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Palone

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[54] **ELECTRIC HEATED SUCKER ROD**

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[51] **Int. Cl.** **H05b 3/02,** E21b 43/24

[58] **Field of Search** 219/277, 278, 541, 307, 219/306; 166/57, 58, 60–62, 302, 303

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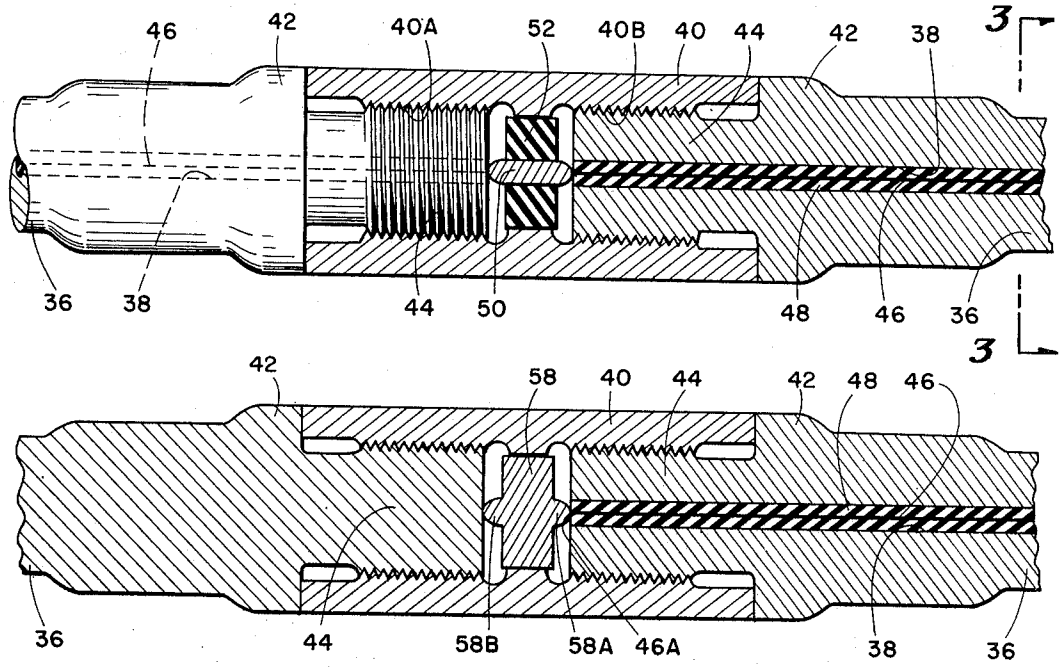
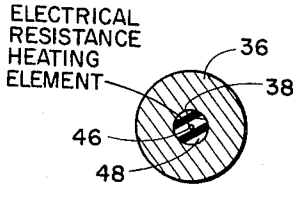
[57] **ABSTRACT**

A vertical sucker rod string formed of lengths of sucker rods, each having means for attachment at each end thereof to adjacent sucker rods, is provided with electric heating means for maintaining the temperature of the crude oil being pumped to the surface above a preselected level to prevent the congealation of paraffin. An electric heating element coextensive in length with the rod is disposed in a small diamater bore hole in each rod. A solid heat conducting electrical insulation completely fills the bore hole in the rod around the heating element. Couplings are provided between adjacent sucker rods to obtain electrical continuity between the heating element in each of the adjacent rods. A terminal coupling provides a connection between the heating element of the lowermost sucker rod and the sucker rod, whereby the sucker rod string serves as a conductor to complete the circuit for energizing the heating elements.

