July 7, 1959 E. E. WILLIAMS ET AL 2,893,490

OIL WELL HEATER

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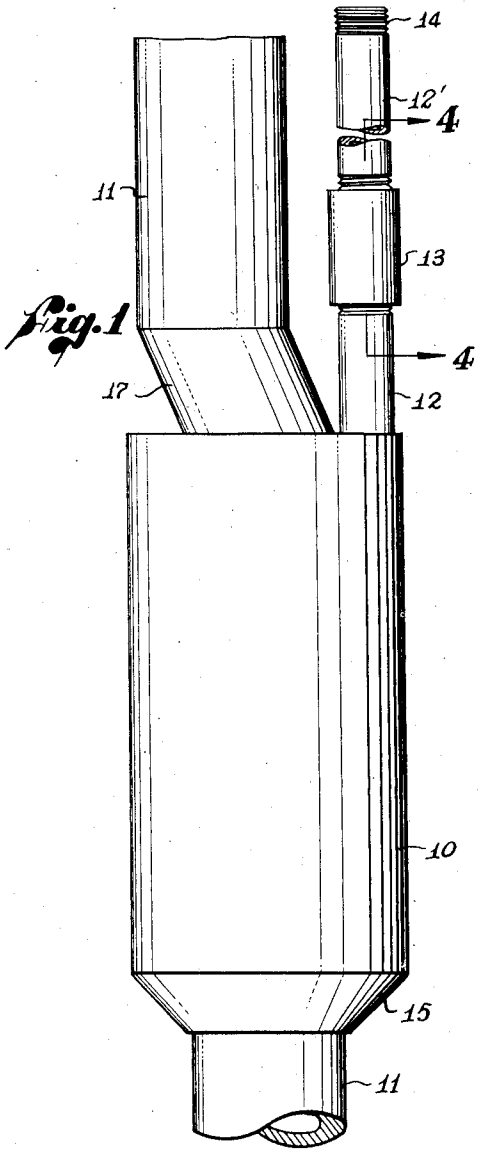


