A self-igniting burner includes a main tube containing a fuel tube (35) and an igniter tube (37). An ignition device (15A, 15B) extends down the igniter tube (37). Fuel flows from an upstream portion of the fuel tube (35) to the igniter tube (37) via a channel (51). The fuel flows down the igniter tube (37) and out the end. A pilot flame is ignited by the ignition device (15A, 15B) from the fuel flowing out the end of the igniter tube (37). Oxidant flows down the main tube between an inner surface of the main tube and outer surfaces of the fuel tube (35) and igniter tube (37). A main burner flame is ignited from the flow of oxidant and a flow of fuel out of the fuel tube (35).
SELF-IGNITING BURNER AND METHOD OF USE, AND METHOD OF MANUFACTURE

Cross-Reference to Related Applications

None.

Background

Conventional industrial burners combusting a fuel and oxidant typically utilize a separate pilot burner for igniting a flame of fuel and oxidant before the flows of fuel and oxidant are initiated for the main burner. Typically, a relatively small flow rate of premixed fuel and air is initiated at the pilot burner and the flame is ignited using an igniter, such as the spark plug-type. Once the pilot flame has been established, a flow of fuel and oxidant for the main burner may be initiated with confidence that the pilot flame will successfully ignite the main burner flame.

Use of this conventional technique, requires that two burners be installed at two separate locations in a furnace. Each of these burners requires at least a separate supply of fuel and oxidant. In the case of gaseous fuel-fired burners, the source of gaseous fuel is typically at a pressure that is suitable for maintaining relatively high flow rates through the main burner but is too high for safe and successful ignition of the pilot burner. In order to address this problem, bulky, complicated gas handling equipment must be installed on a separate fuel line and air line for the pilot burner. This results in a furnace installation that is relatively complex, expensive and invasive.

In the case of oxy/fuel burners combusting gaseous fuel with industrially pure oxygen, the pilot igniter often experiences overheating after ignition of the flame. This leads to faulty igniters needing replacement.

Thus, there is a need for an industrial scale burner that may be successfully ignited without the use of a separate pilot burner or bulky,
complicated gas handling equipment. There is also a need for an industrial
scale burner that is relatively economical, simple, and non-invasive with
respect to the furnace. There is also a need for an industrial scale burner that
does not need frequent furnace shutdowns for replacement of the pilot igniter.

Summary

There is disclosed a self-igniting burner, comprising: a main tube, a fuel
tube, an igniter tube, an oxidant inlet port, and an ignition device. The main
tube has an upstream closed inlet end and a downstream open discharge end.

The main tube also has an oxidant inlet port adapted and configured to be
connected to an oxidant line from an oxidant source to allow a flow of oxidant
from the oxidant line through the oxidant inlet port and into an interior of the
main tube. The fuel tube has an upstream inlet end and a downstream
discharge end. The fuel tube penetrates a wall of the main tube and extends
along the interior of the main tube. The fuel tube discharge end terminates
upstream of the main tube discharge end. The fuel tube inlet end has a fuel
inlet port adapted and configured to be connected to a fuel line from a fuel
source to allow a flow of gaseous fuel from the fuel line through the fuel inlet
port and through the fuel tube. The igniter tube has an upstream inlet end and
an open downstream discharge end. The igniter tube penetrates a wall of the
main tube and extends along the interior of the main tube. The igniter tube
inlet end has an igniter tube inlet port. The igniter tube discharge end
terminates upstream of the main tube discharge end. The ignition device is
disposed within the igniter tube at the downstream end thereof. The igniter
tube inlet end is adapted and configured to securely receive the ignition
device in sealing fashion. The ignition device is adapted and configured to
generate a spark and be electrically connected to a voltage source through
the upstream end of the igniter tube. The ignition device is narrow enough to
allow a slipstream of fuel to flow down the igniter tube around the ignition
device. The ignition device terminates at an electrode end adjacent to or extending just beyond the open downstream end of the igniter tube.

There is also disclosed a method of manufacturing the above self-igniting burner that comprises the following steps. The main tube, fuel tube, igniter tube, oxidant inlet port, and ignition device are assembled. A blind hole is formed that extends from an outer surface of the end plate, through the end plate, through the igniter tube, and to the fuel tube. The open end of the blind hole is welded closed, the closed blind hole being the channel.

