Nov. 5, 1963 L. J. O'BRIEN 3,109,482

WELL-BORE GAS BURNER

Filed March 2, 1961 2 Sheets-Sheet 1

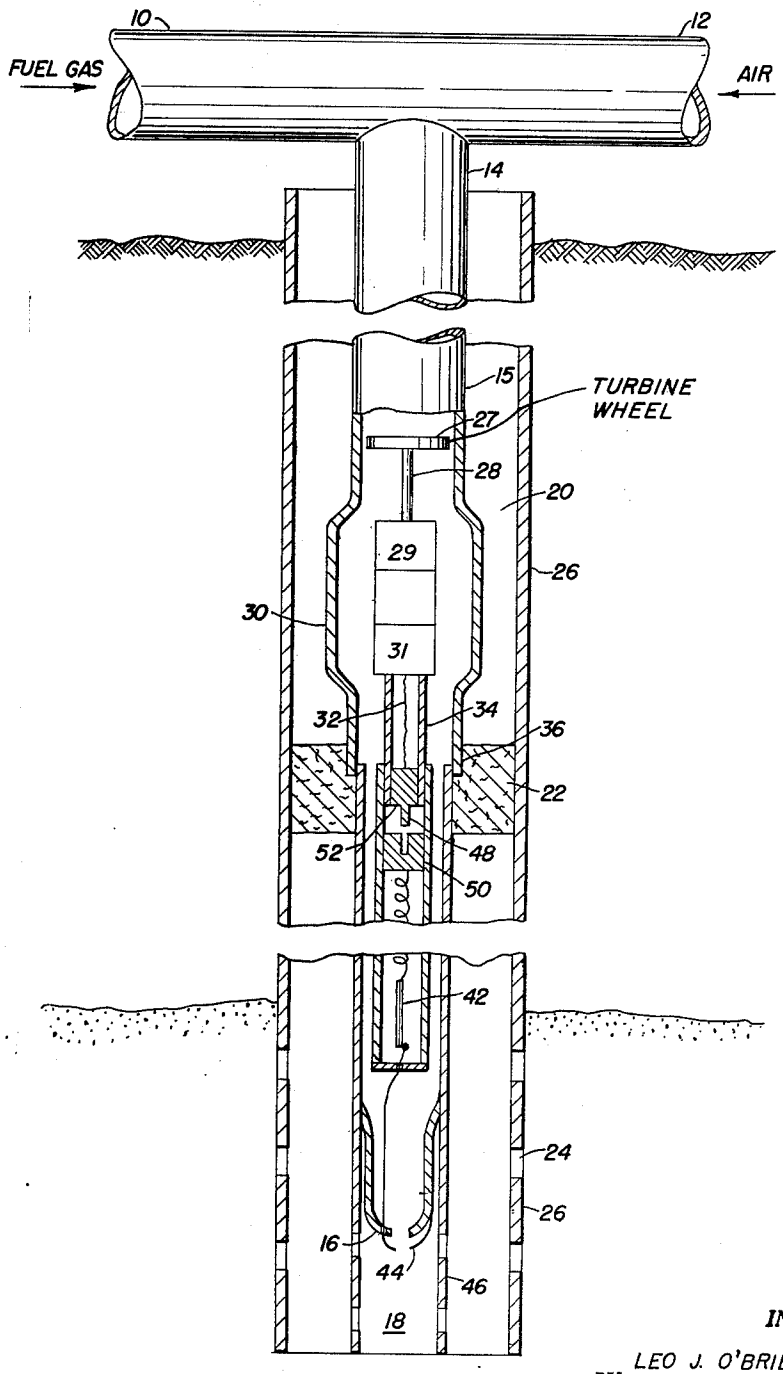


FIG. 1

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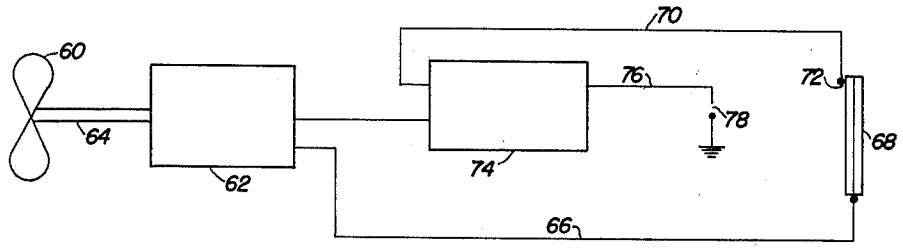


FIG. 2

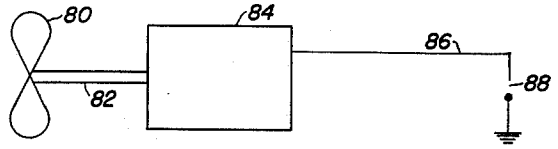


FIG. 3

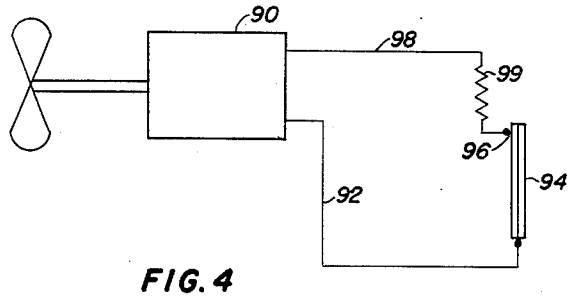


FIG. 4

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3,109,482
WELL-BORE GAS BURNER

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This invention relates to means for igniting gas-fuel-fired burners intended for use in inaccessible locations. In a more specific aspect, the invention relates to automatic means for igniting down-hole burners used in association with oil wells.

