CATALYTIC OXIDATION UNIT FOR DOMESTIC OVEN EXHAUST

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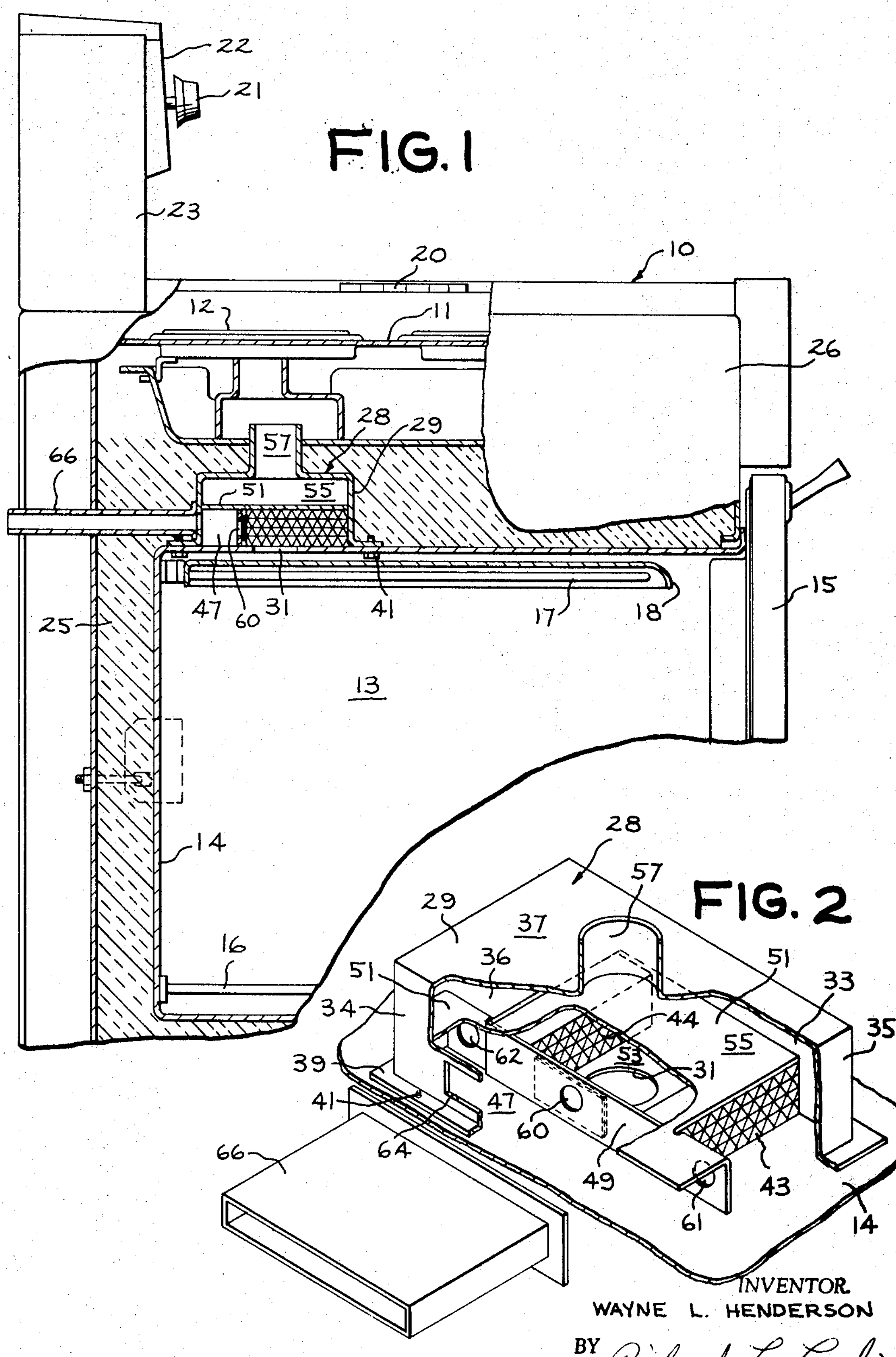