Fig. 1

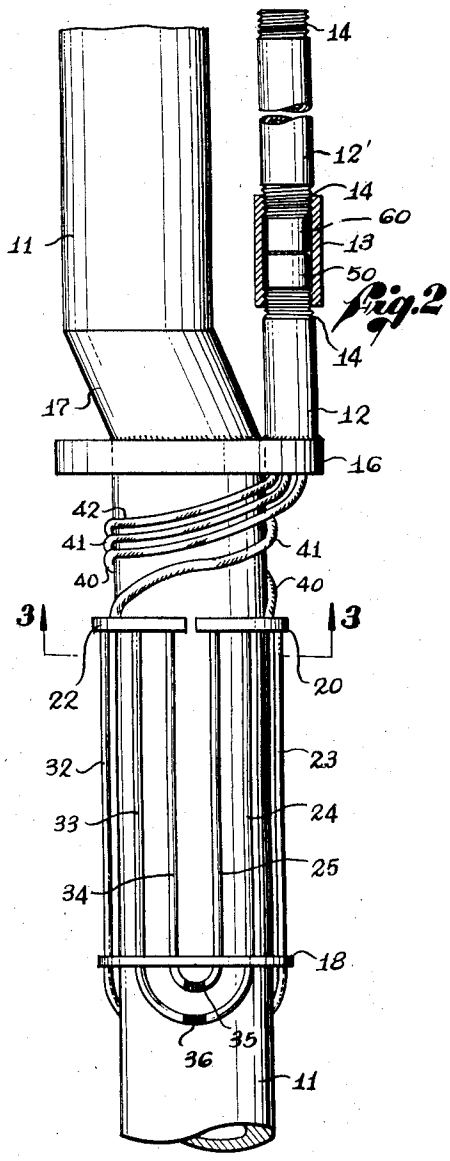


Fig. 2

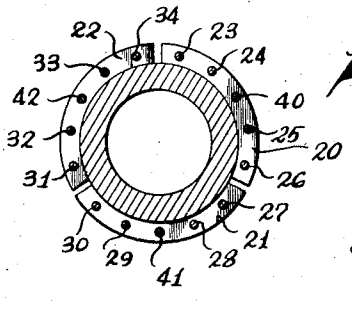


Fig. 3

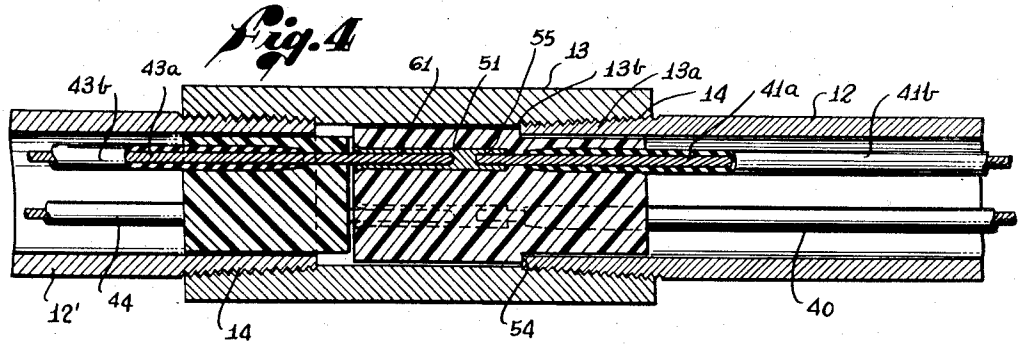
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Fig. 4



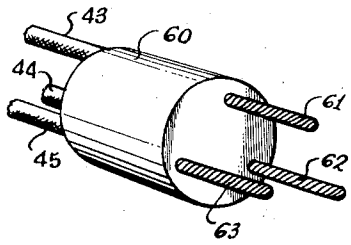
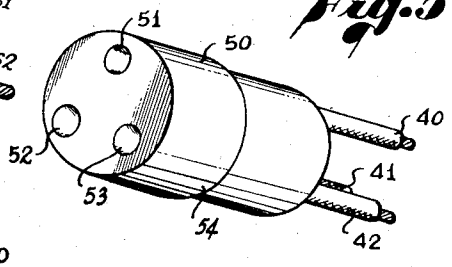


Fig. 5



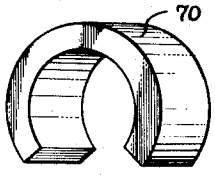


Fig. 7

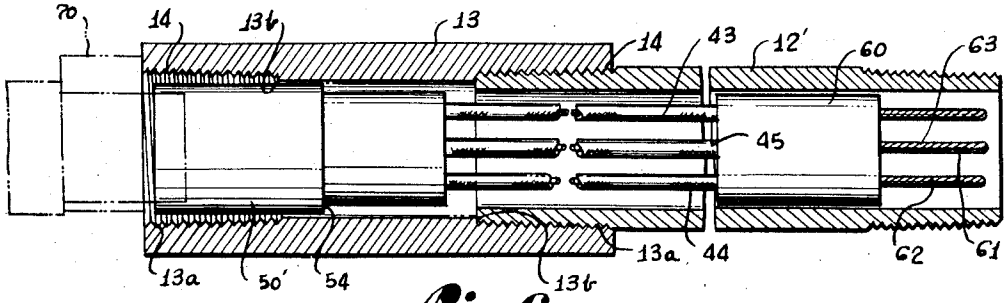


Fig. 6

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OIL WELL HEATER

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Application April 4, 1957, Serial No. 650,672

5 Claims. (Cl. 166—60)

This invention relates generally to oil well heaters, and more particularly to electrical oil well heaters.

It is well known that oil wells, particularly those having high paraffin content, high viscosity, low temperatures, or other conditions which tend to limit the flow; either are, or may become, economically impracticable and that upon proper heating of the material they can become profitable producers.

