May 31, 1949. I. J. McCULLOUGH 2,471,695

METHOD OF AND APPARATUS FOR FORMING WELLS

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Fig. 1

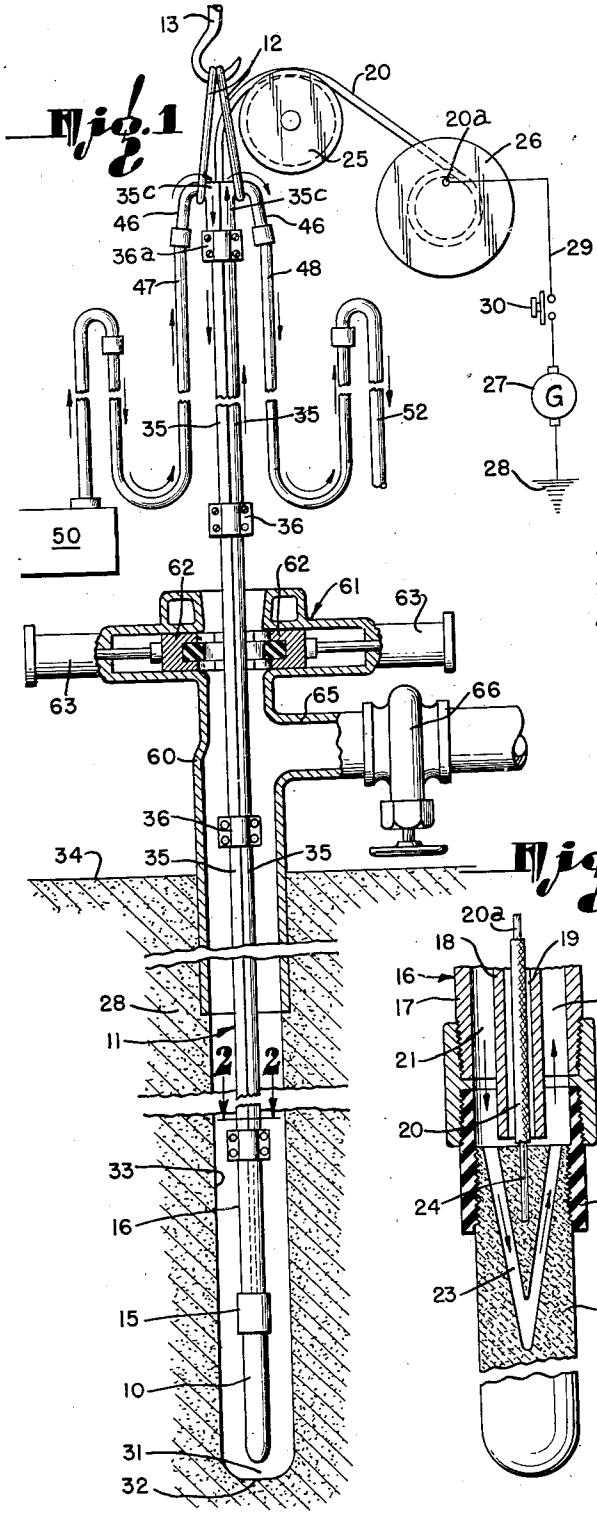


Fig. 2

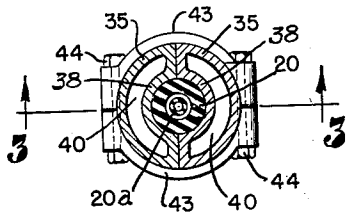


Fig. 3

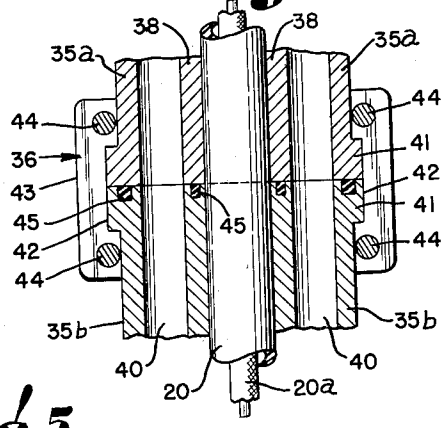
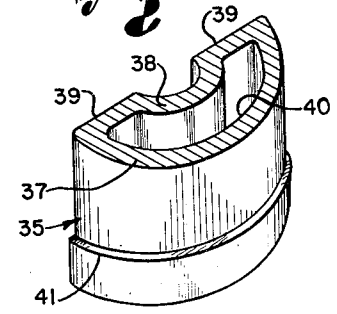


Fig. 5

Fig. 4



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METHOD OF AND APPARATUS FOR FORMING WELLS

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5 Claims. (Cl. 219—15)

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My invention relates to the art of forming in the ground holes which are referred to as wells, and relates particularly to a simple method and apparatus whereby an electrode is moved along a line or path of travel extending down into the earth and an electric arc constitutes the means for removing the ground or earth formation by burning it away along the line of travel so as to form a hole which constitutes the well.

It is an object of the invention to provide a method and apparatus whereby an electrode is moved down into the earth on the lower end of a supporting member which may comprise an electric cable or other vertically elongated member of suitable strength, and an electric current is conducted through a circuit including the earth, an arc formed between the earth and the lower end of the electrode, and the electrode and the current conducting part of the supporting member.

It is an object of the invention to provide an electrode for use in forming the arc and means for controlling the movement of this electrode along a downward path so that the arc will be formed between the lower end of the electrode and the earth therebelow to burn away the ground or earth formation to produce a hole, and whereby the upper end of the hole or well is sealed around the cable or supporting member and the outlet of gases from the upper end of the hole is controlled so as to maintain pressure in the hole and against the formations to hold back fluids in the formations traversed by the hole.

