Dec. 11, 1962 R. DE KAY ET AL 3,068,339

IMMERSIBLE ELECTRIC HEATER

Filed Sept. 12, 1960

Fig. 1.

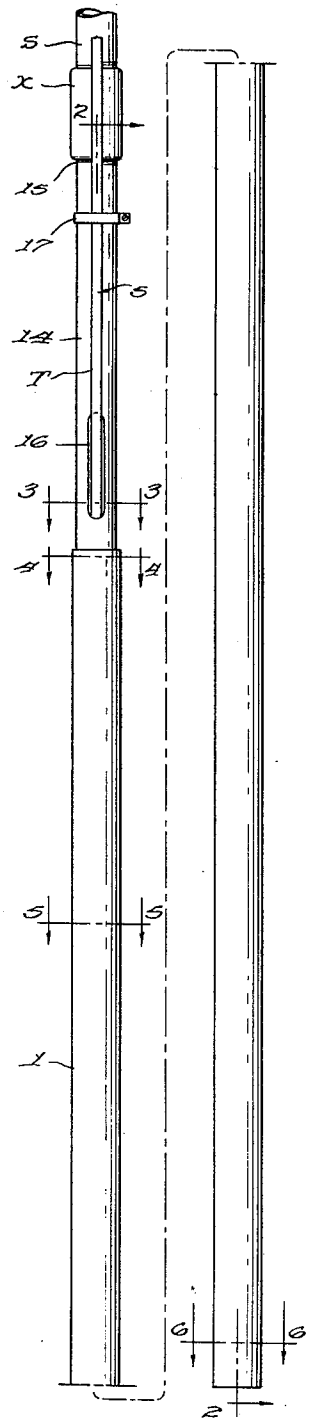


Fig. 2.

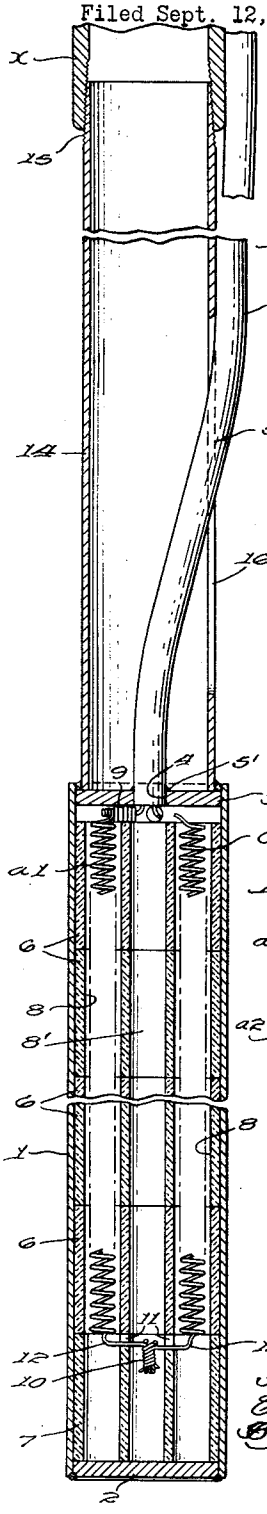


Fig. 7a.

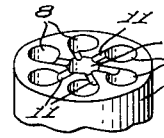


Fig. 3.

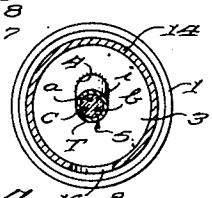


Fig. 4.

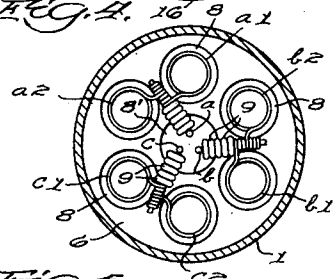


Fig. 5.

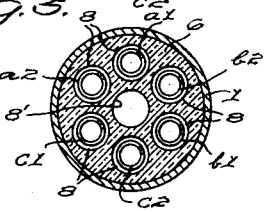


Fig. 6.

