A. E. ROE.

COMBINATION HYDRAULIC JET AND WATER LUBRICATING AIR LIFT.

APPLICATION FILED AUG. 21, 1911.

**1,012,224.**

Patented Dec. 19, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

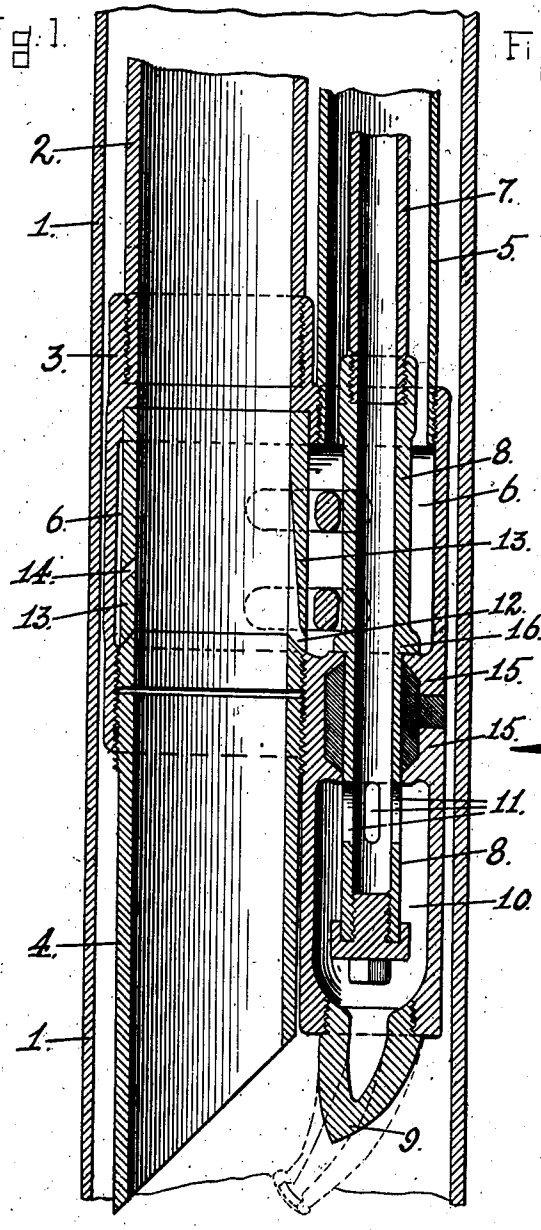
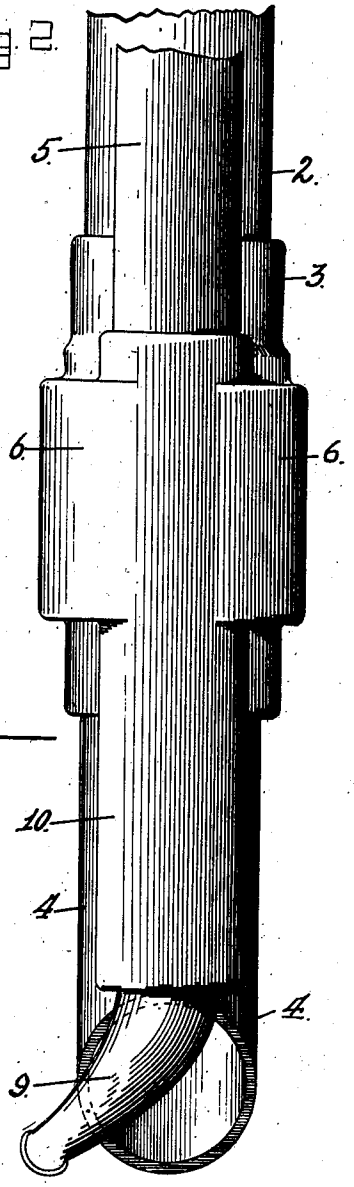



Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 3.

