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WELL HEATING APPARATUS

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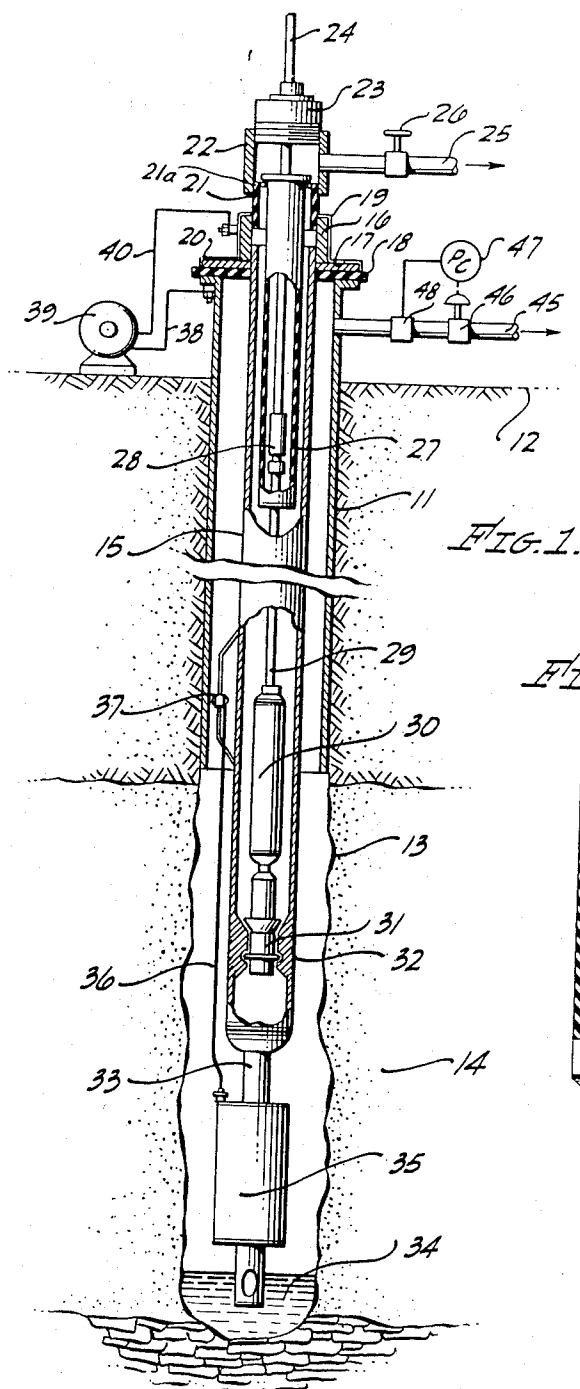


FIG. 1.

FIG. 2.

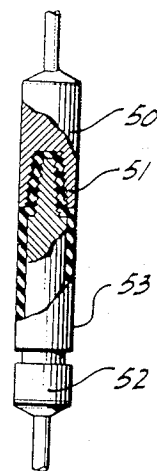


FIG. 4.

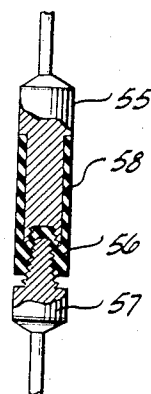
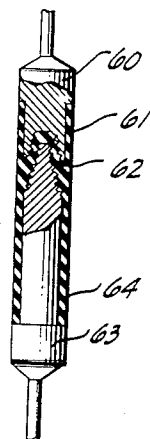


FIG. 3.

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WELL HEATING APPARATUS

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5 Claims. (Cl. 166—60)

This invention relates generally to an apparatus for the stimulation of oil wells by the generation of heat within the well bore. More particularly, this invention relates to an apparatus for eliminating certain safety hazards in the electric heating of oil wells by electrically insulating certain portions of the well head equipment.