A further object of the invention is to provide a method and apparatus for forming a well, wherein the arc-sustaining electrode is connected to the end of a continuous conductor, and wherein the electrode is supported or guided so as to follow a predetermined path of movement by a member which is assembled along the conductor as the hole forming operation progresses.

It is a further object of the invention to provide a method and apparatus for forming wells wherein the supporting or guiding member for the electrode consists of members which are assembled around the conductor so as to substantially enclose the same, at least a part of these members having openings therein to provide a passage for a cooling medium.

Further objects and advantages of the invention will be brought out in the following part of the specification, wherein detailed description of a preferred embodiment of the invention is for the purpose of making a full disclosure without limiting the invention defined in the appended claims.

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Referring to the drawings which are for illustrative purposes only,

Fig. 1 is a schematic view showing an embodiment of the invention.

Fig. 2 is an enlarged cross section taken as indicated by the line 2—2 of Fig. 1.

Fig. 3 is an enlarged fragmentary sectional view taken as indicated by the line 3—3 of Fig. 2.

Fig. 4 is a perspective view of the lower end of one of the complementary tubular supporting members.

Fig. 5 is an enlarged fragmentary section showing the electrode and the lower end of the support to which it is connected.

As shown in Figs. 1 and 5, I secure an electrode 10 of electro-conductive and heat resistant material, such, for example, as carbon, to the lower end of an electric cable 20 which, in some practices of the invention, may be the sole means for supporting the electrode 10. However, the invention also comprehends that the cable may be a component part of supporting and guiding means 11, the upper end of this supporting means 11 being connected by links 12 to the hook 13 of the hoisting equipment ordinarily found in derricks. By controlled operation of the hoisting equipment, it is possible to gradually lower the supporting means 11 so that the electrode 10 will be moved downwardly at a proper rate for the performance of the well forming method.