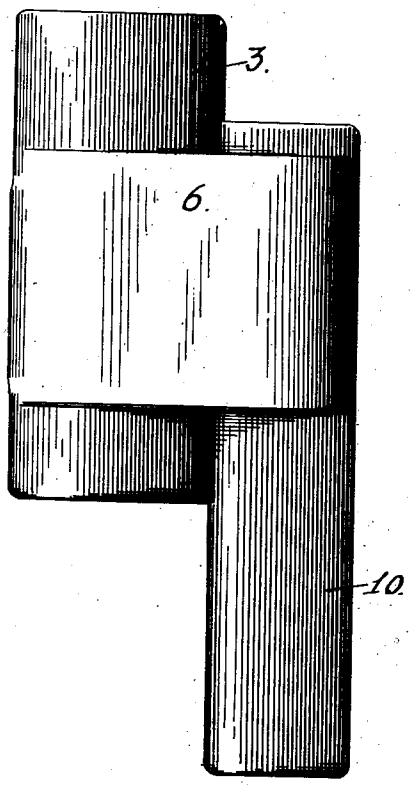



Fig. 5.

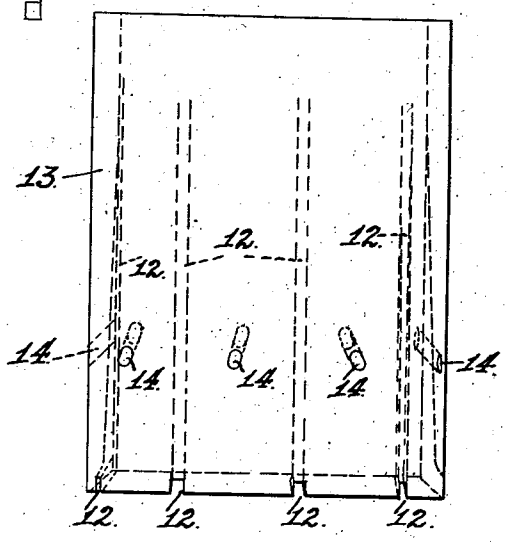



Fig. 6.

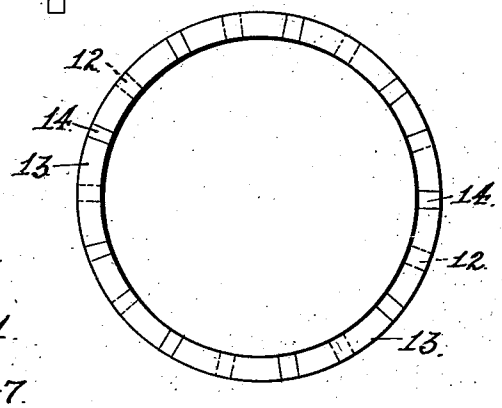
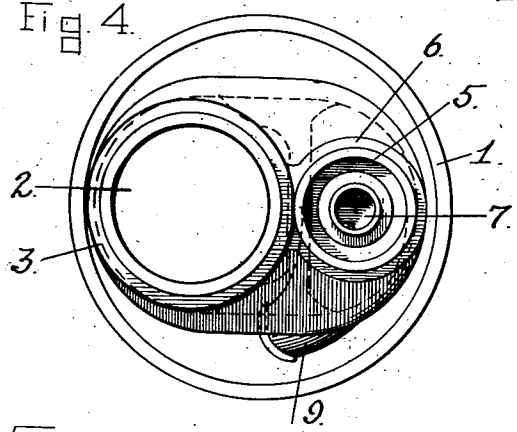



Fig. 4.

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# UNITED STATES PATENT OFFICE.

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## COMBINATION HYDRAULIC-JET AND WATER-LUBRICATING AIR-LIFT.

1,012,224. Specification of Letters Patent. Patented Dec. 19, 1911.

Application filed August 21, 1911. Serial No. 645,288.

*To all whom it may concern:*

Be it known that I, ALPHEUS E. ROE, a citizen of the United States, residing at Oakland, in the county of Alameda and State of California, have invented certain new and useful Improvements in Combination Hydraulic-Jet and Water-Lubricating Air-Lifts, of which the following is a specification.

