April 10, 1951 S. A. GERMAIN 2,548,360

ELECTRIC OIL WELL HEATER

Original Filed May 8, 1942 3 Sheets-Sheet 1

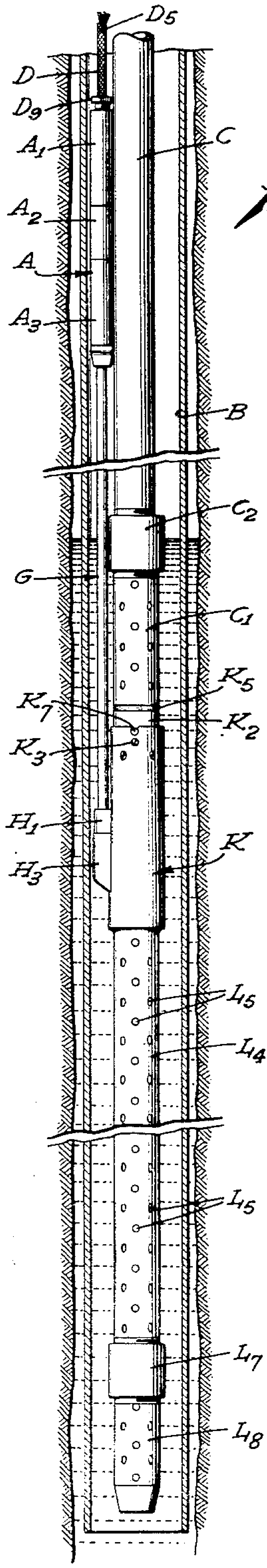


Fig. 1.

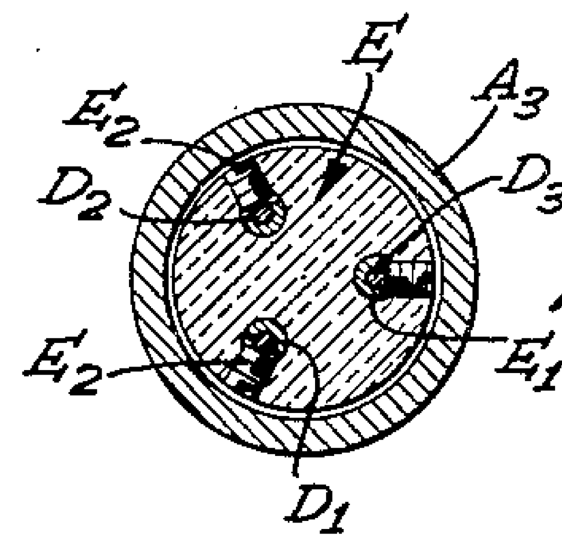


Fig. 5.

