Oct. 10, 1950 J. SCHMER 2,525,376

ELECTRIC HEATER FOR OIL WELLS

Filed March 29, 1948

Fig. 1

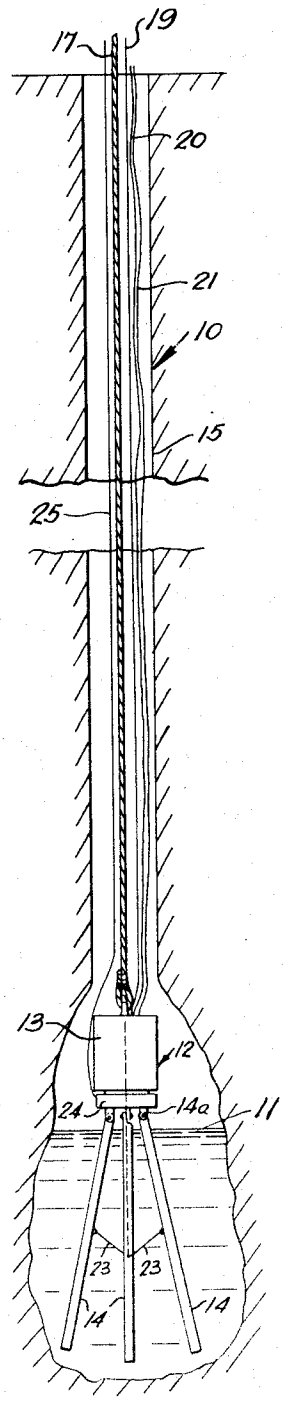


Fig. 2

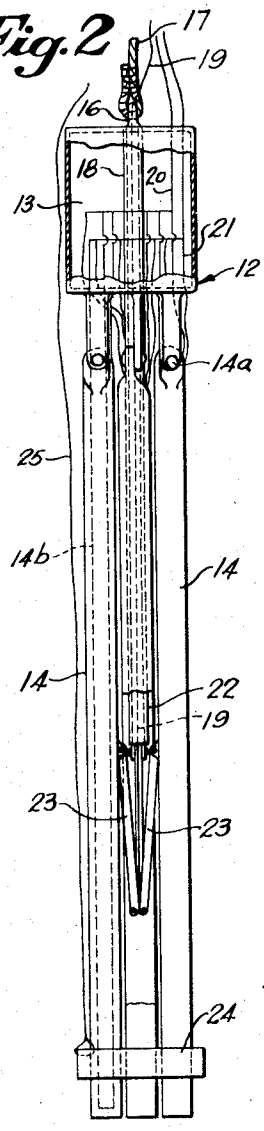


Fig. 3

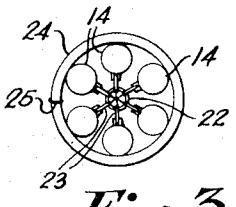


Fig. 4

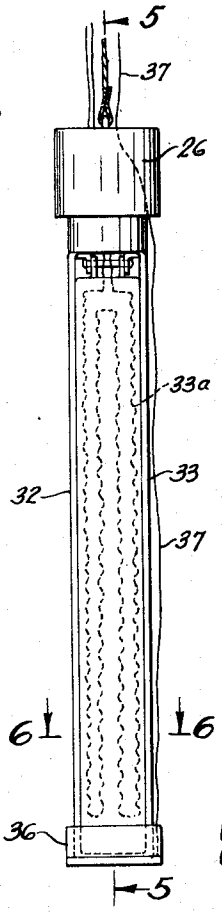
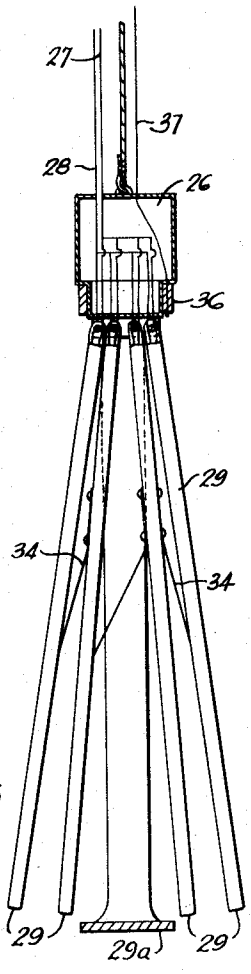


