A device for the complete combustion of gaseous waste products comprising a refractory chamber divided by means of a refractory wall into interconnecting first and second compartments which have an increasing internal cross-section from the point of gas entry to gas exit, and air being introduced in controlled amounts into the stream of gaseous wastes as it traverses the length of the chamber via the first and second compartments. Supplementary heating means are provided in the first compartment to raise the temperature above the point of combustion of the gas/air mixture whenever required.

4 Claims, 4 Drawing Figures
DEIVE FOR COMBUSTION OF GASEOUS WASTES

BACKGROUND OF THE INVENTION

1. Field of the Invention
This invention relates to a device suitable for the complete combustion of gaseous waste products under varying operating conditions.

2. Description of the Prior Art
It has long been known to dispose of waste by burning it in order to produce a relatively large volume of gaseous combustion products and a relatively small volume of solid ash. Historically, waste has been consumed in incinerators directed towards the goal of providing a smaller volume of less noxious material. Commonly, incinerators employing excess air in their primary combustion chamber are used. This results in almost the entire reduction taking place in the incinerator proper. This technique has largely been rejected because it is inefficient and results in frequent pollution of the air by incomplete combustion of hydrocarbons and entrainment of solid particles (e.g. smoke) due to the high velocities developed in the burning process. More recently, units employing limited air supply in the first combustion chamber have been developed. These incinerators pyrolize the waste and generate major quantities of combustible gases which are consumed in afterburners. An improved device of this type is described in my co-pending patent application filed concurrently herewith.

A number of afterburners have been developed which will permit the emission of gases having very low pollutant contents, however, these afterburners are successful only if the gaseous waste entering is relatively constant in quality and quantity. This, in large measure, is due to inadequate design in the afterburner section. The major shortcomings are an inability to provide adequate and controlled oxidant (e.g. air) levels, inability to maintain proper temperatures during the length of time required for combustion and the inability to provide low enough air velocities to permit solid materials to drop out and remain out of the effluent stream.

SUMMARY OF THE INVENTION

It is, therefore, among one of the principal objectives of this invention to provide an improved afterburner device which will avoid the aforementioned prior art shortcomings.

In accord with the present invention, there has now been provided an afterburner device, whose operation results in complete, efficient consumption of combustible waste products, which comprises a refractory chamber divided into a first compartment and a second compartment, a refractory wall partially situated between said first and second compartments and allowing passage therebetween, entrance means being provided in the first compartment for the introduction of combustible gaseous waste thereto and exit means provided in the second compartment for the emission of combusted gaseous waste therefrom said first and second compartments having an increasing internal cross-section from the gas entrance means to the gas exit means, and fluent oxidant in controlled amount introduced into the stream of gaseous waste as it flows turbulent through the refractory chamber via the first and second compartments. Supplementary heating means are provided to the first compartment to enable the operating temperature to be raised above the combustion point of the gas/oxidant mixture whenever required.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be hereinafter more fully described with reference to the accompanying drawing in which:

FIG. 1 is a sectional elevational side view of the invention after-burner device and as illustrated mounted atop a suitable incinerator or pyrolisis chamber partially shown only by phantom lines.

FIG. 2 is a sectional front view taken along line 2—2 of FIG. 1 in the direction of the arrows.

FIG. 3 is a sectional elevational view of another embodiment of the invention showing the afterburner device in a vertical disposition rather than horizontal as in FIG. 1.