There is also disclosed a method for lighting the above self-igniting burner that comprises the following steps. A low flow of gaseous fuel into the fuel tube inlet end is initiated. The gaseous fuel is allowed to flow into the igniter tube from the fuel tube via the channel. The gaseous fuel is allowed to flow down the igniter tube in between an inner surface of the igniter tube and an outer surface of the ignition device and out the discharge end of the igniter tube. The ignition device is energized to form a spark at the electrode end that ignites a pilot flame from ambient oxidant and the gaseous fuel flowing out the discharge end of the igniter tube. A low flow of oxidant into the main tube via the oxidant inlet port is initiated. The pilot flame is allowed to ignite a main burner flame from the flow of oxidant and the flow of fuel from the discharge end of the fuel tube.

There is also disclosed another method for lighting the above self-igniting burner that comprises the following steps. A low flow of gaseous fuel into the fuel tube inlet end is initiated. The gaseous fuel is allowed to flow into the igniter tube from the fuel tube via the channel. The gaseous fuel is allowed to flow down the igniter tube in between an inner surface of the igniter tube and an outer surface of the ignition device and out the discharge end of the igniter tube. A low flow of oxidant into the main tube via the oxidant inlet port is initiated. The ignition device is energized to form a spark at the electrode end that ignites a pilot flame from the flow of oxidant in the main tube and the
gaseous fuel flowing out the discharge end of the igniter tube. The pilot flame is allowed to ignite a main burner flame from the flow of oxidant and the flow of fuel from the discharge end of the fuel tube.

Any of the self-igniting burner, method of manufacturing the self-igniting burner, or lighting the self-igniting burner may include one or more of the following aspects:

- the upstream closed end of the main tube comprises an end plate;
- the fuel tube inlet end is securely received in a fuel port bore formed in the end plate;
- the igniter tube inlet end is securely received in an igniter port bore formed in the end plate; and
- the channel is formed in the end plate.
- the self-igniting burner further comprises a viewing tube penetrating a wall of the main tube and extending along the interior of the main tube, the viewing tube being adapted and configured to sense a flame downstream of a downstream of the viewing tube.
- the self-igniting burner further comprises an open-bore burner head secured to the discharge end of the main tube.
- the discharge ends of the fuel tube and igniter tube terminate inside a combustion space enclosed by the open-bore burner head.
- the burner head is made of a refractory material or water-cooled copper, stainless steel, or inconel.
- the main tube, fuel tube, and igniter tube are made of a nickel/chrome/iron alloy.
- no premixed fuel and oxidant is used.
- the oxidant is air, oxygen-enriched air, or industrially pure oxygen.
- the fuel is natural gas, coke oven gas, methane, propane, or butane.
Brief Description of the Drawings

For a further understanding of the nature and objects of the present invention, reference should be made to the following detailed description, taken in conjunction with the accompanying drawings, in which like elements are given the same or analogous reference numbers and wherein:

Figure 1 is a bottom view of an embodiment of the inventive burner.
Figure 2 is a side view with missing parts of an embodiment of the inventive burner.
Figure 3 is a top view with missing parts of an embodiment of the inventive burner utilizing a second igniter.
Figure 4 is a side view with missing parts of an embodiment of the inventive burner using a first igniter.
Figure 5 is a side view of a vertical, lengthwise cross-section of the end plate of an embodiment of the inventive burner.
Figure 6 is an expanded view of the discharge end of the burner of Figure 3.

Description of Preferred Embodiments

There is disclosed a self-igniting burner that includes a main tube through which a fuel tube and an igniter tube extend and terminate in a combustion space at the burner head end of the main tube. An ignition device is inserted inside the igniter tube to terminate adjacent an end of the igniter tube. A channel connects upstream ends of the fuel tube and the igniter tube in order to allow a flow of gaseous fuel from the fuel tube to the igniter tube. The fuel flows down the igniter tube in between the ignition device and the igniter tube. The ignition device is connected to a voltage source and is adapted and configured to generate a spark at an electrode tip at a downstream end thereof. Fuel flowing out a discharge end of the igniter tube
is ignited by the spark in the presence of oxidant. No premixed fuel and oxidant (such as air) is used. In this manner, there is no need to have a pilot burner separate from the main burner. There is also no need to have a separate gas handling system for diverting fuel to a pilot burner.

As best illustrated in FIGS 1-4, a self-igniting burner includes a fuel inlet port 12, a flame-sensing viewport 14, and an igniter port 16 each one of which is received by and connected to an end plate 17. The fuel inlet port 12 and igniter port 16 are internally threaded to securely receive a fuel line connector 11 from a fuel source and an igniter connector 13, respectively. Each of the fuel inlet port 12, viewport 14, and igniter port 16 has a circular cross-section and may be made of a nickel/chrome/iron alloy such as carbon steel or stainless steel.