Fig. 5



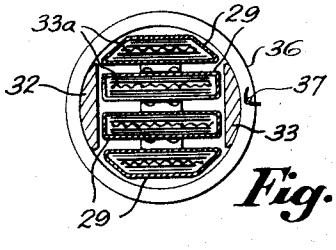


Fig. 6

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ELECTRIC HEATER FOR OIL WELLS

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11 Claims. (Cl. 219—33)

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This invention relates to methods and means for recovering petroleum oil from the subsurface and more particularly to methods and means for increasing the flow of petroleum oil from subsurface strata by the application of electrically generated heat to the oil bearing strata.

The flow of oil in the borehole diminishes gradually during exploitation due to such causes as the natural impoverishment of the strata, loss of pressure and plugging of the pores of the oil-bearing rock by deposits of paraffin wax and/or asphaltic matter. Where highly water-emulsified oils are not encountered, the temperature of the oil body may be raised sufficiently to remove the deposits of paraffin wax and/or asphaltic material with the use of the burner described in applicant's copending application entitled "Methods and Means for Raising the Temperature of Oil in Oil Wells," filed February 11, 1948, Serial No. 8,368, now abandoned. In the case of highly water-emulsified oils, electrical means for heating the oil body may be superior to the aforementioned burner. However, electrical heaters so far developed have the form of a cylinder of a diameter not larger than the diameter of the casing through which they are introduced thereby providing a relatively small heating surface in the center of the borehole. Thus, the heat transfer from the heater to the walls of the borehole is hampered by the distance from the heater to the walls.

It is an object of this invention to facilitate the flow and increase the output of oil from the well by decreasing the viscosity of the oil and by dissolving and/or melting the deposits of the wax and asphaltic matter by the application of electrically generated heat at or near the bottom of the borehole.

Another object of this invention is to utilize one or more electric heaters which can be lowered into or removed from the borehole through the relatively narrow wall casing and which can be spread fan-like in the borehole thus permitting a wider and faster distribution of heat therein.

A further object is to apply continuously or at intervals the proper amount of heat in the borehole of the oil well in a most economical manner.

Other objects of the instant invention will become apparent in the course of the following specification.

In the accomplishment of these objectives, the electrical heater comprises a cylindrical head of suitable diameter to be passed by any suitable means through the oil well casing. Hinged to the base of the cylindrical head are a number

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of long cylindrical or flat heating elements which can be spread fan-wise while in the borehole thereby permitting an easier and faster heat transfer to the oil and to the walls of the borehole over known methods. Electrical resistance wires are wound on a porcelain core or are imbedded in a layer of asbestos or mica and are covered by sheet iron or stainless steel to form cylindrical or flat heating elements and are connected through the cylindrical head to a suitable outside source of electrical energy. Mechanism for spreading either the cylindrical or flat heating elements in the borehole from the top of the oil well is provided. To prevent premature spreading of the heating elements, a ring is slidably disposed along the heating elements and adapted to be operated from the top of the well. The electrical heating elements may be from two to fifteen feet in length or even longer and the heaters may be used individually or in groups in accordance with the requirements.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawing showing by way of example preferred embodiments of the inventive idea.

In the drawing:

Figures 1, 2, and 3 show one embodiment of the electrical heater for raising the temperature of the oil body in a borehole of an oil well in which Figure 1 is a diagrammatic view of an oil well with an electrical heater having cylindrical heating elements submerged below the level of the oil and constructed in accordance with the principles of this invention; Figure 2 is an elevational view of the electrical heater shown in Figure 1, enlarged; and Figure 3 a plan view of the base of the electrical heater shown in Figure 2.