Down-hole oil-well burners are employed for a variety of purposes, such as the control of heavy paraffinic deposits in the formation zone surrounding the well-bore, and to apply intense heat to the formation prior to the institution of in-situ combustion. Conventional types of burners are also frequently employed at inconveniently accessible places for various purposes, such as disposing by combustion of noxious combustible vapors or fumes.

Various means have been devised for igniting such burners, and especially ingenious methods have been worked out for the ignition of down-hole oil-well burners. These burners are connected to one or more tubes through which fuel gas and air are delivered from the earth's surface, through the well-bore, to the burner. Methods for igniting such burners include the use of pyrotechnic devices which are dropped through the well-bore, as well as electric ignition techniques and devices controlled and operated by means of one or more electric cables which extends downward through the well-bore from the surface of the earth. While such methods and means are often satisfactory for initially igniting the burner, they are often cumbersome, expensive, and inconvenient, especially when it becomes necessary to reignite the burner at intervals, because the flame is extinguished intentionally or inadvertently.

It is an object of this invention to provide means for the automatic ignition of gas-fuel-fired burners. Another object of this invention is to provide automatic means for reigniting the burner in instances where the flame is accidentally extinguished. Still another object of this invention is to provide means for the automatic deactivation of the ignitor shortly after ignition has occured. Still another object of this invention is to provide an automatic ignitor for a burner located in an inaccessible position, which ignitor requires no connecting electric cable for actuation. Another object of this invention is to provide a down-hole ignitor for automatically igniting a gaseous fuel stream, which ignitor operates automatically upon the institution of fuel flow, to ignite the fuel.

Briefly, the apparatus of this invention comprises an electrically operated spark or resistance-wire ignitor in association with a gaseous-fuel burner, and a turbine-generator assembly disposed in association with the fuel inlet-line to the burner, so that the gaseous fuel flowing to the burner drives the turbine and generates the electric potential which operates the electric ignitor.

This invention is best described with reference to the drawings, of which,

FIGURE 1 is a sectional view of a well bore in which is disposed a down-hole burner incorporating the novel ignitor means of this invention;

FIGURES 2, 3, and 4 are schematic lay-outs of alternate ignitor means in accordance with this invention.

Referring to FIGURE 1, a gaseous fuel, such as methane, introduced through tubing **10**, and air, introduced through tubing **12**, are combined above the surface of the earth and flow through vertical well tubing **14**, through burner inlet **15**, and to the nozzle **16** of the

burner. The mixture of gas and air is burned in the combustion zone **18** of well-bore **20**, zone **18** being isolated and confined by means of well-bore packer **22**. The hot combustion products flow through perforations **24** in well casing **26** and then into the surrounding formation.

In accordance with this invention, turbine wheel **27** is connected by means of shaft **28** to generator **29**. The generator **29** is located within housing **30** which forms a part of the burner assembly, and is located at the fuel-gas inlet to the burner. Within the fuel-gas inlet **15** is disposed turbine wheel **27**, such that the flow of fuel-gas, or fuel-gas and air mixtures, to the burner causes rotation of the turbine wheel **27**. The turbine utilizes the energy of the flowing mixture of fuel and air to drive generator **29** and generate electric energy, which energy is stored in condenser **31**. Wire **32**, which is insulated to withstand combustion temperature, is positioned in tube **34**, which latter tube is connected to the generator housing. Surrounding tube **34** is positioned tubing **36**, which is an extension of the housing **30** within which the generator and condenser are supported, by radial struts which are not shown in the drawing.

Jack-and-plug assembly **48** and bimetallic element **42** are located in series, and control the current flow in wire **32** so that when either of these elements provide an open circuit, no current can flow to electrodes **44** to produce the igniting spark. The circuit is complete only when the bimetallic element is cool, and when perforated housing **46** engages the bottom of the well and the pipe string above is dropped a few inches with respect to housing **46** to close the connection between jack **50**, which is supported by housing **46**, and plug **52**, which is supported by tube **34**.

The fuel and air mixture is ignited in combustion zone **18**, the circuit to the electrode being broken automatically when the temperature rises sufficiently to actuate bimetallic strip **42**. The production of a spark may be prevented, when so desired, by lifting the tubing string off the well bottom, thereby disengaging jack-and-plug assembly **48**. It is evident that an igniting spark will otherwise occur each time the condenser becomes sufficiently charged to produce an arc discharge across the spark gap between electrodes **44**.

