APPARATUS FOR, AND METHOD OF, OXIDIZING A GASEOUS MIXTURE CONTAINING A COMBUSTIBLE COMPONENT

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ABSTRACT

Apparatus for oxidizing a gaseous mixture containing a potentially combustible component includes a combustion chamber for burning and oxidizing a combustible gas, a heated oxidation chamber for heating and oxidizing an incombustible gas, a conduit communicating a source of the gaseous mixture with the combustion and oxidation chambers, and electrically-operable gas valves arranged in the conduit and operable to deliver a flow of the gaseous mixture to either the combustion chamber or to the oxidation chamber. An electrical control circuit is adapted to sense the combustibility of the gaseous mixture. If such mixture is sensed to be incombustible, the control circuit operates the valves to deliver such flow to the oxidation chamber.

9 Claims, 2 Drawing Figures
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BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates generally to apparatus for oxidizing a gaseous mixture containing a potentially combustible component.

2. Description of the Prior Art
Prior art efforts to provide apparatus for oxidizing a gaseous mixture have begun with the threshold inquiry of whether such mixture is combustible or incombustible.


On the other hand, it is known that an incombustible gas may be oxidized by the influence of heat, this principle being shown in Shiller U.S. Pat. No. 3,404,965, Gerlach U.S. Pat. No. 3,279,168, Phillips U.S. Pat. No. 3,215,501, and Bloxham U.S. Pat. No. 3,190,823.

However, whether a particular gaseous mixture is combustible or incombustible may well depend upon the extent to which a potentially combustible component of the mixture is present with a cooperative amount of oxygen. For example, a particular gaseous mixture composed of gas and air may be either combustible or incombustible, depending upon the relative proportional quantities to which these components are present in the mixture. Therefore, since the concentration of a potentially combustible component may vary with a number of factors, the combustibility of the entire mixture itself may vary.

SUMMARY OF THE INVENTION

The present invention provides apparatus for oxidizing a gaseous mixture containing a potentially combustible component, regardless of whether such mixture itself is combustible or incombustible. Moreover, the apparatus is particularly designed to oxidize a mixture of varying combustibility.

The apparatus broadly includes a combustion chamber having means for igniting a combustible gas; an oxidation chamber having means for heating and oxidizing an incombustible gas; conduit means communicatively connecting a source of the gaseous mixture with the combustion and oxidation chambers; valve means associated with the conduit means and operative to block the same to prevent a flow of the mixture therethrough, or to alternatively direct such flow to either the combustion chamber or to the oxidation chamber; and control means adapted to sense the combustibility of the mixture and to cause the valve means to permit and direct such flow to the combustion chamber when the mixture is sensed to be combustible, and to deliver such flow to the oxidation chamber when the mixture is sensed to be incombustible.

In one embodiment, the control means includes a first flame sensor operatively arranged to sense the presence of a flame in the combustion chamber and adapted to cause the valve means to divert such flow to

the oxidation chamber when no flame is sensed in the combustion chamber.

The control means may further include igniting means, such as a spark generator, operatively arranged to attempt to ignite the mixture delivered to the oxidation chamber, and a second flame sensor operatively arranged to divert such flow to the combustion chamber when the presence of a flame is sensed in the oxidation chamber.

The control means may further include means for sensing the effective temperature of the oxidation chamber for causing the valve means to prevent such flow from entering the oxidation chamber when the temperature within the oxidation chamber is below a preselected minimum temperature.

The inventive apparatus oxidizes a gaseous mixture containing a potentially combustible component by supplying a flow of the mixture from a source thereof, sensing the combustibility of the supplied mixture, diverting the supplied flow to the combustion chamber if the mixture is sensed to be combustible, igniting the combustible mixture in the combustion chamber, diverting such supplied flow to a heated oxidation chamber if the mixture is sensed to be incombustible, and oxidizing such incombustible mixture in the oxidation chamber. In practicing this method, the combustibility of the mixture is preferably sensed by determining the presence or absence of a flame, or the heat thereof.

One object of the present invention is to provide improved apparatus for oxidizing a gaseous mixture containing a potentially combustible component.

Another object is to provide improved apparatus for oxidizing either a combustible or an incombustible gaseous mixture.