There have been a number of heaters designed to attempt to alleviate this condition. Such heaters employ wide varieties of heating means, such as hot water, ignition of gases within the well, electrical resistance, and the like.

Of all the heaters utilized, the electrical resistance type heaters have many decided advantages over other types. The advantages include ease of control, safety of operation, uniformity of temperature, and the other advantages inherent in electrical apparatus.

However, the electrical heaters used in the past also have a number of deficiencies and disadvantages including, among the more important, the difficulty of properly inserting the necessary cable to supply electrical energy and the serious corrosive effects of the contents of oil wells upon the insulation and fittings of such cables. Such heaters also have the inherent disadvantage that certain portions of the heater become hotter than other portions, thus the life of the heating elements themselves is affected. In addition, "hot spots" exist upon which the petroleum products will "coke," which results in decreased heater efficiency and further reduction of flow in extreme cases with possible damage to the producing formations.

Our invention has overcome the disadvantages of other electrical type heaters by providing enclosed solid conduit covered cable in sections the same length as standard oil well tubing with special connecting means such that the different lengths may be easily and efficiently joined and disconnected, as desired, without damage to the cable and providing a complete protection for the cable from the corrosive materials within the oil well. Our invention further incorporates means for uniformly distributing the heat within the heater and quickly conducting the same away from the heating elements so that they do not become overheated.

Thus it is a major object of our invention to provide electrical cable for oil well heaters which can be successfully lowered into a well in enclosed conduit and in sections conforming to the standard oil well tubing lengths.

It is a further object of our invention to provide an electrical heater for use in oil wells in which the heat is uniformly distributed over the entire surface of the heater.

These and other objects and functions of our invention will be best understood by reference to the detailed description of the invention as set forth in this specification, and the accompanying drawings in which:

Figure 1 is an elevational view of a preferred embodiment of our invention;

Figure 2 is a view similar to Figure 1, but with the heater shell and conduit coupling removed, so as to show the internal construction;

Figure 3 is a section taken at 3—3 in Figure 2;

Figure 4 is a section of the conduit connection and electrical connection area, taken at 4—4 in Figure 1;

Figure 5 is a perspective view of the male and female ends of the electrical connector;

Figure 6 is a sectionalized view of a length of electrical conduit and coupling with one length of electrical cable and male and female ends not sectionalized but shown in position; and

Figure 7 is a perspective view of holding clip for cable.

In the drawings there is seen a portion of oil well tubing **11** which is bent, or offset at **17**, and run through a heater shell **10**. The heater shell is welded at its upper end to a flange **16** on the tube **11**, and the bottom end of the shell is conically tapered at **15**, and welded to the tube **11** where it contacts the latter. Conduit **12** passes thru an aperture in the flange **16** and is securely welded thereto. Conduit section **12'** is fastened to conduit **12** by coupling **13**.

The oil tube **11** is offset as shown at **17** in order to reduce the over-all size of the heater unit. By this means the electrical conduit and oil tube above the heater are all within the extended circumference area of the heater shell. By this arrangement the conduit is protected from abrasion and other damage during its descent into a well, while operating, and during extraction from the well.

Conduit section **12** is shown to have threads at **14** to accommodate coupling **13**. All succeeding lengths of conduit such as illustrated by **12'** are threaded at both ends with identical threads **14**. Within conduit **12** there is a special female electrical coupling unit **50** formed of any high heat resisting and insulating material, such as epoxy resin, capable of withstanding temperatures of the order of 600° F. This special connector is used at this position to obviate any possible danger of over-heating due to proximity to the heater unit.

Inside of the connector **50** are three female contact elements **51**, **52**, and **53**. These are connected as shown by crimping or other means of joinder **55** to wires **40**, **41**, and **42**. The wires, such as **41**, are shown to be comprised of conductor wire **41*a*** covered by insulation **41*b***, which insulation extends partially into the female connector, as shown in the drawing, in order that there will be a complete insulation seal. The connector **50** has a shoulder **54** which rests upon the end of the conduit section **12** to prevent the cable and connector dropping below the desired position and to hold the same in place.