The end plate 17 is secured to a large diameter tube 19 in gastight manner. The large diameter tube is secured to a cylindrical holder 21 with set screws 31. The holder 21 is in turn secured to burner head 23 via metal anchors 33 and tack welds 22. The burner head encloses a combustion space 39. An oxidant inlet port 25 fluidly communicates with an interior of the large diameter tube 19. A main tube is thus formed by the combination of the open-ended burner head 23, the holder 21, the large diameter tube 19, and the closed-ended end plate 17. Each of the large diameter tube 19, holder 21, oxidant inlet port 25, and burner head 23 has a circular cross-section. Each of the large diameter tube 19, holder 21, and oxidant inlet port 25 may be made of a nickel/chrome/iron alloy such as carbon steel, stainless steel, inconel or kanthal. The burner head 23 may be made of refractory material or it could be water-cooled copper, stainless steel, or inconel.

An upstream end of an igniter tube 37 is received in igniter port 16 in a secure manner. The igniter tube 37 extends through the interior of the large diameter tube 19 to terminate at a downstream end inside the combustion space 39.
Similar to the igniter tube 37, an upstream end of a fuel tube 35 is received in fuel inlet port 12 in a secure manner. The fuel tube 35 extends through the interior of the large diameter tube 19 to terminate at a downstream end inside the combustion space 39.

Similar to the igniter tube 37 and fuel tube 35, an open upstream end of a viewing tube 38 is received in viewport 14 in a secure manner. The viewing tube 38 extends through the interior of the large diameter tube 19 to terminate at an open downstream end.

Each of the igniter tube 37, fuel tube 35, and viewing tube 38 has a circular cross-section and may be made of a nickel/chrome/iron alloy such as carbon steel, inconel or stainless steel.

FIG 4 is a special side view of the burner of FIGS 1-2. In order to reveal interior features, in FIG 4 a cross-section has been taken along a vertical plane extending lengthwise down the burner to remove half of the end plate 17, large diameter tube 19, ignition tube 37, viewing tube 38, holder 21, and burner head 23. All other features are left intact with the exception of the fuel connector 11, the fuel inlet port 12, and the fuel tube 35 which are all obscured by the presence of the ignition device 15A, ignition port 16, and ignition tube 37.

As best shown in FIG 4, a first option of an ignition device 15A is threadedly received in ignition port 16 in gastight fashion and extends through the interior of the igniter tube 37 to terminate at an electrode tip 42 adjacent to or projecting outwardly from downstream end of the igniter tube 37. Each of the ignition device 15A and ignition rod 59A has a circular cross-section.

FIG 3 is a special top view of the burner of FIGS 1-2. In order to reveal interior features, in FIG 3 a cross-section has been taken along a horizontal plane extending lengthwise down the burner to remove half of the end plate 17, large diameter tube 19, ignition tube 37, viewing tube 38, holder 21, and burner head 23. All other features are left intact with the exception of the
viewing tube 38 which would otherwise be partially obscured by the presence
of the fuel and igniter tubes 35, 37.

As best illustrated in FIGS 3 and 6, a second option of an ignition
device 15B is threaded in the ignition port 16 in gastight fashion and extends
through the interior of the igniter tube 37 to terminate at an electrode tip 55
adjacent to or extending outwardly from the downstream end of the igniter
tube 37. The ignition device 15B includes an ignition rod 59B extending
through the interior of the igniter tube 37. Each of the ignition device 15B and
the ignition rod 59B has a circular cross-section.

As best shown in FIG 5, the end plate 17 includes a fuel port bore 43
for receiving the fuel inlet port 12, an igniter port bore 47 for receiving the
igniter port 16, a fuel tube bore 45 for receiving the fuel tube 35 and an igniter
tube bore 49 for receiving the igniter tube 37. The end plate 17 also includes a
transverse channel 51 that extends between weld 53 through the end plate 17
and bore 47 to bore 43. The channel 51 allows fluid communication of
gaseous fuel between the fuel inlet port 12 and the ignition port 16. After
assembly of the end plate 17, fuel inlet port 12, and igniter port 16, a
transverse hole may be drilled through the end plate 17 to form the channel
51. The open end of the freshly drilled channel 51 is then welded closed.

