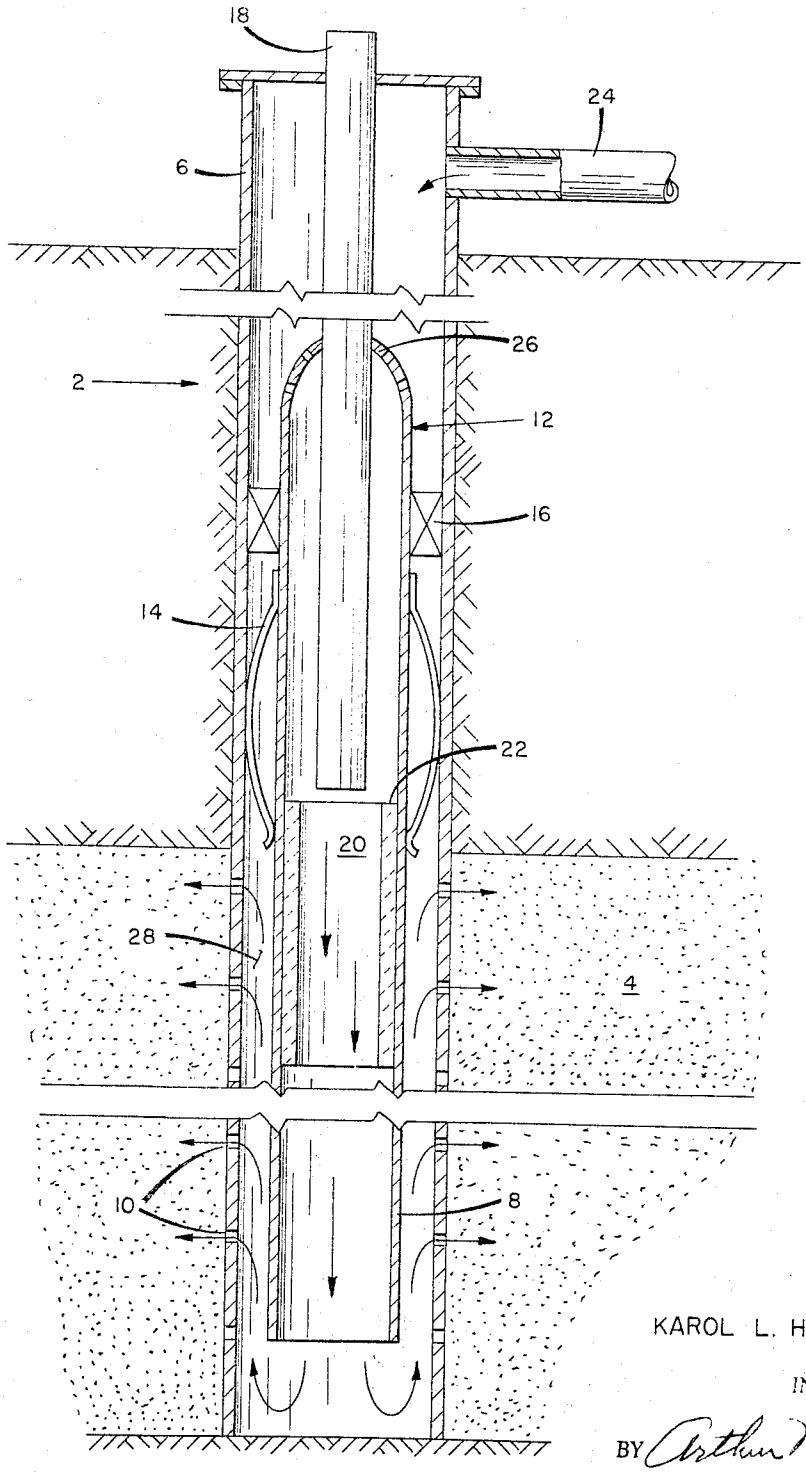
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K. L. HUJSAK

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IGNITION OF THICK PAY FORMATIONS

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KAROL L. HUJSAK

INVENTOR.

BY Arthur McElroy

ATTORNEY.