Another object is to provide improved oxidation apparatus wherein the combustibility of a supplied gaseous mixture is sensed.

Another object is to provide improved apparatus for, and a method of, oxidizing a gaseous mixture wherein the mixture is oxidized by burning in a combustion chamber if such mixture is sensed to be combustible, and oxidized in a heated oxidation chamber if such mixture is sensed to be incombustible.

Still another object is to provide improved apparatus capable of oxidizing a gaseous mixture regardless of the combustibility of the mixture.

These and other objects and advantages will become apparent from the foregoing and ongoing specification which includes the drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a mechanical schematic view of the structure of the apparatus, principally illustrating the combustion and oxidation chambers, the conduit arranged to deliver a flow of the gaseous mixture to the combustion and oxidation chambers, the valves associated with the conduit conduits, and the location of the flame sensor probes, the heat sensor switch, and the high temperature limit control switch.

FIG. 2 is an electrical schematic view of the circuitry of the invention, illustrating the arrangement of the spark generators, the electric heater, and further showing the flame sensing relay arranged to control operation of the valves.
DESCRIPTION OF THE PREFERRED EMBODIMENT

At the outset, it should be clearly understood that like reference numerals are intended to identify the same elements and/or structure throughout the several drawing figures, as such elements and/or structure may be further described or explained by the entire written specification of which this detailed description is an integral part.

Referring initially to FIG. 1, the present invention provides apparatus, generally indicated at 10, for oxidizing a gaseous mixture containing a potentially combustible component, such as gasoline fumes, and flowing from a source (not shown) thereof.

As used herein, a "potentially combustible component" is intended broadly to refer to any gaseous fluid which, when mixed with the proper amount of oxygen, is capable of burning when ignited. However, since such potentially combustible components may be present in gaseous mixtures in varying fractional degrees, it should be clearly understood that combustibility of such mixtures, as a whole, may vary. Hence, some mixtures may be combustible, while others may be incombustible.

The apparatus 10 broadly includes a combustion chamber 11 having means, generally indicated at 12, for igniting a flow of combustible gas delivered to the combustion chamber; an oxidation chamber 13 having means, generally indicated at 14, for heating and oxidizing a flow of incombustible gas rising through the oxidation chamber; conduit means 15 communicatively connecting a source (not shown) of the gaseous mixture with the combustion chamber 11 and with the oxidation chamber 13; valve means, generally indicated at 16, associated with the conduit means 15 and operative to selectively block and prevent a flow of the gaseous mixture through the conduit means, or to alternately permit and divert such flow to either the combustion chamber 11 or to the oxidation chamber 13; and control means, generally indicated at 18 in FIG. 2, adapted to sense the combustibility of the gaseous mixture flowing through the conduit means 15 and to cause the valve means 16 to direct such flow to the combustion chamber 11 when such mixture is sensed to be combustible, and to divert such flow to the oxidation chamber 13 when such mixture is sensed to be incombustible.

Adverting now to FIG. 1, the combustion and oxidation chambers 11, 13 are schematically depicted as contained within an enclosure 19 having a horizontal bottom 20, and a vertical side wall structure 21 rising upwardly therefrom. Side wall structure 21 is shown provided with an open upper end suitably covered by an overhead inverted hopper-like hood structure 22 which functions to direct or funnel the rising flow of gaseous products of combustion and oxidation, such as carbon dioxide (CO₂) and water vapor, (H₂O), upwardly away from the combustion and oxidation chambers 11, 13 and from enclosure 19.

Arranged within this enclosure 19, the combustion and oxidation chambers 11, 13 are depicted as bounded by a pair of laterally-adjacent left and right open-ended vertical tubes 23, 24 respectively, sharing an intermediate common wall 25. The leftward tube 23, bounding the combustion chamber 11, is specifically shown as having upper and lower open ends 26, 28, respectively. Similarly, the rightward tube 24, bounding the oxidation chamber 13 is also shown as having upper and lower open ends 29, 30, respectively. If desired, the vertical tubular walls 23, 24 and 25 may be made of a suitable thermal insulating or refractory material, as depicted in FIG. 1.

