Aug. 29, 1967 K. L. HUJSAK ETAL 3,338,286

HEAT SHIELD FOR BOTTOM HOLE IGNITER

Filed Sept. 12, 1966

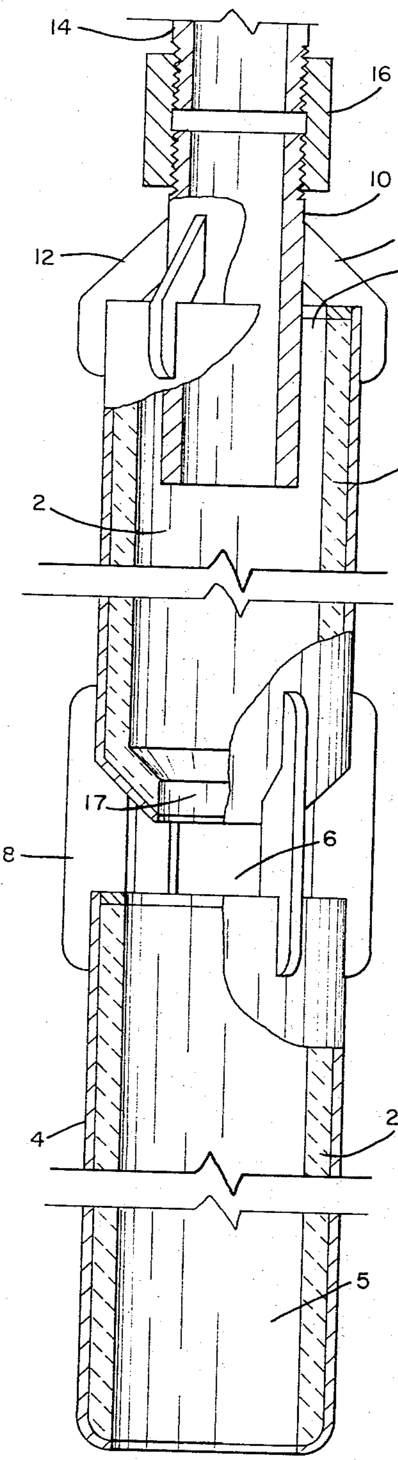

FIG.-1

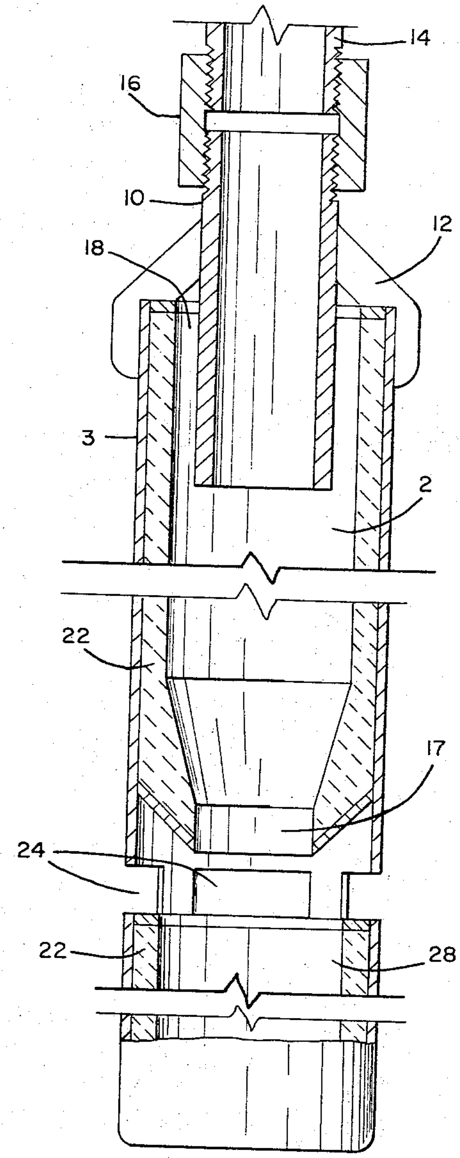

FIG.-2

KAROL L. HUJSAK
WAYNE H. ANDERSON
JOHN W. KIRKPATRICK
HOWARD GREKEL
INVENTORS.