Electrical wires **40**, **41**, and **42** are connected to ring segments **20**, **21**, and **22**, which are spaced angularly about the circumference of oil tube **11** within the heater area. The ring segments **20**, **21**, and **22** are insulated from the pipe **11** and have means provided within them (by means of connecting bar) by which the heater units **23**, **24**, **25**, **26**, **27**, **28**, **29**, **30**, **31**, **32**, **33**, and **34** are connected in groups of four, or other suitable numbers to the electrical wires **40**, **41**, and **42**. The ring segments **20**, **21**, and **22** are further provided with means (not shown) such as riveted brackets which are then welded to tube **11** to hold the same in fixed connection with tube **11**.

The heating elements **23**, **24**, **25**, **26**, **27**, **28**, **29**, **30**, **31**, **32**, **33**, and **34** are formed of tubular heater elements, such as tubular metal encased, magnesium oxide insulated, Nichrome wire, such as General Electric proprietary product "Calrod," or other electrical heating elements. The heating elements are connected in pairs at their lower extremities, as indicated, by flexible connections **35** and **36** joining respectively pairs **26** and **27**, and **25** and **28**, and other connectors for each of the other pairs, which connectors are not shown because of their location with respect to the portions visible on the drawing.

In practice, three-phase electrical current is conducted

through the wires 40, 41, and 42, and by the combination series and parallel type connection, as indicated, causes uniform heating in all of the heater elements. The heater elements 23, 24, 25, and 26 are connected at their upper extremities to conductor 40 through the ring segment 20. The heater elements 27, 28, 29, and 30 are connected through ring segment 21 to conductor 41, and the heater elements 31, 32, 33, and 34 are connected through the ring segment 22 to cable 42. At the lower extremities the heater elements 23 and 34 are connected together, 33 and 24 are connected together, 26 and 27 are connected together, 30 and 31 are connected together, and 29 and 32 are connected together.

The entire heater unit thus formed is suspended at its top end by the connector rings fastened to tube 11 or to the shell 10, or alternately may be supported by a separate support ring to which each heater element unit is firmly fastened. In this latter instance the connector bars then are totally insulated separate from and do not support a load, the entire load being supported by a connection between each of the heater units close to the connector rings but separately attached to the tube 11.

If desired, a single, lengthy heating element may be used in place of each pair, as indicated.

The electrical heating elements, as shown, are held in position relative to one another by guide ring 18 which is attached to flow tube 11 near the lower extremity of the heating element.

The heat space between shell 10 and flow tube 11 is solidly filled with non-packing aluminum powder which is selected for this purpose because it conducts heat well but does not pack. The heat generated by the electrical heating elements is conducted by this powder packing and distributed uniformly to the shell 10 of the heater and the flow tube 11. In distributing the heat, hot spots are eliminated and the actual temperature of the electrical heating elements is maintained at the lowest level consistent with the amount of heat required in the heater as a whole.

Electrical cable is connected in lengths, approximately the same length as standard oil well tubing, in order to be lowered into a well concurrent with the oil well tubing and such that each time a new section of tubing is connected a new section of cable may be connected. Each length of electrical cable and conduit comprises elements, as indicated in Figure 6, wherein there are shown female connector 50 (each successive female connector in each conduit section 12' is equivalent to each other female connector such as connector 50 in conduit section 12 at the heater outlet. Therefore, each female connector is labeled and known as connector 50, whether it is the connector immediately attached to the heater elements or any other female connector in another cable section) with wires 43, 44, and 45, male connector 60 with prongs 61, 62, and 63. The entire cable unit is then seen to be enclosed within conduit 12' with a coupling 13 screwed onto the end in which the female fitting is located. The female fitting is shown to be located within a connector unit and it will be seen that because of the shoulder at 54 it cannot retract within the conduit section 12'.