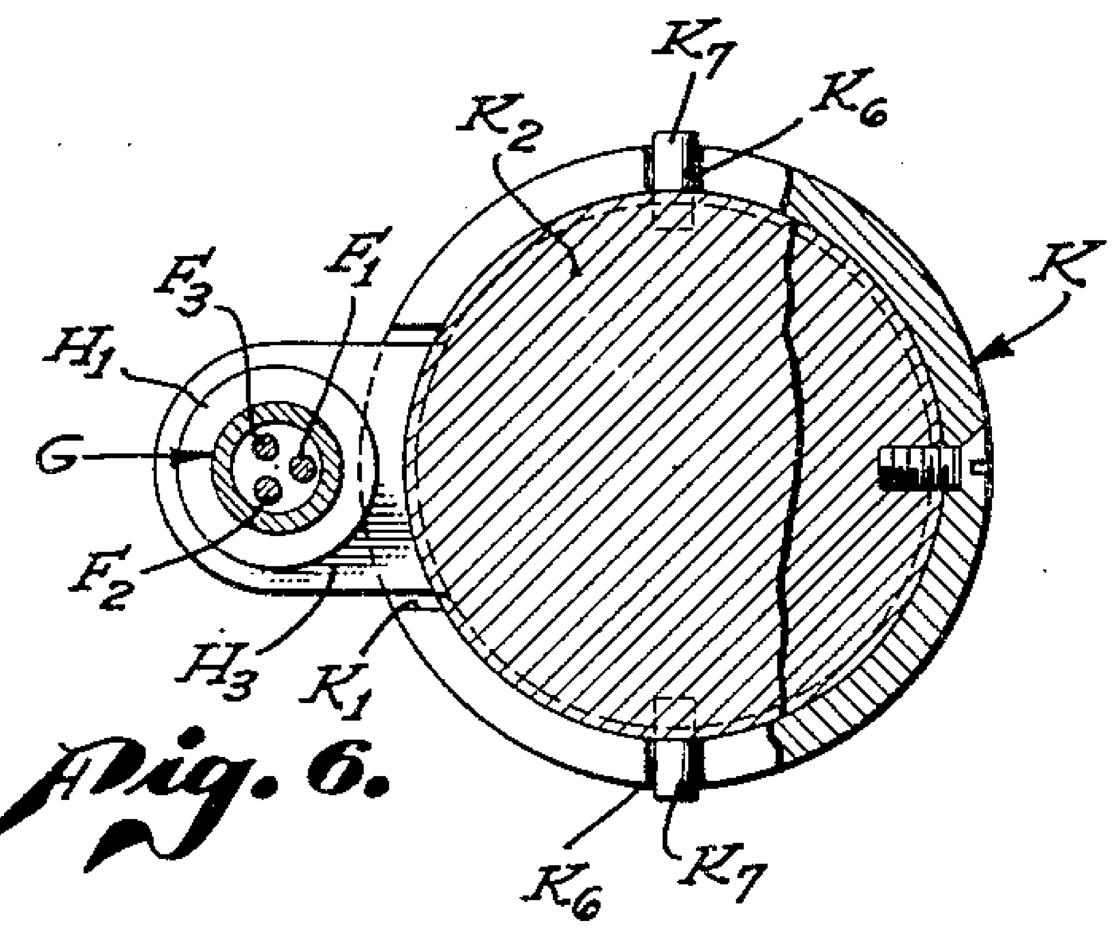


Fig. 6.

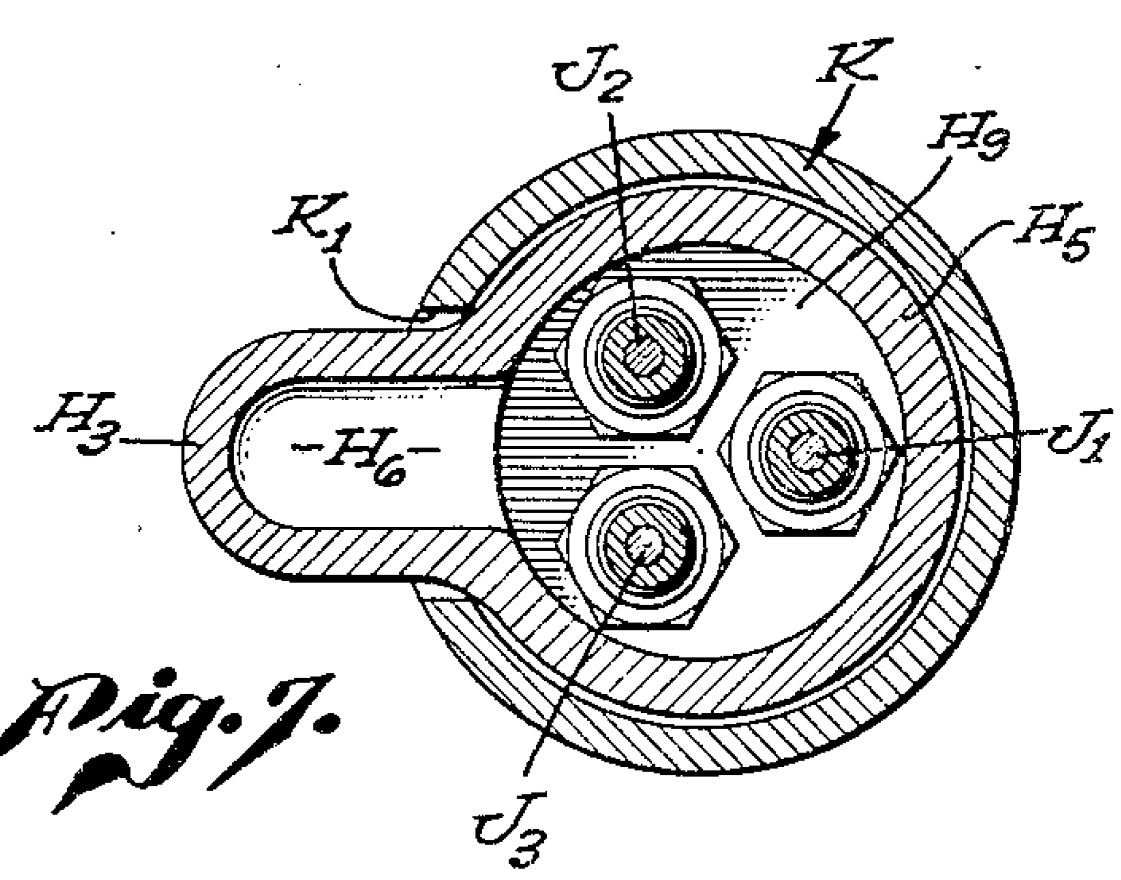


Fig. 7.