BY Arthur Malloy
ATTORNEY.

United States Patent Office 3,338,286
Patented Aug. 29, 1967

3,338,286

HEAT SHIELD FOR BOTTOM HOLE IGNITER

Karol L. Hujsak, Howard Grekel, Wayne H. Anderson, and John W. Kirkpatrick, Tulsa, Okla., assignors to Pan American Petroleum Corporation, Tulsa, Okla., a corporation of Delaware

Filed Sept. 12, 1966, Ser. No. 584,298
4 Claims. (Cl. 158—28)

ABSTRACT OF THE DISCLOSURE

The invention is directed to burners used in igniting hydrocarbon bearing formations at high pressures. Normally under such conditions, high pressure forces the entire flame back to the burner tip and if the latter is near any supporting structure, heat via radiation from the burner tip destroys such structure. The burner here described is recessed within a combustion chamber for a distance sufficient to protect from destructive temperatures, the supporting structure holding the burner in axial alignment with the combustion chamber. The position of the burner tip in the combustion chamber, however, is such that complete combustion occurs within the chamber.

This is a continuation-in-part of our application Ser. No. 333,852, filed Dec. 27, 1963, now abandoned.

The present invention relates to burners suitable for heating or igniting underground, carbonaceous deposits. More particularly, it relates to burners designed especially for use at high pressures.

In the use of burners to heat or ignite carbonaceous deposits traversed by a well, we have found that the pressures encountered can affect very noticeably the efficiency of the burner. Thus, while it has been our experience that little or no difficulties are observed at low pressures, i.e., not above about 50 p.s.i., serious problems are presented when bottom hole pressures of the order of 50–1500 p.s.i. and above are involved. At these higher pressures, the hot combustion products fail to mix rapidly with the cooler gas in the annulus, resulting in localized overheating of the casing and any other equipment that might be in the vicinity of the burner. The failure of proper turbulence to be produced at high pressures so that the hot combustion products can mix with the cooler gas flowing down the annulus, was indeed, surprising.

Accordingly, it is an object of our invention to provide a burner capable of operating efficiently at pressures of at least 3000 p.s.i. It is another object of our invention to provide a burner wherein the temperature of the combustion products contacting the casing or the formation face can be controlled within a range from about 500° to about 1100° F. It is another object of our invention to provide a burner wherein the temperature of the combustion products thereof is controlled by mixing said products within a confined space with excess cool gas flowing down the annulus. It is still another object of our invention to control the temperature of said hot gaseous combustion products by mixing the latter as they come from the burning or combustion zone with cooler air or gas, and passing the resulting mixture under conditions of turbulent flow through a confined path insulated from the well walls or casing, and finally permitting the resulting cooler gaseous mixture to flow out into the well bore.

FIGURE 1 is an elevational sectional view, showing one embodiment of a burner equipped with a heat shield in accordance with our invention.

FIGURE 2 is also a sectional view illustrating a variation in design of the apparatus contemplated by our invention.

Briefly, referring to FIGURE 1, our invention comprises a burner composed of a combustion shield 3 enclosing combustion chamber 2 and a heat shield 4 which in turn contains mixing chamber 5, affixed to the lower end of the combustion chamber by means of spaced web supports 8. The function of heat shield 4 is to confine the gaseous combustion products issuing from chamber 2 and to protect the casing from excessive temperatures until cooler gas, entering mixing chamber 5 via the spaces 6 between web supports 8, has had an opportunity to mix thoroughly with said combustion products and cool the latter to the desired temperature. The function of heat shield 4 is primarily to confine the high temperatures generated so that the casing will be protected. Also it serves to define mixing chamber 5 within which the hot products of combustion from chamber 2 are cooled to the desired temperature by mixing with additional air flowing through openings 6 or 24. At the top of chamber 2, and in axial alignment therewith, threaded nipple 10 is inserted and held in position by spaced web supports 12. Fuel line 14 holds the burner apparatus by means of coupling 16. A narrowed discharge end or throat 17 is provided from combustion chamber 2 to create a high gas velocity flow into heat shield 4 and causing reduced pressure in the vicinity of spaces 6, thereby bringing a flow of cooler secondary air or gas into mixing chamber 5 and mixing with the hot combustion products from chamber 2. Openings 18 and 6 are maintained by spaced web supports 12 and 8, respectively, whereby spaces are provided for the flow of air through combustion chamber 2 and air or other suitable coolant into heat shield 4. Openings 18 permit the flow of primary air into the combustion chamber to maintain combustion while openings 6 allow secondary air, or other cool gas, to flow into heat shield 4. In this connection, it should be pointed out that although air is generally the most readily available coolant, any gas that does not cause an exothermic reaction with the combustion products may be employed as a diluent or coolant.