The horseshoe-shaped clip 70, shown in Figure 7, is slipped over the female connector 50 just below the shoulder 54 and rests upon the end of the conduit coupling 13 to hold the cable in position such that the male connector at the other end is held well within the conduit and so that it will not at this time engage the female connector in the cable adjoiner. The cable is thus contained in this position until the conduit is screwed on to the adjoining coupling 13 on the section of conduit immediately beneath the new section being applied. When the new unit is screwed up, the clip 70 is removed from the female connector 50 at which time the entire cable unit moves and it then drops downward by force of gravity, and, also, it may be pushed downward, until the male connector seats in place within the female connector immediately below it. As the cable is lowered into position, as indicated, any misalignment of the male connectors 61, 62, and 63 with the sockets 51, 52, and 53 is easily corrected by slight turning from the upper end. Each of the openings 51, 52, and 53 is flared widely at its upper end so that a funneling effect is achieved, and, thus, the male connector prongs are easily guided into position. The cable wires are each sufficiently large and rigid so that no buckling of the cable will occur during the joining operation.

It will be noted that each of the couplings 13 has a shoulder at 13*b* at the end of each set of threads 13*a* on each end of the coupling. This shoulder causes a joinder of the lengths of conduit at fixed position to achieve uniform length of each section of conduit and coupling, since it can be screwed up to this point and no further.

When the length of cable has been seated so that the male connecting end 60 is joined with the corresponding female connector 50, the next succeeding female connector, located above such male connector will have become seated and rest upon the shoulder 54 against the upper end of the conduit 12' and thus will be held in position for receiving the next succeeding male connector.

Each section of conduit 12' is preferably strapped or otherwise held to the corresponding section of oil well tubing 11 in order to hold the same firmly in position and avoid any possible buckling or flexing while being worked or lowered or removed from a well.

Each of the male and female connectors 50 and 60, other than those immediately adjacent the heater unit, are formed of any reasonably heat-resistant insulator material.

In practice, our heater is fastened by standard oil well tubing connecting threads to the bottom section of oil well tube and lowered into a well. As each section of oil well tubing is added and the heater lowered further into the well, an additional length of conduit with the cable mounted within it is added. Upon removal of a portion or all of the well tubing, the cable is easily removed section by section in the same manner. In removal of each cable section, the female connector at the upper end of each conduit section is gripped and pulled upward until the connection at the lower end of the cable has been broken. The clip 70 is then inserted in place to hold the cable up in the unit until it is unscrewed. Upon being unscrewed and disconnected, each cable unit is protected by attaching a cap on the end having the male connector and a plug in the coupling end having the female connector.

While particular reference has been made to this heater being employed at the lower end of an oil well tube, where desired the heater can as well be located part way up the oil well tube, in which case the end of the tube 11 projecting beneath the heater will be threaded to receive lengths below it.

Reference has also been made to standard lengths of oil well tubing and that the electrical cable section be in these lengths. This, of course, is not essential and the lengths of the cable can be longer or shorter if desired for particular purposes.

While the particular embodiment we have illustrated is fully capable of performing the objects and accomplishing the purposes desired, it is recognized that a number of modifications and changes may be made without departing from the scope and spirit of our invention. It is not intended that any limitations be imposed thereby, except such as are required by the appended claims.

We claim:

1. An oil well heater of the class described comprising: a length of oil well tubing; an offset heater shell connected to said tubing by an upper flange to form a sealed, water-tight, annular heating space, said heater shell surrounding said tubing at a spaced radial distance therefrom; finely divided aluminum powder packed within said space; electric heater elements formed from metal encased, magnesium oxide insulated Nichrome wire sus-

pended in said space, said heater elements connected in pairs to one another and formed in a U-shape extending along said tubing, said elements being firmly attached to said flange independent of said shell; a plurality of sections of threaded rigid metal conduit adapted to be attached to said flange; a metallic threaded sleeve interconnector adapted to be fastened between said sections of conduit; and lengths of semi-rigid copper-sheathed cable encased in a slidable relationship within said sections of conduits; each of said cables consisting of three semi-rigid copper-sheathed conductor wires having a rigid, non-resilient type male connector with three prongs on one end and a rigid, non-resilient type female connector with three sockets capable of receiving said prongs of said male connector on the other end.