4 Claims, 4 Drawing Figures





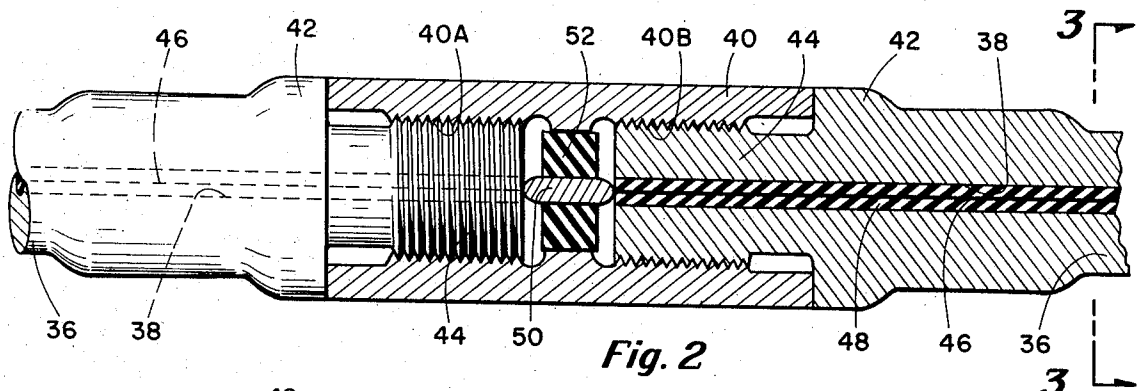


Fig. 2

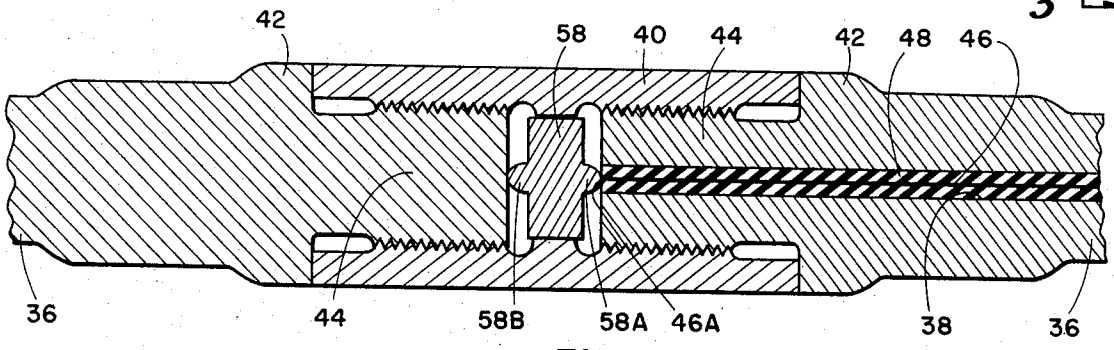


Fig. 4

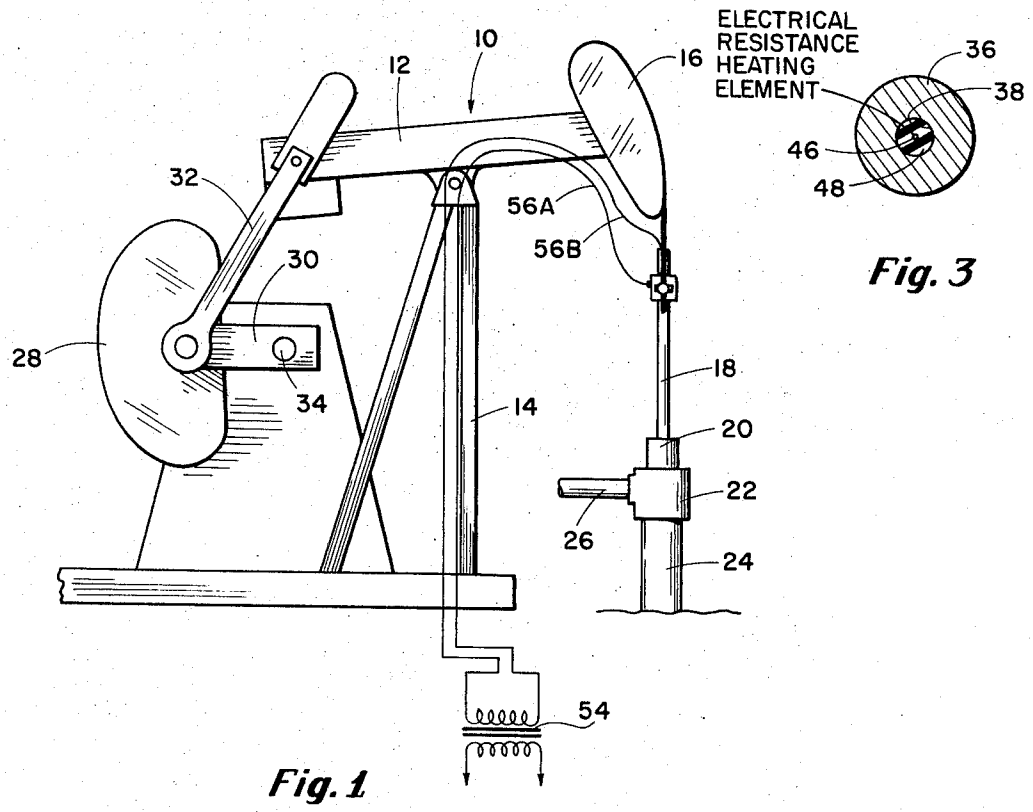


Fig. 1

Fig. 3

ELECTRIC HEATED SUCKER ROD

BACKGROUND AND OBJECTS OF THE INVENTION

When an oil well is completed the pressure of the oil producing formation sometimes is sufficiently great to cause the crude oil to be forced to the earth's surface. Such wells are called flowing wells. Eventually, however, in most instances the pressure of the formation falls below that which is necessary to force the crude oil to the earth's surface. This requires some means of pumping the crude oil. The most commonly used means of lifting crude oil from a subterranean formation to the earth's surface is by means of a bottom hole pump positioned in a tubing string, the pump being reciprocated by a string of sucker rods. This procedure works completely satisfactorily. However, in some geographical areas the crude oil found has a high paraffin content which congeals at a higher than normal temperature. At the temperature in the oil producing formation the crude oil is in liquid form but as it is pumped to the earth's surface in a tubing string it passes upwardly through areas of gradually declining temperatures. If crude oil has a high paraffin content which congeals at higher than normal temperatures, an area is reached in the upward travel of the crude oil wherein the temperature inside the tubing falls below that at which the paraffin content of the crude congeals. At this point the paraffin congeals on the inside of the tubing and on the outside of the sucker rod. If the process continues long enough the tubing can become completely plugged by the congealed paraffin.

In some areas the problem of congealed paraffin is such that wells cannot be economically produced. Others have suggested means of combating the problem of paraffin formation in wells, such as the use of scrapers attached to the exterior of the sucker rods which are configured to scrape the interior of the tubing to dislodge paraffin as it accumulates. The dislodged paraffin is then carried upwardly by the flow of fluid to the surface. This procedure, however, is not completely satisfactory in all instances since in some cases the rate the paraffin congeals is so great the scrapers cannot keep it dislodged. In addition, the scrapers do not help prevent the accumulation of paraffin on the sucker rods and thereby even though the interior of the tubing is scraped the accumulation of paraffin around the sucker rods can soon approach that at which the interior of the tubing is blocked.

