

June 10, 1930.

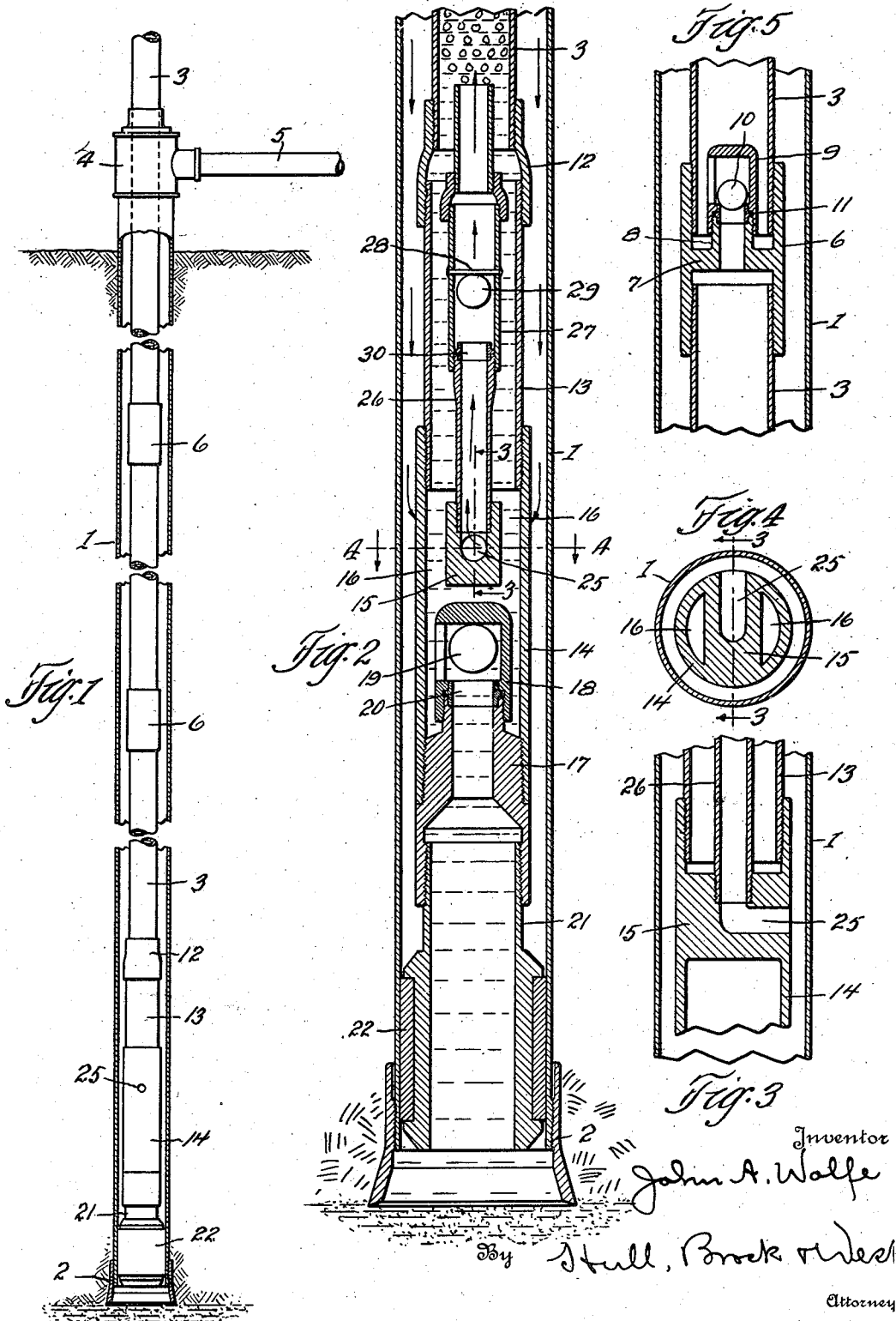
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PNEUMATIC FLOW MEANS FOR DEEP WELLS

