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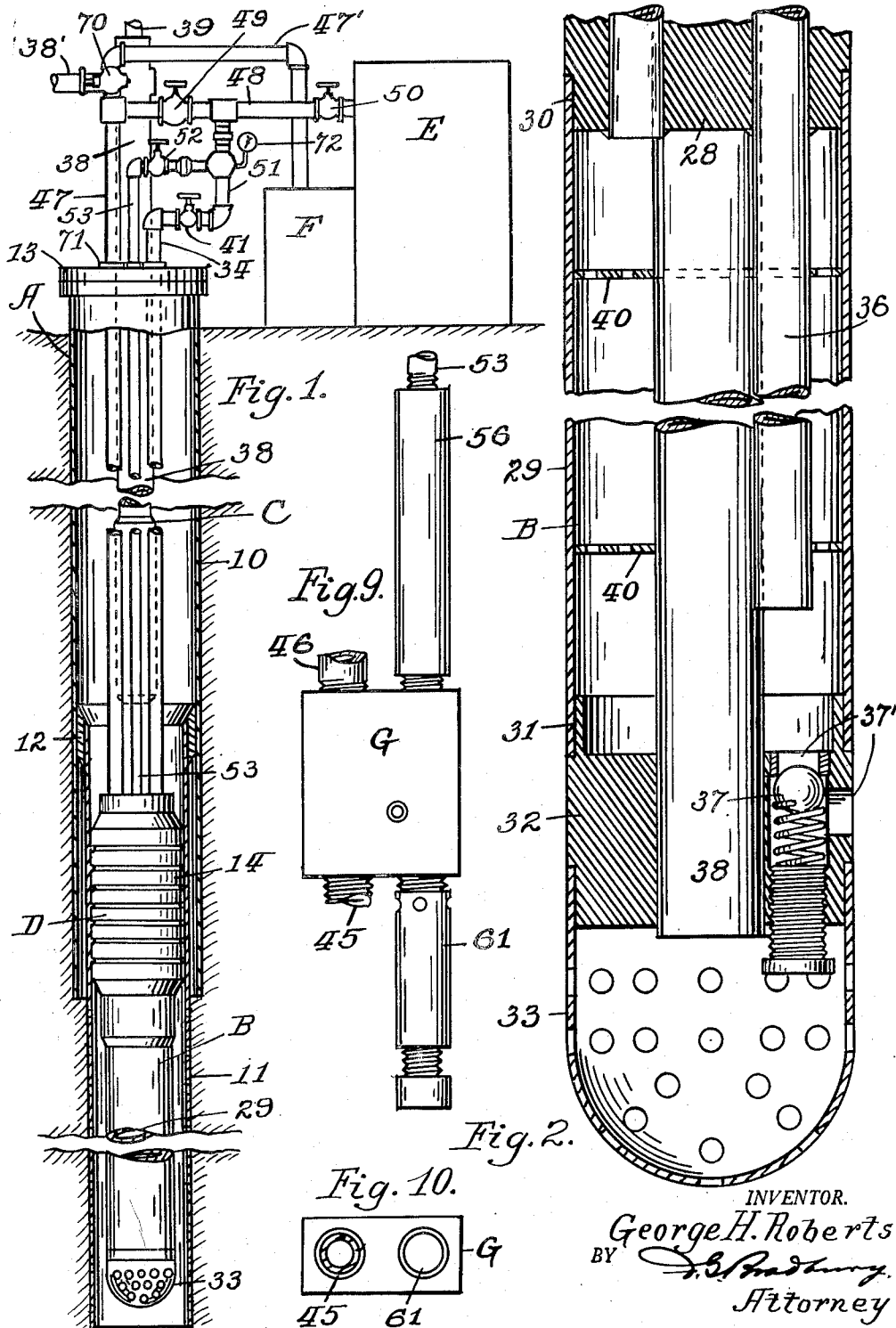
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HEATER FOR OIL AND OTHER WELLS

