake then acts in carrying on the flow of oil upwardly in the oil pipe.

My invention in one of its forms is illustrated in the accompanying drawings, in which;

Figure 1 is an elevation of a well showing the casing broken away and my intake valve pipe sections illustrated at different depths;

Fig. 2 is a vertical section diametrically through one of the pipe valve sections;

Fig. 3 is a horizontal section on the line 3—3 of Fig. 2 in the direction of the arrows.

Fig. 4 is a vertical section of a modified construction omitting the valve;

Fig. 5 is an elevation of a further modified construction for an upward flow between the pipe and the casing

Fig. 6 is a vertical section of the valve of Fig. 5.

In Fig. 1 the well casing is indicated by the numeral 11 and in this casing there is a string of oil pipes 12. These oil pipes are connected to a head 13 above the casing head 14 and have discharge pipes 15. There is a pressure gas pipe 16 connected to the casing head to force gas under pressure into the casing. The natural level of the oil in the well is indicated by the numeral 17 and this may be a thousand feet or more above the oil sands at the bottom of the well through which the oil flows into the casing.

Connected in the oil pipe string I have a series of valve pipe sections 18, these being illustrated as being generally tubular in section and having screw threaded ends 19 fitting in the couplings 20. Each of these pipe sections has a valve structure designated generally by the numeral 21, this valve structure having an intake port 22 with a tapered seat 23 thereabouts. A jet nozzle structure 24 discharges upwardly and a valve stem 25 is slidably mounted in the lower portion of the nozzle structure and has a valve plug 26 mounted therein adapted to form a closure against the seat 23. A compression spring 27 bears against the abutment 28 and the valve plug. A nut and lock nut 29 allow adjustment of the compression of the spring 27. The sections 18 may be screwed in the oil tubing.

In axial alinement with the stem I have a closure plug 30 threaded in a hole in the valve pipe section so that this may be taken out to adjust the tension of the spring 27. It will be noted that there is a bulge 31 on the upper and lower sides of the structure forming the seat 23 so that when the valve plug is in its outermost position the plug cannot directly contact with the well casing. There are also bulges 32 on both sides of the port 22, these form with the bulges 31 a ridge completely protecting the valve plug 26 from damage by the well casing. It is desirable that the valve pipe sections 18 be bulged out so that the cross sectional area of the jet structure will be substantially equal to the cross sectional area of the flow pipe. It is intended also that these intake valves be placed at different depths in the well so that the upper one is below the high level of the oil in the well. My device is intended primarily for deep wells in which the oil rises to a considerable elevation above the bottom and above the bottom of the flow pipe.

The manner of action and functioning of my invention is substantially as follows: The oil under its natural head without any gas pressure on the outside column, that is the column between the flow pipe and the casing will have the same level inside and outside of the flow pipe. When gas pressure forces downwardly on the outer column, this starts the flow of oil through the open port 22 of the upper valve structure and such oil passes upwardly in the flow pipe until the level of the oil on the outside column is such that the gas forces its way through the oil and escapes upwardly in the flow pipe. When this is the case, the rush of gas is such that the valve plug 26 is closed. This may close either before the oil level passes below the uppermost valve or when such oil passes below and the pressure gas starts to flow upwardly to the flow pipe. Such gas pressure closes the valve and maintains it closed.

When the uppermost valve is closed, the gas pressure forces the oil through the valve next below and this inflowing oil at a lower depth maintains the flow already started. The level on the outside column of oil gradually becomes lower and the gas pressure keeps the valve 26 closed. Then when the oil level approaches the second valve or passes this valve, such valve closes in the manner described for the uppermost valve and the next lower valve begins to function.

As the nozzle structures are required to be somewhat small compared to the cross sectional area of the flow pipe, there may, if desired, be several of these valves installed comparatively close together to give a relatively large flow substantially in the same elevations.

In the construction of Fig. 4, the intake pipe sections 35 have an open port 36 at one side and an upwardly extending jet nozzle 37, there is however, no valve in this construction. The pipe section 35 is connected

into the flow pipe in the same manner as illustrated in connection with Figs. 1, 2 and 3 and a gas pressure is used on the outer column of oil between the flow pipe and the well casing.

The manner of operation of the construction of Fig. 4 is by the gas pressure causing an inward flow from the outer column of oil through the port 36. This flow is diverted upwardly by the nozzle 37 and gives an upward flow in the flow pipe. When the oil level of the outer column is lowered below the upper intake pipe a certain amount of gas will blow into this intake and flow upwardly with the inner oil column. This however, acts to lighten the inner column and carry it upwardly.

In the construction of Figs 5 and 6 there is a valve pipe section 40 connected into an inner oil pipe in which the level of the oil rises above the upper outlet valve. This valve as shown in Fig. 6 is provided with a reverse nozzle head structure 41 having an intake port 42 with a valve seat 43 adjacent thereto and an outlet port 44. The inlet port is closed by a valve plug 45 on a slidable valve stem 46. The lower portion of this stem is slidable in a bracket 47 depending from the nozzle structure 41, and the stem is pressed upwardly by a compression spring 48 bearing against a collar 49 on the stem and against an adjustable abutment 50 threaded in the bracket 47 through which the stem slides.

In the operation of the construction of Figs. 5 and 6, before gas pressure is introduced into the center reverse flow pipe the oil level of the outer column and the inner column are the same. Then, a downward pressure of gas in the inner reverse flow pipe forces the oil level downwardly therein and such oil flows out through the port 44 and upwardly with the outer column. When this flow reaches a fairly high velocity or subjected directly to the gas pressure in the reverse inner flow pipe, the valve plug 45 is seated, thus closing the outlet of the upper outlet valve. The outlet valve next below then begins to function until the oil is carried to a position adjacent this second valve. Other valves in succession may then be operated in a similar manner.

