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K. L. HUJSAK ET AL

3,497,000

BOTTOM HOLE CATALYTIC HEATER

Filed Aug. 19, 1968

3 Sheets-Sheet 1

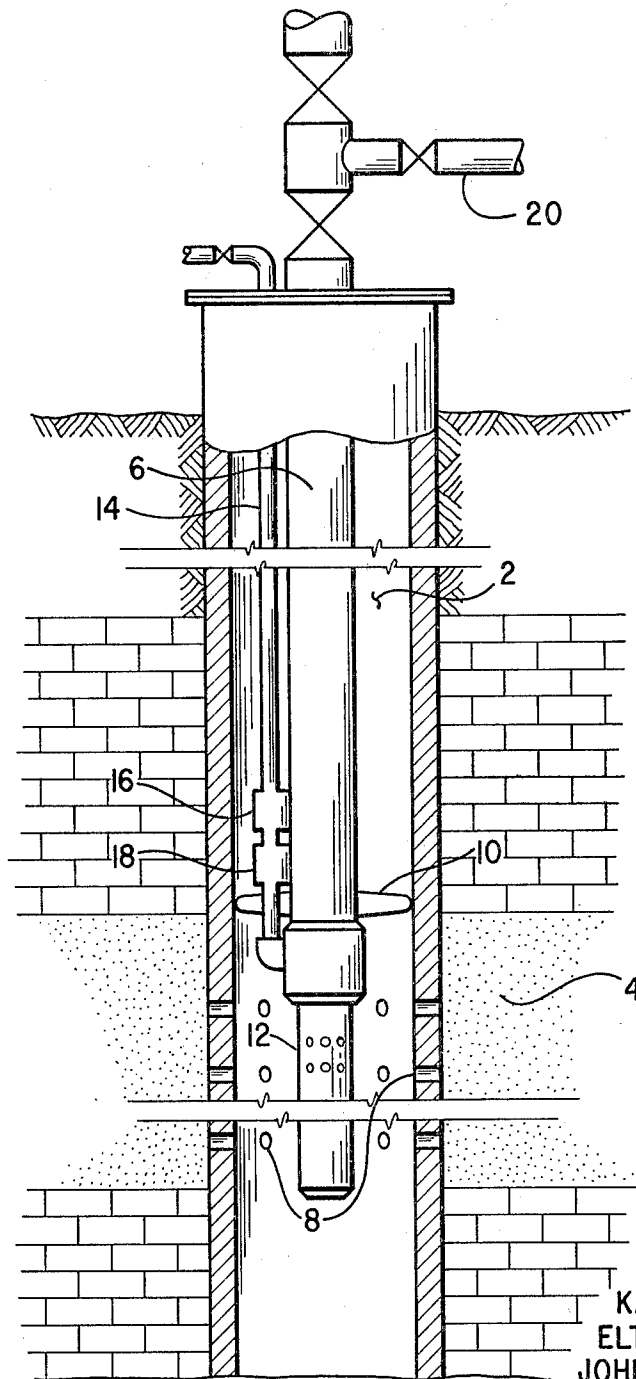


FIG. 1

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3 Sheets-Sheet 2

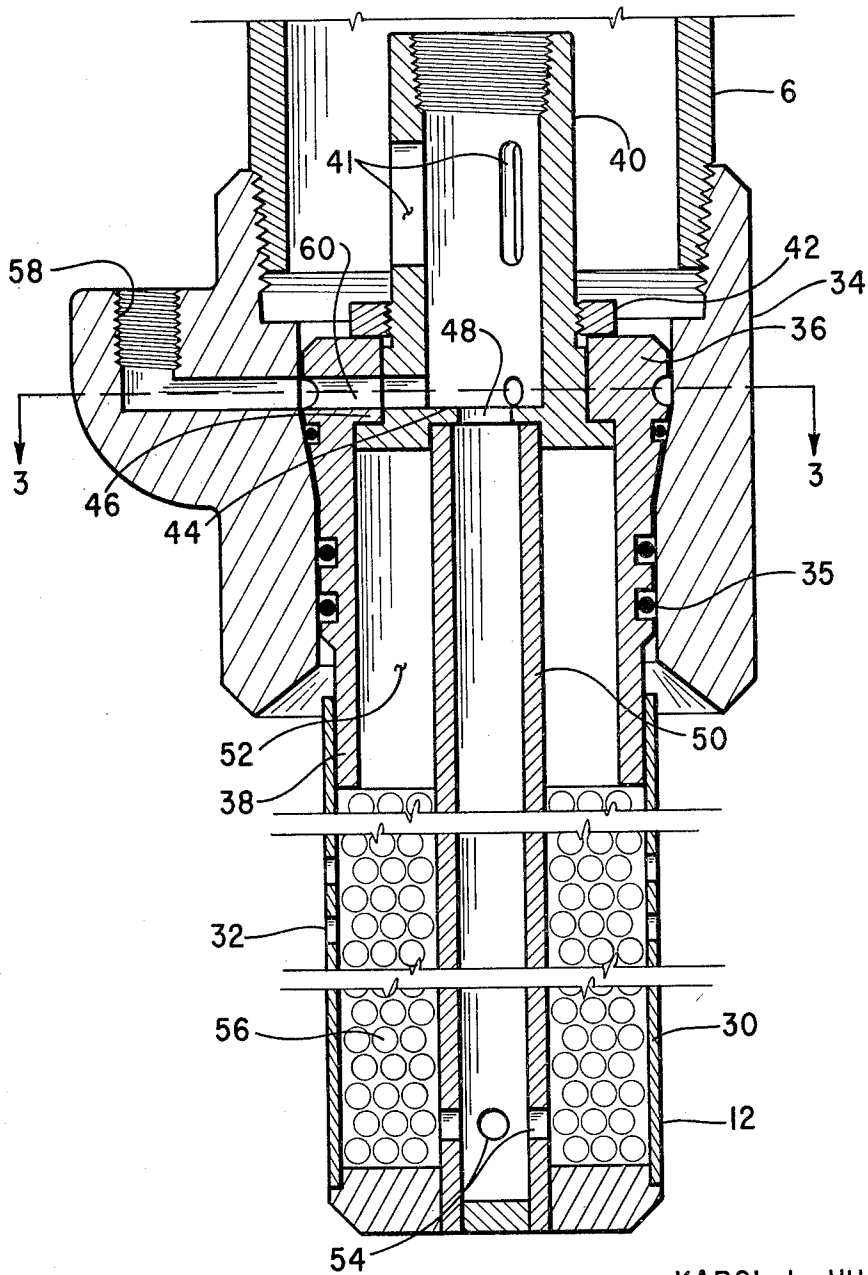


FIG. 2

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3 Sheets-Sheet 3

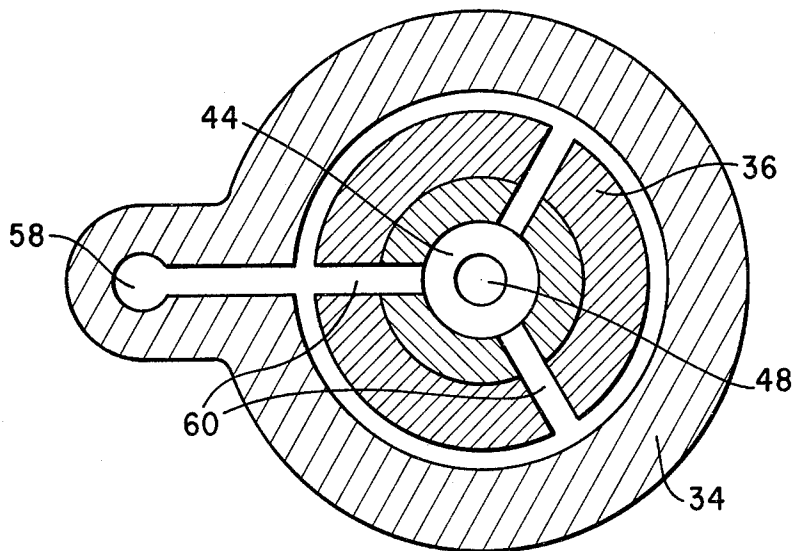


FIG. 3

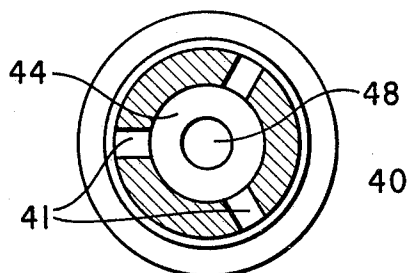


FIG. 5

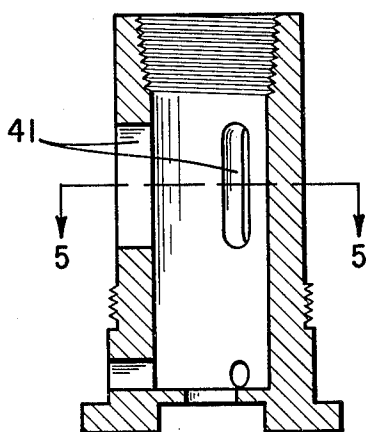


FIG. 4

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BOTTOM HOLE CATALYTIC HEATER

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4 Claims

ABSTRACT OF THE DISCLOSURE

This catalytic heater is designed to operate using fuel in liquid form admixed with air. The air-liquid fuel mixture is produced just prior to contacting the oxidation catalyst and is atomized onto the catalyst through an orifice at the top of the catalyst chamber, thus aiding in the prevention of flashback. Air fuel mixtures prepared at ground level cannot, under high pressure, be vaporized to the desired extent and if use is attempted under these conditions, premature ignition can frequently occur up the hole. The design of this unit enables one to operate at high pressures, typically 3,000 p.s.i.

The present invention relates to a novel catalytic device for use in heating or igniting underground carbonaceous deposits. More particularly, it is concerned with a heater or igniter than can be operated over a wide temperature range using an air-fuel mixture under conditions such that premature reaction of said mixture is prevented.