FIG. 1

FIG. 2

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FIG. 3

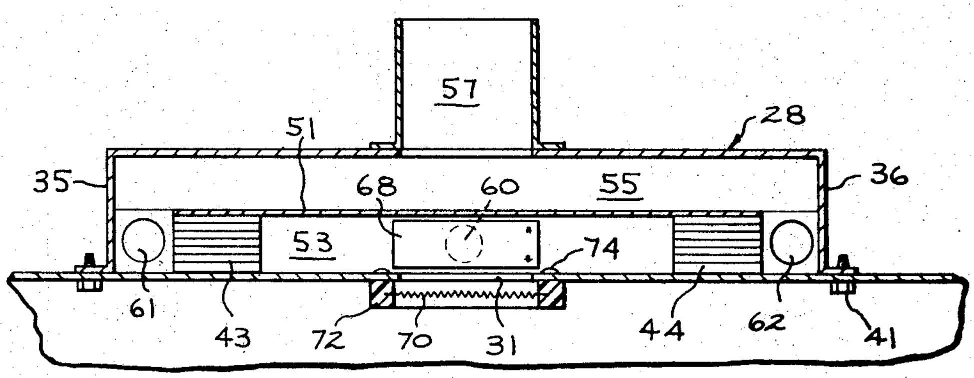
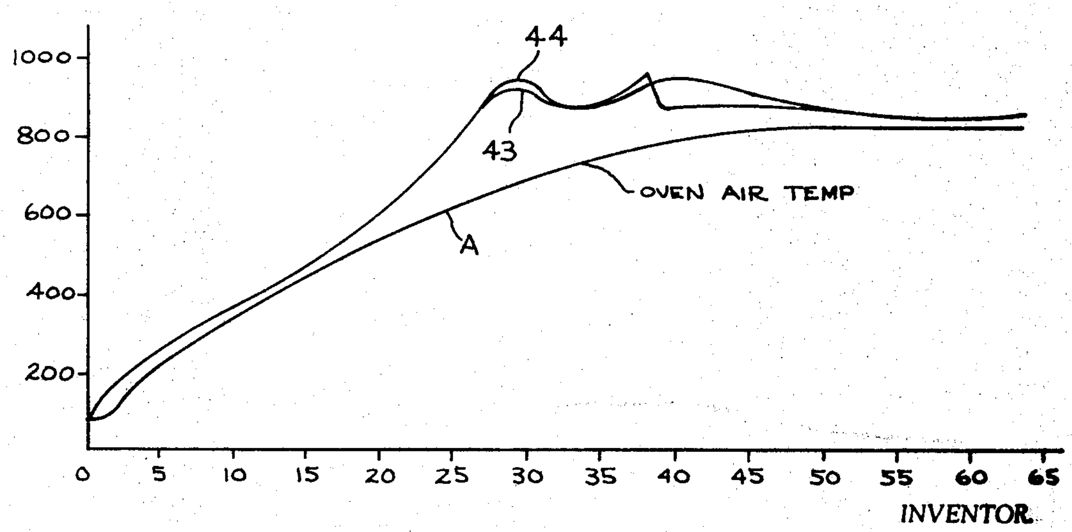


FIG. 4



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CATALYTIC OXIDATION UNIT FOR DOMESTIC OVEN EXHAUST

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U.S. Cl. 23—288 **2 Claims**

ABSTRACT OF THE DISCLOSURE

A catalytic oxidation unit useful in eliminating smoke and odors issuing from the exhaust vent of a domestic cooking oven, particularly a high temperature, self-cleaning oven using a pyrolytic process for degrading food soils. The oxidation unit comprises a hollow housing supporting a plurality of catalyst coated gas burners of cellular ceramic construction and having a high surface-to-volume ratio. The housing has an intake port and an exhaust port and includes a partition which separates the housing into intake and afterburner compartments; with the gas flow being directed from the oven cavity into the intake compartment, then through the catalyst coated gas burners into the afterburner compartment of the housing, and finally venting to the atmosphere through the exhaust port. Primary combustion air may be supplied to the intake compartment, while secondary combustion air may be supplied to the afterburner compartment of the housing to create afterburning of the oven exhaust therein.

