W. D. HUFF.

OPERATING OIL WELLS.

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1,140,982.

Patented May 25, 1915.

Fig. 1.

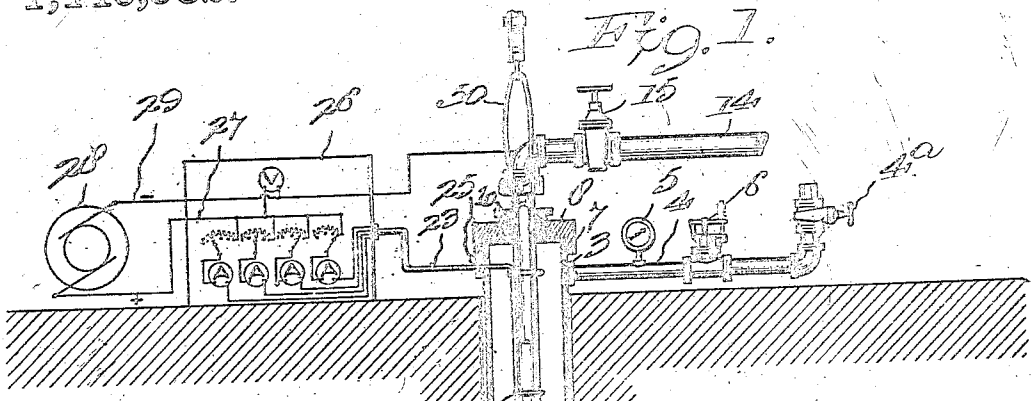


Fig. 2.

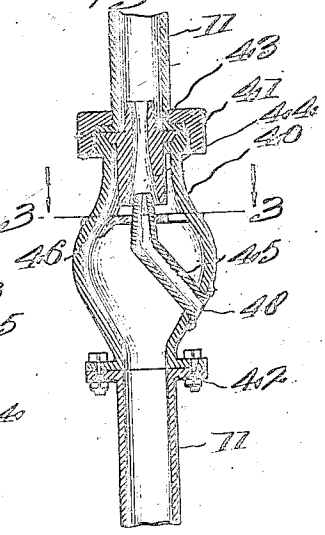


Fig. 4.

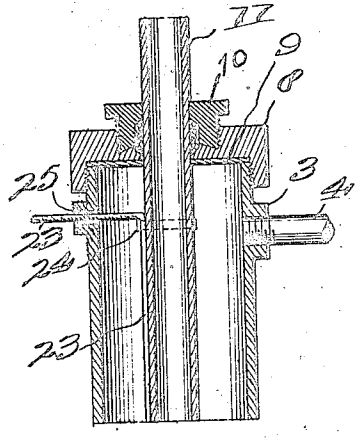
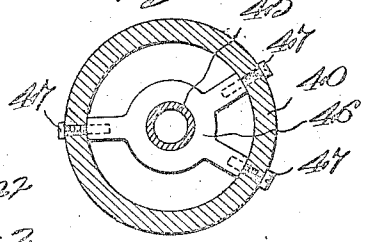


Fig. 3.



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UNITED STATES PATENT OFFICE.

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OPERATING OIL-WELLS.

1,140,982. Specification of Letters Patent. Patented May 25, 1915.

Application filed April 6, 1915. Serial No. 19,607.

To all whom it may concern:

Be it known that I, WILLIAM D. HUFF, a citizen of the United States, residing at La Fayette, in the parish of Lafayette and State of Louisiana, have invented certain new and useful Improvements in Operating Oil-Wells; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My present invention relates to improvements in the operation of oil wells, and it consists in an improved method whereby the oil may be lifted to the surface of the ground by steam, or gas pressure, created by heat generated in the well, as will be hereinafter more fully described and claimed; and my invention also relates to improved apparatus for use in carrying out the herein described process.

According to my invention a high pressure of steam or hydrocarbon gas, or both, is generated in the well by the use of any suitable source of heat, preferably a series of electric heaters arranged in the interior of the well, and the crude oil is forced upward through a central tube, as will be hereinafter more fully described.

My invention will be more clearly understood by reference to the accompanying drawings, in which the same parts are indicated by the same reference symbols throughout the several views.