Others have provided heating elements positioned in the bottom of wells including electrical conductors attached to the exterior of the tubing. In some instances the heating elements are attached to the tubing at points above the lowest level at which the crude oil reaches the temperature at which paraffin content begins to congeal. In this method the electrical conductors to the heating elements are carried on the exterior of the tubing. This procedure works satisfactorily except that it is difficult to run tubing with electrical conductors. In addition, any failure of the heater or the conductors requires that the tubing string be pulled, a relatively expensive process.

This invention is directed towards a simplified means of maintaining the temperature of crude oil as it is pumped to the earth's surface sufficiently high to prevent the formation of paraffin. The invention overcomes the disadvantages of the other known methods of combating paraffin accumulation in oil wells.

It is therefore an object of this invention to provide an improved means of maintaining the temperature within the interior of the tubing string utilized to pump crude oil so as to prevent paraffin congealation.

More particularly, an object of this invention is to provide a sucker rod configuration including means of applying electrical energy to the sucker rod so as to raise the temperature thereof and thereby raise the temperature of the crude oil pumped by the sucker rod to the point wherein the temperature of the crude oil will not fall below that at which severe paraffin congealation takes place.

Still more particularly, an object of this invention is to provide a sucker rod including improved means of heating the sucker rod with electrical energy.

Another object of this invention is to provide a sucker rod including means of electrically heating the sucker rod and means of conducting electrical energy from one sucker rod to the next.

Another object of this invention is to provide an arrangement for electrically heating sucker rods as used in producing oil wells to prevent the accumulation of paraffin within tubing and including means of conducting the heating element to ground at a preselected point within the sucker rod string.

These and other objects will be fulfilled in the following description and claims taken in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of a pumping unit showing means of use of the electric heating sucker rods of this invention.

FIG. 2 is a cross sectional view of a coupling and an electrically heated sucker rod showing means of electrically coupling one sucker rod to another.

FIG. 3 is a cross sectional view taken along the line 3—3 of FIG. 2.

FIG. 4 is a cross sectional view as in FIG. 2 showing a terminal arrangement for connecting the electrically heated wire to the sucker rod body.

