

Aug. 12, 1958

C. L. DE PRIESTER
METHODS OF IGNITING A GAS AIR-BURNER
UTILIZING PELLETIZED PHOSPHORUS
Filed Sept. 20, 1955

2,847,071

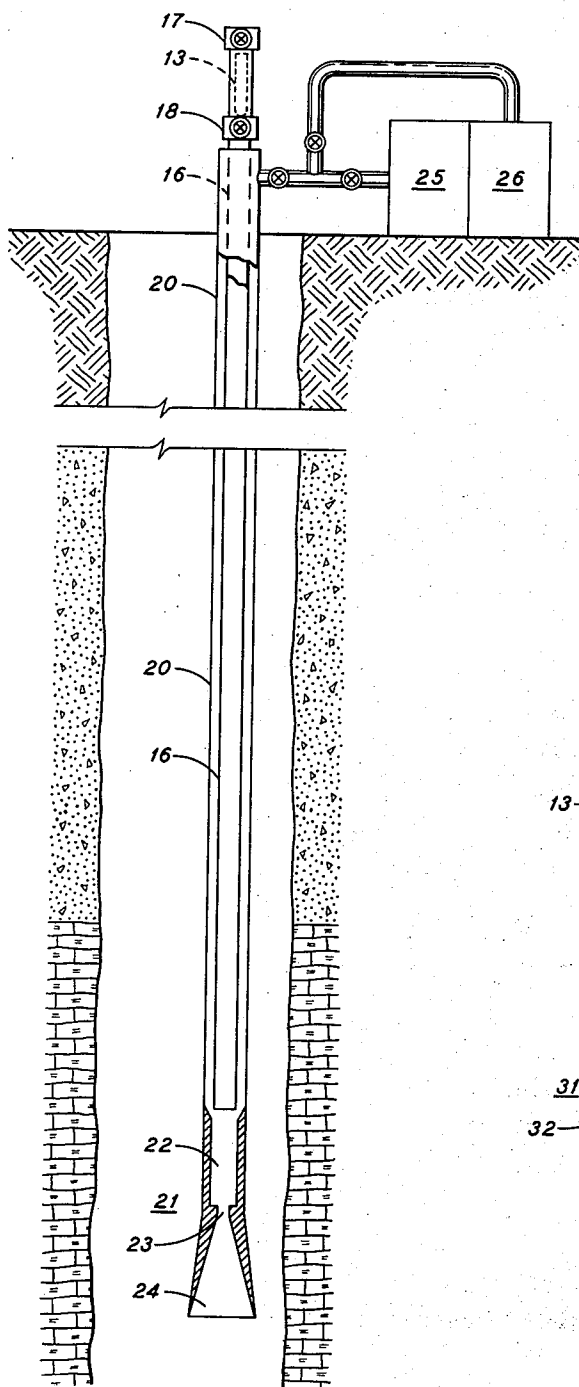


FIG. 2

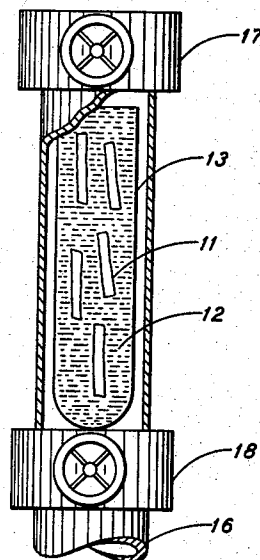


FIG. 1

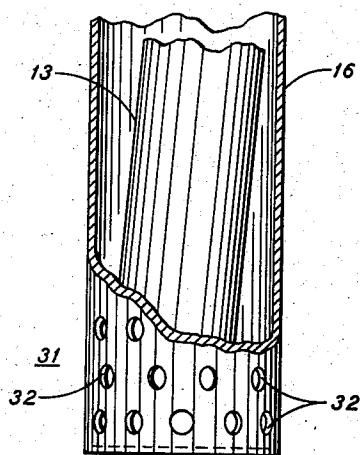


FIG. 3

INVENTOR
CORAL L. DE PRIESTER
BY *O. S. Lundy*
Walter J. Madden, Jr.
ATTORNEYS

1

2,847,071

METHODS OF IGNITING A GAS AIR-BURNER UTILIZING PELLETIZED PHOSPHORUS

Coral L. De Priester, Fullerton, Calif., assignor to California Research Corporation, San Francisco, Calif., a corporation of Delaware

Application September 20, 1955, Serial No. 535,462

2 Claims. (Cl. 166—39)

This invention relates to methods of generating heat in subterranean formations penetrated by a well bore and relates more specifically to methods for generating such heat to ignite downhole gas-air burners.