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3 Sheets-Sheet 1



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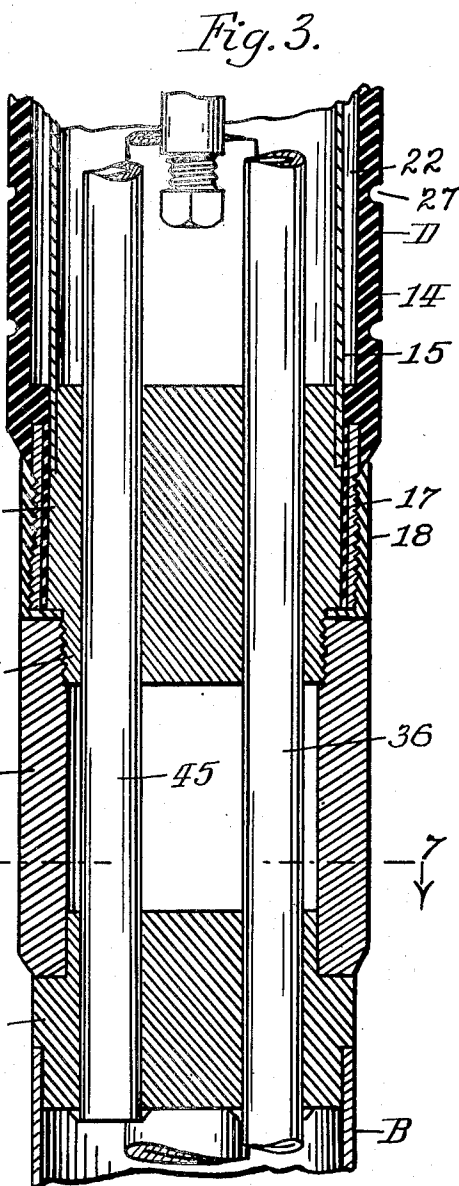
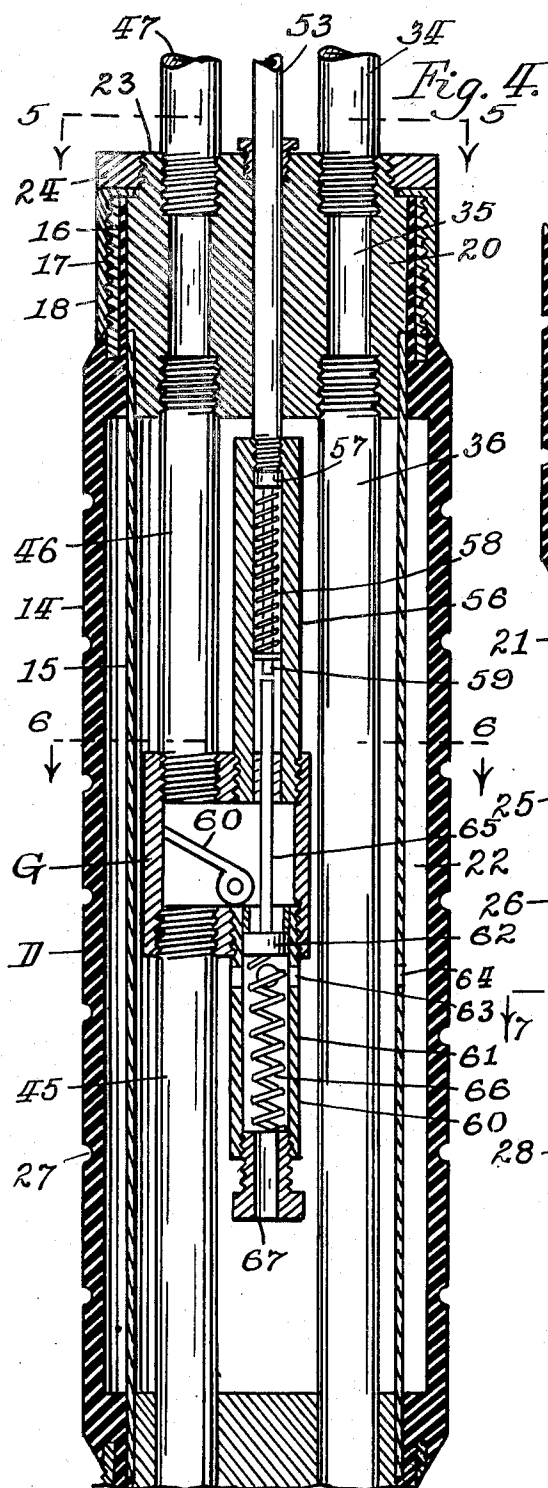
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HEATER FOR OIL AND OTHER WELLS