SUMMARY

The invention is a sucker rod construction providing means of heating petroleum produced in an oil well so as to raise the temperature of the petroleum above that which results at which paraffin congeals. The sucker rod, which has means at each end for attachment to an adjacent sucker rod, has a small diameter axial bore through the entire length. An electrical heating element is positioned within the bore and is surrounded by heat conducting electrical insulation. Means is provided for applying voltage to the element to cause current to flow through it and thereby heat it. Heat flows through the electrical insulation to the sucker rod and then to the petroleum fluid being pumped to the surface. Heat is thereby applied to the petroleum fluid to maintain the temperature thereof above the congealing temperature of paraffin. Couplings are provided between adjacent sucker rods to obtain electrical continuity between the electrical heating element in each of the adjacent sucker rods. Terminal coupling is provided for connecting the lower end of the heating element in the lowermost sucker rod to the sucker rod. In this way the sucker rod string serves as a conductor to

complete the circuit by which the heating element is energized.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings and first to FIG. 1 the basic arrangement for pumping an oil well by reciprocation of a sucker rod string is shown. The arrangement includes a pumping jack indicated generally by the numeral **10** which has a walking beam **12** pivotally supported on a post **14.** At one end of the walking beam is a horse head **16** which includes cable means for attachment to a polished rod **18.** The polished rod extends through a stuffing box **20** in a well head **22** attached to the upper end of casing **24.** Pipe **26** extends from the well head and carries the produced petroleum to a tank battery for further distribution.

The end of the walking beam **12** opposite horse head **16** is attached to a counter weight **28** driven by a crank arm **30,** the counter weight and crank arm being attached to a connecting rod **32** extending to the walking beam **12.** The crank arm **30** is attached to a shaft **34** rotated by a gear box (not shown), driven in turn by a prime mover, such as an electric motor or engine, also not shown. By the rotation of shaft **34** the walking beam **12** is pivotally reciprocated moving horse head **16** up and down and thereby reciprocating the polished rod **18.** The pumping jack of FIG. **1** described to this point is a standard means of reciprocating sucker rods in an oil well and form no part of the invention.

The polished rod **18** connects to a string of sucker rods which extend within a tubing (not seen) within the casing **24,** the sucker rod and tubing extending downwardly within the earth to a subterranean crude oil producing formation. In effect, the polished rod **18** is an upward extension of the string of sucker rods and is different only that it has a smooth external configuration to reciprocate against packing within the stuffing box **20** which prevents produced crude oil from escaping outwardly of the stuffing box rather than flowing through pipe **26.**

The sucker rod string is shown best in FIGS. **2, 3** and **4.** The sucker rod string is made up of a series of elongated sucker rods **36** each of which is typically 20 to 25 feet in length. In the known application of sucker rods the rods are of solid configuration. However, in the present invention the sucker rods include an axial bore hole **38** through the entire length of each rod. As shown in FIGS. **2** and **4** only a small portion of the lengths of the sucker rods are shown. In FIG. **2** the right hand portion shows an end of a sucker rod in cross section while in the left hand portion an end of a sucker rod is shown in exterior configuration, with a coupling **40** shown in cross sectional configuration as used to connect in end to end relationship the adjacent sucker rods. Each of the sucker rods **36** includes an enlarged shoulder portion **42** which terminates in an externally threaded pin portion **44.** The interior of the couplings **40** is threaded at **40A** and **40B** to threadably receive the externally threaded pin portions **44** of adjacent sucker rods.

As shown in FIGS. **2** and **4** the coupling **40** is threaded internally at each end thereof at **40A** and **40B.** However, it can be seen that if desired the coupling may include a continuous thread running through the full length of the coupling.

Positioned within the bore hole **38** of each of the sucker rods **36** is an electrical heating element. In the embodiment illustrated the heating element is in the form of a resistance wire **46.** When current flows through wire **46** heat is imparted to the sucker rod **36** and thereby to the crude oil surrounding the sucker rod so as to maintain the temperature above that at which paraffin will congeal.

To prevent the resistance heating wire **46** from contacting the sucker rod the wire is surrounded by electrical insulation **48,** which may be of a variety of compositions and may be, as an example, a mineral insulation. While the main function of the insulation **48** is to prevent electrical contact between the resistance wire **46** and the sucker rod **36** the insulation preferably is of a type which is a good heat conductor so as to conduct the heat of the resistance wire to the surrounding sucker rod.

In order to connect the resistance wires **46** of adjacent sucker rods making up a sucker rod string, it is necessary that electrical continuity be had from one rod to another. FIG. **2** shows one method of accomplishing this. In this arrangement an axial conductive element **50** is centrally positioned within coupling **40** in a manner so as to contact the resistance wire **46** of adjacent sucker rods **36.** The conductive element **50** is held in axial position by means of an insulating member **52** which may be formed of any insulating material, such as plastic. It can be seen that the resistance wires may be interconnected for as many successive sucker rods as is required.