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2 Sheets-Sheet 1



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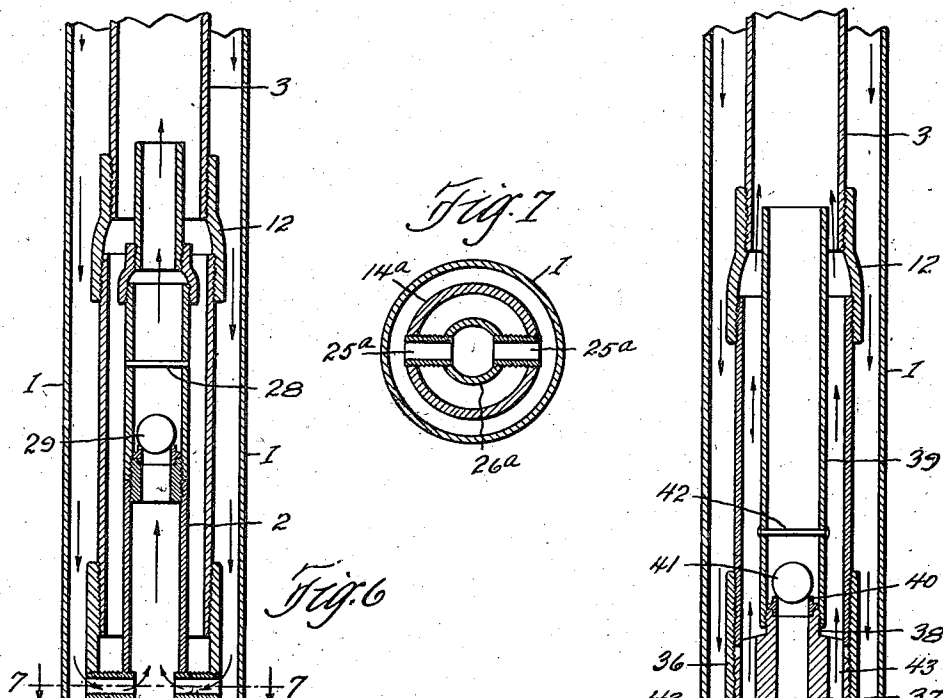
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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PNEUMATIC FLOW MEANS FOR DEEP WELLS

Application filed March 4, 1927. Serial No. 172,614.

This invention relates to pneumatic means for lifting or extracting liquids from deep wells, such as oil from oil wells, and its objects are to provide means of the aforesaid nature by which the liquid or oil may be raised economically, efficiently and safely from low producing wells and which will act to increase the flow in wells of this character.

The employment of pneumatic means for the purpose set forth in lieu of the usual pumping outfits effects a great saving of time, labor and expense, and does away with the use of an individual power unit, working barrel, sucker rods, hangers, etc. in connection with each well, and besides it is much more convenient and safer of handling.

In connection with the pneumatic means, large compressor units may be used for supplying fluid under high pressure to several wells of a group, or a portable compressor may be employed for a single well; and air, or residue gas, or a mixture of both may be utilized as the pressure fluid, and where the term "pressure fluid" occurs herein, it is to be understood as meaning either or both of these fluids, or any substitute therefor.

Further objects of my invention are to provide means of the character above set forth involving units that are relatively simple and inexpensive, are substantial and durable, and are so designed as to expedite manufacture and facilitate assembly.

Embodiments of the invention by which the foregoing objects, with others hereinafter appearing, are attained are illustrated in the accompanying drawings wherein Fig. 1 is a vertical section through a well equipped with one form of my invention, the well casing being shown in central section; Fig. 2 is an enlarged central vertical section through the lower end of the well casing and includes the packer, main check valve, and injector unit; Fig. 3 is a section on the line 3—3 of Figs. 2 and 4; Fig. 4 is a horizontal section on the corresponding line of Fig. 2; Fig. 5 is a central vertical section through one of the trap valves; Fig. 6 is a central vertical section through a modified form of the invention; Fig. 7 is a section on the line 7—7 of Fig. 6; Fig. 8 is a central vertical section

through a further modification; and Fig. 9 is a horizontal section on the correspondingly numbered line of Fig. 8.

The well casing is designated 1 and at its lower end is equipped with the usual casing shoe 2 which rests upon the oil sand. A sectional flow tube 3 is extended downwardly through the casing 1, and the joint between the tube and the upper end of the casing is closed, as shown at 4. Compressed air or other pressure fluid from a suitable source is introduced into the top of the casing through a pipe 5.