My invention relates to apparatus for lifting oil from wells, and it consists in an apparatus which from its several functions may properly be termed a combination hydraulic-jet and water-lubricating air-lift, in that it combines three essential features, found to be most useful in pumping oil wells with compressed air. First and most simple is the straight air lift, successful where the liquid is an emulsion of oil and water. Second, the use of the hydraulic jet in combination with the straight air lift in wells where the lower casing is filled with sand or fine gravel, packed hard, which cannot be lifted out with the straight air lift. Third, in wells which carry large quantities of fine sand or silt and little or no water. I have found that when a very small amount of water introduced with the air is sprayed or dashed against the inner surface of the tubing and discharge pipe, the friction of the viscous oil is much relieved and the air pistons formed in the discharge tubing will carry the mixture to the surface and discharge it in a very satisfactory quantity and with very good economy in the use of compressed air.

Heretofore, the several practical conditions have been met and worked upon separately. To explain; it has been found that crude heavy oil cannot be successfully lifted through the tubing of a deep oil well without adding water. This has been done, in practice, by turning water into the well casing from the surface, which water, due to its greater specific gravity, will pass down through the oil to the bottom of the casing and be lifted out by the compressed air. If just the proper amount of water is thus introduced into the well, some oil will be emulsified and carried out with it. If the amount of water is too great, the oil will be floated above the intake of the lift, and practically no oil will be discharged with the water. It has been found, in practice, very difficult to operate this plan successfully, for in some wells, the amount of oil in the casing is much deeper, varying from a few feet to several hundred feet. Again, in cases where sand is firmly packed in the lower casing of the well, water-jetting this sand by introducing an additional pipe down to the surface of the sand, past the air lift, has been done and successful work accomplished. This, however, in practice, is not always possible for the reason that the air lift practically fills the well casing and the work of guiding even a small pipe by or past it in the well casing is difficult and dangerous for if it should jam and be broker., it may become a matter of great expense to clear the well again.

By introducing water with the air, as provided for in my apparatus, the quantity can be controlled perfectly, and since it is introduced or dashed evenly around the inner surface of the discharge tubing, it does not emulsify with the oil but is held in a thin film by capillary attraction to the inner surface of the tubing and the oil slips over the wetted surface as the whole is lifted through the tubing by the air. It is found in practice, that a comparatively small quantity of water thus introduced is required and that the quantity of oil which can be discharged through a given size of well tubing is much greater than can be pumped in the usual manner. The fine sand or silt is carried up with the oil and the well will continue to operate with no attendance, until the air pressure is shut off.

In my apparatus, as will hereinafter appear, the hydraulic pipe and jet serves both as a powerful hydraulic agitating agent to loosen the sand in the lower casing and carry it to the discharge tubing, and also as a means to carry the water to the air lift proper when operating on crude oil alone.

The nature of my apparatus and the manner of its use will be fully understood from the following description and by reference to the accompanying drawings:—

Figure 1 is a vertical section showing the apparatus in detail as it would appear in the well inside of a casing. Fig. 2 is an outline view of the shell in the direction of the arrow of Fig. 1, and shows the section of suction, air and discharge pipes attached; also the spirally shaped hydraulic jet nozzle. Fig. 3 is an outline side view of the

shell as the casting would appear without pipe connections, it being intended to make this shell or casting of phosphor bronze or some equally good composition. Fig. 4 is a plan looking into the well casing, the discharge pipe, air and water pipe, with an outline of the shell and the spirally attached hydraulic nozzle shown partly in dotted and partly in full lines where the same projects outward beyond the shell. Figs. 5 and 6 are details of the sleeve 13 through which the air and water pass as hereafter described.

1 is the well casing.

2 is a section of the discharge pipe which, as shown, is screwed into the collar 3 at the top of the shell casting.

4 is a section of the suction pipe and is shown as screwed into the lower end of the shell. 5 is a section of air pipe also screwed in at the top end of the shell above the air chamber 6.

7 is a section of the water pipe which, as shown, is screwed into the top of hydraulic plunger 8.

9 is the hydraulic nozzle screwed in position to the bottom end of the hydraulic chamber 10 of the shell.

11 indicates the four slots through which the water passes from the hydraulic plunger 8 into the hydraulic chamber 10 and out through the hydraulic nozzle 9, into the well casing 1, below the lower end of the suction pipe 4 of the lift.