FIG. 4 is a sectional top view taken along line 4—4 of FIG. 3 in the direction of the arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the figures of the drawing and specifically to FIGS. 1 and 2 there is shown therein the invention after-burner device 10 (hereinafter referred to as afterburner) which comprises a refractory lining 12 enveloped by a cylindrical metal housing 14 forming a refractory chamber 16, hereinafter referred to as "chamber." In this embodiment the chamber is shown in a horizontally disposed condition, however, as will be described subsequently hereinbelow this is merely but one form of the invention. At the bottom of the chamber, as illustrated, the afterburner 10 has an entrance 18 through which waste gases subject to further combustion are introduced and, at the top of the chamber, an exit 20 through which combusted, i.e. fully oxidized gases are emitted, either to the atmosphere, or preferably and as partially shown by the drawing, to a stack 22 which can be conventionally constructed and is not intended to be a part of the invention. If desired a space 24 can be allowed between exit 20 and the stack 22 to enable cooling air to come in contact with the combusted waste gas.

Adjacent to the entrance 18 supplementary heating means are provided to heat the waste gases to their combustion temperatures, if necessary. Said heating means are in the form of a burner 26, usually gas or oil and only diagrammatically shown, which supplies a secondary source of heat and air directing its flame above the gas entrance approximately perpendicular thereto and in the direction of gas flow. The burner is capable of modulation from a very high input all the way down to zero, modulation being controlled by a conventional thermocouple (not shown) usually placed in the base of the stack and measuring the exhaust temperatures. Temperatures, inside the afterburner are maintained between 2000° and 2200° F.

The chamber 16 is divided into two sections by a sloping archshaped elongated partition 30, also formed of a refractory material, forming a first compartment 32 and a second compartment 34. Partition 30 is positioned at its one end 36 nearest entrance 18, at a point below an imaginary line which would be the chamber's horizontal center line, if drawn, increasing in slope to-
wards its opposite end 38 and crossing said imaginary line near said opposite end. Further, partition 30 only partially divides the chamber 16 thereby forming a connecting passage 40 between the first and second compartments.

The first and second compartments have an increasing internal cross-section starting at the entrance end of the first compartment and terminating at the exit end of the second compartment, the refractory walls diverging continuously until they reach that exit end. Thus, the first compartment 32 increases in internal cross-section from the gas entrance end to its terminus where the passage 40 (formed by partition 30) to the second compartment 34 has still a larger cross-section and finally where the second compartment's initial cross-section is again larger continuing to increase until it reaches the gas exit end. It will be apparent then that the length and slope of the partition 30 will be determined in a manner such that the internal cross-sections of the first and second compartments will increase continuously from point of beginning to end. Thus, the length and slope of the partition will vary depending on the shape and size of the chamber 16, but at all times maintaining an increasing internal cross-section starting from the entrance end of the first compartment to the passage between the compartments and finally to the exit end of the second compartment.

Surrounding the housing 14 is a plenum 42 to which air or other fluorescent oxidizer can be fed through duct 45 from a source not shown. The latter can be a conventional radial blade fan capable of providing twice as much air than is needed for combustion of all waste gases expected to be introduced.

Plenum 42 is connected to the chamber 16 by a plurality of air tubes 44 arranged in longitudinally spaced sets along the length of the housing and refractory lining with the tubes in each spaced set being in circumferentially spaced relation around the housing. As shown most clearly in FIG. 1, air tubes 44 are disposed through the refractory lining 12, preferably slanting off the prependicular slightly, in the direction of the gas flow. However, the first two sets of air tubes 44 a and b can be perpendicular to the horizontal plane of the first compartment for a reason to become more evident hereinbelow.

In another embodiment of the invention shown by FIGS. 3 and 4, the refractory chamber identified by the number 16' is disposed in the vertical position as opposed to the horizontal disposition show in FIGS. 1 and 2. All other features of the invention remain constant. That is to say chamber 16' is divided by a sloping arched shaped elongated partition 30', forming first and second compartments 32' and 34', respectively, with connection passage 40' therebetween. As before, the first and second compartments have an increasing internal cross section from entrance to exit. Similarly, there is provided plenum 42' with its chamber-connecting air tubes 44'. While the chamber is FIGS. 1-4 is shown cylindrical it is to be understood that it can be rectangular or square so long as all other features of the invention are maintained.