In the presently preferred embodiment herein disclosed, the means 14 for heating and oxidizing a gas delivered to the oxidation chamber is schematically shown as including an electrical-resistance-type heating element 31 suitably mounted within right tube 24 to heat the oxidation chamber. When energized, this heating element 31 operates to elevate the temperature of a gas rising through oxidation tube 24 to oxidize such rising gas and to reduce hydrocarbons therein to carbon dioxide (CO₂) and water vapor (H₂O).

The conduit means 15 is shown as including a main supply conduit 32 communicating the source (not shown) of the gaseous mixture with a first branch conduit 33 leading to the combustion chamber 11, and with a second branch conduit 34 leading to the oxidation chamber 13. The first branch conduit 33 includes, in series, pipe conduit 35 communicating with supply conduit 32, electrically-operable gas valve 36, pipe conduit 38, air shutter 39, and gas burner 40 mounted to penetrate the enclosure bottom 20 and having an uppermost perforated burner head 41 arranged beneath the combustion chamber 11. Similarly, the second branch conduit 34 includes, in series, pipe conduit 42 communicating with supply conduit 32 electrically-operable gas valve 43, pipe conduit 44, air shutter 45, and gas burner 46 mounted to penetrate the enclosure bottom 20 and having an uppermost perforated burner head 48 arranged beneath the oxidation chamber 13.

Thus, the conduit means 15, which includes the first and second branch conduits, 33, 34, respectively, communicatively connects the source (not shown) of the mixture with the combustion chamber 11 and with the oxidation chamber 13.

In the presently preferred embodiment, the means 12 for igniting a combustible gas is shown as being a conventional spark generator operatively arranged between burner head 41 and the lower open end 28 of combustion chamber 11 to attempt to ignite gas rising upwardly from burner head 41.

The valve means 16 includes electrically-operated gas valves 36, 43, arranged in the first and second branch conduits 33, 34, respectively. Each of valves 36, 43 may be selectively operated by the control means 18 to block its associated branch conduit to prevent the gaseous mixture from flowing from the source (not shown) to its serviced burner, or to alternatively unblock its associated branch conduit to enable such flow. Hence, if valve 36 is opened and valve 43 is closed, the gaseous mixture will be permitted to flow from the source through the main supply conduit 32 and the first branch conduit 33 to the combustion chamber 11. Conversely, if valve 36 is closed and valve 43 is opened, the gaseous mixture will be permitted to flow from the source through the main supply conduit 32 and the second branch conduit 34 to the oxidation chamber 13. Thus, by selectively closing one of these valves and opening the other, the valve means 16 functions to permit and direct such flow to either the combustion chamber or to the oxidation chamber. Obviously, if gas valves 36, 43 are both closed, the conduit means 15 will be blocked to prevent such flow to either
the combustion chamber 11 or the oxidation chamber 13. It should be clearly understood that in lieu of providing a separate valve in each branch conduit, a single three-way valve, capable of performing the same functions as valves 36, 43 may be arranged at the juncture of the main supply conduit 32 with the first and second branch conduits, 33, 34, respectively.

Referring now conjunctively to FIGS. 1 and 2, the control means 18 broadly includes igniting means, such as spark generator 49, arranged between the oxidation chamber lower end 30 and burner head 48; heat sensor switch 50 and high temperature limit control switch 51 mounted on enclosure side wall 21 and operatively arranged above the oxidation chamber 13, and a flame sensing relay 52 having flame sensor probes 53, 54 arranged above the combustion chamber burner head 41 and the oxidation chamber burner head 48, respectively (FIG. 1).

Adverting now to FIG. 2, the electrical circuitry of the apparatus is schematically depicted as broadly including manual "on-off" switch 55; high temperature limit control switch 51; spark generators 12, 49; electrical heater 14; flame sensing relay 52; heat sensor switch 50; and electrically-operable gas valves 36, 43.

An input voltage applied across circuit input terminals 56, 58 will produce a like potential between a hot wire connected to circuit terminal 56, and a ground wire connected to circuit terminal 58. This hot wire includes, in series: conductor 59 connected to circuit input terminal 56; manual switch 55 when in the closed position; conductor 60; normally closed (N/C) high temperature limit control switch 51, and conductors 61, 62, 63 and 64. The ground wire includes, in series: conductor 65 connected to circuit input terminal 58, conductors 66, 68, 69 and 70, and grounded conductor 71.