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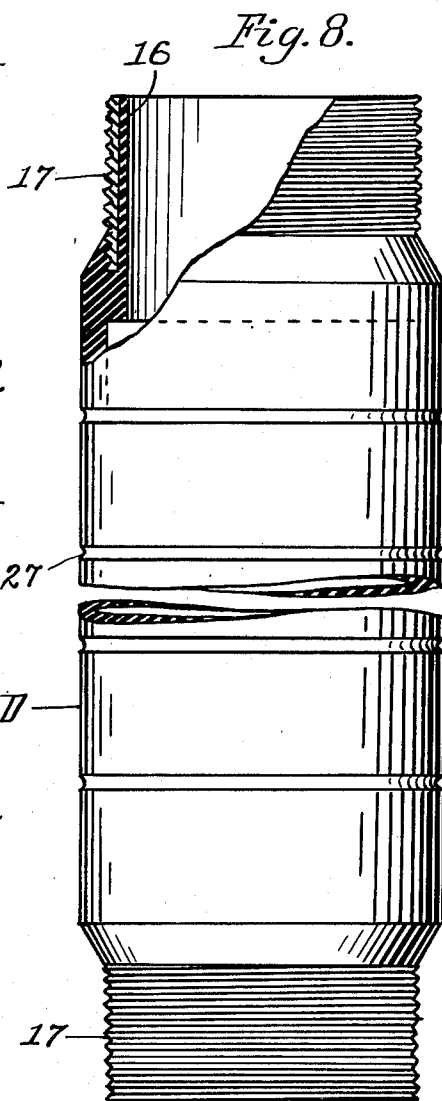
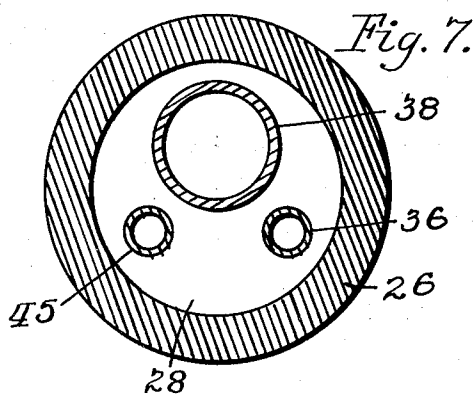
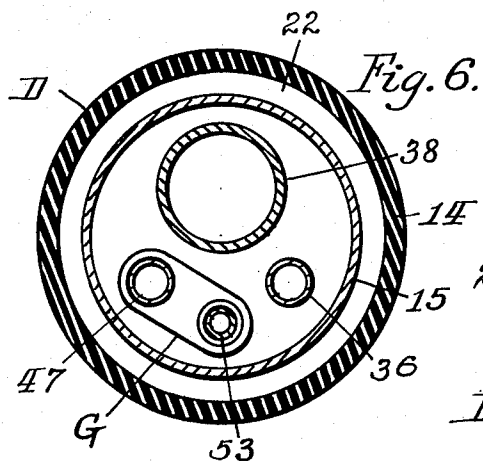
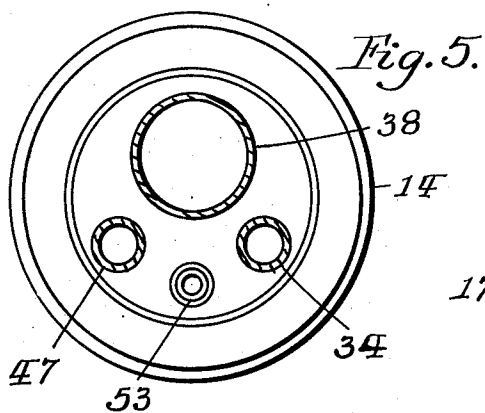
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HEATER FOR OIL AND OTHER WELLS

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UNITED STATES PATENT OFFICE

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HEATER FOR OIL AND OTHER WELLS

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2 Claims. (Cl. 166—17)

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This invention relates to a heater for use in deep and shallow wells to reduce oil and other deposits in the earth to fluid condition so that they can be pumped or made to flow to the surface of the well. To this end my invention provides simple and effective means which when lowered into a well can be controlled in operation entirely from above the well and can be made to reduce the oil or other deposit in the formation in which the well is located to free flowing condition. Another object is to provide apparatus for the above purpose which most effectively reduces said deposit to fluid condition at a minimum of expense to operate and which is adapted to recover substantially all of the oil or other deposit which is held in the formation adjacent to the well.