Referring to FIGURES 2, 3, and 4, alternate electric-generating and igniting means are shown. Referring to FIGURE 2 turbine wheel **60** drives generator **62** through shaft **64**. The output of the generator, which may be a conventional low-voltage generator having a fractional watt output, is conducted through wire **66** to bimetallic element **68**. When bimetallic element **68** is cold, connection is made to wire **70** which contacts the bimetallic element at **72**, and is connected to the input of electric coil **74**. High-tension wire **76** leads from coil **74** to spark gap **78**. The output of generator **62** may be a high-frequency A.C. voltage, and this voltage may be increased to a suitable potential to jump spark gap **78** by means of the windings of coil **74**. Alternatively, the output of generator **62** may be a direct current, and coil **74** may be equipped with a continuously operating relay device to make and break the connection in the primary circuit of the coil. Such spark coils are well known and were commonly used in the ingition systems of older automobiles. It is evident that upon the institution of fuel flow, rotation of turbine wheel **60** will cause an electric current to be produced. This current actuates the ignition coil to produce a spark at spark gap **78** to ignite a combustible fuel-and-air mixture. After burning has commenced, bimetallic element **68** becomes heated and bends to break contact and disconnect the ignition coil **74**. In this manner, excessive deterioration of the elements forming the spark gap may

be avoided. It is evident, however, that the bimetallic element **68** may be omitted completely, if desired, permanent connection then being made between the primary circuit of the ignition coil **74** and generator **62**.

Referring to FIGURE 3, turbine wheel **80**, which is supported by shaft **82**, drives magneto-type generator **84**. The high-tension output of this generator is connected through high-tension wire **86** to spark gap **88**. Referring to FIGURE 4, generator **90** is connected by means of wire **92**, bimetallic element **94**, contact **96**, and return wire **98** to ignition resistance element **99**. Generation of electricity by generator **90** results in the heating of resistance element **99**, to product ignition of the fuel-gas mixture. Bimetallic element **94** is provided to prevent over-heating and deterioration of the resistance element. The bimetallic element **94** serves to break connection with generator **90** after the occurrence of ignition of the combustible mixture of fuel and air.

It will be evident that with respect to each embodiment described, the flow of fuel gas to the burner results in the generation of an electric potential which automatically operates ignition means to start the fire in the burner. It is evident that in each case, when the flow of fuel gas is terminated, as by closing a fuel-line control valve, operation of the generator terminates. However, upon reopening of the control valve to again provide fuel to the burner, ignition is automatically provided. In the case of the constant-ignition-providing embodiments, as shown in FIGURE 3, the ignition means operates continuously as long as fuel is flowing to the burner. Hence, if the flame becomes extinguished for any cause, reignition is automatically immediately provided. In the examples where a bimetallic element is used to interrupt operation of the ignition device after burning of the fuel has commenced, if the flame becomes extinguished for any cause other than termination of the flow of fuel to the burner, reignition will automatically be provided upon the cooling of the bimetallic element to re-establish electrical connection between the generator and the ignition device.

It will be evident that the ignition means of this invention may be employed with conventional gas burners, and is not limited to the use of down-hole oil-well burners. In cases where fuel only is provided to the burner, and mixed with available atmospheric air for combustion, the operation of the device will be the same as described in the specific embodiment, except that only the gaseous fuel will be available to drive the turbine wheel. This is not a serious limitation, since the amount of electricity needed to operate the ignitor is not great. Depending upon whether spark ignition or resistance-element ignition is employed, the power requirement for the generator may vary from a tenth of a watt to 100 watts. In most instances, however, a fractional wattage generator will provide ample power for ignition, and can most conveniently be employed without requiring serious modification of conventional burner structure. The apparatus of this invention may therefore be adapted for use with conventional gaseous fuel burners, such as those described in U.S. Patents 2,506,853 and 2,832,417. It should be understood that the ignition means comprising resistance wires, spark coils, etc., have been described by way of illustration only, and the invention should not be considered to be limited to these specific ignition means.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An apparatus for burning a combustible gaseous fuel in a well-bore comprising

(1) a downhole burner unit including

(*a*) a burner housing having a gaseous fuel inlet opening at the upper end thereof and adapted to receive support from the interior of a well-bore,

(*b*) electrically actuated ignitor means within said burner housing, and

(*c*) a first electrical terminal supported adjacent the upper end of said housing and connected electrically to said ignitor means,

(2) a housing having open upper and lower ends, said upper end being adapted for connection to a gaseous fuel well tubing, said lower end being connected with said opening in said burner housing,

(3) electricity generating means supported within said last named housing,

(4) a turbine wheel connected to drive said generator means and positioned to be driven by the flow of gaseous fuel through said last named housing, and,

(5) a second electrical terminal connected to the output of said generating means, supported for movement with said last named housing, and positioned adjacent the lower end of said last named housing to contact said first terminal when said last named housing is in a lowered position with respect to said burner housing, but not to contact said first terminal when said last named housing is in a raised position with respect to said burner housing.

2. An apparatus in accordance with claim 1 in which said first and second terminals are disposed concentrically with respect to said openings at the upper end of said burner housing and at the lower end of said last mentioned housing, respectively.

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