Figures 4, 5, and 6 show another embodiment of the electrical heater utilizing flat electrical heating elements rather than the cylindrical elements shown in the first embodiment and in which Figure 4 is an elevational view of the electrical heater prior to the spreading of the flat heating elements; Figure 5 is a sectional view along the line 5—5 of Figure 4 with flat electrical heating elements spread and shown in full; and Figure 6 is a sectional view along the line 6—6 of Figure 4, enlarged.

Referring now in greater detail to the drawings in which like reference numerals indicate like parts, reference numeral 10 indicates an oil well, 11 the surface of the oil in the oil well, and 12 the electrical heater.

The electrical heater 12 comprises a short steel

cylindrical head 13, about four to ten inches in diameter and adapted to pass through the casing 15 of the oil well 10. At the top of the cylindrical head 13 is the lifting eye or hook 16 to which one end of the rope 17 is attached by any suitable means for raising and lowering the electrical heater 12 in the casing 15. Substantially along the axis of the cylindrical head 13 is an opening 18 which permits a second rope 19 to actuate the subsequently described spreaders 23. Also in the cylindrical head 13 are properly insulated distributors for the electrical conductors 20 and 21 designed for parallel connection to the resistance wires 14b, subsequently described, in the electrical heating elements 14. The cylindrical head 13 is made tight by the proper use of plastic materials so that no oil or brine from the well can infiltrate.

On the base of the cylindrical head 13 is a bundle of elongated cylindrical heating elements 14 hinged by any suitable means 14a around and within the circumference thereof to permit the bundle to pass through the casing 15. Within the heating elements 14 are the resistance wires 14b of nichrome or other suitable alloy imbedded in a layer of asbestos or mica in the general form of a sheath. The resistance wires 14b are designed to be treated by an electrical current, usually red hot but below 1800° F. while the temperature of the surface of the electrical heating elements 14 in contact with the oil is maintained from 200° F. to about 700° F. or below the temperatures at which a thick insulating deposit of carbon forms from the oil. The electrical leads connecting the resistance wires 14b to the distributor in the cylindrical head 13 are insulated by a material which is a good electrical insulator and insoluble in oil, such as Perbunan rubber, or polyvinyl chloride or Thiokol plastics. In addition the aforementioned leads which may be exposed to elevated temperatures may be supplied with a thermally resistant insulating material such as teflon or silicons plastics. Also on the base of the cylindrical head 13 and in the center of the bundle of heating elements 14 is a downwardly extended tubular member 22 (Fig. 2) alined with the previously mentioned opening 18 in the cylindrical head 13 and attached to the base thereof by any suitable means. The tubular member 22 is of sufficient length to prevent the subsequently described spreaders 23 from being moved upwardly beyond a straight angle. Alined with the downwardly extended tubular member 22 is the apex of an inverted collapsible conical formation of spreaders 23, similar to the spreading mechanism of an umbrella. At about the center of each heating element 14 is hingedly attached a thin spring-like rod or spreader 23 having a length ranging from about one-quarter to one-half of that of the heating elements 14. The bases of the spreaders 23 extend downwardly between the heating elements 14 and are hingedly connected to each other at the downwardly extended ends and to which one end of the rope 19, previously mentioned, is attached. Thus, by pulling upwardly in the rope 19, the apex of the inverted collapsible formation of spreaders is moved upwardly toward but not beyond the end of the tubular member 22 thereby spreading the heating elements 14 outwardly in the manner of an umbrella.

To prevent the heating elements 14 from premature spreading, the ring 24 is fitted over the ends of the elements 14 as shown in Figure 2 and made slidable therealong. One end of a rope 25 is attached to the ring 24 and extends upwardly through the casing 15 to the surface. When it is desired to spread the electrical heating elements 14, an upward movement of the rope 25 moves the ring 24 upwardly to the top of the members as shown in Figure 1 thereby releasing the members 14 for spreading in the manner previously described. Of course, the ropes 19 and 25 could be combined in one rope shortly above the heater 12.