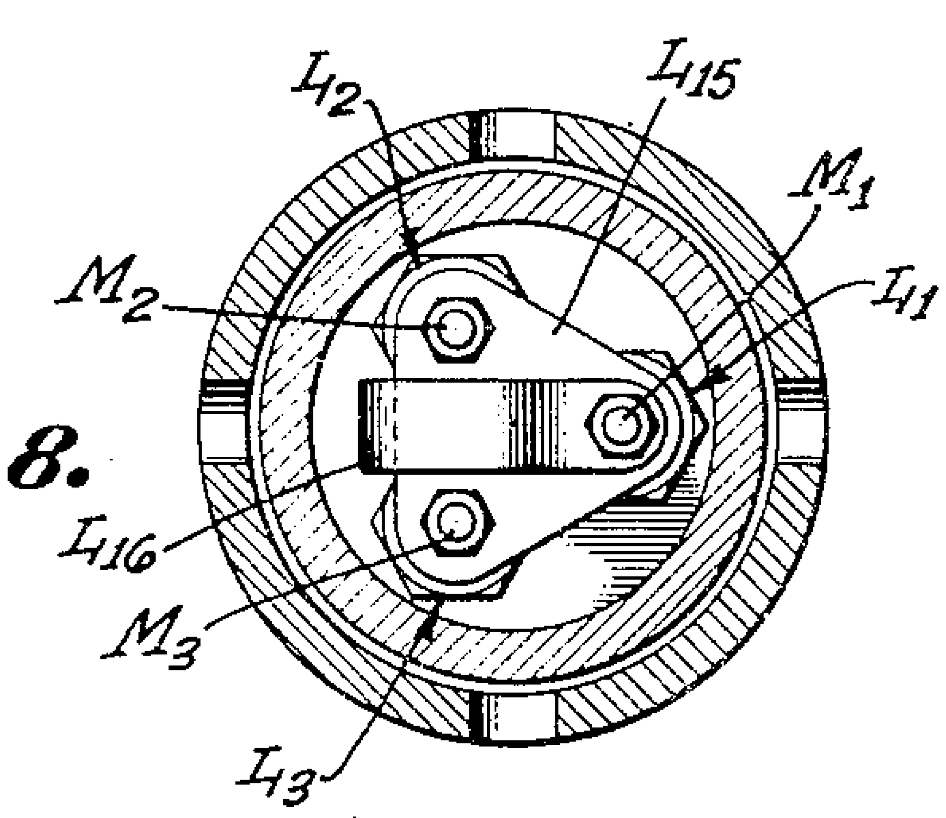


Fig. 8.

STANLEY A. GERMAIN,
INVENTOR

BY [signature]
ATTORNEYS

April 10, 1951 S. A. GERMAIN **2,548,360**

ELECTRIC OIL WELL HEATER

Original Filed May 8, 1942 3 Sheets-Sheet 2

Fig. 2.

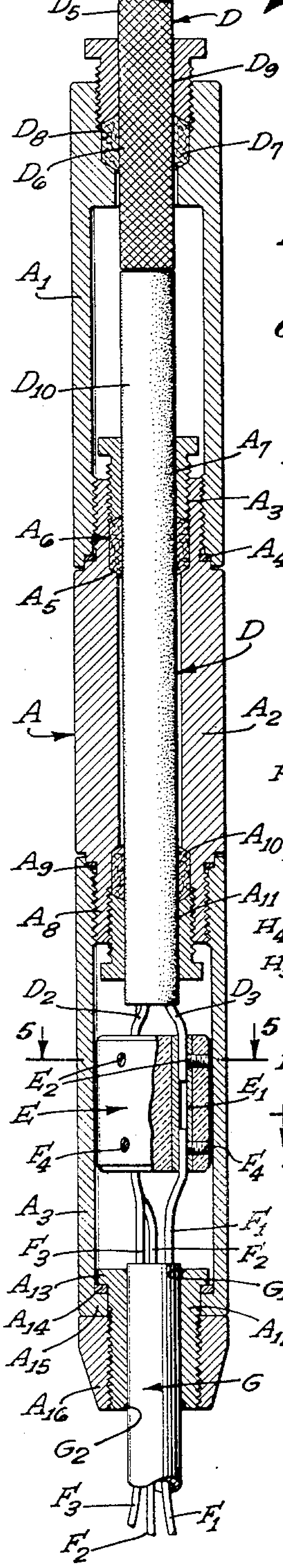


Fig. 3.