Inserted at suitable intervals in the flow tube 3 are trap valves 6, one of which is shown in detail in Fig. 5. This trap valve consists of a hollow body having a transverse bridge wall 7 intermediate its ends, and the opposite ends of the body are internally threaded for the reception of the adjacent ends of adjoining tube sections. Rising from the bridge wall 7 is a central hollow boss 8 on the threaded upper end of which is screwed a cage 9 for a ball check valve 10 that is arranged to cooperate with a seat 11 that is clamped by the cage 9 to the upper end of the boss 8.

Attached to the lower end of the tube 3, through the intervention of a coupling 12 and a sleeve 13, is an injector unit 14 consisting of a hollow cylindrical body provided intermediate its ends with a transverse bridge wall 15 through which passageways 16 extend. The body is internally threaded at its upper end for the reception of the lower threaded end of the sleeve 13, and at its lower end for application to a tubular check valve body 17. Onto the upper reduced end of the body 17 is screwed a cage 18 enclosing a ball valve 19 that cooperates with a seat 20 that is clamped between the cage and the adjacent end of the body 17. The threaded neck 21 of a packer 22 is screwed into the lower end of the check valve body 17 and the packer engages the well casing and effects a sealed joint between it and the assembly comprised of the foregoing parts. In other words, it shuts off communication between the bottom of the well and the space between the flow tube 3 and the well casing 1. A port 25 in

the bridge wall 15 of the injector unit opens laterally through the side of said unit into the space just mentioned, and the inner end of said port extends upwardly and is internally threaded for the reception of the threaded lower end of an injector nozzle 26 which, for convenience of manufacture, is comprised of three parts, a lower, intermediate, and terminal part. The intermediate part, designated 27, has a transverse pin 28 and serves as a cage for a check ball valve 29 that cooperates with a seat 30 that is set within the upper end of the lower part. The terminal part, connected to the intermediate part by a reducer coupling 31 constitutes a jet pipe designated 32.

With the parts constructed and arranged as above set forth and subjected to what natural rock pressure as may exist within the oil sand, the oil will rise through the bore of the packer and that of the check valve body 17 past the check valve 19—the check valve being lifted from its seat by the pressure of the rising liquid—upwardly about the injector nozzle 26 into the tubing 3, and then upon the introduction of pressure fluid (such as compressed air of about two hundred to six hundred pounds or even higher pressure, depending upon the depth of the well and the quantity of liquid to be lifted) into the well casing through the pipe 5, the same will find its way to the interior of the tubing 3 through the port 25 and injector nozzle 26, lifting the valve 29 from its seat and issuing from the jet pipe 32 at a high velocity. This will cause the liquid to be lifted by the kinetic energy of the pressure fluid. Also, this introduction of the pressure fluid into the column of oil within the tubing 3 will aerate the oil and reduce the specific gravity of the mixture and this will, of course, enhance the upward flow of the oil. By the action of the air as it issues from the injector nozzle, a suction is created within the lower portion of the well which has the effect of increasing the flow of oil from the oil sand or, in other words, creating an artificial flow of oil from the sand. This condition can prevail with advantage for a limited time only, however, as obviously the oil that is immediately available to satisfy such suction would gradually be depleted, and when this stage is reached the pressure fluid is cut off. Upon the shutting off of the pressure fluid, the main check valve 19 will drop to its seat, as will also the valve 29 of the injector nozzle 26, thus retaining within the lower portion of the tubing such oil as may be present therein and prevent its finding access in the space between the tubing and the well casing. Also, the oil present within the tubing above the trap valves 6 will be retained at the elevations to which it was lifted through the preceding pumping operation until the apparatus is again set in action

by a further injection of pressure fluid into the well casing. If it were not for the trap valves acting as stated, the liquid would settle down during the periods of inaction into the lower portion of the casing, and this entire body of liquid would again have to be elevated to its former height before the main check valve would open and admit additional oil from the well. Furthermore, in the absence of the trap valves, upon the recovery of the natural rock pressure and the resultant inflow of oil through the check valve 19, the weight of the entire contents of the flow tube would be imposed upon the incoming oil and this would introduce such a resistance to the natural flow as to greatly retard it.