When switches 55 and 51 are both closed, current may flow through a plurality of parallel circuits severally connected to the hot wire and to the ground wire. Specifically, current may flow from hot wire conductor 61 through a first parallel circuit containing conductor 72; a first branch circuit containing, in series, conductor 73, spark generator 12, and conductor 74; a second branch circuit arranged in parallel with the first branch circuit and including, in series, conductor 75, spark generator 49, and conductor 76; and conductor 78 connected to ground wire conductor 65.

Current may also flow from hot wire conductor 62 through a second parallel circuit containing, in series, conductor 79, resistance heater 14, and conductor 80 connected to ground wire conductor 66.

Current may also flow from hot wire conductor 63 through a third parallel circuit containing, in series, conductor 81, flame sensing relay 52, and conductor 82 connected to ground wire conductor 68.

Current may also flow from hot wire conductor 64 through a fourth parallel circuit containing, in series, conductor 83; flame sensor controlled switch 84; a third branch circuit including, in series, conductor 85, heat sensor switch 50 when closed, conductor 86, solenoid valve 43, and conductor 88 connected to ground wire conductor 69; and a fourth branch circuit arranged in parallel with the third branch circuit and including, in series, conductor 89, solenoid valve 36, and conductor 90 connected to ground wire conductor 70.

OPERATION

To operate the apparatus 10 from a deactivated condition, manual switch 55 must first be closed to energize the several parallel circuits. When this switch has been closed, current may flow from the hot wire to the ground wire through spark generators 12, 49; electric heater 14; and flame sensing relay 52. However, since a "no flame" condition will be initially sensed in the combustion chamber by flame sensor probe 53, relay 52 will cause switch 84 to move to the position shown in FIG. 2, thereby attempting to operate valve 43 to deliver a flow of the gaseous mixture to the oxidation chamber 13.

Heat sensor switch 50 determines when resistance heater 14 has heated the oxidation chamber 13 to its preselected operating temperature capable of oxidizing the gaseous mixture, and thereafter closes to complete the circuit including valve 43 to operate this valve and enable a flow of the gaseous mixture to the oxidation chamber 13 through the second branch conduit 34.

When such flow of the gaseous mixture in second branch conduit 34 passes upwardly through burner head 48, spark generator 49 attempts to ignite the mixture. If the mixture is combustible, such mixture will not be ignited and a no flame condition in the oxidation chamber 13 will be sensed by flame sensor probe 54. This condition is transmitted via flame sensing relay 52 to maintain switch 84 in its present position, allowing a continued flow of the combustible gaseous mixture to pass through the second branch conduit and rise upwardly through burner head 48 to the oxidation chamber. During its ascent through the heated oxidation chamber, this combustible gaseous mixture is oxidized under the influence of heat supplied by heater 14.

Should the gaseous mixture delivered to the oxidation chamber become combustible, spark generator 49 will ignite the mixture and flame sensing probe 54 will then sense a "flame" condition in the oxidation chamber. Should this occur, flame sensing relay 52 will cause switch 84 to move to the phantom position depicted in FIG. 2, thereby deenergizing and closing valve 43 to block the first branch conduit 34, and energizing and opening valve 36. When valve 36 has opened, the gaseous mixture will be permitted to flow from the source thereof through the first branch conduit 33 to the combustion chamber 11 wherein such combustible gaseous mixture rising through burner head 41 will be ignited by spark generator 12. This combustible gas will be continuously supplied to the combustion chamber as long as flame sensor probe 53 senses the presence of a flame in the combustion chamber.

Should the gaseous mixture then become combustible, a no flame condition will be sensed by flame sensor probe 53. When this occurs, flame sensing relay 52 will cause switch 84 to revert to the solid position depicted in FIG. 2, thereby deenergizing and closing valve 36, and energizing and opening valve 43 to divert the flow of the gaseous mixture from the combustion chamber to the oxidation chamber.