Before or after installation of the self-igniting burner in a desired
location of a furnace wall, an oxidant line is connected to oxidant inlet port 25.
The oxidant may be air, oxygen-enriched air, or industrially pure oxygen.
Oxygen-enriched air is understood to be a mixture of air and industrially pure
oxygen. The specific purity of the industrially pure oxygen depends upon the
method of production and whether or not the produced oxygen is further
purified. For example, the industrially pure oxygen may be gaseous oxygen
from an air separation unit that cryogenically separates air gases into
predominantly oxygen and nitrogen streams in which case the gaseous
oxygen has a concentration exceeding 99% vol/vol. The industrially pure
oxygen may be produced through vaporization of liquid oxygen (which was liquefied from oxygen from an air separation unit, in which case it, too, has a purity exceeding 99% vol/vol. The industrially pure oxygen may be also be produced by a vacuum swing adsorption (VSA) unit in which case it typically has a purity of about 92-93% vol/vol. The industrially pure oxygen may be sourced from any other type of oxygen production technology used in the industrial gas business.

Before or after installation of the self-igniting burner in a desired location of a furnace wall, a fuel line may be connected to the burner via fuel connector 11. The fuel may be any gaseous fuel including natural gas, coke oven gas, methane, propane, or butane. The ignition device 15A, 15B (as the case may be) is inserted into the igniter tube 37 via the igniter port 16 and threadedly secured thereto. The ignition device 15A, 15B is then connected to a voltage source sufficient to generate the ignition spark.

The self-igniting burner may be operated as follows. A flow of gaseous fuel is initiated through fuel connector 11, fuel inlet port 12 and fuel tube 35. The gaseous fuel also flows from the fuel inlet port 12 through channel 51 and into the igniter port 16 and down through the igniter tube 37. The voltage source is turned on to energize the ignition device 15A, 15B. The resultant spark formed at the tip of the ignition device 15A, 15B ignites the mixture of gaseous fuel and ambient air to generate the pilot flame in the combustion space 39. Next, a relatively low flow of oxidant is then initiated from oxidant inlet port 25 and into an interior of the large diameter tube 19 in between an inner surface thereof and outer surfaces of the fuel tube 35, igniter tube 37, and viewing tube 38. Alternatively, the pilot flame may be ignited with the ignition device 15A, 15B with both flows of fuel and oxidant. The burner power is then slowly ramped with increases in the flows of fuel and oxidant to the desired power.
The self-igniting burner has the several advantages. The ignition device is contained with the igniter tube helping to protect it from overheating from the main flame once ignited. The ignition device is also cooled by the flow of the fuel around it through the igniter tube further helping to protect it from overheating from the main flame once ignited. The fuel, such as natural gas, absorbs the thermal energy from the main flame and cracks into other combustible gasses/particles. As a result, the ignition device does not need to be replaced as frequently as conventional ignition devices.

Preferred processes and apparatus for practicing the present invention have been described. It will be understood and readily apparent to the skilled artisan that many changes and modifications may be made to the above-described embodiments without departing from the spirit and the scope of the present invention. The foregoing is illustrative only and that other embodiments of the integrated processes and apparatus may be employed without departing from the true scope of the invention defined in the following claims.
What is claimed is:

1. A self-igniting burner, comprising:

   a main tube with an upstream closed inlet end and a downstream open discharge end, the main tube having an oxidant inlet port adapted and configured to be connected to an oxidant line from an oxidant source to allow a flow of oxidant from the oxidant line through the oxidant inlet port and into an interior of the main tube;

   a fuel tube having an upstream inlet end and a downstream discharge end, the fuel tube penetrating a wall of the main tube and extending along the interior of the main tube, the fuel tube discharge end terminating upstream of the main tube discharge end, the fuel tube inlet end having a fuel inlet port adapted and configured to be connected to a fuel line from a fuel source to allow a flow of gaseous fuel from the fuel line through the fuel inlet port and through the fuel tube;

   an igniter tube having an upstream inlet end and an open downstream discharge end, the igniter tube penetrating a wall of the main tube and extending along the interior of the main tube, the igniter tube inlet end having an igniter tube inlet port, the igniter tube discharge end terminating upstream of the main tube discharge end;

   an ignition device disposed within the igniter tube at the downstream end thereof, the igniter tube inlet end being adapted and configured to securely receive the ignition device in sealing fashion, the ignition device being adapted and configured to generate a spark and be electrically connected to a voltage source through the upstream end of the igniter tube, the ignition device being narrow enough to allow a slipstream of fuel to flow down the igniter tube around the ignition device, the ignition device terminating at an electrode end adjacent to or extending just beyond the open downstream end of the igniter tube.
2. The self-igniting burner of claim 1, wherein:
   the upstream closed end of the main tube comprises an end plate;
   the fuel tube inlet end is securely received in a fuel port bore formed in
   the end plate;
   the igniter tube inlet end is securely received in an igniter port bore
   formed in the end plate; and
   the channel is formed in the end plate.