The upper end of the electrode 10 is fitted and secured within a sleeve 14 of insulating material which is connected by means of a coupling 15 at the lower end of a tubular member 16. The tubular member 16 consists of an outer pipe 17 and an inner wall 18 which defines an axial space 19 to receive the cable 20 which includes an insulated conductor 20a. The inner wall 18 also defines within the pipe 17 passages 21 and 22 which communicate with a passage 23 in the electrode 10. The lower end 24 of the conductor 20 is electrically connected to the upper end of the electrode 10.

The cable 20, containing the insulated conductor 20a, extends vertically upwardly and passes over a sheave 25 and is wound upon a drum 26. A source of electrical power, shown as a generator 27, is connected to the ground 28 and is connected through a conductor 29, having a switch 30 therein, with the electric current conducting part of the supporting means 11, consisting, in the present disclosure, of the conductor 20a of the cable 20. When the switch 30 is

closed, the generator 27 will be connected in series with the electrode 10 and with the ground so as to form an electric arc in the space 31 between the lower end of the electrode 10 and the bottom 32 of the hole 33 which is being formed in the ground 28. Herein, the term "ground" is intended to include all of those substances which may be encountered below the surface 34 by the electrode 10 in its downward movement in the earth.

As the downward movement of the electrode 10 progresses, the cable 20 is gradually fed downward and the vertical extension of the supporting means 11 is increased. Above the tubular member 16 the supporting means 11 comprises not only the cable 20, but also pairs of complementary tubular sections 35 connected in end to end relation by connectors 36. Each of the tubular sections 35 is of semi-cylindrical form, as shown in Figs. 2, 3, and 4. Referring in particular to Fig. 4, each of the sections 35 includes an outer semi-cylindrical wall 37, an inner cylindrical wall 38 arranged coaxially therewith, and radial walls 39 disposed along a diametral plane and connecting the vertical edges of the semi-cylindrical walls 37 and 38. The walls 37, 38 and 39 are arranged so as to form a tube of the cross-section shown and defining a passage 40 of arcuate cross section.

As shown in Fig. 2, a pair of the members 35 are assembled around a portion of the insulated cable 20, the inner semi-cylindrical walls 38 defining a vertical passage to receive the conductor 20. As shown in Figs. 3 and 4, the upper and lower ends of the sections 35 have semi-cylindric enlargements 41. When, as shown in Fig. 3, an upper pair of the tubular members 35, indicated by the numerals 35*a*, are placed in end to end engagement with a lower pair of the members 35, specifically indicated at 35*b*, the semi-cylindric enlargements 41 form adjacent collars which fit into semi-cylindric channels 42 formed within complementary semi-cylindric connectors 43 employed in pairs to provide the connectors 36 of the supporting means 11. The complementary members 43 are secured together around the adjacent ends of the pairs of members 35 and around the collar forming cylindric enlargements 41, by bolts 44. Sealing members 45 are disposed between the ends of the members 35 to prevent leakage of fluids from the passages 40, which are connected in end to end relation.

To the upper end of the string of members 35, shown in Fig. 1, modified members 35, indicated specifically as members 35*c*, are connected to the upper ends of the uppermost pair of members 35 by means of a connector 36 indicated specifically as 36*a*. The members 35*c* are of the general form of the part 35 shown in Fig. 4, but are shortened and are provided with laterally and downwardly extended tubular arms 46 under which the power portions of the links 12 pass. The members 35*c* are hollow and the interior spaces communicate with the upper ends of the spaces 40 in the members 35. The hollow arms 46 define passages through which flexible conduits 47 and 48 may be connected to the upper ends of the passages 40 of the members 35*c*, 35, and the passages 21, 22, and 23 at the lower end of the supporting means 11, as shown in Fig. 5. A cooling medium, such as water or brine, is forced by a pump 50, through the flexible conduit 47 and the leftward member 35*c* into one of the vertical passages formed in the supporting member 35 by the end to end arrangement of the passages 40 in the members 35 extended vertically along the left hand side of the supporting means 11 and the passage 21 of the tubular member 16 into one side of the passage 23 in the electrode 10. This cooling medium then passes out of the right hand side of the passage 23, through the passage 22, and the right hand passage of the supporting means 11 formed by the end to end arrangement of the passages 40 in the members 35 which lie along the right hand side of the supporting means 11, to the flexible conduit 48 which is connected to a stand pipe 52. The members 35 and 16 protect the cable 20 from the high temperatures produced in the hole 33 by the arc formed in the space 31, and the cooling medium is caused to flow through a path along and substantially surrounding the cable 20, thereby preventing execessive rise in the temperature of the cable and keeping the metal parts of the supporting means 11 cool.