Various changes may be made in the principles of my invention without departing from the spirit thereof as set forth in the specification, drawings and claims.

I claim:

1. An apparatus for flowing deep wells, comprising in combination a flow pipe adapted to extend to a considerable depth below the oil level in a well casing, there being an outer column of oil between the pipe and the casing, and an inner column in the pipe, an intake valve positioned between the bottom of the flow pipe and the level of the outer column, means to retain said valve normally open, means to exert pressure on the outer column whereby the oil flows in the valve, said valve being constructed to close on the relative change of interior and exterior pressures.

2. An apparatus for flowing deep wells comprising in combination a flow pipe adapted to extend to a considerable depth in the oil rising in the well casing, there being an outer column of oil between the pipe and the casing and an inner column in the pipe, an intake valve positioned between the surface of the outer column of oil and the bottom of the flow pipe, means to hold said valve open when subjected to substantially equal internal and external pressures, means to exert a pressure on the outside column of oil, said oil flowing in the valve and upwardly in the flow pipe and said valve being constructed to close when subjected to a rapid flow of the exterior oil column and the pressure on such column.

3. An apparatus for flowing wells comprising in combination a flow pipe adapted to extend a considerable distance into the oil of a well, there being an outer column of oil between the pipe and the well casing and an internal column in the flow pipe, an intake valve positioned between the bottom of the flow pipe and the level of the outer column of oil, means to exert a gas pressure on the top of the outer column, said valve being open when the pressures inside and outside the flow pipe are substantially equal, the oil flowing inwardly of said valve and such valve closing when subjected to increased pressure, such as that of the gas or rapidly flowing oil.

4. An apparatus for flowing deep wells, comprising in combination a flow pipe positioned in a well casing with the main intake of the pipe a considerable distance below the surface of the oil on the casing, there being an external column of oil between the pipe and the casing and an internal column in the pipe, an intake valve positioned between the bottom of the pipe and the level of the outer column, a spring normally holding said valve open, means to exert pressure on the outer column and thereby flow oil upwardly through the flow pipe through the intake valve, said intake valve closing when subjected to an outer pressure relatively greater than the pressure in the flow pipe.

5. An apparatus for flowing deep wells comprising in combination a flow pipe positioned with its main intake at a considerable depth below the level of oil in the well casing, there being an external column of oil between the pipe and the casing and an internal column in the pipe, an intake valve positioned closer to the oil level of the outer

column than to the main intake, said valve having an upward discharge in the flow pipe, the valve being maintained open when the internal and external pressures are substantially equal, means to exert pressure on the outer column and thereby flow the outer oil into the flow pipe and upwardly, said valve closing when subjected to a materially greater external pressure than internal pressure.

6. An apparatus for flowing deep wells, comprising in combination a flow pipe positioned in a well casing with its main intake positioned a considerable distance below the oil level in the casing, there being an outer oil column between the pipe and the casing and an inner column in the pipe, a valve pipe section in the flow pipe positioned between the outer oil level and the main intake, said valve having a port forming a valve seat at one side, a stem slidable in the valve pipe section and having a valve plug thereon, a spring normally pressing said plug outwardly and opening the port, means to exert external pressure on the outer column and flow oil through the open valve, said valve closing when the external pressure is materially greater than the internal pressure in the flow pipe at the valve pipe section.

7. An apparatus for flowing deep wells, comprising in combination a flow pipe positioned in the well casing with its main intake a considerable distance below the oil level in the casing, there being an outer oil column between the pipe and the casing and an inner oil column in the pipe, an intake valve positioned in the pipe between the oil level of the outer column and the main intake, said valve being normally open when the external and internal pressures are substantially equal, means to exert a gas pressure on the outer column and flow the outer column through the valve and upwardly in the flow pipe, the said valve closing when subjected to the direct action of the compressed gas.

8. In an apparatus for flowing deep wells, a valve pipe section having means to connect same into a flow pipe of a deep well, a port on one side of the pipe section having a valve seat, a valve plug forming a closure therefor, means to normally hold said plug unseated and the port open, the plug being adapted to close the port when subjected to greater external than internal pressure.

9. In an apparatus for flowing deep wells, a valve pipe section adapted for connection in a flow pipe, a port on one side of said pipe section, a jet nozzle structure connected adjacent the port and discharging upwardly, a stem slidable in said nozzle structure and having the valve plug thereon adapted to seat against the port, means normally retaining said plug unseated, the said plug becoming seated when subjected to a flow of oil or gas under pressure greater on the exterior than on the interior of the pipe section.

10. In an apparatus for flowing deep wells as claimed in claim 9, the means to retain the plug in the open position comprising a spring, means on the stem to adjust the tension of the spring and a plug in the opposite side of the pipe section to that of the port to give access to said means.

11. In an apparatus for flowing deep wells, a valve pipe section having means to connect same in a flow pipe, a valve in said section having an intake port at one side and an exterior marginal rim surrounding said port, the port forming a valve seat, a nozzle structure discharging upwardly from the port, a stem slidably mounted in said structure and carrying a valve plug, a spring thrusting the plug outwardly, the plug being adapted to seat in the port, the said rim preventing contact of a well casing with the plug, said plug being adapted to seat when subjected to an external pressure greater than the internal pressure.

12. In an apparatus for flowing deep wells as claimed in claim 11, an opening in the pipe section diametrically opposite the port and in alinement with the stem, a closure plug therefor and means to adjust the stem to vary the tension of the spring accessible through the said opening.

In testimony whereof I have signed my name to this specification.

ROBERT H. BESS.