In both combustion shield 3 and heat shield 4, there is an inner refractory cement lining 22. This cement may be chosen from a wide range of materials such as the high alumina cements which generally contain from 35 to 40 percent Al_2O_3, 30 to 35 percent CaO, 10 to 15 percent Fe_2O_3, and a combined percentage of silicon and magnesium oxides of from 5 to 10 percent. Any castable refractory material capable of withstanding temperatures of at least about 3,000° F. is suitable. One particular refractory we have found useful for this purpose is Alfrax refractory cement manufactured by the Carborundum Company, Perth Amboy, New Jersey. This is a castable material which can be applied as a mud after mixing with water. The refractory sets within about 24 hours and generally firing before use in unnecessary.

FIGURE 2 is an integral unit, varying from the apparatus shown in FIGURE 1 only in that it may be constructed from a single piece of metal and has ports 24 through which the secondary air supply enters mixing chamber 28 and mixes with hot products from combustion chamber 2. A narrowed discharge end or throat 17 is provided from combustion chamber 2 so as to create a high velocity gas flow into mixing chamber 28. In turn causing a reduced pressure in the vicinity of ports 24, thereby bringing a flow of secondary air or gas into chamber 28 and mixing with hot combustion products from chamber 2 under conditions of proper mixing.

The dimensions of the heat shield may vary rather widely, depending on the secondary air supply available to it via the openings provided therefor. Obviously, its length should be sufficient to permit adequate mixing of the cool gas entering through said openings to bring the final adiabatic mixture temperature to a level of from

500° to about 1100° F. A shield of the minimum length would require optimum turbulence or mixing of the combustion products with the gaseous coolant. We have found that the length and internal diameter of the heat shield preferably should be approximately equal to that of the combustion chamber. The size of openings **6** and **24**, shown in FIGURES 1 and 2, respectively, should generally correspond in cross-sectional area to openings **18** of FIGURES 1 and 2. The relationship of these areas to cross-sectional areas of the combustion chamber and heat shield, likewise, may vary within rather wide limits. In this connection, we generally prefer to employ a unit in which the ratio of these cross-sectional areas, i.e., said openings to the chamber is about 1:2. It is important that the open area between chamber **2**, for example, in FIGURE 2, and nipple **10** be as large as possible to keep the flame temperature within combustion chamber **2** as low as possible. The diameter of the heat shield should be as large as practical for the size casing in the well at the burner level.

Typical dimensions for a burner of the design contemplated by our invention and suitable for use in 5-inch casing are: Outside diameter of combustion shield and heat shield, 4 inches; length of combustion and heat shields, 18 inches each; open space between lower end of combustion shield and upper end to heat shield, 1¼ inches; internal diameter of fuel conduit, i.e., nipple **10**, extending into combustion shield, 1.8 inches; external diameter of nipple **10**, 2.2 inches; inside diameter of combustion shield, as defined by ¼ inch thick ceramic lining, is 3¼ inches; inside diameter of combustion chamber discharge throat (**17**), 2½ inches; and web supports **8** and **12**, such as shown in FIGURE 1, are ½ inch wide by ¼ inch in thickness by about 4 inches in length and are approximately 2 inches apart. Inconel, type 316 and type 304 stainless steel have been used successfully in construction of these burners.