3. The self-igniting burner of claims 1 or 2, further comprising a
   viewing tube penetrating a wall of the main tube and extending along the
   interior of the main tube, the viewing tube being adapted and configured to
   sense a flame downstream of a downstream of the viewing tube.

4. The self-igniting burner of any one of claims 1-3, further
   comprising an open-bore burner head secured to the discharge end of the
   main tube.

5. The self-igniting burner head of claim 4, wherein the discharge
   ends of the fuel tube and igniter tube terminate inside a combustion space
   enclosed by the open-bore burner head.

6. The self-igniting burner of claim 4, wherein the burner head is
   made of a refractory material or water-cooled copper, stainless steel, or
   inconel.

7. The self-igniting burner of any one of claims 1-6, wherein the
   main tube, fuel tube, and igniter tube are made of a nickel/chrome/iron alloy.
8. A method of manufacturing the self-igniting burner of any one of claims 2-7, comprising the steps of:

- assembling the main tube, fuel tube, igniter tube, oxidant inlet port, and ignition device;
- forming a blind hole extending from an outer surface of the end plate, through the end plate, through the igniter tube, and to the fuel tube; and
- welding the open end of the blind hole closed, the closed blind hole being the channel.

9. A method for lighting the self-igniting burner of any one of claims 1-7 with a pilot flame, comprising the steps of:

- initiating a low flow of gaseous fuel into the fuel tube inlet end;
- allowing the gaseous fuel to flow into the igniter tube from the fuel tube via the channel;
- allowing the gaseous fuel to flow down the igniter tube in between an inner surface of the igniter tube and an outer surface of the ignition device and out the discharge end of the igniter tube;
- energizing the ignition device to form a spark at the electrode end that ignites a pilot flame from ambient oxidant and the gaseous fuel flowing out the discharge end of the igniter tube;
- initiating a low flow of oxidant into the main tube via the oxidant inlet port; and
- allowing the pilot flame to ignite a main burner flame from the flow of oxidant and the flow of fuel from the discharge end of the fuel tube.

10. A method for lighting the self-igniting burner of any one of claims 1-7 with a pilot flame, comprising the steps of:

- initiating a low flow of gaseous fuel into the fuel tube inlet end;
allowing the gaseous fuel to flow into the igniter tube from the fuel tube via the channel;
allowing the gaseous fuel to flow down the igniter tube in between an inner surface of the igniter tube and an outer surface of the ignition device and out the discharge end of the igniter tube;
initiating a low flow of oxidant into the main tube via the oxidant inlet port; and
energizing the ignition device to form a spark at the electrode end that ignites a pilot flame from the flow of oxidant in the main tube and the gaseous fuel flowing out the discharge end of the igniter tube;
allowing the pilot flame to ignite a main burner flame from the flow of oxidant and the flow of fuel from the discharge end of the fuel tube.

11. The method of claims 9 or 10, wherein no premixed fuel and oxidant is used.

12. The method of claims 9 or 10, wherein the oxidant is air, oxygen-enriched air, or industrially pure oxygen.

13. The method of claims 9 or 10, wherein the fuel is natural gas, coke oven gas, methane, propane, or butane.
### INTERNATIONAL SEARCH REPORT

**INTERNATIONAL APPLICATION NO.**

PCT/CN2011/076809

**CLASSIFICATION OF SUBJECT MATTER**

According to International Patent Classification (IPC) or to both national classification and IPC

**FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: F23D, F23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, EPDOC, WPI: burner, combustor, gas, gaseous, fuel, oxidant, air, self-w-ignit+, ignit+, pilot, tube, pipe, conduit

**DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of Box C.

See patent family annex.

**Date of the actual completion of the international search**

28 Mar. 2012 (28.03.2012)

**Date of mailing of the international search report**

12 Apr. 2012 (12.04.2012)

**Name and mailing address of the ISA/CN**

The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451

Form PCT/ISA/210 (second sheet) (July 2009)

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