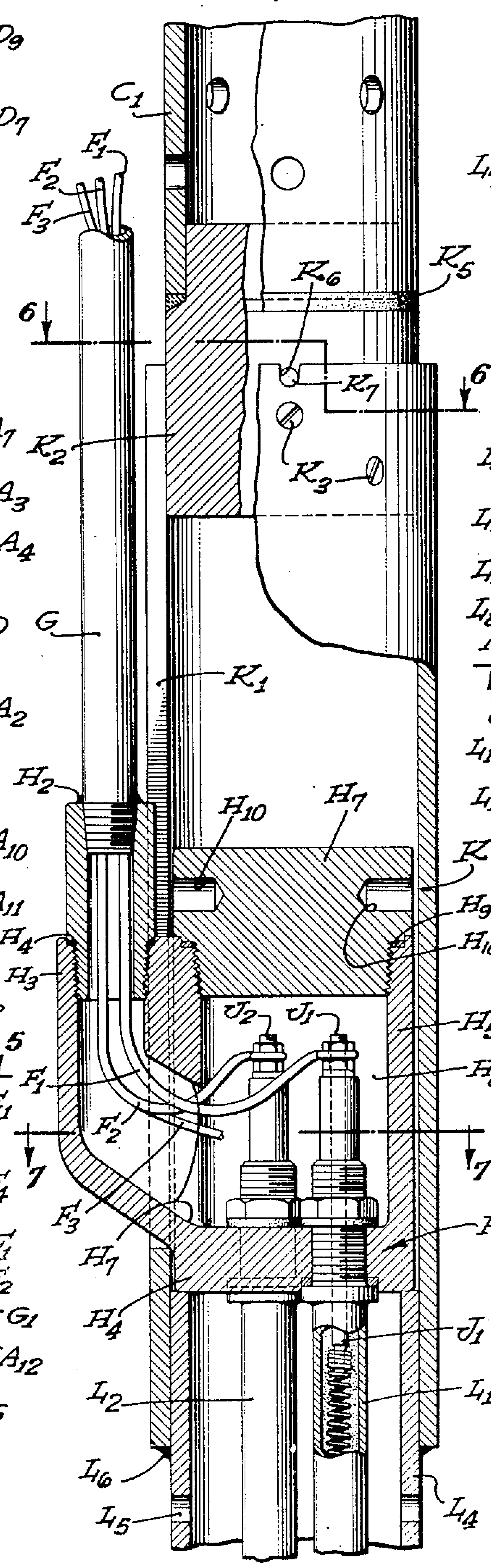
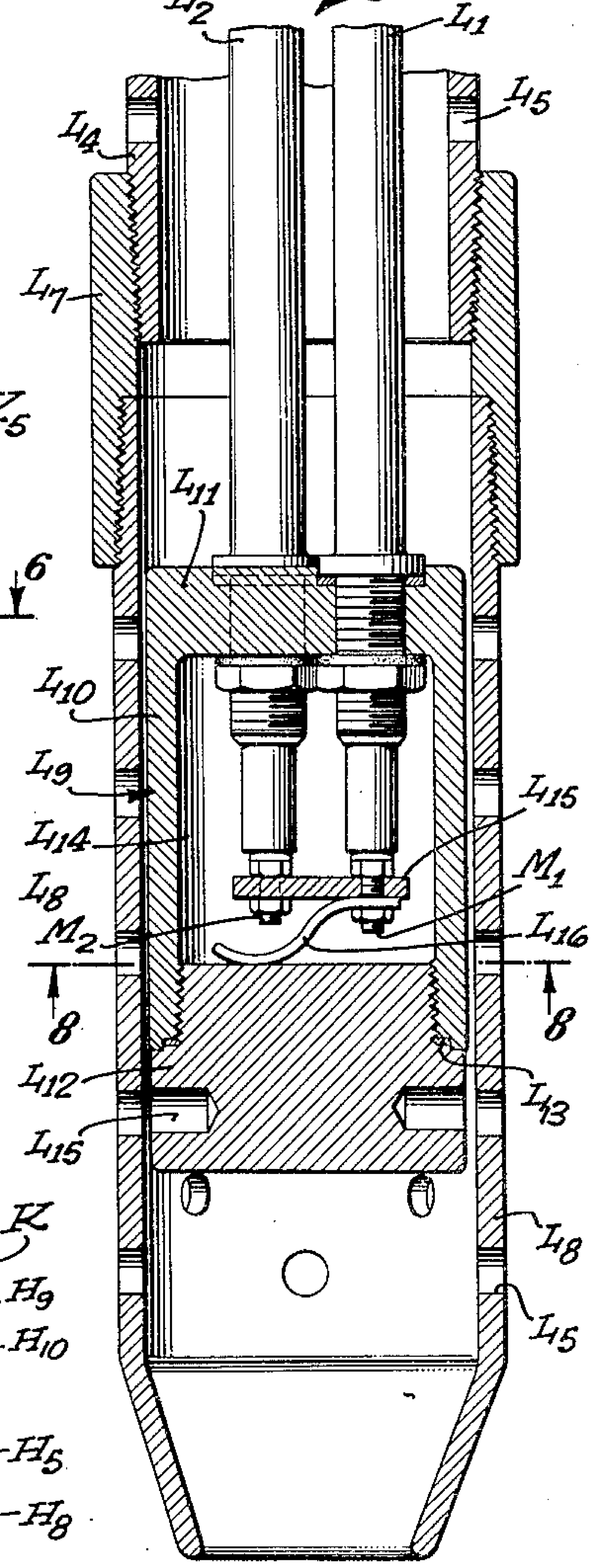


Fig. 4.