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IGNITION OF THICK PAY FORMATIONS

Karol L. Hujsak, Tulsa, Okla., assignor to Pan American Petroleum Corporation, Tulsa, Okla., a corporation of Delaware

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The present invention relates to a novel method for igniting carbonaceous deposits. More particularly, it is concerned with the ignition of relatively thick deposits, i.e., from about 30 to about 400 feet in thickness.

Briefly, my invention involves the addition of a long shield or dip leg affixed to the burner or heater, said leg extending to a level at or near the bottom of the deposit to be burned. Up near the top of the burner is a packer forming a seal, thereby preventing hot gasses from flowing up the well, forcing them to flow around the bottom end of the dip leg into the formation at all levels between the bottom of the deposit and the packer. In this way, an opportunity is afforded for the hot gases to enter the lowermost levels of the deposit as well as the upper portions thereof.

Currently there are available a number of burners or igniters by which subterranean carbonaceous deposits can be ignited for the purpose of producing valuable hydrocarbons by means of combustion. The use of these burners, however, is limited to relatively thin petroleum- or tar-containing formations, i.e., formations not in excess of about 30 feet in thickness. When ignition of thicker pay sections is attempted by placing such burner near the lower level of the deposits to be ignited, the hot combustion products which flow up the well heat the relatively cool fuel mixture traveling to the burner, by means of indirect heat exchange. This results in higher temperature combustion products which preheat the air-fuel mixture flowing to the burner to even a higher level and, in turn, produces still higher combustion product temperatures. This continued increase in the temperature level of the combustion products proceeds until the latter become hot enough to melt the burner and damage the casing as well as any other equipment in the vicinity.

To avoid this effect, the burner should be held at a level slightly above the pay section to be ignited. While this technique works well with the thin sections, the heat is dissipated into the upper levels of a thick section since such levels are usually more permeable and, hence, the lower portions of a thick formation receive little or no heat when the burner is placed in the aforesaid position.

Accordingly, it is an object of my invention to provide a method and apparatus for igniting a thick, petroliferous formation by conducting the hot combustion products from a burner through a confined path to the lower portion of said formation under conditions which permit said products both to rise up the wellbore and to penetrate the formation to heat the latter to ignition temperature. It is another object of my invention to provide means for heating to ignition temperature deposits of oil shale and coal as well as oil-bearing formations in which it may be desired to carry out an underground combustion process.

The accompanying drawing is a vertical sectional view of an arrangement of equipment in a wellbore suitable for use in carrying out the method of my invention.

My invention will now be described in detail by reference to the accompanying drawing in which a cased well **2** penetrates a thick, oil-bearing formation **4**. The casing **6** is perforated substantially from the top to bottom opposite formation **4**. Igniter equipment is then lowered down the well to a level such that the end of dip tube **8** is about even with the lowermost of perforations **10**. The dip tube is preferably constructed of a suitable heat- and oxygen-resistant metal, such as, for example, stainless steel or Inconel. Tube **8** generally corresponds in length to the thickness of the formation to be ignited and, hence, may vary from about 30 to about 400 feet or more. Burner assembly **12**, to which the dip tube is attached, is held in position by means of centralizer **14** and packer **16** which is preferably of fire- or heat-resistant construction. Burner assembly **12** is mounted on fuel line **18** which terminates just above combustion chamber **20**, lined with refractory material **22**. This refractory 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 I 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 is unnecessary. Air which mixes with the fuel discharging into chamber **20** enters the burner system via line **24** and ports **26**.

In operation, a mixture of fuel and air is ignited in chamber **20** by means of a sparkplug, a pyrophoric material, or equivalent means, not shown. The fuel may be liquid or gaseous, however, I generally prefer a gaseous material such as, for example, natural gas or the normally gaseous hydrocarbons. In chamber **20**, the resulting hot combustion products travel downwardly through dip leg **8** to the end thereof and back up the annular space **28** formed by the casing and dip leg **8**. Pressure is built up in space **28** owing to the seal in the system formed by packer **16**. As a result, hot gases are forced into formation **4** throughout its height via perforations **10**. This operation is ordinarily continued until the total heat added amounts to from about 1 to 1.5 million B.t.u. per foot of formation thickness. In the case of such thick formations, the initial ignition step may require as much as 5 to 10 days. Thereafter, the burner is removed and combustion commenced by resuming air injection into the system via line **24**, assuming forward combustion is contemplated. If reverse combustion is to be carried out, air is injected into a suitable offset well in the usual manner and the well in which ignition was carried out then becomes a producing well.