12 indicates milled apertures through the sleeve 13, as shown in detail in Figs. 5 and 6, through which water passes to lubricate the inner surface of discharge pipe 2.

14 represents air holes in the sleeve 13 through which air passes from air chamber 6 to discharge pipe 2. As will be seen, the air chamber 6 extends entirely around sleeve 13. These air openings are drilled and spaced as shown in Figs. 5 and 6. The partition 15 which separates the air chamber 6 from hydraulic chamber 10 and through which the hydraulic plunger 8 passes, is a part of the shell casting and is lined with genuine Babbitt metal to prevent corrosion or deterioration of the surfaces by electroylsis.

The arrangement of parts is shown in position as they would appear when the lift is operating as a straight air lift with hydraulic jetting system in operation. In this condition, air would be admitted to air chamber 6 through air pipe 5 and pass through openings 12 and 14 through the sleeve 13 into the discharge pipe 2. At the same time water would be passing from water pipe 7 through the hydraulic plunger 8 into the hydraulic chamber 10 through the slots 11 in the hydraulic plunger and out through the hydraulic nozzle 9 into the well casing 1 striking the surface of sand or materials in the casing, and by the spiral direction, cause these materials to be agitated and be drawn into the suction pipe 4 by the uplifting force of air in the discharge pipe 2.

When it is desired to operate the lift as in the case of a well in which only crude oil is contained and without sufficient water, the water pipe 7 which is attached to the hydraulic plunger 8 is lifted up through the partition 15 so that the top of slots 11 projects slightly above the partition and are wholly sealed by the Babbitt lining in said partition at their lower portion, thus entirely cutting off the supply of water from entering hydraulic chamber 10. When in this position, the hydraulic plunger 8 will deliver water to the air chamber 6 in whatever quantity may be admitted to the water pipe from the surface, this quantity being under control by suitable valve for the purpose. Under this condition, the openings 12 through the bottom of sleeve 13 serve to conduct this water to the inner surface of said sleeve and by the upward tendency of the liquid through the discharge pipe 2, the water wets the inner surface of the same throughout its length thereby causing the oil to slip easily over the inner surface and to be borne upward through the discharge pipe by the air which enters through the openings 14 of the sleeve 13 into the discharge pipe 2.

Suitable provision is, of course, made at the top of the well for introducing air into the air pipe 5 and water into water pipe 7 separately and under pressure, to more than balance the column of liquid in the well casing; also a suitable mechanical device is provided to balance the weight of water pipe 7 in the position shown and described for these two purposes of its use, namely, 1st, as a hydraulic jetting system, and, 2nd, to convey water for lubricating inner surface of discharge pipe as described.

When the apparatus is to be used as a straight air lift in the usual and ordinary manner, the water pipe 7 and hydraulic plunger 8 are lowered so that the collar or shoulder at 16 on the hydraulic plunger is in contact with the upper surface of the partition 15 as shown in Fig. 3 and the supply of water cut off from the water pipe at the surface. In this condition, the lift is properly proportioned and equipped for handling an emulsified liquid of oil and water when conditions in the well warrant its use in this manner.

Thus it will be seen that the lift is adapted for three separate and distinct conditions of service, all of which may be met with in the same well and, indeed, are frequently demanded. In practice, the lower portion of the well casings are perforated to permit the oil to enter the casing and in so

entering, particles of sand are carried through with it and sometimes the inflow of sand is so great as to partially clog; and in cases when the well is inoperative, as when changing pump or air lift for a period of several hours, the sand will have settled into the casing in a hard compact mass which will not be lifted by the straight air lift as usually applied. In such cases with the combination proposed, it will be possible to put the hydraulic jetting system in operation and effectually clear the well without the necessity of removing the tubing as is often the case in the usual and ordinary practice.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is—

1. In an apparatus of the character described, involving a flow-pipe within the well casing, means for introducing into said flow pipe air under pressure, and means for introducing to said flow pipe with the air, water under pressure, said water being directed upon the internal surface of the flow pipe for the purpose described.