STANLEY A. GERMAIN,
INVENTOR

BY

ATTORNEYS

April 10, 1951 S. A. GERMAIN 2,548,360

ELECTRIC OIL WELL HEATER

Original Filed May 8, 1942 3 Sheets-Sheet 3

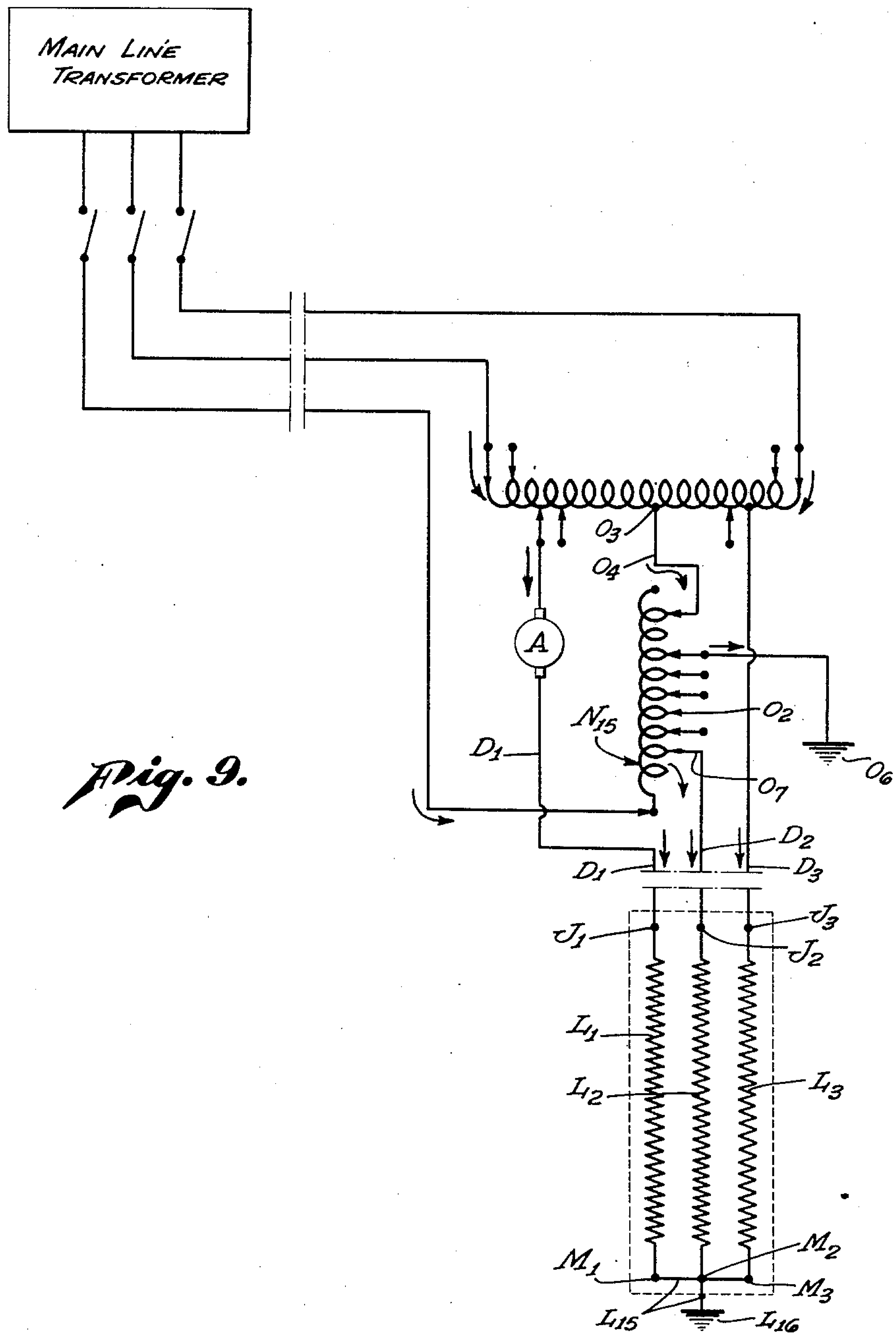


Fig. 9.

STANLEY A. GERMAIN, INVENTOR

BY [signature]

ATTORNEY

Patented Apr. 10, 1951 2,548,360

UNITED STATES PATENT OFFICE

2,548,360

ELECTRIC OIL WELL HEATER

Stanley A. Germain, Glendale, Calif.

Substituted for abandoned application Serial No. 442,175, May 8, 1942. This application March 29, 1948, Serial No. 17,675

3 Claims. (Cl. 219—33)

1

The present application is filed to take the place of abandoned application S. N. 442,175, filed May 8, 1942.

This invention comprehends the provision of an improved heater for oil wells for the same purpose of that shown in my pending application for patent filed May 6, 1939, Serial No. 272,203, issued March 17, 1942, as Patent No. 2,276,833, and contemplates the provision of an electric heater adapted to be lowered into the casing of a well and submerged in the oil in such a manner and to such effect that heavy gravity oil which is ordinarily incapable of being pumped from the well in its natural state, at least in sufficient volume to render a well profitable or efficient, may be heated and thereby thinned to a constituency capable of being pumped in full and profitable volume.

An object is to provide a mechanical pump structure which is particularly arranged to receive and support a special and novel form of electrical heating apparatus embodying a plurality of heating elements of special form and characteristics which, when connected with a source of electricity will not influence or disturb the operation of one or more of the elements in the event that another or others are broken or impaired, and, at the same time will permit of variations in any of the elements without affecting the others.

Another object is to provide an electric circuit including a multiple conductor cable, the conductors of which are surrounded by a conductor at ground potential for controlling the current supplied to the elements at a point common to all of the conductors of the cable.

It is an object also to provide an oil well heater embodying an electrical circuit in which the resistance characteristic is variable in such a manner as to provide greatly increasing resistance to the flow of current depending upon the temperature of the heating elements, together with means for varying the resistance in accordance with its temperature so as to avoid excessive temperatures in the elements by lowering the current flow by reason of the increased resistance corresponding to the higher temperatures. Also, in such case, the resistance characteristic is so established that it will prevent destructive temperatures in the elements.