In the embodiment of the electrical heater shown in Figures 4, 5, and 6, the cylindrical head 26 has a diameter suitable for passing through the casing 15 of the oil well 10, and is made airtight to prevent injury to the subsequently described electrical conductors 27 and 28 which bifurcate into a number of parallel electrical paths in the cylindrical head 26 for connection to the resistance wires 33a in the flat electrical heating elements 29, later described.

A plurality of elongated flat electrical heating elements 29 are hingedly attached on the base of the cylindrical head 26 adjacent one to the other as shown in Figures 4, 5, and 6 and may be of different widths with the outer elements being narrower and those toward the center being wider in order to obtain the maximum heating area within the limits of the diameter of the cylindrical head 26 and the length of the members 29. So mounted, the flat electrical heating elements 29 are made to spread in the manner of a fan or the leaves of a book. The mechanism for spreading the flat electrical heating elements 29 may be the flat springs 34 (Fig. 5) attached on the flat sides of the heating elements 29 between successive members and parallel to the longitudinal center line thereof so that when the elements 29 are compressed the springs are under expanding tension. A shock absorber 29a is disposed below the bases of the flat electrical heating elements 29 and held in place by the opposed members 32 and 33, along the ends of the elements 29, and supported at the top by the cylindrical head 26. The elements 29 are held together by the ring 36 (Fig. 4) slidably disposed along the opposed members 32 and 33 and actuated by the rope 37, one end of which is attached to the ring 36 and the opposite end passed through the casing 15 to the surface.

Within the flat electrical heating elements 29 are the resistance wires 33a imbedded in asbestos or mica as shown in Figure 6 and covered by sheet iron or stainless steel in a general form of a sheath. The electrical leads connecting the resistance wires with the distributing paths in the cylindrical head 26 are insulated in the manner previously described under the first embodiment.

The operation for the first embodiment shown in Figures 1, 2 and 3 is as follows:

One end of a rope 17 is made fast to the lifting hook or eye 16 on the top of the cylindrical head 13 with the ring 24 at the base as shown in Figure 2. The heater 12 is then lowered through the casing 15 of the oil well 10 into the borehole as shown in Figure 1. Substantially in the borehole and under the level 11 of the oil, the rope 25 is pulled upwardly to move the ring 24 above the hinged joints 14a of the electrical heating elements 14. Now free to be spread, the rope 19, actuating the inverted collapsible conical mechanism formed by the spreaders 23, is pulled upwardly which spreads the electrical heating elements 14 in the manner shown in Figure 1. The electrical conductors 20 and 21 are then

connected to a source of electrical energy at the surface which supplies the necessary energy for heating the electrical heating elements 14. Usually at the beginning the amount of heat is relatively high, for instance 20,000 B. t. u.'s per hour or more, say 50,000 B. t. u.'s. When the oil is warmed up sufficiently, to around 200° F. or even higher, the heat input may be reduced conveniently by decreasing the voltage of the current passing through the resistance wires 14b. The regulation of the heat input is conveniently obtained by an electrical transformer at the surface and the temperature of both the heating elements 14 and the oil may be determined by thermocouples. Such heating might last from 1 to 5 days or more until a sufficiently increased flow of oil from the oil-bearing rock into the borehole is assured and is dependent upon the nature and thickness of the wax deposit and upon the rate of heating.

After the wax in the pores of the oil-bearing rock is melted, the heater is preferably pulled out from the well, the heating elements being folded automatically when pulled through the casing. The heater may be replaced now by any suitable instrument to lift the oil to the surface for regular exploitation.