CROSS-REFERENCE TO RELATED APPLICATIONS

The present invention is an improved modification of the ceramic oxidation unit described in the copending application of Bohdan Hurko and Raymond L. Dills, Ser. No. 396,551, now Pat. No. 3,428,435, and a second copending application of Bohdan Hurko, Ser. No. 396,549, now Pat. No. 3,428,434, both of which are assigned to the same assignee as is the present invention.

BACKGROUND OF THE INVENTION

Considerable testing of ceramic oxidation units in conjunction with the exhaust gases issuing from a self-cleaning baking oven has indicated that there are several important factors to consider in addition to the amount of surface area of the substrate on which the catalytic coating is supported. These additional factors are the velocity of the hot exhaust gases passing over the catalyst and the length of time that the gases are exposed to high temperatures within the oxidation unit before they are exhausted from the oxidation unit. Thus it is important to obtain complete burning of the gases so as to convert all of the gases generated by the pyrolytic breakdown of the soils on the oven liner to CO_2. Two methods are used for automatically controlling the velocity of the gases. First, the gas stream entering the oxidation unit housing is divided and directed in opposite directions to pass through the ceramic burners, and then the flow is reversed as the combustion gases pass up and around a partition which divides the housing into two compartments. This second compartment operates at a high temperature to assist the completion of the oxidation process before the gases are returned to the kitchen atmosphere. Moreover, the length and size of each cell of the ceramic block will reduce the flow so that the hot gases remain in the oxidation temperature longer.

The principal object of the present invention is to provide a ceramic oxidation unit with a gas flow pattern that automatically controls the velocity of the hot gases and treats these gases at a high temperature for a sufficient amount of time while supplying these gases with

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ample oxygen to insure complete degradation and conversion of the gases to CO_2.

A further object of the present invention is to provide an oxidation unit with catalytic coated cellular ceramic blocks of the type described and a delayed supply of primary air for these ceramic burners, as well as a constant supply of secondary air downstream of the burners to insure complete combustion.

SUMMARY OF THE INVENTION

The present invention, in accordance with one form thereof, relates to a corrugated ceramic, catalytic oxidation unit such as for use over the exhaust vent in the walls of an oven cooking cavity. This oxidation unit has walls forming a hollow housing with an intake port and an exhaust port, and there is a catalytic coated gas burner having a perforated ceramic substrate of deep cellular construction that is arranged at one or more sides of the intake port. A baffle is fastened over the top of the burner and also to certain side walls of the housing to form a first intake compartment upstream of the burners and a second afterburner or exhaust compartment downstream of the burner. These burners are adapted to be mounted so as to derive much of their heat from the walls of the oven cooking cavity. Modifications of this invention would include a delayed source of primary air upstream of the ceramic burners and a continuous source of secondary air downstream of the ceramic burners. Moreover, in order to increase the efficiency of the ceramic burners during the initial stage of its operation a supplementary heating means may be provided in the intake compartment to increase the ambient temperature of the ceramic burner so that catalytic action is started when the initial gases from the oven reach the burner.

BRIEF DESCRIPTION OF THE DRAWINGS

My invention will be better understood from the following description taken in conjunction with the accompanying drawings and its scope will be pointed out in the appended claims.

FIG. 1 is a left side, fragmentary, elevational view of a free-standing electric range with a ceramic catalytic oxidation unit embodying the present invention furnished over the oven vent, there being some parts broken away and others in cross-section to best show the invention and the environment in which the invention is best suited to operate.

FIG. 2 is a perspective view on an enlarged scale of the ceramic catalytic unit of the present invention with parts broken away to improve the understanding of the interior construction of the unit with its subdivision into an intake compartment and an exhaust or afterburner compartment, and also showing the primary air opening communicating with the intake compartment and two secondary air openings communicating with the exhaust compartment.