A still further object is to provide in a heater of the character mentioned, means for insulating the heating elements of the system so as to divide the voltage applied to them and between them, and a common ground through the use of terminals encased in protective shields.

Another object is to provide means for individually varying the flow of current in any of the heating elements fed by their respective conductors in order that the temperature of any one

2

of the elements may be continuous and inherently adjusted for its individual indicated temperature condition without interference with the temperature effects of the remaining elements.

Other objects include: provision of means for varying the voltage applied to each of the heating elements independently of the variations in the external circuit; means for indicating the temperatures of resistance elements far below the surface of the earth by the employment of current indicating devices previously calibrated to the resistance of the heating elements and their resistance temperature characteristics while under normal load conditions.

Other objects will appear as the description of my invention progresses.

I have shown in the accompanying drawings a preferred form of oil well heater particularly adapted to carry out the purposes of my invention, subject to modification, within the scope of the appended claims, without departing from the spirit of my invention.

In said drawings:

Fig. 1 is a sectional elevation of an oil well with my improved apparatus operatively installed therein;

Fig. 2 is a sectional elevation of the uppermost unit of the apparatus as shown in Fig. 1 by means of which a multiple conductor cable from a point above the ground surface is operatively connected with the heater;

Fig. 3 shows a sectional elevation of the upper portion of the heater;

Fig. 4 is a sectional elevation of the lower portion of the heater;

Fig. 5 is a cross sectional view of the structure on line **5—5** of Fig. 2;

Fig. 6 is a cross sectional view of the same on line **6—6** of Fig. 3;

Fig. 7 is a cross sectional view on line **7—7** of Fig. 3;

Fig. 8 is a cross sectional view on line **8—8** of Fig. 4; and

Fig. 9 is a circuit diagram of the heater and associated elements.

As shown in Figs. 1 and 2 a cable connecting unit A is suspended within the well casing B outwardly of the pump casing C and is formed of a plurality of axially alined and connected sections A_1, A_2, and A_3. A cable D depending from the surface carriers a plurality of independently insulated conductors D_1, D_2, and D_3 which are embedded in a thermoplastic body D_4 covered exteriorly by means of a metal armor D_5. That portion of the cable D which extends into the upper portion of section A_1 of unit A, as at D_6, is wiped or soldered with metal so as to provide a uniformly smooth periphery for the cable in order that its entrance to the section A_1 may be suitably packed against leakage of water or oil. To this end a conventional stuffing box structure is provided at the upper end of section A_1 and includes a compressible packing ring D_7 seated in a bore D_8 formed in the upper end of section A_1 and a plug D_9 threaded into the open end of section A_1 and adapted to compress the packing ring D_7 around the portion D_5 of the cable and between the end of plug D_9 and bottom of bore D_8 of section A_1.

Sections A_1 and A_2 are detachably secured together by means of a nipple A_3 threaded into the lower end of section A_1 so that adjacent ends of sections A_1 and A_2 will compress a copper and asbestos gasket A_4 therebetween. Also at the joint between intermediate sections A_1 and A_2 I provide a stuffing box including a compressible packing ring A_5 held in a bore A_6 of section A_2 adapted to be compressed around a portion D_{10} of cable D by means of an adjustable plug A_7 threaded into the nipple A_3. Portion D_{10} of the cable is stripped of its armor from a point slightly below the packing ring D_7 to its lower end as shown in Fig. 2.

Sections A_2 and A_3 are detachably connected, as shown in Fig. 2, by means of a nipple A_8 threaded into the upper end of section A_3, and this joint is rendered leakproof by means of a copper and asbestos gasket A_9, a packing ring A_{10} and a plug A_{11}, arranged in a manner similar to the elements of the joint between sections A_1 and A_2, the portion D_{10} of the cable being extended through the ring A_{10} and plug A_{11}.

Within the section A_3 I provide a dielectric block E in which the conductors D_1, D_2, and D_3 are inserted and held in tubular contacts E_1 as by means of set screws E_2, and in which contacts insulated wires F_1, F_2, and F_3, are similarly held by means of set screws F_4. The lower end of section A_3 is closed by means of a closure A_{12} which has a flange A_{13} overlying a copper and asbestos washer A_{14} held against a shoulder A_{15}. Closure A_{12} is threaded so as to receive a nut A_{16} below the lower end of section A_3 so that when the nut is tightened the lower end of the section A_3 will be leakproof. Wires F_1, F_2, and F_3 are enclosed in a metal conduit G which is welded at G_1 and G_2, respectively, to the upper and lower ends of the plug A_{12}. Wires F_1, F_2, and F_3 are insulated apart and from the conduit G.