Many methods have been employed in the prior art for heating oil wells; e. g., by electric means, by injecting heat transfer agents into the well such as steam, hot oils, etc., and by burning gas in the well bore. Often in the electric heating of oil wells one portion of the pipe within the well bore e. g., the casing, is grounded, and another portion of the producing string, such as the tubing and/or sucker rods, carries a high voltage current. Electrical energy is thus transmitted to the heater at the bottom of the bore hole through the existing intervening apparatus. The employment of this system invariably results in portions of the well head being charged at a high potential relative to ground, thus creating an extreme electrical hazard to those personnel required to operate such equipment.

It is an object of this invention to provide an apparatus for transmitting electrical energy from the earth's surface to an electric heater wherein exposed portions of the well head are at ground potential.

It is another object of this invention to provide an apparatus for the transmission of electrical energy within bore holes.

It is another object of this invention to provide an insulating joint for insertion in sucker rod strings.

Other objects and advantages of this invention will become apparent to those skilled in the art as the description thereof proceeds.

Briefly, this invention relates to means for the insulation of well heads and for the transmission of electric energy to and through well bores undergoing electric heating. In a preferred embodiment of the invention, the well casing is grounded and the tubing, tubing hanger, and tubing head are electrically charged relative thereto. Suitable connections are provided to carry such energy from the tubing and casing to the electric heater. In another modification of the invention, the exposed portions of the electrically charged tubing hanger and tubing head are coated with a ferro-enamel coating to protect personnel and other apparatus from direct contact therewith. The sucker rod string contains a special insulated joint such that the upper portion is maintained at ground potential while the lower portion may, or may not, become charged during the operation. A tubular sheath is suspended within the well head equipment to protect the upper portion of a sucker rod string from electrical contact with the charged tubing. An insulated nipple or other coupling is fitted to the tubing hanger which is in turn employed to support the balance of the well head equipment including the control valve assembly which is usually referred to as the Christmas tree.

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The invention is also directed to a new apparatus for insulating one portion of a sucker rod string from another portion. An outstanding feature of this particular insulating member resides in the fact that it may be successfully employed under adverse conditions within the well bore resulting from the tendency of minor amounts of moisture to penetrate the innermost recesses of the apparatus and thus short circuit the apparatus.

In the accompanying drawing which forms a part of this specification:

Figure 1 shows an overall partial cross sectional view of the apparatus of this invention which provides for a non-charged well head.

Figure 2 shows one method for insulating one portion of the sucker rod string from another portion.

Figure 3 shows an alternative modification of the apparatus of Figure 2.

Figure 4 shows another alternative modification of Figure 2.

Referring now more particularly to Figure 1, casing 11 extends downwardly from the earth's surface 12 within bore hole 13 to a point somewhat above oil-bearing sand 14. Tubing 15 is suspended within casing 11, being supported by tubing hanger 16 which is in turn supported by tubing head 17. Tubing head 17 rests on insulating member 18 and is in turn supported by suitable flanges at the top of casing 11. Tubing hanger 16 and tubing head 17, respectively, are coated with ferro-enamel coverings or other insulating materials 19 and 20 which serve to insulate the exterior thereof.

Insulated nipple 21 is threadedly attached to tubing hanger 16 and in turn supports well head member 22 which is, for example, a portion of the Christmas tree. Above member 22 stuffing box 23 permits vertical reciprocation of upper sucker rod 24 while maintaining a pressure seal.

Oil flow from the well bore is removed through line 25 by suitable manipulation of valve 26 which in turn communicates with the interior of well head member 22.

Tubular sheath 27 is suitably suspended within the interior of insulating member 21, for example by means of shoulder 21a on the inside of member 21, and extends coaxially downwardly within tubing 15. Tubular sheath 27 is fabricated from a non-conducting material, such as polystyrene, polyethylene, fiber, synthetic rubber, or the like. Upper sucker rod 24 passes coaxially within tubular sheath 27 to insulated joint 28 whereby it is insulated from lower sucker rod 29. The relationship of insulated joint 28 to tubular sheath 27 is such that the lowermost portion of tubular sheath 27 is a considerable distance below insulated joint 28, e. g., at least about 1 foot and preferably at least about 3 feet.