In the following specification I have shown and described my improved apparatus when applied for use in an oil well and supplied with superheated steam as an energizing medium. It will however be understood that the apparatus may be modified in construction, that other deposits than oil may be treated in the well, and that other activating medium instead of superheated steam may be employed as a motivating medium within the spirit of the invention.

In the accompanying drawings forming part of this specification, Fig. 1 is a side elevation partly in vertical section of a typical oil well, showing the well lined with the usual casing and my improved heater set in the well and connected with the surface installation by which energizing fluid is provided and controlled for operating the heater and packer in the well; Fig. 2 is a vertical central section at increased scale of the lower portion of my improved heater assembly; Fig. 3 is a vertical section of the central portion of the heater assembly; Fig. 4 is a vertical section of the upper portion of the heater assembly, it being understood that portions of the heater shown in Figs. 2, 3, and 4 constitute the entire heater structure; Fig. 5 is a plan taken in the plane indicated by the line 5—5 of Fig. 4, showing the upper end of the heater assembly; Fig. 6 is a section taken on the line 6—6 of Fig. 4; Fig. 7 is a section taken on the line 7—7 of Fig. 3; Fig. 8 is a side elevation, partly broken away and in section of the packer which may be employed with my improved apparatus; Fig. 9 is a side elevation of the pressure release valve which controls the operation of the packer, and Fig. 10 is a lower end view of the valve shown in Fig. 9.

In the drawings, A represents a well in which

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my improved heater is shown applied in use, said well being lined with the usual casing 10, said casing being set by its lower end in the oil or other residual deposit bearing earth formation in which it is desired to apply my improved heater. Assuming that the casing is set in oil bearing formation, the lower end portion thereof is provided with an inner perforated liner 11 of reduced diameter which is connected to the casing 10 by the usual adapter 12. The upper end of the casing above or close to the surface of the well is closed by the usual casing head 13.

My improved heater B is provided with a self contained pneumatic packer D which has an elastic cylindrical jacket 14 and an inner relatively thin cylindrical tube 15 on which the ends of the jacket are tightly secured. The jacket is composed of resilient material so that when it is inflated it engages the inner surface of the casing in the well and seals the heater therein. Each of the opposite ends of the resilient jacket resembles a sleeve 16 which is extended lengthwise over the tube and is held tightly on each end thereof by an outwardly threaded collar 17, said collar being threadedly engaged and clamped tightly by a pressure seal ring 18 and bonded by vulcanizing on the ends of the tube. This end structure is substantially similar on both ends of the packer. One end portion of the packer structure is closed tightly by a coupling head 20 which engages the adjacent end of the tube 15, and the opposite end portion of the packer structure is closed by a coupling head 21 which in a substantially similar manner engages the lower end of the tube 15. In this manner an inflating chamber 22 is formed within the packer. The upper end of the coupling head 20 is formed with a threaded nipple 23 on which a lock ring 24 threadedly engages and holds the seal ring 18 tight to prevent turning. In like manner the lower end of the lower coupling head 21 (Fig. 3), is provided with a threaded nipple 25 on which a downwardly extended lock sleeve 26 threadedly engages and holds the lower seal ring 18 tight to prevent turning.

The construction of the pneumatic packer is shown in Fig. 8, when removed from the coupling heads. When desired the outer cylindrical surface of the body portion of the packer may be provided with annular channels 27 to assist in forming a tight leakproof connection when the packer is inflated and expanded into tight engagement with the inner surface of the liner portion 11 of casing 10, at the desired vertical position in the well.