As shown in Fig. 3 the lower end of conduit G is screwed into a nipple H_1 and is welded at H_2 to the upper end of said nipple. The lower end of said nipple is screwed into a projection H_3 of a fixture H and has a gasket H_4 interposed between said nipple and said projection to render the joint leakproof. Fixture H has a bottom H_4 and a circular wall H_5, together with a passage H_6 affording communication between the interior of the fixture and the portion H_3 whereby wires F_1, F_2, and F_3 may be led into the interior of the fixture for connection with terminals J_1, J_2 and J_3, respectively, mounted on bottom H_4 of member H for connection with heating elements to be hereinafter described.

Member H is enclosed in an elongated sleeve K_2 and the lateral projection H_3 to which the conduit G is attached extends through an elongated peripheral slot K_1. The upper end of sleeve K is closed by means of a coupling K_2 which telescopes into the sleeve and is securely held by means of a plurality of screws K_3. The upper end of closure K_2 is reduced and extended into a pump nipple C_1 while the lower end of said nipple is welded at K_5 to said closure, as shown in Fig. 5. Closure K_2 and the fixture H are detachably associated with the sleeve K for the purpose of assembly and disassembly of the parts, the slot K_1 being open at the upper end of the sleeve so that said fixture may be readily moved into and from operative position in the sleeve, and the nipple and closure are also removable from the sleeve when the screws K_3 are loosened. It will be noted that the upper end of the sleeve K has a plurality of recesses K_6 which are adapted to be engaged by pins K_7 for properly alining the nipple C_1 and sleeve K.

Fixture H has a separate closure H_7 which is threaded into the upper open end of a chamber H_8 against a gasket H_9 and may be provided with peripheral bores H_{10} preferably arranged with their axes on a diametrical line so as to receive a spanner wrench by means of which the closure may be tightened so as to provide a leakproof joint. Inasmuch as chamber H_6 is in constant communication with chamber H_8 the closures H_1 and H_7 for said chambers, respectively, completely seal the chamber H_8 against the entrance of air or moisture except such as may result from condensation of the latent air in conduit G.

It must be understood that while the terminals J_1, J_2, and J_3 are insulated apart as well as from the bottom H_4 of member H within chamber H_8 it is important that there should be no possibility of the presence of moisture in the vicinity of the exposed ends of the terminals. Hence, the moisture absorber is an extra though not always, a necessary precaution.

The pump casing C is connected with the perforated inlet nipple C_1 by means of a coupling C_2 and, as shown in Fig. 1, said nipple is substantially below the level of oil in the well in order that the oil which is heated at points below the pump will be readily induced into the nipple for expulsion at a point above the surface.

The heater proper includes a plurality (three in the form shown herein) of heating elements which are chosen because of certain characteristics whereby they are subject to a variation of their inherent resistance to the flow of electric current therethrough in accordance with created temperatures. For instance, I have determined that a heater for the purpose of my invention should be capable of normally and consistently maintaining a temperature of about 340 or more degrees Fahrenheit when submerged in oil of a well, and that lower or higher temperatures will, respectively, decrease the efficiency of the heater and deteriorate the elements. Hence, I have ascertained that a modification of a certain element now in use has what may be termed a thermostatic effect and that as the temperature thereof is approaching a predetermined point, depending upon the peculiar characteristics of the element in different cases, the resistance will vary to a sufficient extent with temperature changes, so as to prevent an excessive temperature or rapidly reduce a prevailing temperature to a normal point.

I have shown in Figs. 3 and 4, three of such elements connected in a grounded electrical circuit with a source of power from above the surface and suitably encased in a protective shell or housing. Said elements are indicated at L_1, L_2, and L_3 and are connected at their upper ends, respectively, with the terminals J_1, J_2, and J_3. A perforated casing or housing L_4 encloses the elements and yet by means of the perforations L_5 therein affords direct contact between the oil of the well and the elements for heating purposes. The upper end of casing L_4 extends substantially into the bottom of sleeve K and preferably against the bottom H_4 of fixture H. The casing is welded at L_6 to sleeve K so as to remove possibility of leakage of oil from the casing into chamber H_8 and thereby causing short circuiting of the terminals J_1, J_2, and J_3.

Casing L_4 is of substantial length and is connected at its lower end to a coupling L_7 which, in turn, is connected with the upper end of a relatively short tubular section usually known in the art as a "bull plug" L_8. Said member L_8 is open at its bottom and is perforated throughout its length and serves to enclose the lower end of the heating elements L_1, L_2, and L_3, as shown in Fig. 4.

A fixture L_9 is loosely mounted within member L_8 and has a cylindrical wall L_{10}, a closed top web L_{11} and a detachable bottom closure L_{12} which is screwed into the lower end of the wall L_{10} against a gasket L_{13} for the purpose of sealing a terminal chamber L_{14} within fixture L_9 against the entrance of oil from the well.

Closure L_{12} is similar to closure H_7 in that it is provided with wrench receiving bores L_{15}. The lower ends of the heating elements L_1, L_2, and L_3 are attached to but insulated from the bottom L_{11} of fixture L_9 and are connected with terminals M_1, M_2, and M_3, respectively, within chamber L_{14}. The lower ends of the terminals support a contact plate L_{15} which is continuously in electrical contact with all of the elements of the system and also with a ground contact L_{16} attached to one of the heating element terminals and engaging the upper side of closure L_{12}, for affording a common ground to all of the elements through the plate L_{15}.