FIG. 3 is a cross-sectional elevational view of a modification of the oxidation unit of FIG. 2 showing a supplementary heater in the intake port of the unit, as well as a thermal, time delay valve normally closing the primary air opening in the lower temperature range of the intake compartment.

FIG. 4 is a temperature-time chart comparing the change of the temperatures of the two ceramic burners with respect to the change of temperature of the air at the center of the oven cavity.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to a consideration of the drawings, and in particular FIG. 1, there is shown for illustrative purposes an electric range **10** having a top cooking surface or cooktop 11 with a plurality of surface heating elements 12, an oven cavity 13 located beneath the cooktop and formed by a box-like oven liner 14 and a front-opening, drop door 15. The oven cavity is supplied with two standard heating elements; namely, a lower baking element 16 and an upper broiling element 17 that may be furnished with an inverted reflector pan 18 which overlies the same for directing radiant energy in a downward direction during broiling operations. The surface heating elements 12 are controlled by selector switches 20 located in the side-arms of the cooktop 11, while the oven heating elements 16 and 17 are controlled by a combined oven selector switch and oven thermostat 21 which is positioned in the control panel 22 of a backsplasher 23 that is vertically positioned along the back edge of the cooktop 11.

As is conventional in this art, the oven liner 14 is surrounded by a thick layer of thermal insulating material 25, such as fiberglass or the like, for retaining the heat generated within the oven cavity. A range body or cabinet structure 26 forms the external structure of the range for supporting the various elements therein, and it is provided with an outer appearance finish of porcelain enamel, stainless steel or the like as is conventional in this art.

It is standard practice to provide an oven with a vent or exhaust duct communicating with the kitchen atmosphere; especially, for use during broiling operations when a large volume of room air is passed through the oven, usually by means of a partially open oven door so as to hold down the oven air temperature. The broiling operation utilizes a maximum temperature setting of the oven thermostat to obtain a steady ON condition of the broil element 17. Moreover, it is necessary in a high temperature, self-cleaning oven which operates on a pyrolytic principle to provide an oxidation unit such as 28 in the oven vent system to degrade the oven gases and remove the smoke and odors before the gases are returned to the kitchen atmosphere. In place of a standard exhaust duct I have attached on the top wall of the oven liner a catalytic oxidation unit 28 comprising the present invention with walls forming a hollow housing 29 that is positioned over the oven vent opening 31 in the top wall of the oven liner 14.

The particular nature of the oxidation unit 28 can best be understood by studying the perspective view of FIG. 2 which is taken from the left hand, rear corner of the range 10 looking down upon the oxidation unit. First to help in the orientation, there is the top wall of the oven liner 14 with the oven vent opening 31 cut therein. The hollow housing 29 is formed by a front wall 33, a back wall 34, opposite side walls 35 and 36 and a top wall 37. Notice that there is no bottom wall, and that the vertical walls 33–36 are each provided with an outwardly turned flange 39 on the lower edge thereof so that fastening screws 41 may be inserted through suitable holes therein and through holes in the oven liner to fasten the housing 29 to the top wall of the oven liner.

The oven exhaust vent opening 31 constitutes the intake port for the unit 28. Arranged on opposite sides of this port is a pair of catalytic coated, perforated ceramic blocks 43 and 44 of thin wall cellular construction. One suitable source of this ceramic material is the Minnesota Mining and Manufacturing Company through its American Lava Corporation. This material is designated by them as "corrugated ceramic." Another available source of this ceramic material is the E. I. Du Pont de Nemours Company, which designates this material as "honeycomb ceramic." Two types of ceramic that have been found successful are cordierite and alumina. The term "corrugated ceramic" is apparently derived from the fact that the material is of cellular construction having a configuration of multple layers of corrugated paper in that there is one series of spaced, flat partitions where each pair is separated by a corrugated spacer. The corrugations are of a size with about seven corrugations per inch, and the

width of each cell is about .100 inch. The depth of the block is about one inch. The length and size of the cells of the burner are also designed to reduce the flow so that the hot gases remain at the oxidation temperature for a longer period of time. Thus it can be seen that the ceramic block is indeed perforated and of cellular construction. The designation "honeycomb ceramic" apparently comes from the fact that the cells are cut in transverse cross-section, thereby giving it the appearance of cells of honey built by honeybees.