The normally-closed high temperature limit control switch 51 is provided as an additional safety feature. Should the temperature in oxidation chamber 13 exceed a preselected maximum temperature, as by sustained combustion of the gaseous mixture in the oxidation chamber, switch 51 will automatically open to disconnect the electrical circuit of the apparatus from the
In this manner, the inventive apparatus 10 operates to sense or determine the combustibility of the gaseous mixture flowing through the conduit means, and to deliver such flow to the oxidation chamber if such mixture is sensed to be combustible, and to deliver such mixture to the combustion chamber if such mixture is sensed to be non-combustible. It will be noted by those skilled in this art that after the oxidation chamber has been heated to its operating temperature, the control means will automatically divert the flow of the gaseous mixture to either the combustion chamber or the oxidation chamber in response to the sensed combustibility of the mixture.

The several mechanical and electrical components of the inventive apparatus are well known to those skilled in this art and need not be specifically described. However, it is contemplated that spark generators 12, 49 may operate either continuously or intermittently, as desired.

While a preferred embodiment of the present invention has been shown and described herein, it will be understood by those skilled in this art that various changes and modifications may be made without departing from the spirit of the invention which is defined by the following claims.

What is claimed is:

1. Apparatus for oxidizing a gaseous mixture containing a potentially combustible component and flowing from a source thereof, comprising:
   - a combustion chamber having means for igniting a combustible gas delivered thereto;
   - an oxidation chamber having means for heating and oxidizing a gas delivered thereto;
   - conduit means communicatively connecting said source with said combustion and oxidation chambers;
   - valve means associated with said conduit means and operative to block said conduit means to prevent said flow and to permit and direct said flow to either said combustion chamber or to said oxidation chamber;
   - control means adapted to sense the combustibility of said mixture and to cause said valve means to direct said flow to said combustion chamber when said mixture is sensed to be combustible, and to deliver said flow to said oxidation chamber when said mixture is sensed to be non-combustible.

2. The apparatus according to claim 1 wherein said control means includes a first flame sensor operatively arranged to sense the presence of a flame in said combustion chamber for causing said valve means to divert said flow to said oxidation chamber when no flame is sensed in said combustion chamber.

3. The apparatus according to claim 1 wherein said control means includes igniting means operatively arranged to attempt to ignite said mixture delivered to said oxidation chamber, and a second flame sensor operatively arranged to cause said valve means to direct said flow to said combustion chamber when a flame is sensed in said oxidation chamber.

4. The apparatus according to claim 1 wherein said control means includes a first flame sensor operatively arranged to sense the presence of a flame in said combustion chamber for causing said valve means to divert said flow to said oxidation chamber when no flame is sensed in said combustion chamber, igniting means operatively arranged to attempt to ignite said mixture delivered to said oxidation chamber, and a second flame sensor operatively arranged for causing said valve means to direct said flow to said combustion chamber when a flame is sensed in said oxidation chamber.

5. The apparatus according to claim 1 wherein said control means further includes a temperature switch for sensing the temperature of said oxidation chamber and for causing said valve means to prevent said flow from entering said oxidation chamber when the temperature of said oxidation chamber is below a preselected minimum temperature.

6. The apparatus according to claim 4 wherein said control means further includes a temperature switch for sensing the temperature of said oxidation chamber and for causing said valve means to prevent said flow from entering said oxidation chamber when the temperature of said oxidation chamber is below a preselected minimum temperature.

7. The method of oxidizing a gaseous mixture containing a combustible component, comprising the steps of:
   - supplying a flow of said mixture from a source thereof,
   - sensing the combustibility of such supplied mixture,
   - delivering such supplied flow to a combustion chamber if said mixture is sensed to be combustible,
   - attempting to ignite said mixture and to cause said valve means to direct said flow to said oxidation chamber when said mixture is sensed to be combustible, and to deliver said flow to said oxidation chamber when said mixture is sensed to be non-combustible.

8. The method according to claim 7 wherein the step of oxidizing such combustible mixture, includes the further steps of:
   - delivering such supplied flow to a heated oxidation chamber if said mixture is sensed to be combustible,
   - attempting to ignite said mixture and to cause said valve means to direct said flow to said oxidation chamber when said mixture is sensed to be combustible, and to deliver said flow to said oxidation chamber when said mixture is sensed to be non-combustible.

9. The method according to claim 7 wherein the step of delivering such supplied flow to an oxidation chamber if said mixture is sensed to be combustible includes the further step of:
   - admitting said combustible mixture to said oxidation chamber only when the temperature of said oxidation chamber exceeds a preselected minimum temperature.