BACKGROUND OF THE INVENTION

Although gas fueled heaters or igniters such as, for example, those described in U.S. 3,307,609 and U.S. 3,223,165, are very satisfactory under certain conditions of use, in many areas of the world where it is desired to use such devices there is no gas source readily available. It has been suggested that fuels such as LPG be used under these circumstances. However, we have found that they are entirely unsatisfactory and cannot be employed for more than a period of six to eight hours because of excessive coke formation in the vicinity of the burner.

Other catalytic heaters have been used such as are described in U.S. 3,376,932 with good results where the pressures involved were not excessive. The heater in the patent referred to, however, employed a methanol-air mixture which was formed at the surface. Although this procedure is workable at bottom hole pressures of the order of not more than about 150 p.s.i., it cannot be used conditions of high pressures, e.g., 150 to 3,000 p.s.i. because the methanol cannot be vaporized to the desired extent under the existing bottom hole pressure and temperature. Pre-mixing of air and alcohol at the surface also favors premature ignition of the air-fuel mixture up the hole away from the level where it is desired to supply the heat.

DESCRIPTION OF THE INVENTION

Briefly, our invention comprises an elongated hollow container closed at its lower end and perforated along a portion of the sides thereof exposing catalyst in the container which fills the annular space formed by inserting in said container a tube of relatively small diameter, said tube running substantially the length of the container. Near the base of the centrally spaced tube are openings which place the annular space in communication with the interior of the tube. Air and a suitable liquid fuel such as, for example, methanol, are separately injected into a mixing chamber at the top of said tube and the resulting mixture is forced through a relatively small

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orifice at the top of said tube. Velocities are used so that the mixture in effect is atomized and then flows down to the bottom of said tube into the aforesaid annular space contacting a bed of suitable oxidation catalyst resulting in a self-starting reaction. Hot production of combustion emerge from the container through perforations or ports extending a length over the heater surface corresponding to about the depth of the catalyst bed contained in the heater. The hot products of combustion make direct contact with the carbonaceous deposit such as coal, oil shale, petroleum, etc., that is to be ignited. The catalyst container uses no cover or shield. On addition of heat in quantities corresponding to about 1 million B.t.u. per foot of formation to be ignited, it generally will be found that a satisfactory combustion zone has been established.

DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an overall elevational view, partly in section, showing the igniter in place in a well and the arrangement of auxiliary equipment required for operation of the igniter.

FIGURE 2 is a detailed sectional view of our novel catalytic heater showing the latter resting in the lower portion of tubing string having an appropriate seating or landing collar to hold the heater.

FIGURE 3 is a sectional plan view of FIGURE 2 taken along line 3—3.

FIGURE 4 is a fragmentary elevational view showing the arrangement of air injection slots 41 in conduit 40.

FIGURE 5 is a sectional plan view of FIGURE 4 taken along line 5—5.

Referring again to FIGURE 1, a cased well 2 penetrates a tar sand deposit 4. Within the well is tubing 6 extending down to the uppermost of casing perforations 8. Tubing 6 is held in a fixed position by means of centralizer 10. Catalytic heater 12 hangs from the lowermost end of air tubing 6 and is positioned opposite the main bank of perforations 8. Running parallel to tubing 6 is fuel (methanol) line 14 equipped with filter 16 and check valve 18. Line 14 leads into the base of tubing 6 where a fuel-air mixture is formed before entering heater 12. After ignition is established, heater 12 and associated equipment are pulled from the well and combustion is effected by injection of air at high pressures via line 20.

FIGURE 2 is a detailed sectional view of one embodiment of heater 12 shown generally in FIGURE 1 and comprises a catalyst basket 30 having ports 32. Catalytic heater 12 rests in seating collar 34 which is in turn threadedly engaged to tubing 6. The upper portion of heater 12 includes a seating plug 36 having thin walled sides 38 which extend downwardly and fit by friction within the upper portion of basket 30. The entire heating unit is held in substantially gas tight relation with the interior of seating collar 34 by means of O-rings 35 which are constructed out of any of a number of high temperature resistant synthetic rubbers.

Extending into the top portion of seating plug 36 is inlet line 40, the uppermost portion of which is threaded and adapted to receive a suitable plug (not shown) making it possible to raise and lower the heater assembly on a wireline. Near the base of line 40 are three air injection ports or slots 41. Line 40 is held in position by means of nut 42. The lower end of line 40 has an annular base 44 which serves as the top enclosure for catalyst basket 30. By adjusting nut 42 base 44 can be made to seat flush against inner shoulders 46 of seating plug 36. Positioned in the center of base 44 is orifice 48 which is of smaller diameter than tube 50. The latter forms an annular space 52 with the walls of basket 30 and this space is filled with a suitable oxidation catalyst slightly above the uppermost row of ports 32. At the base of tube 50 is another set of perforations 54 through which

the methanol-air mixture flows from tube 50 into catalyst bed 56.

At one side of seating collar 34 is liquid methanol injection port 58 which receives line 14 shown in FIGURE 1. Liquid methanol flows through channels 60 meeting a down flowing stream of air entering from tubing 6 via ports 41. The resulting mixture of air and methanol is forced through orifice 48 thus assuring atomization of the alcohol. Orifice 48 also serves as a flashback arrester to prevent premature reaction of air and alcohol. The air-alcohol mixture flows downwardly through tube 50 out of ports 54 and contacts catalyst 56 forming combustion gases having temperature of the order of 500° F. to 1500° F. depending, of course, on the composition of the air-methanol mixture. These hot gases flow out of heater 12 via ports 32 contacting the petroleum deposits and usually within 30-40 hours heat the formation to a depth of .5 to about 1 foot to ignition temperature. Space 52 above the uppermost row of ports 32 may, if desired, be filled with inert temperature resistant material such as, for example, ceramic, or be left unfilled. It is generally undesirable to have catalyst in this space owing to the heat that would be generated, possibly resulting in premature reaction of the air-methanol mixture as it entered orifice 48.

The heater may vary widely in its dimensions. However, the one that we have used with success and which was employed in the example mentioned below was approximately 8 feet in length and employed a catalyst bed of about 6 feet in depth. Another important dimension is the ratio of diameters of the conduit 50 to the orifice opening 48. It has been found for general purposes that the ratio of conduit diameter to that of the orifice opening should range between about 4:1 to about 6:1. Other dimensions of the apparatus used referring specifically to the embodiment illustrated in FIGURE 2 were as follows:

Orifice 48 ----- .36 I.D.
Ports 41 ----- 1 inch long x .25 inch wide
Line 40 ----- .93 inch I.D.
Tube 50 ----- 1.98 I.D.
Channels 60 ----- .25 inch I.D.