The use of downhole gas-air burners for well stimulation and for initiating underground combustion drive in secondary recovery operation is becoming increasingly common in the petroleum industry, and the use of such devices offers a number of advantages over other ignition and well stimulation methods and systems. Such burners usually are disposed adjacent the formation to be treated and are supplied from the surface with a mixture of fuel gas and an oxygen-containing gas. A number of ignition methods have been proposed for such burners, but so far as I am aware none of such proposed systems have been entirely satisfactory. Some of such burners are ignited by electrical means such as an electric heating coil or a spark plug disposed in or adjacent the burner combustion chamber and energized from the surface to produce the required temperature for ignition. However, such systems have the disadvantage that they require an electrical conduit from the surface to the burner location, thus increasing the complexity and cost of the burner installation and increasing the possibility of malfunctioning through failure of the electrical conduit. The use of such systems has the additional disadvantage that the electrical igniting units often fail, owing to the elevated temperature to which they are exposed adjacent the burner, and this failure usually necessitates the removal of the entire burner assembly from the well bore for replacement or repair.

Numerous chemical methods have been proposed for igniting downhole gas-air burners or for otherwise providing an elevated temperature in a well bore. One proposed system for heating the well bore and contacting the formation with alkali metal hydroxides utilizes sodium or potassium capsulated in a suitable water-soluble material and injected into the well bore. Water is then injected into the well bore to dissolve the encapsulating material and react with the sodium or potassium to produce the desired exothermic reaction. However, this system is not suitable for burner ignition owing to the fact that heat is released from the reaction at a higher rate than can be utilized, resulting in a violent reaction and expulsion of the unreacted sodium from the burner prior to ignition of the gas-air mixture. This system has the further disadvantage of requiring the injection of water into the formation to dissolve the water-soluble coating, thus creating the possibility of producing water blocking of the treated formation.

Broadly the present invention contemplates the use of a pellet of elemental phosphorus encased in an inert solid having a melting point below the temperature at the burner location. The pellet is injected into the formation through tubing running from the surface to the burner, and is lodged in a position in the burner to produce ignition. The flow of the gaseous combustible

2

mixture over the pellet produces or hastens melting of the material in which the phosphorus is encased. Upon exposure of the elemental phosphorus to the passing gaseous combustible mixture the phosphorus reacts with the oxygen in the mixture, is ignited and subsequently ignites the gaseous combustible mixture.

It is therefore an object of the present invention to provide improved methods and apparatus for igniting downhole gas-air burners.

It is an additional object of the present invention to provide methods of igniting a downhole gas-air burner utilizing the delivery to the burner location of selected chemicals capable of producing an exothermic reaction.

It is a further object of the present invention to provide methods for igniting a downhole gas-air burner in which a selected chemical capable of producing an exothermic reaction is delivered to the burner to produce ignition without requiring the injection of extraneous materials into the well bore.

It is a further object of the present invention to provide methods of igniting a downhole gas-air burner by exothermic chemical reaction such that no residue from the reaction or delivery process remains in the burner system.

It is an additional object of the present invention to provide methods of igniting a downhole gas-air burner which do not require the use of electrical cables or wire lines from the earth's surface to the burner location.

It is a further object of the present invention to provide methods of igniting downhole gas-air burners utilizing a pellet comprising elemental phosphorus encased in an inert solid having a melting point below the temperature existing at the burner location.

It is a further object of the present invention to provide a method of igniting a downhole gas-air burner utilizing a pellet comprising elemental phosphorus encased in ice, in which the pellet is delivered to the burner location and the encasing ice melted to expose the elemental phosphorus to the passing gaseous combustible mixture.

Objects and advantages other than those set forth above will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 illustrates a representative pellet suitable for use in the present invention in connection with a portion of valving associated therewith;

Fig. 2 illustrates the disposition of representative equipment in a well bore for carrying out the method of the present invention; and

Fig. 3 illustrates a device for retaining a pellet in a predetermined position in the combustion chamber.

Referring more particularly to the drawing by character of reference, Fig. 1 illustrates the disposition of a representative pellet of the present invention in a portion of the delivery assembly. As shown in Fig. 1, reference character 11 designates particles of elemental phosphorus encased in a suitable solid material 12 to form a pellet 13. Material 12 may be any suitable material which is inert to the elemental phosphorus and which has a melting point below the temperature at the location of the burner. Suitable inert materials include benzene, tridecane and triethylene glycol. Additionally, I have found that water is a particularly desirable inert material to use, since it is economical and easily solidified. Pellet 13 may be formed in a mold or any other suitable means to form the pellet to the desired shape, and if desired, pellet 13 may be retained in the mold until ready for use. In the embodiment illustrated in Fig. 1, pellet 13 is placed in the upper end of a length of delivery tube 16 in a chamber closed at either end by valves 17 and 18.