Figure 1 shows a section through the well casing and well, with the inner tube in elevation, and the electric heating arrangement shown diagrammatically, parts being broken away. Fig. 2 shows a central vertical section through the ejector, but on a larger scale than in Fig. 1. Fig. 3 shows a section along the line 3—3 of Fig. 2, and looking down; and Fig. 4 shows, on a larger scale, the head of the well casing and connected parts.

The well casing 1 is preferably constructed in the usual way of a series of sectional joints secured together as the casing is put down in the well. These joints should form a gas-tight hollow cylinder wall, perforated only toward the bottom as at 2, but instead of the perforations 2, a suitable strainer, such as is well known in the art, may be used if desired. The top section of the casing is perforated, as at 3, to receive the relief pipe 4 carrying the relief valve 4^a, the pressure gage 5, and a suitable safety valve 6. The upper end of the casing is screw-threaded, as at 7, to engage the screw cap 8 beneath which is preferably placed a suitable packing 9. This cap is provided with a suitable stuffing box 10, through which passes the inner pipe 11, which inner pipe is also made up in the usual way of a series of sections connected together, and the lower section or sections of the pipe are preferably perforated, as at 12, to permit the flow of said liquid into said pipe from the interior of the casing 1. The upper portion of this inner pipe 11 terminates in a delivery pipe 14 for carrying the liquids delivered from the well to any desired receptacle, not shown, and this pipe 14 is controlled by a valve 15.

I provide on the interior of the casing suitable heating devices such, for instance, as electric heaters 21, which are preferably cylindrical in shape and surround the inner pipe 11, as shown. Any suitable electric heater may be used in this connection, and I do not claim any special form of heater as part of my invention. These electric heaters are supplied with electricity from the individual feed wires 22, which are bound up in a suitable insulated cable 23, which cable is secured to the inner pipe in any convenient way, as by the strips 24. This cable passes up through a plug 25 in the well casing, and the individual conductors are connected to separate switches located in the switch-board 26, each of which switches is adapted to make connection with the main 27 which is supplied with electricity from any suitable source, as the dynamo 28. The return main 29 is grounded in any convenient way, preferably by connecting same to the inner pipe 11, as shown in Fig. 1, thus providing an all-metallic circuit for the electricity.

Between the mains 27 and 29 a suitable volt meter, indicated by V, is preferably provided, and suitable resistance coils and ammeters A may be provided for each switch, as shown in Fig. 1. The electric connections are shown diagrammatically in said figure, but the apparatus is intended to provide means for heating each electric coil, and for regulating the temperature of each coil, independently of all the others.

I provide a suitable ejector for use on the well known principle of such apparatus,

comprising a short bulbous connection 40 between the adjacent lengths of the inner pipe 11, which connection is attached to the upper portion of the inner pipe 11 in any convenient way, as by the coupling 41, and mounted in the upper end of this bulbous connection 40 is the upper nozzle 43 of the ejector, which upper nozzle is provided with a conical chamber 44, into which projects the upper end of the inlet nozzle 45, as shown most clearly in Fig. 5. This lower nozzle should be preferably steadied in the connection 40, and I have shown a spider 46 used for this purpose, which spider is preferably made three-legged in order to be conveniently slipped into place in the connection 40, and may be held in place in any convenient way, as by the screw bolts 47. Any suitable mode of mounting the ejector may be employed.

To raise and lower the inner tube in the well, a suitable hoist 50 may be attached to the top of said tube, and the raising and lowering may be accomplished by the apparatus (not shown) installed when the well is bored and used in handling the pipes. In oil wells there is nearly always more or less water, and in those wells that require pumping, or in old or abandoned wells, there is often considerable water to be removed before the well can be caused to deliver the crude oil properly.

In the operation of the device, the first point is to determine the depth below the surface of the ground of the static head X of the liquid in the well; this may be done by a floating plummet introduced into the well before the cap is put on, as is well known in the art. Having determined the depth of the static head, and incidentally the height the liquid is to be raised above the static head, I submerge the ejector to a point sufficiently below the static head to require adequate pressure to be generated in the casing to depress the level of the liquid therein below the location of said ejector, in order to give pressure sufficient to cause the ejector to lift the column of liquid in the inner tube to surface of the ground. Suppose, for instance, the static head to be 400 feet below the surface of the ground, and assuming the casing to be strong enough to stand an internal pressure of say 400 pounds per square inch, the ejector inlet should preferably be about 1200 feet below the surface of the ground. Then the cap of the well being closed, and the electric connections made, electricity is turned on to operate the submerged heaters, with the result that the liquid in the well casing is heated and steam and hydrocarbon steam and other gases are generated, which gases will rise up through the liquid and accumulate in the top of the well casing, forcing the liquid down in said casing from the level indicated at X, or static head, to a point below the inlet opening of the ejector.