In using the above mentioned heater to ignite an underground tar sand formation the latter was first fractured after which the tar was ignited through casing perforations. Good ignition was accomplished by injection of seven million B.t.u. based on the quantity of alcohol (119 gallons) consumed. The ignition required about 34 hours with an alcohol rate of approximately 3.6 gallons per hour and an air rate of 15,000 standard cubic feet per hour. Within a few minutes after the flow of air and methanol was initiated the temperature downhole at a depth of 1106 feet started to increase. After about 30 minutes the temperature at 1103 feet of depth rose to between 1400° and 1500° F. on two different occasions. The temperature was decreased each time by shutting off the alcohol feed for about a minute. Generally the maximum downhole temperature during the ignition was below 1,050° F.

Air injection pressure to the well started at about 500 p.s.i.g. and gradually increased to 810 p.s.i.g. after 26 hours from the start of ignition, then dropped to 765 p.s.i. in one hour. At this same time the temperature at 1105 feet increased and reached 1200° F. An attempt to lower this temperature by decreasing the alcohol rate, reducing fuel alcohol rate as previously employed, was not successful. A temperature survey showed a peak temperature of 1500° F. at 1096 feet. This was about three feet above the igniter seating nipple. After decreasing the alcohol rate to about half, the temperature decreased to 1360° F.

The catalyst used in heaters of the type described

above may be selected from a wide list of materials and form no part of our invention. Typical catalysts suitable for oxidation of air-fuel mixtures contemplated herein include platinum, palladium, rhodium, etc. These materials are preferably used in very dilute concentrations, e.g., 0.05 to about 0.5 weight percent and may be supported on materials having a large surface area such as pumice, aluminum oxide, metal wool, for example, stainless steel wool, and the like. Supported platinum oxide, which is a suitable catalyst for this purpose, is manufactured by the Chemitron Corporation of Louisville, Kentucky and is identified as G-43. This catalyst is available in 1/4" x 1/4" tablets which are well suited for use in the igniter of our invention. In operation the portion of catalyst apparently entering into the oxidation reaction is that with which the feed mixture first comes in contact.

The materials employed in fabricating the igniter covered by our invention are generally readily available. Ordinarily we prefer to use the heat resistant stainless steels, such as 304 stainless, or similar alloys.

We claim:

1. In a catalytic igniter for underground carbonaceous deposits the combination comprising an elongated hollow uncovered container closed at its lower end and perforated along a portion of the sides thereof, a hollow tube of substantially smaller diameter than the diameter of said container affixed to and perforated near said lowermost end, said tube forming an annular space with the interior of said container, a conduit affixed to the uppermost portion of said tube forming essentially a gas tight seal at the upper end of said annular space, an orifice at the uppermost end of said tube having a diameter less than that of said tube, a first means communicating with said orifice via said conduit for the introduction of a fluid, and a second means adjacent said orifice separate from said first means communicating with said orifice for introduction of a fluid into said orifice.

2. The igniter of claim 1 wherein said annular space contains a catalyst suitable for the oxidation of methanol.

3. In a catalytic igniter for underground carbonaceous deposits the combination comprising an elongated hollow uncovered container closed at its lower end and perforated along a portion of the sides thereof, a seating plug affixed to the uppermost end of said container, a seating collar holding said plug in essentially gas tight relationship, a conduit within and spaced centrally of said container defining an annular space between said container and said conduit, one end of said conduit being secured to said closed end and running substantially the length of said container, means near the lowermost end of said conduit providing direct communication with said annular space, an opening at the opposite end of said conduit smaller in diameter than the diameter of said conduit, and two separate means for the introduction of a fluid both of which are in direct communication with said opening.

4. The igniter of claim 3 wherein the ratio of said conduit diameter to that of said opening ranges from about 4:1 to about 6:1.

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