Referring now to Fig. 2, tube 16 extends down into the well bore inside a length of outer tubing 20. Tubing

16 and tubing 20 are connected at their lower ends to a suitable gas-air burner shown diagrammatically as 21. The combustible mixture is supplied to the burner through the annulus between tubing 16 and tubing 20. Burner 21 may comprise a combustion chamber portion 22 into which conduit 16 leads and in which the combustion occurs. Combustion chamber 22 is preferably terminated at its lower end by restricting passage 23 having a diameter less than the minor dimension of pellet 13. Burner 21 may further comprise a conical exhaust portion 24 for directing the combustion products from combustion chamber 22 into contact with the formation and/or the fluid in the well bore. A gas-air burner having features similar to those illustrated in Fig. 2 is disclosed and claimed in the copending application of C. L. De Priester and C. N. Simm, Serial No. 525,505, filed August 1, 1955. The gaseous combustible mixture to be burned may be of any suitable type, such as a mixture of natural gas and air, and such mixture is supplied from suitable sources designated generally as 25 and 26 to the annulus between tubing 20 and tubing 16.

In operation of the present invention, pellet 13 is placed in the upper end of tubing 16 by opening valve 17 with valve 18 closed. After placing the capsule in the delivery chamber, valve 17 is closed, and valve 18 is opened to permit pellet 13 to fall freely through tubing 16. If desired, suitable lubricating material may be placed around pellet 13 to facilitate its fall through tubing 16, although I have found that when ice is used as the encasing material, the normal melting of the ice in the delivery chamber or tubing provides satisfactory lubrication.

Pellet 13 falls freely through tubing 16 to combustion chamber 22 and becomes lodged in the restricted opening 23 at the lower end of combustion chamber 22. The gas-air mixture may then be supplied from sources 25 and 26 through the annulus between tubing 20 and tubing 16 to combustion chamber 22 to hasten the melting of the encasing material. When the encasing material melts sufficiently to expose the elemental phosphorus particles 11 to the gas-air mixture, oxidation of the phosphorus occurs and produces a sufficiently elevated temperature to ignite the gas-air mixture. The gas-air mixture combustion flame then stabilizes in combustion chamber 22 to produce the desired heating effect.

In the embodiment described in connection with Fig. 2, the pellet lodged in the restricted opening 23 in the lower end of combustion chamber 22, and it was assumed that the pellet of phosphorus and ice was completely dissolved so that no debris remained. However, if the nature of the pellet should be such that plugging of the burner could possibly result from debris, the arrangement illustrated in Fig. 3 can be utilized to prevent such plugging. As shown in Fig. 3, tubing 16 is terminated at its lower end by a basket member 31 having perforations 32 therein. Member 31 is closed at its lower end to retain capsule 13 therein. Basket member 31 may be positioned in or just above combustion chamber 22 so as to retain pellet 13 in this location after it is dropped through tubing 16. Pellet 13 dissolves as before, and the phosphorus is oxidized by the gas-air mixture to produce the required ignition temperature. Any undissolved matter of a particle size larger than perforation 32 is retained in the basket member 31 so that no plugging of burner orifices can result.

The method of the present invention was tested under simulated downhole conditions using injection apparatus similar to that shown in the drawing. A 3/4-inch diameter pellet was formed by freezing phosphorus in water in a copper mold surrounded by Dry Ice. The pellet was injected through 0.824-inch I. D. tubing a distance of approximately six feet into the combustion chamber of a gas-air burner submerged in water. Water was utilized in these particular experiments rather than crude oil, but the nature of the medium surrounding the burner is immaterial to the present process. A gas-air mixture was then supplied through the annulus between the tubing to the burner, and this mixture was successfully ignited a number of times. In connection with these experiments, the effects of pressure and temperature on the reaction of phosphorus with oxygen were investigated to some extent, and it was found that at a temperature of 70° F. and above, the desired reaction proceeded satisfactorily under pressures ranging from one atmosphere to 20 p. s. i. g.

It will be seen that the method of the present invention does not require the introduction of any extraneous materials such as water or other chemicals into the well bore or burner to dissolve the encasing material, and further, there is no debris remaining from the pellet, since the phosphorus will be substantially consumed by oxidation and the encasing material will be blended in with the other well bore fluids. Further, the ignition method of the present invention may easily be repeated any desired number of times until the required ignition occurs.

Although but a few embodiments of the present invention have been described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. The method of igniting a downhole gas-air burner comprising the steps of introducing into said burner a pellet comprising elemental phosphorus surrounded by ice, said ice melting in said burner to expose said phosphorus, and supplying a gaseous, combustible, oxygen-containing mixture to said burner for oxidizing said exposed phosphorus to produce a temperature sufficient to ignite said combustible mixture.

2. The method of igniting a downhole gas-air burner connected to the surface of the earth through a length of tubing comprising the steps of injecting a pellet through said tubing to position said pellet adjacent said burner, said pellet comprising elemental phosphorus surrounded by ice, said ice melting at the temperature existing at the location of said burner to expose said phosphorus, and supplying a gaseous combustible, oxygen-containing mixture to said burner for oxidizing said exposed phosphorus to produce a temperature sufficient to ignite said mixture.

References Cited in the file of this patent

UNITED STATES PATENTS

1,278,217	Reid	Sept. 10, 1918
2,188,737	Hixon	Jan. 30, 1940
2,558,726	Barker	July 3, 1951
2,630,307	Martin	Mar. 3, 1953
2,747,672	Simm	May 29, 1956