When there is only water in the well casing, steam, of course, will be the only gas generated, and hereafter whenever the words "gas" or "gas pressure", or "gaseous pressure", are used I mean to include in these generic terms "steam" and "steam pressure", and in the same way I mean by the term "liquid" to include water, and such other liquid, or semi-liquid, compositions, or mixtures of matter as are found in wells of the character described. Under certain conditions, it may be desirable to furnish more water than is already available, and for this purpose either the pipes 4 or 14 may be connected to any suitable source of water supply, and water may be pumped into, or allowed to run into the well, thus providing a liquid mass suitable for the purposes of generating the steam, whereby the process is carried out.

When the surface of the liquid falls below the inlet opening 48 of the inlet nozzle 45, there will be a rush of gas under pressure through said nozzle and up through the upper nozzle 43 which will enter the column of liquid in the inner pipe above said upper nozzle and cause an upward flow of the liquid in the upper portion of the inner pipe 11.

In addition to the dynamic effect of the rapid inrush of gases into the ejector, the steam, and especially the gas, entering the column of liquid above the nozzle 43 will also tend to promote the upward flow of the column of liquid above the nozzle 43 under the well known principle of the aerial column, as shown, for instance, in the patents to J. G. Pohle entitled Process of elevating liquids, No. 487639, granted December 6, 1892, and No. 532699 for Process of and apparatus for elevating liquids, granted January 15, 1895. Furthermore, the mixture of liquid and gas will be lighter than a similar column of liquid alone, and the pressure required to lift the superposed column in the inner pipe will be materially decreased.

Suitable heaters may be provided along the length of the inner pipe 11 above the ejector, whereby a high temperature of the liquid, and more especially of the gases contained therein, may be secured, with the result that the buoying-up effect of the gases may be materially increased.

If there be free liquid connection between the oil bearing strata of the well and the screen and bottom of the well casing, as in free flowing wells, the height of the liquid in the inner tube will remain constant, corresponding to the normal static head of the well, irrespective of the gas pressure in the well casing, until the gas can get into the ejector nozzle; but should the flow of

the well be slow and the gas pressure be suddenly raised there would be a lifting of the column in the inner tube to balance the excess gas pressure in the casing, which might under certain circumstances be sufficient to cause the liquid to flow out of the top of the inner tube; but this lifting of the inner column of liquid by pressure alone will have no other effect than the advantageous one of facilitating the starting up of the operation after the gas gets below the inlet nozzle of the ejector, when the operation under the ejector principle becomes continuous, and commensurate with the flow of oil into the bottom of the well. It will be obvious that the actual height of the liquid has to be raised is determined by the depth of the normal static head of the well below the surface of the ground.

The operation of the apparatus will continue indefinitely as long as the flow of oil continues through the screen, near the lower end of the casing, and adequate pressure is maintained in the upper end of the casing above the liquid therein. But should the flow of oil through the screen be diminished due to the thickening of the oil or other causes, and it be necessary or advisable to warm and consequently thin the consistency of the oil in the region surrounding the screen, the valve 15 is closed, and the pressure is permitted to escape through the valve 4^a, permitting the liquid in the casing to assume the normal static head. Then heat this column of liquid by the electric heaters, and closing the valve 4^a, generate pressure enough in the upper casing to force a portion of the heated oil in the casing back through the screen and into the oil strata, heating the same and thinning the oil, and incidentally cleaning the screen. This heating process can be repeated until the strata are adequately heated to permit the free flow of the oil in the well again. When the oil again flows freely the valve 15 is opened and process of ejecting the liquid is resumed. This heating and cleaning of the screen and oil strata may be performed as often as found necessary.