Lower sucker rod 29 operates reciprocating pump 30 which is secured through pump lock shoe 31 to pump lock 32. The intake of pump 30 extends through skeeter bill 33 to the oilpool 34 at the bottom of the bore hole 13. Skeeter bill 33 carries electric heater 35. One terminal of heater 35 is connected through skeeter bill 33 to tubing 15 which is charged as described hereinafter. The second connection of heater 35 is connected through cable 36 to spring contact 37 which is insulated from and carried by tubing 15. Spring contact 37 establishes electrical contact with casing 11 which is in turn connected through conductor 38 to electric generating means 39. The second lead of electric generating means 39 is connected through conductor 40 to tubing hanger 16 and tubing head 17, thus completing the circuit for heater 35.

The gas production of the well is permitted to flow upwardly through the annular space between the tubing and casing and is removed through line 45 by the action of motor valve 46 which is in turn controlled by pressure controller 47 operating through pressure tap 48. The

operation of motor valve 46 is preferably controlled to maintain a positive back pressure as described herein-after.

During the electric heating it is apparent that the only exterior members of the well head which are electrically charged are tubing hanger 16 and tubing head 17. The ferro-enamel coverings 19 and 20 insulate these members externally and protect those persons and/or objects coming in physical contact therewith.

The electric heating as described in connection with Figure 1 requires an effective insulating joint 28. Conventional insulated joints which comprise doubly threaded truncated cones have proved inadequate in practice. This form of insulation is subject to moisture penetration and results in short circuiting. The insulated joints of this invention include a lower skirt extending coaxially along the outer surface of either the male member or female joint member, or both, which skirt increases the electrical path and minimizes short circuiting. In the preferred modification of the invention, the insulation is a continuous form without holes in order to prevent possible arcing and short circuiting.

Referring now more particularly to Figure 2, upper female member 50 is threadedly attached to insulation member 51. Male member 52 threadedly engages insulation member 51 coaxially with female member 50 from the lower end of insulation member 51. Insulation member 51 is fitted with an extended lower skirt 53 which coaxially envelopes a portion of male member 52 and increases the electrical path between exposed metal of male member 52 and female member 50. The threads of female member 50, insulation member 51 and male member 52 are preferably of Whitworth or of the British Association Standard types so that the insulation disposed between the male and female members is maintained substantially in a state of compression rather than tension.

The skirt 53 is of such length that the exposed portions of female member 50 and male member 52 are separated by a distance of at least 6 inches and preferably by a distance of at least 10 inches.

Figure 3 shows a modification of Figure 2 wherein the skirt extends upwardly along the exterior of the female member.

Referring now more particularly to Figure 3, upper female member 55 threadedly engages insulation member 56 which in turn threadedly engages male member 57. Female member 55, insulation member 56 and male member 57 are coaxially aligned. The skirt 58 of insulation member 56 extends upwardly and coaxially over a portion of female member 55.

Figure 4 shows a modification of Figure 2, wherein a double skirted insulation member is employed.

Referring now more particularly to Figure 4, female member 60 is in part covered by upper skirt 61 of insulation member 62, and is threadedly and coaxially engaged therewith. Male member 63 is partially covered by lower skirt 64 of insulation member 62, and is threadedly and coaxially engaged therewith. The use of a double skirted insulation member increases the electrical path of short circuiting and renders short circuiting substantially impossible in the absence of a dielectric breakdown.

In the use of this invention, alternating current is generally preferred to direct current for convenience of handling and availability. Electrolytic corrosion is generally greater when direct current is employed. The voltages employed in the case of alternating currents are generally between about 10 to 1000 volts, preferably between about 30 to 600 volts. Voltages between about 5 to 600 volts, preferably between about 20 to 300 volts, are employed in the case of direct currents.