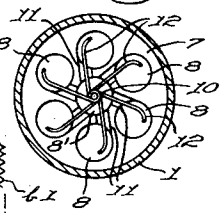
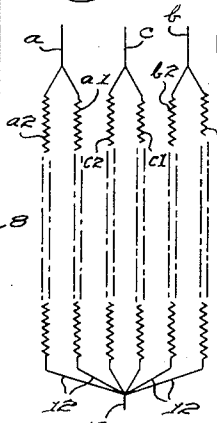


Fig. 8.



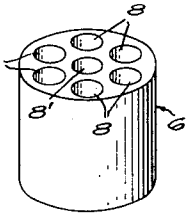


Fig. 7.

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United States Patent Office 3,068,339 Patented Dec. 11, 1962

3,068,339

IMMERSIBLE ELECTRIC HEATER

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Filed Sept. 12, 1960, Ser. No. 55,491
10 Claims. (Cl. 219—33)

This invention relates to oil well heaters of the type adapted to be lowered into the well and submerged in the oil whereby the fluidity of the oil is increased so that it may be more readily removed from the well.

The principal objects of the invention are to provide a submersible heater for oil wells characterized by simple, rugged construction; which is of small diameter to enable it to be used in small diameter wells; which is adapted to be energized by three phase electric current; in which the heat generating resistance means are effectively insulated against short circuiting; and in which the said heat generating means is effectively sealed against the entrance of oil in which the heater is submerged.

With the foregoing objects in view, together with such additional objects and advantages as may subsequently appear, the invention resides in the parts, and in the construction, combination and arrangement of parts described, by way of example, in the following specification of a presently preferred embodiment of the invention, reference being had to the accompanying drawings which form a part of said specification and in which drawings:

FIG. 1 is a side elevational view of an oil well heater embodying the invention, the upper end of the heater being shown as connected by a coupling to the lower end of a string of tubing for lowering it into a well,

FIG. 2 is an enlarged, medial sectional view taken on the line 2—2 of FIG. 1, the portion of the heater between the upper and lower ends being omitted to permit illustration on the large scale,

FIG. 3 is a transverse sectional view on the same scale as FIG. 2 taken on the line 3—3 of FIG. 1 showing the shank end construction of the heater,

FIG. 4 is a greatly enlarged transverse sectional view taken on the line 4—4 of FIG. 1 and showing the connection between the electrical conductors and resistance elements employed at the upper end of the illustrated embodiment of the invention,

FIG. 5 is a transverse sectional view on the same scale as FIG. 2 and taken across one of the ceramic insulators and the contained resistance units as, for example, on the line 5—5 of FIG. 1,

FIG. 6 is a transverse sectional view on the same scale as FIG. 2 taken on the lines 6—6 of FIGS. 1 and 2 and showing the interconnection between the resistance elements at the lower end of the illustrated embodiment of the invention,

FIG. 7 is a perspective view of one of the ceramic insulating units,

FIG. 7*a* is a fragmentary top perspective view of the bottom insulator, and

FIG. 8 is a circuit diagram of the interconnection between the resistance elements of the heater and the power leads connected thereto.

Referring to the drawings, the illustrated embodiment of the invention includes a casing 1 formed from a length of steel tubing; said casing enclosing the heating means and having the lower end closed by an end plate 2 welded therein and the upper end closed by a top end plate 3 welded therein; said top end plate having a central opening 4 through which the conductor cable 5 extends for connection of the conductors to the resistance means within the casing. The conductor cable 5 is a heavy cable having a copper tubing exterior T and containing three leads designated *a*, *b* and *c* embedded in a ceramic

type insulating medium *i* and best shown in FIG. 3. The exterior of the cable is soldered as at 5' in the opening 4 to seal the interior of the casing against the entrance of fluid at this point.

The inside of the casing 1 is filled with a series of insulators 6 extending from a base insulator 7 formed of ceramic material and resting on the bottom plate 2; each of said insulators 6 comprising a cylindrical ceramic body having a series of six holes 8 extending therethrough parallel to the axis of the body and disposed circumferentially in spaced relation adjacent to the outer surface of the cylindrical body and having a central axial hole 8' effective to reduce the internal wall thickness and to increase the surface area of the block to facilitate the manufacture thereof. Extending through the aligned holes 8 of the stacked insulators 6 are resilient, self-sustaining helically formed resistance wire elements designated as *a*1 and *a*2 connected to the lead *a*, *b*1 and *b*2 connected to the lead *b* and *c*1 and *c*2 connected to the lead *c*. These elements may be either formed initially with the approximate required spacing between convolutions or they may be close wound and stretched to provide the desired spacing between convolutions as may be found most convenient. In the illustrated embodiment of the invention, the leads *a*, *b* and *c* are bent to extend radially parallel to the under surface of the end plate 3 and carry glass or ceramic beads 9 thereon for a portion of their lateral length to serve as spacers and insulators. The ends of the connected resistance elements are then wound upon the exposed ends of these leads as shown in FIG. 4.