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The lock sleeve 26, which is mounted by the nipple 25 on the lower end of the coupling head 21, extends downwardly and is secured to the annular head member 28 of heater B. The heater has a cylindrical jacket 29 joined by a slip joint 30 and welding at its upper end to the coupling head 28 and depends therefrom in the well. Its lower end is attached by a slip joint 31 and welding to a valved head 32, which in turn supports a perforated screen 33.

The heater and packer are thus united into a self contained unit which is adapted to be applied at any desired elevation in the well so as to block off and isolate that portion of the well which contains oil or other residual deposit and to apply heat thereto. Assuming that superheated steam at any desired pressure and temperature (for illustration 300 pounds to the square inch pressure and 300 degrees F.), is employed as an energizing medium, it is conducted downwardly into the heater by ducts 34, 35 and 36 (Fig. 4). A release check valve 37 is provided in head member 32 and is adapted to conduct steam at predetermined pressure and temperature from the chamber within heater B through the port passages 37' into the oil or other residual deposit bearing structure so as to reduce said deposit in the well into free flowing condition, whereby it can be readily pumped upwardly through the flow line 38 out of the well. The flow line 38 is extended upwardly through the heater B, whereby it is maintained in heated condition by live steam in the chamber within the heater. The flow line tubing is connected to the ingress and egress ends of the reciprocable pump C above the heater. The pump C, of ordinary construction is actuated by the reciprocable sucker rod 39, which is extended upwardly above the well through the egress flow line tubing 38 and is driven by any suitable means (not shown). The live steam heating tube section 36 (Fig. 2) and the intake lower portion of the flow line 38 are assisted in being maintained in fixed position in the heater by the baffle plates 40. The live steam duct 34 (Fig. 1), leading from boiler E which contains a superheater (not shown) is assisted in being controlled by the hand operable valve 41.

A suitable surface installation for activating the combined heater and packer is provided, which comprises the boiler E and its steam condenser F and superheater, and a system of valved steam lines connected to the casing head 13 as shown in Fig. 1. As the heater B, packer D and pump C are operated simultaneously, heated oil or other residual fluid deposit obtained from the structure in which the well is located, after being reduced to free flowing condition is drawn into the well by the negative force or vacuum tendency which is created by the heater and the pump, and is then removed from the well through the flow line 38. During this action live steam from the boiler and its superheater is conducted downwardly into the heater by the input steam line sections 34, 35 and 36, which are connected together in series. As pressure increases in the heater the release valve 37 automatically permits the steam to circulate through the structure in which the heater is applied, thus liquifying the residual deposit in the structure and surrounding the heater. The suction and vacuum tendency created by the heat and the pump tends to draw the resulting fluid from the earth structure into the heater, from which it is pumped to the surface above the well and re-

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leased through the outlet portion 33' from the flow line 38.

Circulating steam passing through the heater is adapted to be returned to the condenser F through the steam exhaust line which is composed of duct sections 45, 46 and 47 (Fig. 4), the latter section being extended above the casing head 13 and connected to the condenser F through branch 47'. Live steam supply duct 48 from the boiler is connected to the heater steam exhaust duct 47 and is controlled by valves 49 and 50. Duct 48 is also connected to the live steam supply line 34 through branch 51 which is controlled by valve 41. The main supply line 48 is additionally controlled through the operation of valves 49 and 50.

A live steam control line is tapped into the supply duct 48 by the valved connection 52, which in turn is extended downwardly through the casing head 13 and packer head 20 by the control cylinder 56 (Figs. 4 and 9), which contains a reciprocable piston 57. This piston is adapted to function by steam pressure against the tension of spring 58, and supports a longitudinally extended actuating push rod 59.

A control valve housing G is provided in the inner chamber of the packer to which the opposite ends of the steam exhaust line sections 45 and 46 are connected (Figs. 4 and 9). This valve housing contains a flap valve 60 which functions automatically and in normal position intercepts the ducts through sections 45 and 46 but is adapted to open automatically under steam exhaust pressure upwardly when the packer is released from engagement with the casing in the well.