The afterburner of this invention can be attached to the exit opening of the main combustion chamber of an incinerator wherein solid or semi-solid waste is rendered into combustible gaseous products, as set forth, for example, in my copending application, referred to hereinabove, and filed concurrently herewith.

In operation, gas is generated from the pyrolysis of waste in the primary chamber and then passes by convective action and aspiration into the first afterburner section (32) and, aided by thermal convection and injected air direction, pass down the length of the first compartment. The gases are heated in this chamber above the combustion point by the auxiliary burner (26). If they are already hot enough for combustion, auxiliary heat is not required. As the gases pass through the first compartment, air is introduced (through air tubes 44) in staged increments and controlled in such a fashion that the waste gases do not become chilled below the combustion point and excessive localized dilution of the combustion gases does not occur. Complete mixing of the oxidizer and the waste gas takes place as the air enters the gas stream at a much higher velocity than the gas stream travels and at an angle approximately perpendicular or slightly off, to its path. Further, sharp bending of the main gas stream as it enters the first compartment (32), again as it passes from the first compartment (through passage 40) to the second compartment (34) propelled through the passage by perpendicular streams of air (air tubes 44 a and b) as it finally turns again to leave the chamber, assists in the mixing.

As air is injected into the hot, combustible gas stream, in controlled and limited quantity, the combustibles are oxidized only to the limit of the oxidant and maximum temperature rise occurs. The gases, therefore, reach and maintain the temperature necessary to insure decomposition. The gases expand due to increasing temperature and the introduction of additional combustion air and the increasing cross section of the gas path permits this to occur with a minimum of back pressure and resistance to gas flow. Gas velocities remain low and ample time is provided for combustion to take place. When the point is reached that combustible gases no longer exist, having all been converted to carbon dioxide and water, the air entering the stream serves to cool it off.

A very low velocity area exists at the extreme end of the gas path beneath the stack (22) and any significant particulate matter which remains entrained will drop out at this point (23) and be retained in the afterburner itself. A clean out door 50 is provided at this location, just above the partition end 36, to enable removal of the particulate matter.

Heat generated in the first compartment (32) passes through the wall (30) separating the two compartments (32, 34) and serves to maintain good temperatures in the second (34) further improving the destruction of the waste. The fact that the separating wall 30 is arched exposes more area for heat conductance from the first to second compartments.

Control circuits have not been described and are not part of this invention. Improved efficiency may be experienced by the control of the volume of air provided in the afterburner. This control may be accomplished by reducing or increasing air pressure available in the plenum supplying the air tubes and may be the result of sensing a reduction or increase, respectively, in the volume of waste gas entering the afterburner. Increased air would be called for by a measurement of low temperatures in the exhaust gases.

It will also be understood that use of the present invention is not confined to exclusively to waste incinerator systems, but rather it can be used also to consume
What is claimed is:

1. An afterburner device for the substantially complete combustion of gaseous waste products which comprises a refractory chamber divided into a first compartment and a second compartment, a sloping elongated refractory wall in said chamber partially situating between and forming said first and second compartments and allowing passage therebetween, entrance means provided in said first compartment for the introduction of combustible gaseous waste thereto and exit means provided in said second compartment for the emission of combusted gaseous waste therefrom, said first and second compartments having an increasing internal cross-section from gaseous entrance to exit means, the length and slope of said refractory wall maintaining said internal cross-section, and fluent oxidant in controlled amounts being introducible into the stream of gaseous waste as it flows turbulent through said refractory chamber.

2. A device according to claim 1 wherein supplementary heating means are further provided in said compartment for supplemental heating of the introduced combustible gaseous waste.

3. A device according to claim 1 wherein said sloping refractory wall has an arch-shaped transverse cross-section.

4. A device according to claim 1 wherein said fluent oxidant is introduced into the stream of gaseous waste at a plurality of spaced intervals and at planes non-parallel to said stream.