On the upper end of a pipe or casing 60 which extends down into the upper part of the hole 33, I provide control means 61 for controlling the flow of gases from the upper end of the hole 33. This control device 61 includes a pair of gates 62 adapted to be closed, by hydraulic or mechanical actuators 63, around the cable 20 if it is employed without the remaining parts of the supporting means 11, or around the members 35 should they be employed in the manner shown in the drawing. From the side of the pipe 60, in a plane just below the gates 62, a pipe 65 is extended, for carrying off fluids which issue from the hole 33. The pipe 65 has therein a gate valve 66 for control of the flow of gases therethrough, whereby the pressure in the hole 33 may be regulated, the purpose of this pressure being to hold back fluids in the formations communicating with the hole 33.

I claim as my invention:

1. In a means for forming a hole in the ground, the combination of: an electrode; conductor means connected to said electrode; a source of electric power; means for connecting said source of power to the ground and to said conductor means; means for supporting said electrode and forming a channel to receive said conductor means, said supporting means having therein a passage for a cooling medium; means for moving said supporting means; and means connected to said passage for delivering thereto a cooling medium.

2. In a means for forming a hole in the ground, the combination of: an electrode; conductor means connected to said electrode; a source of electric power; means for connecting said source of power to the ground and to said conductor means; means for supporting said electrode and said conductor means, said supporting means comprising a plurality of tubular sections and means for connecting them together in series and on opposite sides of said conductor means so that said section will serve to guard said conductor means, said tubular sections providing a passage for a cooling medium; means for moving said supporting means; and means connected to said passage for delivering thereto a cooling medium.

3. In a means for forming a hole in the ground, the combination of: an electrode; conductor means connected to said electrode; a source of electric power; means for connecting said source of power to the ground and to said conductor means; means for supporting said electrode and said conductor means, said supporting means

comprising elongated sections adapted to be arranged around said conductor means so as to substantially enclose the same and means for connecting said sections so arranged in end to end relation, at least a part of said sections defining a passage for a cooling medium along said conductor means; means for moving said supporting means; and means connected to said passage for delivering thereto a cooling medium.

4. In means for forming a hole in the ground, the combination of: an electrode; means for supporting said electrode; a source of electrical power; means for connecting said source in series with the ground and with said electrode; means for controlling the movement of said electrode so that an arc will be formed between said electrode and the adjacent ground and a hole will be formed as the result of the burning effect of said arc converting the contiguous ground into products of combustion; and valve means for controlling the flow of fluids from the outer end of the hole so as to maintain a controlled pressure in the hole.

5. A method of forming a hole in the earth, comprising the steps of: moving an electrode downwardly into the earth at a controlled rate of movement; forming an electric circuit including said electrode and the earth and applying to said circuit electric current of such character as to produce between said electrode and the earth an arc of a magnitude to cause combustion of and thereby volatilize the earth in the path of movement of said electrode, the earth being thus changed from solid natural state to gaseous and ash state; conducting a flow of the products of said combustion out through the upper end of the hole formed by the burning of the earth as described; and controlling the rate of said flow of combustion products out through the upper end of the hole in such relation to the rate at which said combustion products are formed as to thereby maintain a desired gas pressure in the hole.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,898,926	Aarts et al.	Feb. 21, 1933
2,052,796	Rava	Sept. 1, 1936
2,308,860	Clark	Jan. 19, 1943