A catalytic material such as platinum or other precious metal is applied as a thin coating to the ceramic blocks 43 and 44, and including the interior surfaces of the cells thereof which are to come into contact with the hot oven gases flowing therethrough.

The normal cooking temperatures in a domestic oven vary between about 150° F. and about 550° F. Within recent times a self-cleaning oven design has been introduced on the market and manufactured according to the teachings of the Bohdan Hurko Pat. 3,121,158 that was mentioned earlier. Such an oven design uses a pyrolytic process for removing the food soils and grease splatter that accumulate on the surfaces of the oven liner and inner door panel. This is done by raising the oven temperatures to a heat cleaning temperature somewhere above about 750° F. and holding it for a sufficient length of time to reduce the food soil and grease splatter into gaseous products which are further degraded in a catalytic oxidation unit such as unit 28, before the gases are returned to the kitchen atmosphere.

One of the first catalytic oxidation units used in the commercial self-cleaning oven was built according to the teachings of the patent of Stanley B. Welch 2,900,483, which is likewise assigned to the assignee of the present invention. Welch discloses a spiral, metal sheathed resistance heating element used in conjunction with a platinum coated wire screen that is interleaved in the turns of the spiral for oxidizing the smoke and odors and grease that might be present in the oven exhaust gases. This Welch design is a most satisfactory design from an operational viewpoint, yet the use of a metal sheathed heater contributes a great deal to its unit cost. Moreover, the woven wires forming the screen have a very small surface area, and they are contacted by the gases for only a fleeting moment as compared with the action of elongated cells of the ceramic blocks of the present invention.

The heating of the food soils and grease splatter within the oven cavity during the heat cleaning operation produces corresponding primary gaseous degradation products which are combined with a controlled amount of ambient air drawn into the oven cavity usually through a small gap around the oven door. Such degradation includes methane, ethane, water vapor, carbon monoxide, some free carbon and other elements. Smoke, odors and other underisable products are initially generated at temperatures of around 300° F., and it is important to be able to eliminate these before the hot oven gases are returned to the kitchen atmosphere.

Considerable testing has indicated that the amount of carbon monoxide in the exhaust stream coming from the oxidation unit 28 is related to the amount of odor being produced. This is an observation that has been made during a number of tests in which carbon monoxide was being measured. Carbon monoxide is, of course, odorless, but it signals a condition of incomplete burning and a product which has odor must be present. Tests have also shown that the velocity of the gases being passed through the oxidation unit effect its efficiency. The present invention will automatically control the velocity of the gases and thus will produce more complete burning and convert the oven gases to carbon dixide which is odorless. The oxidation unit 28 has an open bottom wall that is mounted directly to the top wall of the oven liner 14 so that the ceramic blocks 43 and 44 are bearing directly on the surface of the oven liner. Thus the ceramic blocks are heated by the oven liner and this reduces the temperature differential between the oven exhaust gas temperature and the temperature of the ceramic blocks. In the vicinity of the air intake opening **31** turbulence is produced and this in turn reduces the gas velocity so that the gas is in contact with the catalytic surfaces of the ceramic blocks **43** and **44** for a longer period of time than if the gases pass directly through the ceramic blocks without turbulence.

Looking at FIGS. 2 and 3, there is a supplementary air chamber **47** inside the back wall **34**, and it is defined by a vertical, parallel wall **49**, opposite side walls **35** and **36**, the top wall of the oven liner **14** and a cover plate **51** which covers both the air chamber **47** and the two ceramic burners **43** and **44**. Thus, the cover plate **51** creates an intake compartment **53** over the oven vent opening **31** and between the two burners **43** and **44**.

The portion of the cover plate **51** over the two burners stops short of the side walls **35** and **36** and actually terminates at the rear edge of each burner as is best seen in FIG. 2. Thus, the gases divided and flow through one of the burners and the side wall deflects the flow upward into an afteburner or exhaust compartment **55** where the gas flows back over the top of the cover plate **51** and passes out of the exhaust port **57**.