The operation of the electrical heater shown in the second embodiment, Figures 4, 5, and 6, is substantially the same except that the flat electrical heating elements 29 automatically spread in the borehole when the ring 36 is moved upwardly above the hinged joints as shown in Figure 5 by pulling upwardly on the rope 37.

An oil well 1,200 feet deep, was producing originally by pumping 16 barrels of paraffin base crude daily. After three years the production fell to 4 barrels per day whereupon electric heating in accordance with this invention was applied for three days. During the first day, the heat was applied at the rate of about 20,000 B. t. u.'s per hour, the second day 15,000 B. t. u.'s, the third day 10,000 B. t. u.'s On the fourth day, the electric heater was replaced by a pump and the production rose to 14 barrels per day for one week and then was stabilized for several months at a level of 11 barrels per day.

Of course the heating apparatus may be composed of one or a plurality of the electrical heaters and may be attached to the regular instruments used in lifting the oil to the surface or may be used independently.

It is apparent that the specific illustrations above shown have been given by way of illustration and not by way of limitation and that the structures above described are subject to wide variation and modification without departing from the scope or intent of the invention, all of which variations and modifications are to be included within the scope of the present invention.

What is claimed is:

1. An electrical heater adapted to raise the temperature of the oil in the borehole of an oil well comprising at least two electrical heating elements, means lowering the electrical heating elements into the borehole below the surface of the oil therein, means supplying an electrical current for the electrical heating elements, and means spreading the electrical heating elements and adapted to diffuse the heat throughout the oil body, in which the means spreading the electrical heating elements are characterized by being of the umbrella type and comprises a spreader for each of the electrical heating elements, means hingedly connecting one end of the spreaders

in opposed relationship on the inside surface portions of the electrical heating elements, the opposite ends of the spreaders extending downwardly between the electrical heating elements, means hingedly connecting the downwardly extended ends of the spreaders, and means applying an upwardly directed force to the downwardly extended ends of the spreaders.

2. An electrical heater adapted to raise the temperature of the oil in the borehole of an oil well according to claim 1 in which the means spreading the electrical heating elements is characterized by being of the fan type and comprises a spring disposed between the electrical heating elements and adapted to be under tension prior to the spreading of the elements.

3. An electrical heater adapted to raise the temperature of the oil in the borehole of an oil well according to claim 1 in which the electrical heating elements are of the umbrella type and characterized by being substantially elongated cylindrical members.

4. An electrical heater adapted to raise the temperature of the oil in the borehole of an oil well according to claim 1 in which the electrical heating elements are of the fan type and characterized by being substantially elongated rectangular members.

5. An electrical heater of the umbrella type adapted to raise the temperature of the oil in the borehole of an oil well comprising a head of appropriate design for lowering through the casing of the oil well, at least two substantially cylindrical electrical heating elements hingedly disposed in opposed relationship on the base of the head, electrical resistance wires in the heating elements, means connecting the resistance wires to an outside source of electrical energy; the electrical heater further comprising a spreader hingedly attached to each heating element and adapted to spread the same in the manner of an umbrella.

6. An electrical heater of the umbrella type adapted to raise the temperature of the oil in the borehole of an oil well comprising a substantially airtight cylindrical head, the diameter of the head being substantially less than the diameter of the oil well casing, an opening through the cylindrical head along the axis thereof, a tubular member disposed on the base of the cylindrical head and alined with the opening, a lifting fastener disposed on the top surface portion of the cylindrical head; the electrical heater further comprising a rope, one end of the rope being attached to the lifting fastener, the rope being of sufficient length to permit lowering of the heater into the borehole; the electrical heater further comprising at least two substantially cylindrical electrical heating elements, means hingedly attaching one end of the elements to the base of the cylindrical head in opposed relationship and with the tubular member therebetween, electrical resistance wires disposed in the cylindrical heating elements, means electrically connecting the resistance wires to an outside source of electrical energy; the electrical heater further comprising means releasably maintaining the electrical heating elements together, and means spreading said elements substantially in the manner of an umbrella comprising at least one spring-like rod for each electrical heating element, means hingedly connecting one end of the rods to the heating elements in opposed relationship and substantially along the line of intersection of a plane tangent to the end of the tubular member with

the heating elements, the opposite ends of the rods extending downwardly between the heating elements and below the end of the tubular member, means hingedly connecting the downwardly extended ends of the rod; the electrical heater further comprising a rope, one end of the rope being passed through the opening in the cylindrical head and tubular member and connected to the downwardly extended and hingedly connected ends of the rods, the opposite end of the rope being passed through the oil well casing to the surface.