FIG. **1** shows one means of imparting electrical energy to the sucker rods. By means of a transformer **54** current is supplied to conductors **56A** and **56B.** Conductor **56A** is attached to the exterior of the polished rod **18** and thereby to the sucker rod string. Conductor **56B** is attached to the resistance wire **46** which extends internally of the polished rod **18** and is connected to the resistance wire in each of the succeeding lower lengths of sucker rods **36.**

One method of providing a return current flow is shown in FIGS. **1** and **4.** Conductor **56A** is connected to the exterior of polished rod **18** and thereby to each of the successive lengths of sucker rods **36.** To provide a return path of current flow the resistance wire **46** must be connected at some point to the sucker rod string. In order to achieve this arrangement FIG. **4** shows a terminal conductive means including a terminal conductive element **58** positioned in the interior of a coupling **40.** The conductive element **58** is of conductive material, such as copper or copper alloy or the like and communicates the end **46A** of the resistance wire **56** to the couplings **40** and thereby back to sucker rods **36.**

The conductive element **58** includes axial protrusion portions **58A** and **58B** at opposite ends thereof. Protrusion portion **58A** contacts the end **46A** of resistance wire **46** and protrusion **58B** engages the pin portion **44** of the next lower sucker rod **36** to insure connection of the resistance wire **46** to the sucker rods **36.** In addition to contacting the pin portion **44** the next lower adjacent sucker rod **36** the conductive element **58** also provides current flow through coupling **40.** Thus, as shown in FIG. **1** the conductor **56B** communicates with the resistance element **46** in a sucker rod string and conductor **56A** connects to the sucker rod string itself through polished rod **18** so that a complete path of current flow is provided.

As crude oil is pumped upwardly in a tubing the temperature gradually lowers until a point is reached wherein with high paraffin content crude, congealing begins. By the use of this invention the number of sucker rods **36** which must be heated can be regulated so as to extend downwardly into the well only that distance required to provide heat to the crude oil in the upper portion of the tubing string. In some wells the length of the sucker rod string which must be heated will be substantially the full length of the tubing. In other wells only the upper portion of the column of fluid being produced need by heated. Between each adjacent length of sucker rod **36** wherein the lower rod is to be heated the conductive element **50** as shown in FIG. **2** is utilized. At the lower end of the string of sucker rods requiring heating a terminal conductive element **58** as shown in FIG. **4** is utilized. The sucker rods below element **58** are not heated.

While the invention has been described with a certain degree of particularity it is manifest that many changes may be made in the details of construction and the arrangement of components without departing from the spirit and scope of this disclosure. It is understood that the invention is not limited to the embodiments set forth herein for purposes of illustration, but is limited only by the scope of the attached claim or claims, including the full range of equivalency to which each element thereof is entitled.

What is claimed:

1. In an oil well including a vertical string of sucker rods extending from the earth's surface downward to a subterranean pump including means at the surface for reciprocation of the sucker rods for actuation of the pump, a means for maintaining the temperature of the crude oil being pumped to the surface above a preselected level to prevent the congealation of paraffin, comprising:

a vertical sucker rod string formed of lengths of sucker rods, each sucker rod having means for the attachment at each end thereof to adjacent sucker rods, each sucker rod having an axial small diameter bore hole therein;

an electrical heating element positioned in said bore hole;

solid heat conducting electrical insulation completely filling said bore hole in said sucker rod surrounding said heating element, and

means of applying a voltage to cause current to flow through said heating element.

2. A means for preventing congealed paraffin formation in an oil well according to claim **1** wherein said means of applying voltage to said resistance wire includes two conductors having voltage thereacross, one of the conductors being electrically attached to said heating element and the other electrically attached to said sucker rod and wherein the lower end of said heating element is electrically connected to said sucker rod.

3. A means for preventing congealed paraffin formation in an oil well according to claim **2** including couplings between adjacent sucker rods in said string of sucker rods, each said coupling providing electrical continuity between said sucker rods, each said coupling being tubular and having a central insulating element therein positioned between the ends of adjacent sucker rods, and an axial conductive element supported by said insulating element, said conductive element providing electrical contact between said heating element positioned within adjacent sucker rods.

4. A means for preventing congealed paraffin formation according to claim **2** including a terminal coupling means between adjacent sucker rods positioned in said sucker rod string at the lowermost point wherein heat is required to maintain the crude oil above the preselected temperature level, the terminal coupling being tubular and threadably receiving at the upper end a sucker rod having said heating element therein and threadably receiving at the lower end a lower sucker rod and said coupling having a conductive element therein contacting said heating element and providing continuity between said heating element and said lower sucker rod.

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