There is a primary air inlet **60** in the center of the wall **49** of the supplementary air chamber **47** and a pair of secondary air inlets **61** and **62**, one at each end of the wall **49** to be located downstream of the burners **43** and **44**. The back wall **34** is furnished with a large rectangular air inlet **64**, as is best seen in FIG. 2. Over this inlet **64** is fastened a thin but wide air duct **66** that extends rearwardly to the back wall of the range **10** and is open to the atmosphere. The supplementary air input system for primary and secondary air is so constructed that this air is raised in temperature above room ambient temperature prior to entering the combustion area of the oxidation unit. This heating of the supplementary air supply, as it passes through the duct **66** that is buried in the thermal insulation **25**, improves the efficiency of the oxidation cycle.

Notice that the primary air inlet **60** is provided with a bimetal valve or shutter **68** of cantilever construction which is supported from the wall **49** and normally closes the inlet **60** at gas temperatures below about 750° F. Above this temperature or other more suitable temperature, the bimetal **68** is open to supply primary air to the intake compartment **53**. Moreover, the secondary air inlets **61** and **62** are always open to the atmosphere. The size of the secondary air inlets **61** and **62** automatically controls the amount of air supplied because the change in temperature between ambient air and the exit of the burners **43** or **44** is a function of the amount of soil being oxidized.

In the second modification of FIG. 3, an auxiliary resistance heater **70** of wire or screen formation is assembled across the intake port **31** of the oxidation unit **28** to raise the ambient temperature of the gases entering the intake compartment **53** especially during the beginning of the cycle as was mentioned heretofore. The heater **70** is supported from a ring **72** of insulating material that is in turn fastened over the intake port **31** by screw fasteners **74**. The heater is adapted to be electrically connected to a 120 volt circuit for energizing the heater, when desired.

Looking at the time-temperature graph of FIG. 4, the lower curve A represents the variation of the oven air temperature with time, while there are two upper curves labeled **43** and **44** as they represent the surface temperatures of the two ceramic burners **43** and **44** respectively.

Modifications of this invention will occur to those skilled in this art. Therefore, it is to be understood that this invention is not limited to the particular embodiments disclosed, but that it is intended to cover all modifications which are within the true spirit and scope of this invention as claimed.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A smoke and odor oxidation unit that is adapted to be mounted over the exhaust vent in the walls of an oven cooking cavity, the unit having walls forming a hollow housing with an intake port and an exhaust port, and a plurality of catalyst-coated gas burner means with a perforated ceramic substrate of deep cellular construction and a high ratio of surface area to volume, at least two of such burner means being arranged within said hollow housing and located on at least two of the opposite sides of the intake port, baffle means located in said housing and arranged over the tops of said two burner means and joined to certain side walls of said housing so as to partition the hollow housing into a first intake compartment located upstream of said two burners with said intake port communicating therewith and a second afterburner compartment located downstream of said two burners with said exhaust port communicating therewith wherein the gas flowing into said intake compartment is divided into a plurality of streams which flow through said at least two burner means into the afterburner compartment, said burner means being adapted to derive much of its heat by conduction from the walls of the oven cooking cavity, and electrical resistance heater means located adjacent the first intake compartment for use at least during an initial preheat stage to heat up the gases entering the housing from the cooking cavity, the walls of the hollow housing having a primary air inlet opening communicating with the intake compartment and a secondary air inlet opening downstream of each of said two burner means in the afterburner compartment, and a normally closed thermally responsive valve cooperating with the primary air inlet opening and operable to open at temperatures of about 750° F. and above to allow primary air to mix with the hot gases issuing from the oven cooking cavity vent before passing through the burner means.

2. A smoke and odor oxidation unit as recited in claim **1** wherein a single air duct communicates with both the primary air inlet opening and the two secondary air inlet openings, the said air duct being adapted to be heated by its surrounding environment so as to preheat both the primary and secondary air before they enter the oxidation unit.

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126—21; 219—396