Below the lowermost of the insulators 6, the ends of all of the resistance elements are united by being twisted together and soldered to form an interconnection 10; said interconnection being housed in the center hole 8' of the lowermost insulator 7. The said bottom insulator 7 is generally similar to the blocks 6 except that the upper face thereof is provided with a series of grooves 11, one each extending similarly tangentially from each of the holes 8 thereof to the center hole 8' thereof to accommodate the runs 12 of the resistance elements leading to the interconnection 10 thereof.

The entire heater assembly is suspended from a tubular shank 14 welded to the upper end of the casing 1 and having an externally threaded upper end 15 adapted to be connected by a coupling X to the lower end of a tubing string S. The shank is provided with an elongated slot 16 in the side wall thereof through which the conductor 5 is led to the outer surface of the shank and tubing string; the conductor being secured at spaced intervals by straps such as shown at 17 and being connected at the top of the well to a suitable source of electrical energy.

The assembly of the device can be in either of two generally preferred modes. For example, the assembly of the insulator block 6 and resistance elements can be built up outside of the casing, the cable can be led through the opening in the top end plate 3 which may have been previously welded into the top of the casing and, after the leads of the conductor have been connected to the resistance elements, the entire heating assembly can be drawn into the casing after which, the soldered joint between the cable and the hole 4 in the top end plate can be formed, the bottom insulator 7 inserted and the bottom end plate 2 welded in place.

Alternatively, the casing and bottom end plate can be united and the bottom insulator inserted therein after which the preassembled insulator 6 and the resistance elements can be inserted and connected to the leads of the cable which has previously been led through the slot in the shank and through the hole in the top plate whereupon by welding the end plate in place and soldering the

cable into its opening through the end plate and welding on the shank, the device is completely assembled. These descriptions of possible modes of assembly are cited merely as examples and are to be regarded as descriptive and not as limitations.

While the above described, presently preferred embodiment is shown as comprising six resistance heating elements, it will be understood that where the device is intended for use with three phase current the number of heating elements may be three or any multiple of three dependent upon the size of the device and the heat output required. While the device is preferably used in connection with three phase current, it will be understood that it can also be adapted for use with single phase current.

Attention is directed also to the simplicity of the device and to its adaptability to being manufactured to order in any desired length. The resistance elements can, of course, be formed on a spring winding machine in any desired size of wire and diameter and number of turns. As a matter of fact, the resistance element material can most readily be made in large, close wound quantities of indefinite length and the resistance elements cut from the supply to the number of turns required to produce the desired length. Likewise, the tubing can be of any desired length and if a single length of tubing is not sufficiently long, several lengths can be united to produce a casing of the desired length for a particular installation. The insulators are, of course, standard for any one diameter of device and the different lengths of heaters are accommodated by the number of such insulators as may be required. Thus, it will be seen that the manufacture of heaters made according to this invention can be economically achieved and that no considerable expense for special tooling and the like is required. Other than some skill in welding and soldering, no special skills are required for manufacturing the heateers. Further, while different modes of interconnection of the current carrying instrumentalities are shown at the opposite ends of the illustrated embodiment of the invention it will be appreciated that either form of connection can be used at either end and that the same type of connection can be used at both ends, the only essential being that the various resistance elements be properly interconnected and be connected to the proper leads of the conductor.

While in the foregoing specification there has been described a presently preferred embodiment of the invention together with certain suggested modifications thereof, such disclosure has been by way of example and it is not to be assumed that the invention is limited to specific form so disclosed, and it will be understood that the invention includes as well all such changes and modifications in the parts and in the construction, combination and arrangement of parts as shall come within the purview of the appended claims.