2. An oil well heater of the class described comprising: a length of oil well tubing; a heater shell connected to said tubing by an upper flange to form a sealed, watertight, annular heating space; finely divided aluminum powder packed within said space; electric heater elements within said space, said heater elements connected in pairs to one another, said elements being firmly attached to said flange; a plurality of sections threaded conduit adapted to be attached to said flange; a sleeve interconnector adapted to be fastened between said sections of conduit; lengths of electric cable encased in a slidable relationship within said sections of conduits; each of said cables consisting of conductor wires having a male connector on one end and a female connector on the other end.

3. An oil well heater of the class described: a length of oil well tubing; conduit; a heater shell connected to said tubing by an upper flange to form a sealed, watertight annular heating space; said heater shell surrounding said tubing at a spaced distance therefrom; finely divided aluminum powder packed within said space; metal encased insulated electric heater elements suspended within said space; said heater elements connected in pairs to one another and formed in a U-shape extending along said tubing; said elements being firmly attached to said flange independently of said shell; a plurality of sections of threaded rigid metal conduit adapted to be attached to said flange; a metallic sleeve interconnector adapted to be fastened between said sections of conduit; lengths of semi-rigid electric cable, encased in a slidable relationship within said sections of conduit, each of said cables consisting of semi-rigid conductor wires having a non-resilient type male connector with prongs on one end and a non-resilient type female connector with sockets on other end.

4. In an electric oil well heating system, means for the conduction of three phase electric current to an electric heater consisting of: sections of rigid metallic hollow conduit of a predetermined length corresponding to lengths of normal oil well tubing, said conduit having

threaded ends on the outer periphery; each of said sections of conduit having a hollow threaded metallic connector engaged on one end thereof, each of said connectors having perpendicular shoulders therein such that each connector may be screwed only to a predetermined length upon said sections of conduit; each of said sections of conduit having located therein in a slidable relationship three lengths of semi-rigid, copper-sheated wire of equal corresponding predetermined length parallel to each other and to said conduit, an insulated solid male connector molded one one set end of each set of said wire; said male connector having a plurality of non-metallic, non-corrosive prongs protruding from said insulated connector and joined therein to said semi-rigid wires; an insulated non-resilient female connector at the other end of each set of said semi-rigid copper-sheathed wires having a plurality of sockets adapted to receive the prongs of said male connector which are therein joined to said wires, said sockets having a flanged aperture and metallic means for conduction of current along the circumference of each socket, a downwardly facing shoulder on said female connector suitable to engage the end of a section of conduit about said cable causing said female connector to possess two different exterior diameters.

5. In an electric oil well heating system means for conduction of electric current to an oil well heater consisting of: sections of conduit of a predetermined length corresponding to lengths of normal oil well tubing, said conduit having threaded ends on the outer periphery; each of said sections of conduit having a connector located on one end thereof, each of said connectors having a perpendicular shoulder therein, such that each connector may be screwed only to a predetermined length upon said sections of conduit; each of said sections of conduit having located therein in slidable relationship lengths of semi-rigid wire of equal corresponding predetermined length parallel to each other and to said conduit; a male connector molded on one end of each set of said wire; said male connector having prongs protruding from said connector and joined therein to said wires; a female connector at the other end of each set of said wires having sockets adapted to receive the prongs of said male connector which are therein joined to said wires, said sockets having means for conduction of current along the circumference of each socket; and a downwardly facing shoulder on said female connector suitable to engage the end of a section of conduit about said cable.

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