In the modification illustrated in Fig. 6, the cage 18^a of the check valve 19 is reduced and threaded at its upper end for the application of the internally threaded lower end of an air nozzle 26^a, and a plurality of threaded nipples 25^a are screwed in through registering tapped holes in the cylindrical body 14^a and the nozzle 26^a. The principle and mode of operation is the same in this form of the invention as in that above described.

In Fig. 8 a further modification is shown in which the neck 21 of the packer 22 is screwed directly into the lower end of a body 35 which is connected, through a coupling 36, to the lower end of the sleeve 13. The body 35 has a bore 37 that opens at its upper end through an externally threaded boss 38 to which is applied the internally threaded lower end of a tube 39. A valve seat 40 is applied to the upper end of the boss 38, and cooperating with this is a main ball check valve 41 that is restrained from undue upward movement by a pin 42 that extends across the tube 39. Ports 43 in the body 35 lead inwardly from the space between the tubing and the casing and thence upwardly to the space between the sleeve 13 and the tube 39.

In this form of the invention, the pressure fluid enters through the ports 43 and rushes upwardly about the tube 39, aerating and lifting the oil that has entered through the bores of the packer and the body 35 past the check valve 41 and through the tube 39. Furthermore, by reason of the velocity of the air, a suction is created within the tube 39 which serves to draw in additional oil, as in the instances above described.

Having thus described my invention, what I claim is:

1. Means of the character set forth comprising, in combination with a well casing, a flow tube extending downwardly into the casing, the joint between the top of the casing and flow tube being closed, means for introducing fluid under pressure into the casing, and an assembly connected to the lower

end of the flow tube and incorporating an injector involving a jet nozzle disposed axially of the tubing and a port leading from said nozzle to the space between the tubing and the casing, a check valve involving a tubular body applied to the lower end of the injector, and a tubular packer connected to the check valve body and engaging the well casing thereby to seal the joint between the lower end of said assembly and the well casing.

2. Means of the character set forth comprising, in combination with a well casing, a flow tube extending downwardly into the casing, the joint between the top of the casing and flow tube being closed, means for introducing fluid under pressure into the casing, and an assembly connected to the lower end of the flow tube and incorporating an injector, a check valve governing communication between the tubing and the bottom of the well, and a packer for closing the joint between the assembly and the well casing.

3. Means of the character set forth comprising, in combination with a well casing, a flow tube extending downwardly into the casing, the joint between the top of the casing and flow tube being closed, means for introducing fluid under pressure into the casing, and an assembly connected to the lower end of the tube and involving a cylindrical body, an injector nozzle disposed centrally within said body, a check valve below said injector nozzle and governing communication between the interior of the body surrounding said tube and the bottom of the well, and a ported member connecting the injector nozzle to the tubular body and through which communication is established between the nozzle and the space between said body and the well casing, and a packer below said check valve for sealing the space between the body and the well casing.

4. Means of the character set forth comprising, in combination with a well casing, a flow tube extending downwardly into the casing, the joint between the top of the casing and flow tube being closed, means for introducing fluid under pressure into the casing, and an assembly connected to the lower end of the tube and involving a cylindrical body having a central bore, a tube surmounting said body and communicating with said bore, a check valve confined within the second mentioned tube for governing the flow of liquid through the bore, a sleeve concentric with said tube and through which the body is joined to the lower end of the flow tube, the body having ports that open at their outer ends into the space between the body and the well casing and at their inner ends into the space between the second mentioned tube and sleeve, and a packer connected to the lower end of said body for sealing the space between the body and the well casing.

5. Means of the character described com-

prising, in combination, a well casing, a flow tube extending downwardly into the well casing, the joint between the top of the casing and the flow tube being closed, means for introducing the fluid under pressure between the casing and flow tube, and an assembly connected to the lower end of the flow tube and including an injector nozzle arranged axially of the flow tube and having its discharge end directed outwardly, a check valve within said injector disposed a substantial distance below the delivery end thereof, a ported member providing a communication between the lower end of the well casing and the lower end of the flow tube, said means including a downwardly seating check valve.

In testimony whereof, I hereunto affix my signature.

JOHN A. WOLFE.