We claim:

1. In a submersible electric heater, a fluid tight casing comprising a metal tube having one end closed by an end plate united thereto and having another end plate united to and closing the other end thereof; said last named end plate having an opening therethrough for reception of an electrical conductor, a plurality of self-sustaining, electrical resistance elements contained within said casing and extending parallel to each other substantially from end to end thereof and uniformly spaced from each other and from the inner surface of said tube, heat resistant, electrical insulating means supported by said first-named end plate and interposed between said resistance elements and said casing and between adjacent ones of said elements, a metal covered electrical conductor including a plurality of leads extending through said opening in said last-named end plate and having the metal cover thereof united to the end plate to complete the sealing of said casing against the entrance of fluid; each of said leads being electrically conductively connected to a separate pair of said resistance elements within said casing and all of said elements having their opposite ends electrically interconnected.

2. A submersible electric heater as claimed in claim 1 in which said insulating means comprises a plurality of ceramic blocks of identical cross-section configuration loosely fitting the interior of said casing and disposed in end to end relation therein; said blocks each having a plurality of holes extending therethrough parallel to the length of said casing and aligned with the holes in the adjacent ones of said blocks and in at least some of which holes some of said resistance elements are disposed.

3. A submersible electric heater as claimed in claim 1 in which said casing is provided with a coaxially disposed tubular shank having one end attached to said casing and having the other end thereof threaded for attachment to a tubing string for lowering said heater into an oil well.

4. A submersible electric heater as claimed in claim 2 in which portions of the one of said blocks resting on said first-named end plate and of the block resting on said one of said blocks combine to form laterally extending clearance spaces through which said opposite ends of said elements extend for said electrical interconnection whereby said elements are maintained out of contact with said first-named end plate.

5. A submersible electric heater as claimed in claim 4 in which said shank is of smaller diameter than said casing and is attached to the end thereof into which said conductor enters said casing, and in which said conductor extends along the exterior of said shank parallel to the axis thereof, thence passes to the interior thereof through an opening in the wall of the shank and thence through said opening in said end plate to the interior of said casing.

6. A submersible electric heater comprising a fluid tight casing including an elongated, hollow metal body having one end thereof closed by a first end plate, a second end plate closing the opposite end of said tubular body member and having an opening therethrough for entry of an electrical conductor, a plurality of self-sustaining electrical resistance elements extending longitudinally interiorly of said body and uniformly spaced from each other and from the interior surface of said body, heat conducting, heat resistant, electrical insulating means supported by said first end plate interposed between said resistance elements and the interior of said body and between adjacent ones of said elements for the full length of said elements, and electrical conductor comprising a plurality of leads surrounded by a fluid impervious sheath extending through said opening in said last named end plate; each of said leads being electrically conductively connected to one each of a corresponding number of pairs of said resistance means elements, and means for joining the exterior of said sheath to said second end plate in the region of said opening to complete the fluid tight sealing of said heater and all of said elements having the other ends thereof electrically interconnected.

7. A submersible electric heater as claimed in claim 6 in which said insulating means comprises a plurality of ceramic blocks of identical cross-section configuration loosely fitting the interior of said casing and disposed in end to end relation therein; said blocks each having a plurality of holes extending therethrough parallel to the length of said casing and aligned with the holes in the adjacent ones of said blocks and in at least some of which holes some of said resistance elements are disposed.

8. A submersible electric heater as claimed in claim 6 in which said casing is provided with a coaxially disposed tubular shank having one end attached to said last named end plate and having the other end thereof threaded for attachment to a tubing string for lowering said heater into an oil well.

9. A submersible electric heater as claimed in claim 7 in which portions of the one of said blocks resting on said

first end plate and of the block resting on said one of said blocks are combined to form laterally extending clearances through which said other ends of said elements extend for said electrical interconnection thereof whereby said other ends of said elements are maintained out of contact with said first end plate.

10. A submersible electric heater as claimed in claim 8 in which said shank is of smaller diameter than said casing and is attached to the end thereof into which said conductor enters said casing, and in which said conductor extends along the exterior of said shank parallel to the axis thereof, thence passes to the interior thereof through an opening in the wall of the shank and thence through said opening in said end plate to the interior of said casing.

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