The lower end of the control cylinder 56 is threadedly engaged in the upper portion of the valve housing G with its piston rod depending therein and normally urged into superior position by spring 58. Cylinder 61 depends from the lower portion of the valve housing G in alignment with the upper cylinder 56 and contains a reciprocable piston valve 62, which is adapted to open and close valve ports 63 and thus connect the duct 46 with the inflating chamber 22 of the packer through the port passage 64 in the tubular casing 15. The piston valve 62 has a stem 65 extended upwardly and sliding through the lower end of cylinder 56 in line to be thrust downwardly by the depression of the piston 57 to effect the opening of valve ports 63. A helical spring 66 in the cylinder 61 normally urges the valve 62 upwardly into closed position when the actuating piston 57 assumes superior position. The spring is regulated in tension by the adjustable hollow nut 67.

Operation

My improved heater and packer assembly is adapted for use in wells for recovering oil, gas, sulphur and other residual deposits in the earth structure and particularly, although not exclusively, when it has been found difficult to extract solid or semisolid deposits in natural formations in the earth. As an illustration of one type of operation of my invention I have described its application to an oil well but it should be understood that it is equally applicable for use for removing other liquifiable deposits from the structure in the earth. In applying my improved apparatus for use in recovering heavy or thick oil in an oil well and in the surrounding formation in which the well has been sunk, my im-

proved assembled packer, heater and pump are lowered into the well together with the steam supply lines and flow tubing, the latter parts being joined and assembled by threadedly connected lengths (not shown) as the heater, packer and pump are lowered into the well. The heater is preferably submerged in the fluid in the well opposite the oil sands and oil bearing formation. The heater, packer and pump are applied in use while the steam lines and flow tubing are locked securely and tightly in the casing head 13 in any well known manner such as by packing gland nuts 71 (Fig. 1).

Inflating the packer with steam pressure causes the packer to engage the casing and hold the heater at the desired elevation in the well. To accomplish this result, first close valves 70, 52 and 41. Second, open valve 49 to release steam exhaust pressure from the boiler head into the steam line 47 so as to inflate packer to the desired pressure as indicated by pressure gauge 72 which is assembled in the steam line 51. By closing valve 70 steam pressure is delivered to the check line valve assembly G in the inner packer pressure chamber through the steam exhaust line 47 and is released into the inner pressure chamber by depressing spring actuated valve 62 through ports 63 and into packer chamber 22 through port 64 in the inner packer jacket 15.

When the packer has been inflated to hold heater in position in the casing, close valves 49 and 50, then open valve 70 in exhaust line 47. When pressure has been released through exhaust line 47 depressed valve 61 reseats itself thus closing ports 63 and retaining pressure in packer chamber 22 until released for removal operation of the packer and heater from the well.

Control valve G operates to inflate and deflate packer D and to permit exhaust steam to flow through line 47 to condenser without infiltrating into the inner pressure chamber or packer chamber 22. When steam pressure is applied to inflate packer, the flap valve 60 is depressed, thus closing the orifice to tube 45 and thereby depressing valve 62, opening ports 63 and releasing steam into the inner pressure chamber and through port 64 into packer chamber 22. When the packer is inflated and steam supply is cut off, spring actuated valve 62 returns to its normal seated position closing ports 63 and retaining pressure in the packer until released for removal from the well. Exhaust steam returning to the condenser from the heater through line 47 forces flap valve 60 upward, thus permitting free flow of steam upwardly through line 47.

To permit exhaust steam to return to the condenser, valves 49 and 52 are closed. Valves 50, 41 and 70 remain open to circulate steam from the boiler through the heater and exhaust steam from the heater to the condenser. Flap valve 60 then opens automatically to permit upward flow of exhaust steam to the condenser through steam line 47. In the event condensate accumulates in the heater which tends to impair its efficiency, same may be removed from the heater by closing valves 49, 52 and 70. Valves 41 and 50 are then opened and increased steam pressure from the boiler is then applied to the heater to depress spring check valve 37 which opens ports 37' to permit accumulated condensate to discharge from the heater chamber by the increased steam pressure through ports 37' into the well.

To release the packer for removal of the heater from the well, first close all valves. Then open

valve 52 in the steam line 53 and open valve 50 to release live steam from the boiler into said steam line. Pressure in the steam line 53 depresses spring actuated piston 57, which in turn depresses valve 62, which opens ports 63, releasing pressure in the inner pressure chamber and packer chamber 22 through valve B into the exhaust line 47. When the packer is deflated close valves 50 and 52 and the heater may then be removed from the well.