7. An electrical heater of the umbrella type adapted to raise the temperature of the oil in the borehole of an oil well according to claim 6 in which the means releasably maintaining the electrical heating elements together comprises a ring slidably disposed along the electrical heating elements, and means raising the ring substantially above the hinged connections of the electrical heating elements on the base of the cylindrical head.

8. An electrical heater of the fan type adapted to raise the temperature of the oil in the borehole of an oil well comprising a substantially airtight cylindrical head, the diameter of the head being substantially less than the diameter of the oil well casing, a lifting fastener disposed on the top surface portion of the head, and a rope, means securing one end of the rope to the lifting fastener, the rope being of sufficient length to permit lowering of the heater into the borehole from the surface; the electrical heater further comprising at least two flat electrical heating elements having a width substantially less than the diameter of the head, means hingedly attaching one end of the flat electrical heating elements on the base of the head in opposed relationship, electrical resistance wires disposed in the flat electrical heating elements, means insulating the wires, and means connecting the resistance wires to an outside source of electrical energy and adapted to raise the temperature of the flat electrical heating elements; the heater further comprising means spreading the flat electrical heating elements, and means releasably maintaining the flat electrical heating elements together.

9. An electrical heater of the fan type adapted to raise the temperature of the oil in the borehole of an oil well according to claim 8 in which the means spreading the flat electrical heating elements comprises a spring member disposed between opposed surface portions of each flat electrical heating element and adapted to be under tension prior to the spreading of said members.

10. An electrical heater of the fan type adapted to raise the temperature of the oil in the borehole of an oil well according to claim 8 in which the means releasably maintaining the flat electrical heating elements together comprises a ring

slidably disposed therealong and means moving the ring above the hinged mounting means of the flat electrical heating elements on the base of the head.

11. An electrical heater of the fan type adapted to raise the temperature of the oil in the borehole of an oil well comprising a substantially airtight cylindrical head, the diameter of the head being substantially less than the diameter of the oil well casing, a lifting fastener disposed on the top surface portion of the head, and a rope, means securing one end of the rope to the lifting fastener, the rope being of sufficient length to permit lowering the heater into the borehole from the surface; the electrical heater further comprising a plurality of substantially elongated flat electrical heating elements of progressively decreasing width, the maximum width being substantially less than the diameter of the head, means hingedly connecting the flat electrical heating elements to the base of the head on either side of the center in opposed relationship and with the flat electrical heating elements of greatest width on the inside with those of progressively narrower widths in consecutive order toward the circumference of the head, a spring disposed between each consecutive flat electrical heating element and adapted to be under tension when the planes of the flat electrical heating elements are parallel to the plane through the axis of the head; the heater further comprising a shock absorber disposed below the base of the flat electrical heating elements, opposed members disposed on the cylindrical head along the ends of the flat electrical heating elements and adapted to support the shock absorber; the heater further comprising electrical resistance wires disposed in the flat electrical heating elements, means insulating the wires, and means connecting the electrical resistance wires in parallel through the cylindrical head to an outside source of electrical energy and adapted to raise the temperature of the flat electrical heating elements; the heater further comprising means releasably maintaining the flat electrical heating elements together comprising a ring slidably disposed along the opposed members of the shock absorber, and means raising the ring above the hinged means of the flat electrical heating elements on the head.

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The following references are of record in the file of this patent:

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