The parts of the heater unit illustrated in Fig. 4 are so formed that the assembly and disassembly thereof may be readily accomplished, particularly with respect to the outside diameter of fixture L_9 and the inside diameter of protective casing L_4, so that the heater unit when completely assembled may be inserted through casing L_4 and into the lower member L_8.

The oil well heater herein shown and described has peculiar characteristics and functions which have not in my knowledge been employed and which are briefly defined as follows:

The employment of three separately controlled electrical circuits with but three single conductors and a ground connection, thereby permitting variations in any of the elements without disturbing the balance of the elements;

The connection of three or more elements of an electrical circuit in such a manner that they may be supplied with current by means of a multiple conductor cable and at the same time surrounded by a conductor at ground potential for controlling the current supplied to the elements at a point common to all;

The employment of resistance elements, the inherent characteristics of which adapt them to high variations in resistance in accordance with temperature changes and in which the resistance characteristics vary with temperature changes, thereby lowering the current flowing through the elements by reason of the increase of resistance in accordance with the temperature of the elements.

By means of the structure and electrical connections shown and described I am enabled to insulate the elements of the circuits so as to regulate and divide the voltage applied to the heating elements through the use of shielded and encased terminals.

The temperatures of the several elements being predetermined and approximately consistent throughout the operation of the heater and in definite and known relation to the resistance of the elements under varying conditions, I am enabled to indicate at the surface of the earth the prevailing temperature of any element without the use of pilot wires, potential leads or other auxiliary circuits as well as a consequent interruption of the power circuit supplying the elements.

It will be apparent that all of the above effects and others result from the use of my heating apparatus, and especially when the heater is submerged in the oil of a well a particular feature consists in the arrangement and connections of the several heating elements with a source of current supply so that in the event any of the elements should become impaired the other elements would remain unaffected.

Now, with regard to the mechanical structure of my apparatus it may be mentioned that all of the units for operatively connecting the heater with a pump are separately assembled and the final assembly of all of said units is therefore accomplished with facility. All joints between parts of the units are sealed where necessary against possibility of leakage and other joints are formed so that certain parts may be readily assembled and disassembled. There is no possibility of short circuiting any of the lead in wires or elements because of the individual and group insulation of such wires and elements.

In operation the heater assembly is lowered into the well as shown in Fig. 1 to a point below the level of the oil in the well. When the heat generated in the heat penetrating structure by the heating elements becomes effective for thinning the oil of the well the oil is caused to flow and is exhausted from the well by means of the pump C in far greater volume and to greater profit than when a heater is not employed. Usually, it has been ascertained, the well production is more than doubled and generally always substantially increased over production without a heater.

I claim:

1. In oil well heaters incorporating elongated metal sheathed electrical resistance heating elements and supported from and below the screen tube of a submerged oil well pump, a structure comprising: an elongated tubular member detachably secured to the lower end of the pump screen and provided with a longitudinally extending slot through the wall thereof and opening into the upper end thereof; a hollow member mounted within said tubular member and having a laterally projecting hollow part extending through the slot in said tubular member, whereby said hollow member may be readily mounted in the tubular member before the latter is connected to the screen, the upper terminals of the elongated electrical resistance heating elements being mounted fluid tight in the lower wall of said hollow member and projecting into the interior of said member; a detachable fluid tight cover for said hollow member; a fluid tight electrical conductor-enclosing conduit secured at its lower end to the laterally projecting part of said hollow member and projecting upwardly therefrom; insulated electrical conductors extending through said conduit and each secured to one of said heating unit terminals within the hollow member; a cable leading electrical current to said conductors; and means effective to seal the upper end of said conduit about the cable.

2. A structure as set forth in claim 1 and in which the means for sealing the upper end of the conduit about the cable comprises a threaded closure welded to the upper end of the conduit and provided with a peripheral flange; a nut mounted on the threaded portion of said closure, a cable-connecting conduit having an inturned flange at its lower end clamped against the flange of said closure member by the nut; a length of armored cable extending into the upper end of said cable-connecting conduit, a connector mounted within said cable-connecting conduit connecting the conductors of said armored cable to the conductors secured to the electrical resistance heating units; and a packing gland arranged at the upper end of said cable-connecting conduit sealing the upper end thereof against the armored cable.

3. A structure as set forth in claim 1 and in addition comprising a fluid tight casing arranged within the end of said tubular member said end being perforated to allow circulation of oil therethrough and around the heating elements, the

lower ends of the metal sheathed resistance heating elements being secured in fluid tight relation in the upper wall of said casing with the ends of the resistance elements projecting into said casing; a removable plug of conductive material closing the lower end of said casing; and spring finger means grounding the resistance elements to said casing and thereby to the pump casing.

STANLEY A. GERMAIN.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,535,776	Hollister	Apr. 28, 1925
1,646,599	Schaefer	Oct. 25, 1927
1,864,960	Taylor	June 28, 1932
2,134,610	Hogg	Oct. 25, 1938
2,233,890	Hoover	Mar. 4, 1941
2,276,833	Germain	Mar. 17, 1942