It may be desired, in certain cases, to raise or lower the inlet 48 of the ejector to suit varying conditions of the flow of liquid in the well, such for instance as are occasioned by the lowering of the natural static head of the liquid in the well. This may be accomplished in various ways, for instance, by using the derrick arrangement, not shown, employing in constructing the well and by attaching the hoist 50 of the inner pipe 11, and thus raising or lowering said pipe.

While I have shown herein the preferred form of apparatus and have described the method of operating the same, it will be obvious that various modifications, both in the apparatus and in the mode of operation, may be employed which could be used without departing from the spirit of my invention, and I do not intend to limit myself to details of construction and operation, except such as are specifically set forth in the claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is:—

1. The herein described method of operating oil wells, which consists in closing said well at its top and sides against steam or other gas pressure, inserting in said closed top well a pipe provided with an ejector opening through the side of said pipe and adapted to direct gas pressure upward in said pipe, and extending said pipe to the desired depth below the normal surface or static head of the liquid in the well, and in finally supplying heat to the interior of said well, whereby gas under pressure is generated from the liquid in said well, causing the fluid pressure of said gas to force the surface of the liquid inside the well below the inlet nozzle of said ejector, and causing the gas so generated to blow up through said pipe, thereby lifting to the surface of the ground the column of liquid in said pipe, substantially as described.

2. The herein described method of operating oil wells, which consists in closing said well at its top and sides against steam or other gas pressure, inserting in said closed top well a pipe provided with an ejector opening through the side of said pipe and adapted to direct gas pressure upward in said pipe, and extending said pipe to the desired depth below the normal surface or static head of the liquid in the well, and in finally electrically generating heat to the interior of said well, whereby gas under pressure is generated from the liquid in said well, causing the fluid pressure of said gas to force the surface of the liquid inside the well below the inlet nozzle of said ejector, and causing the gas so generated to blow up through said pipe, thereby lifting to the surface of the ground the column of liquid in said pipe, substantially as described.

3. The herein described method of operating oil wells, which consists in inserting a casing into said well, closing said casing at its top and sides against steam or other gas pressure and providing means for the admission of liquids at or near the bottom of said casing, inserting an inner pipe in said casing and extending same below the static head of the liquid in the well, said inner pipe being provided with an ejector near the lower end thereof, and in finally supplying heat to the interior of said casing beneath the surface of the liquid in the well, whereby gas under pressure is generated from the liquid in said well, causing the fluid pressure

of said gas to force the level of the liquid inside said casing down below the inlet nozzle of said ejector in the inner pipe, thereby causing said gas to lift the column of liquid in the inner pipe through the top of the well, substantially as described.

4. The herein described method of operating oil wells, which consists in inserting a casing into said well, closing said casing at its top and sides against steam or other gas pressure and providing means for the admission of liquids at or near the bottom of said casing, inserting an inner pipe in said casing and extending same below the static head of the liquid in the well, said inner pipe being provided with an ejector near the lower end thereof, and in finally supplying heat to the interior of said casing beneath the surface of the liquid in the well, and also above the surface of said liquid, whereby gas under pressure is generated from the liquid in said well, causing the fluid pressure of said gas to force the level of the liquid inside said casing down below the inlet nozzle of said ejector in the inner pipe, thereby causing said gas to lift the column of liquid in the inner pipe through the top of the well, substantially as described.

5. The herein described method of operating oil wells, which consists in inserting a casing into said well, closing said casing at its top and sides against steam or other gas pressure and providing means for the admission of liquids at or near the bottom of said casing, inserting an inner pipe in said casing and extending same below the static head of the liquid in the well, said inner pipe being provided with an ejector near the lower end thereof, and in finally electrically generating heat to the interior of said casing beneath the surface of the liquid in the well, whereby gas under pressure is generated from the liquid in said well, causing the fluid pressure of said gas to force the level of the liquid inside said casing down below the inlet nozzle of said ejector in the inner pipe, thereby causing said gas to lift the column of liquid in the inner pipe through the top of the well, substantially as described.