Advantages

By combining the heater and packer in a self contained unit, the installation and operation thereof at any depth is simplified and the expense thereof reduced to a minimum.

The entire control of the heater and packer unit from the surface above the well saves time and expense and improves the effectiveness of the apparatus.

The heater and packer unit is equally applicable in oil, sulphur and other wells, for liquifying residual deposits throughout a comparative large area and rendering the same free to flow so that they may be pumped or made to flow out of the well.

When the heater operates the heat therefrom extends farther and farther into the formation and since there is substantially no external heat radiation, the only loss of heat arises from heat that is contained in the oil or other residual deposit that is removed from the well. Also as the heat expands farther and farther into the deposit, it serves to release more and more oil or other residual condensate from the deposit bearing structure, since the oil or other deposit separates from the water, sand and basic sediments.

There can be a cracking action of oil if heat at sufficient temperature by superheated steam or other fluid is applied in the well by my improved heater.

The heat that is directed into the formation by my improvement develops expansion at sufficient pressure which causes the oil or other liquified deposit to seek the line of least resistance, namely, the well hole, where it is raised to the surface above the well. Simultaneously, vacuum tendency is created in the earth formation which tends to draw the oil or other liquified deposit from a larger and larger radius as the heat expands farther and farther into the formation.

The greater the heat temperature and pressure that is applied to the heater and in the formation by the use of superheated steam, the faster the activating fluid will expand into the formation and a greater pressure and vacuum tendency will be created, bringing about a greater production of oil or other liquified deposit.

By reason of the release of the oil and other deposits from the formation, wells which are now considered as depleted, even though as little as 20% of the oil saturation has been recovered, will be reactivated by the use of my improvement, and a recovery of from approximately 60% to 80% from the sands and deposit bearing structure is possible.

It is anticipated that wells can be made to flow through the increased pressure and vacuum tendency created by my improvement and that the pumping equipment might be dispensed with.

My improved heater will liquify and extract wax, paraffine and oil from bituminous sand and shales.

My improved heater will also permit the production of oil and other products from wells all

the year around, even during cold wheather, especially in case of wells which usually have to be shut down when the temperature, due to winter conditions is low.

At the casinghead, sufficiently high pressure can be maintained so that gas will impregnate oil formation in a well and surrounding structure, thereby raising its gravity. Consequently, it is possible not only to control the flow but also in a measure to increase and control gravity of the oil, or at least raise such gravity, within reasonable limits, to the desired degree.

In accordance with the patent statutes, I have described the principles of operation of my invention together with the construction thereof which I now consider to represent the best embodiment thereof, but I desire to have it understood that the construction shown is only illustrative, that the parts of my invention may be assembled in a different manner, and that the invention can be carried into practice by other means and applied to uses other than those above set forth within the spirit thereof and within the scope of the following claims.

I claim:

1. In an apparatus for liquefying a residual deposit in a producing formation and recovering liquid therefrom, a well hole having a casing set in said formation, an expandable packer unit in proximity to said deposit, a controlled source of heated pressure fluid passing downwardly through the packer and connected to said heater to apply heated fluid to said heater whereby the deposit is liquefied in proximity to said heater, a valve housing in said packer, a conduit extending from said valve housing to the surface of the well, an exhaust conduit extending from said

valve housing downward to said heater, a first check control valve in said housing which opens automatically under fluid pressure from below, but which closes said downwardly extending exhaust conduit when pressure is applied to said first mentioned conduit from the surface, a passage communicating between said valve housing and the interior of the packer, a second check control valve in said passage which opens when pressure is applied through said first mentioned conduit to permit heated pressure fluid to flow into said packer and expand the same into engagement with said casing and thereby support the heater in said casing, but closes when pressure is released in said first mentioned conduit, and means for removing liquid from the well as it is reduced by said heater from said deposit.

2. The structure of claim 1 wherein said second check control valve is provided with a stem extending upwardly out of said valve housing, an extension on said valve housing which encloses the upper end of said stem and which serves as a third fluid pressure conduit, so that pressure in said conduit may act upon said stem and open said second check control valve independently of the aforesaid valve-operating means.

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