In so far as we are aware, the requirements for a burner to function in the manner of operation intended herein at pressures of the order of 300 to at least about 3,000 p.s.i. are more severe than for any other application. As the pressure increases, the burner flame tends to flatten out or be pushed back toward the gas or fuel supply tube. For example, in runs we have carried out at pressures of 400 and 800 p.s.i. using the apparatus of our invention, peak temperatures of about 1800° F. were generated in the immediate vicinity of the burner tip, e.g., the end of nipple **10**. In this case, the tip was recessed in the combustion chamber (36 inches in length) about 4 inches from the top of the chamber. At a distance approximately 2 feet from the burner tip, the temperature leveled off at about 900° F. At 800 p.s.i., the combustion appeared to proceed slightly faster than at 400 p.s.i., but not appreciably so. The important observation was that the supporting members **12** were heated only to a temperature of about 150° F. during the six hour run. With a burner in which the tip thereof is essentially flush with the top of the combustion chamber, the heat generated will destroy the supporting members **12** in far less time than is required to ignite a formation as contemplated herein.

It should be specifically understood that the heat shield or extension employed in accordance with our invention may be used in combination with any burner utilizing either gaseous fuel-air, or liquid fuel-air mixtures. As previously mentioned, the need for such attachments to the main combustion chamber of such burners arises where pressures of the order of at least 50 p.s.i. are encountered. Typical burners to which the heat shield of our invention is particularly adapted, are those described

in copending application U.S. Ser. No. 271,262, filed April 8, 1963, by Karol L. Hujsak, now U.S. 3,223,165.

Burners of the types contemplated herein have been used with success at pressures as 3,500 p.s.i. at depths of 6,500 feet and at heat output rates of 7 to 10 million B.t.u. per day, based on natural gas consumed. In a single application of such burners over a seven-day period, as much as 67 MM B.t.u. have been generated. The burners of our invention which are capable of operating under the rigorous conditions encountered in the igntion of carbonaceous formations, should be constructed so that the tip of the gas or fuel inlet tube (nipple **10** of the drawings) extends into combustion shield **3** for a distance corresponding to at least 10% of the length of said chamber but not so far as to prevent complete burning of the combustible mixture in said chamber. Openings **18** should be of such a size to permit enough air to flow into the combustion chamber at well conditions to effect complete combustion of the fuel in the chamber.

On the basis of the work we have done, there is no reason to believe that any serious operating problems would be encountered at greater depths or operating pressures than those cited above. A heat generation rate in excess of 10 MM B.t.u. per day is not desirable since local overheating of the casing near the burner (combustion chamber) level can occur even with the heat shield present.

Gas velocities employed in the operation of our device should generally not exceed 15 ft./sec. at all pressures to achieve stable flame conditions.

The term "carbonaceous," as used throughout the present description, is intended to refer to heavy viscous oils, tars and shale as well as petroleum of an intermediate viscosity.

We claim:

1. In a burner apparatus for heating underground carbonaceous deposits, a combustion chamber open at both ends, a fuel supply means to supply fuel at pressures in excess of 1500 p.s.i., said fuel supply means including a conduit of smaller diameter than said chamber and protruding into the upper end of said chamber for a distance corresponding at least to about 10% of the length of said chamber but less than the distance which would prevent complete combustion from occurring therein, spaced supporting members holding said conduit and said chamber in coaxial alignment, thereby defining gas intake means in the annulus between said conduit and said chamber, and a constriction in the other end of said combustion chamber, said other end having no additional means therein for promoting combustion.

2. The burner apparatus of claim **1** wherein a second chamber open at both ends is affixed to and spaced coaxially apart from said constricted end to define gas intake means at the junction of said chambers.

3. The apparatus of claim **1** wherein the ratio of the cross-sectional areas of said gas intake means and said chamber is approximately 1:2.

4. The apparatus of claim **3** wherein a second chamber open at both ends is affixed to said combustion chamber and spaced coaxially apart from said constricted end to define gas intake means at the junction of said chambers.

References Cited

UNITED STATES PATENTS

448,460	3/1891	Seigle-Goujon	158—99 X
1,069,243	8/1913	Fogler.	
1,405,100	1/1922	Cornwell et al.	
2,506,853	5/1950	Berg et al.	166—59
2,796,118	6/1957	Parker et al.	126—91 X

JAMES W. WESTHAVER, *Primary Examiner.*