6. The herein described method of operating oil wells, which consists in inserting a casing into said well, closing said casing at its top and sides against steam or other gas pressure and providing means for the admission of liquids at or near the bottom of said casing, inserting an inner pipe in said casing and extending same below the static head of the liquid in the well, said inner pipe being provided with an ejector near the lower end thereof, and in finally electrically generating heat to the interior of said casing beneath the surface of the liquid in the well, and also above the surface of said liquid, whereby gas under pressure is generated from the liquid in said well, causing the fluid pressure of said gas to force the level of the liquid inside said casing down below the inlet nozzle of said ejector in the inner pipe, thereby causing said gas to lift the column of liquid in the inner pipe through the top of the well, substantially as described.

7. In an oil well the combination with a casing and a closed cap therefor, of an inner pipe projecting down through said closed cap and provided with an ejector opening into the interior of said casing and adapted to direct steam or other gas under pressure upward through said inner pipe, and means for generating heat in said casing, substantially as described.

8. In an oil well the combination with a casing and a closed cap therefor, of an inner pipe projecting down through said closed cap and provided with an ejector opening into the interior of said casing and adapted to direct steam or other gas under pressure upward through said inner pipe, and electric heaters mounted in said casing for generating heat therein, substantially as described.

9. In an oil well the combination with a casing and a closed cap therefor, of an inner pipe projecting down through said closed cap and provided with an ejector opening into the interior of said casing and adapted to direct steam or other gas under pressure upward through said inner pipe, and electric heaters carried by said inner pipe and adapted to generate heat in said casing, substantially as described.

10. In an oil well the combination with a casing and a closed cap therefor, of an inner pipe projecting down through said closed cap and provided with an ejector opening into the interior of said casing and adapted to direct steam or other gas under pressure upward through said inner pipe, and electric heaters mounted in said casing for generating heat therein, with means for conveying a current of electricity through said electric heaters either singly or in groups, substantially as described.

11. In an oil well the combination with a casing and a closed cap therefor, of an inner pipe projecting down through said closed cap and provided with an ejector opening into the interior of said casing and adapted to direct steam or other gas under pressure upward through said inner pipe, and electric heaters carried by said inner pipe and adapted to generate heat in said casing, with means for conveying a current of electricity through said electric heaters either singly or in groups, substantially as described.

12. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through

the closed top of said casing and opening into same near its bottom, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils into or out of said circuit when desired, substantially as described.

13. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through the closed top of said casing and opening into same near its bottom, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils, singly or in groups, into or out of said circuit when desired, substantially as described.

14. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, and means for generating heat on the interior of said casing, substantially as described.

15. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils into or out of said circuit when desired, substantially as described.

16. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils, singly or in groups, into or out of said circuit when desired, substantially as described.

17. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through the closed top of said casing and opening into same near its bottom, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, substantially as described.

18. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through the closed top of said casing and opening into same near its bottom, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils into or out of said circuit when desired, substantially as described.

19. Apparatus for operating oil wells, comprising a casing for the well open at near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, substantially as described.

20. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, comprising a series of electric coils mount-

ed on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils into or out of said circuit, when desired, substantially as described.

21. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through the closed top of said casing and opening into same near its bottom, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means operated by electricity for generating heat on the interior of said casing, substantially as described.

22. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through the closed top of said casing and opening into same near its bottom, means for raising and lowering said inner pipe relative to said casing, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, substantially as described.

23. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, an inner pipe passing through the closed top of said casing and opening into same near its bottom, means for raising and lowering said inner pipe relative to said casing, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils into or out of said circuit when desired, substantially as described.

24. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, means for raising and lowering said inner pipe relative to said casing, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, substantially as described.

25. Apparatus for operating oil wells, comprising a casing for the well open at or near the bottom and having gas-tight sides and top, with means for limiting the pressure in said casing, an inner pipe passing through the closed top of said casing and opening into same near its bottom, means for raising and lowering said inner pipe relative to said casing, an upwardly-disposed ejector nozzle mounted in said inner pipe near the lower end thereof, and an inlet nozzle passing through the side of said inner pipe below said ejector nozzle for transmitting fluid under pressure upward through said inner pipe from the interior of said casing, and means for generating heat on the interior of said casing, comprising a series of electric coils mounted on said inner pipe, a source of electricity, an electric circuit between said source of electricity and said coils, and means for cutting said coils into or out of said circuit when desired, substantially as described.

In testimony whereof, I affix my signature.

WILLIAM D. HUFF.