2. In an apparatus of the character described, involving a flow-pipe within the well casing, means for introducing into said flow pipe air under pressure, and means for separately introducing to said flow pipe simultaneously with the air and in the vicinity of the air entrance, water under pressure, said water being directed upon the internal surface of the flow pipe, for the purpose described.

3. In an apparatus of the character described, involving a flow-pipe within the well casing, means for introducing into said flow pipe air under pressure, and means for separately introducing to said flow pipe, simultaneously with the air, water under pressure, said water being introduced through an annular series of openings through the walls of the flow pipe arranged to deliver the water upon the inner surface of said pipe for the purpose described.

4. In an apparatus of the character described, involving a flow-pipe within the well casing, means for introducing into said flow pipe through an annular series of openings therein, air under pressure, and means for separately introducing to said flow pipe through an annular series of openings therein in the vicinity of the air openings, water under pressure, said water being directed upon the inner surface of said pipe for the purpose described.

5. In an apparatus of the character described, a shell fitted in the well casing, a discharge pipe connected with the top of the shell and a suction pipe connected with the bottom of the shell, a sleeve within the shell alined with the discharge and suction pipes and circumferentially separated from the shell by an encircling air chamber, said sleeve having an annular series of air openings and a separate annular series of water openings, an air pipe connected with the top of the encircling air chamber of the shell and a water pipe passing through the air pipe and opening into the air chamber.

6. In an apparatus of the character described, a shell fitted in the well casing, a discharge pipe connected with the top of the shell and a suction pipe connected with the bottom of the shell, a sleeve within the shell alined with the discharge and suction pipes and circumferentially separated from the shell by an encircling air chamber, said sleeve having an annular series of air openings and a separate annular series of water openings, below the air openings and made upwardly inclining through the sleeve walls to direct the water to and upon the inner surface of said sleeve, an air pipe connected with the top of the encircling air chamber of the shell and a water pipe passing through the air pipe and opening into the air chamber.

7. In an apparatus of the character described, a shell fitted in the well casing; a discharge pipe connected with the top of the shell and a suction pipe connected with the bottom of the shell; a sleeve within the shell alined with the discharge and suction pipes and circumferentially separated from the shell by an encircling air chamber, said sleeve having air openings through its walls; a water pipe passing through the air pipe and air chamber and communicating with a water chamber in the shell below and separated from the air chamber, and a water nozzle fitted to said water chamber and disposed to direct a jet of water upon the sand and gravel under the lower end of the suction pipe.

8. An apparatus of the character described, comprising a shell fitted in the well casing; a discharge pipe connected with the top of the shell and a suction pipe connected with the bottom of the shell; a sleeve within the shell alined with the discharge and suction pipes and circumferentially separated from the shell by an encircling air chamber, said sleeve having separate air and water openings through its walls; an air pipe connected with the top of the encircling air chamber of the shell; a vertically slidable water pipe passing through the air pipe and air chamber into a water chamber in the shell below which said water chamber is separated from the air chamber by a partition, said water pipe having slots in its walls adapted by the vertical movement of the pipe to be exposed to the air chamber above while cut off by the partition from the water chamber below and vice versa; and a water nozzle fitted to said water chamber and disposed to direct a jet of water upon

the sand and gravel under the lower end of the suction pipe.

9. An apparatus of the character described, comprising a shell fitted in the well casing; a discharge pipe connected with the top of the shell and a suction pipe connected with the bottom of the shell; a sleeve within the shell alined with the discharge and suction pipes and circumferentially separated from the shell by an encircling air chamber, said sleeve having through its walls an annular series of air openings, and below these an annular series of water openings upwardly inclined to direct the water upon the inner surface of the sleeve; an air pipe connected with the top of the encircling air chamber of the shell; a vertically slidable water pipe passing through the air pipe and air chamber into a water chamber in the shell below which said water chamber is separated from the air chamber by a partition, said water pipe having slots in its walls adapted by the vertical movement of the pipe to be exposed to the air chamber above while cut off by the partition from the water chamber below and vice versa; and a water nozzle fitted to said water chamber and disposed to direct a jet of water upon the sand and gravel under the lower end of the suction pipe.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ALPHEUS E. ROE.

Witnesses:
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D. B. RICHARDS.