The ferro-enamel coating employed in the apparatus of the invention may be deposited on the iron or steel tube by any of the conventional methods. One method consists of immersing the object in a suitable clay-containing ferro-enamel mixture, draining the mixture from the

object and thereafter firing it such as at 1100° F. to form a hard ferro-enamel surface on the surface of the object.

With regard to the amount of heat required in order to remove deposits so as to sustain a high rate of flow from a given oil-bearing sand during pressure controlled production, it has been found that usually a heater operating at a power rate between about 0.02 and 1.0 kilowatts of energy per foot of formation to be heated is suitable. Preferably the power rate should be between about 0.1 and 0.5 kilowatt per foot. During the heating period the gaseous phase above the oil pool should be heated at least to about 25° F. above the formation temperature and the oil in the well bore should be heated at least about 10° F. above the formation near the well bore temperature. In general, the gaseous phase next to the heater should be heated to between about 100° F. and 200° F., preferably to between about 130° F. and 180° F. When the oil is heated to higher temperatures considerable deleterious gas separation and coke and gum deposition occurs. At appreciably lower temperatures no increase in the production rate is obtained.

The foregoing disclosure of this invention is not to be considered as limiting since many variations may be made by those skilled in the art without departing from the spirit and scope of the following claims.

I claim:

1. An apparatus for recovering oil from an oil well comprising, in combination, a well casing extending within the well bore, well tubing extending coaxially within said well casing and electrically insulated therefrom, upper and lower sucker rod strings joined by an electrically non-conductive coupling extending coaxially within said well tubing, an electrically non-conductive sleeve coaxially disposed between said well tubing and said sucker rod string and extending downwardly to a point below said coupling, a well pump carried on said well tubing and actuated by reciprocation of said sucker rod string, an electric heater carried on the lower end of said well tubing and comprising an electrical resistance heating element, means for electrically connecting one terminal of said heating element to said well tubing, and means for electrically connecting the other terminal of said heating element to said well casing.

2. In an apparatus for transmitting electrical energy through a well casing and tubing string to the bottom of a well bore, the combination of a sucker rod string extending coaxially through said tubing string, an electrically non-conducting coupling separating said sucker rod string into an upper sucker rod string and a lower sucker rod string, an electrically non-conducting sleeve coaxially disposed between said tubing string and said sucker rod string, said sleeve extending above the top of said tubing string and below said coupling.

3. A coupling for joining sucker rod strings comprising a threaded male joint member, a threaded female joint member, an electrically non-conductive connector having a threaded female portion at one end threadedly and coaxially receiving said threaded male joint member and a threaded male portion at the other end threadedly and coaxially engaging said threaded female joint member, said connector having a coaxial skirt extending around the exterior surface of at least one of said joint members.

4. The coupling of claim 3 wherein the said skirt extends around the exterior surface of both of said joint members.

5. An apparatus for recovering oil from an oil well comprising, in combination, a well casing extending within the well bore; well tubing extending coaxially within said well casing and electrically insulated therefrom; upper and lower sucker rod strings extending coaxially within said well tubing and joined by an electrically non-conductive coupling, said coupling comprising an electrically non-conductive member threadedly engaging at its upper end said upper sucker rod string and threadedly engaging at its lower end said lower sucker rod string and having a

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coaxial skirt extending around the exterior surface of at least one of said threaded engagements; an electrically non-conductive sleeve coaxially disposed between said well tubing and said sucker rod string and extending downwardly to a point below said coupling; a well pump carried on said well tubing and actuated by reciprocation of said sucker rod string; an electric heater carried on the lower end of said well tubing and comprising an electrical resistance heating element; means for electrically connecting one terminal of said heating element to said well tubing; means for electrically connecting the other terminal of said heating element to said well casing; and electrical generating means for applying a potential across said well tubing and said well casing.

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