It is to be understood that there are many variations and modifications that may be employed without deviating from the scope of my invention. For example, instead of effecting this ignition procedure in a cased well, the process may be carried out with similar results in open hole. It is contemplated that any heater or burner which in operation generates hot, gaseous combustion products, can be modified for use in accordance with my invention by the addition of a suitable dip leg to the discharge end of such burner. As examples of suitable burners, there may be mentioned the catalytic burner described and claimed in copending application U.S. Serial Number 271,664, filed April 9, 1963, by Howard Grekel and Karol L. Hujsak, and the gas-fueled burner described and claimed in my application U.S. Serial Number 271,262, filed April 8, 1964.

The term "thick," as used herein in reference to carbonaceous oil-bearing formations, is intended to mean formations in excess of about 30 feet in thickness. The term "carbonaceous," as used herein, is intended to refer to materials comprising either free or combined carbon.

I claim:

1. In a method for igniting a thick, carbonaceous deposit penetrated by a well, said well extending into said deposit for a distance of at least about 30 feet, the improvement which comprises isolating a first zone opposite said deposit in said well extending for a distance corresponding to approximately the distance said well penetrates said deposit, conducting separate streams of fuel and an oxygen-containing gas in combustible proportions into a second zone within said first zone to form a combustible mixture, igniting said mixture in said second zone and continuing the injection of said fuel and gas in combustible proportions into said second zone to produce hot combustion products, conducting said products from said second zone in a downwardly direction through a confined path and out of direct contact with said deposit and said first zone to a position in said well substantially adjacent and above the lower boundary of said first zone, withdrawing said products from said confined path at said position into said first zone, and forcing said products into said deposit opposite said first zone.

2. The method of claim 1 in which the fuel is natural gas and the oxygen-containing gas is air.

3. The method of claim 1 in which said first zone is an open hole section.

4. In a method for igniting a thick, carbonaceous deposit penetrated by a well, said well extending into said deposit for a distance of at least about 30 feet, the improvement which comprises isolating a first zone opposite said deposit in said well extending for a distance corresponding to approximately the distance said well penetrates said deposit, conducting separate streams of fuel and an oxygen-containing gas in combustible proportions into a second zone within said first zone to form a combustible mixture, igniting said mixture in said second zone and continuing the injection of said fuel and gas in combustible proportions into said second zone to produce hot combustion products, conducting said products from said second zone in a downwardly direction through a confined path and out of direct contact with said deposit and said first zone to a position in said well substantially adjacent and above the lower boundary of said first zone, withdrawing said products from said confined path at said position into said first zone and forcing said products into said deposit opposite said first zone by continued injection of said fuel and gas.

5. The method of claim 4 in which said fuel and gas are injected until the total heat content thus introduced amounts to at least about 1 million B.t.u. per foot of deposit thickness.

6. In a method for igniting a thick, carbonaceous deposit penetrated by a cased well having perforations opposite and throughout the thickness of said deposit, the improvement which comprises isolating a first zone opposite said deposit in said well extending substantially the entire height of said deposit, conducting separate streams of fuel and air in combustible proportions into a second zone within said first zone to form a combustible mixture, igniting said mixture in said second zone and continuing the injection of said fuel and air in combustible proportions into said second zone to produce hot combustion products, conducting said products from said second zone in a downwardly direction through a confined path and out of direct contact with said deposit and said first zone to a position in said well substantially adjacent and above the lower boundary of said first zone, withdrawing said products from said confined path at said position into said first zone, and forcing said products into said deposit opposite said first zone.

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CHARLES E. O'CONNELL, *Primary Examiner.*

JACOB L. NACKENOFF, *Examiner.*

S. J. NOVOSAD, *Assistant Examiner.*