

[54] INCINERATOR

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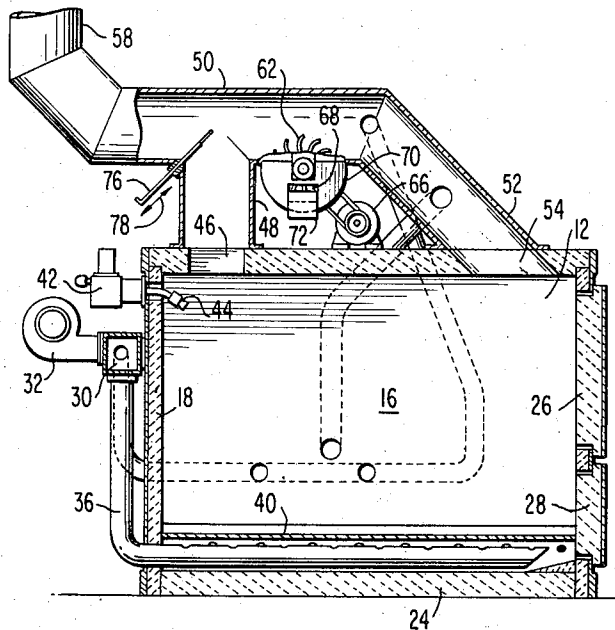
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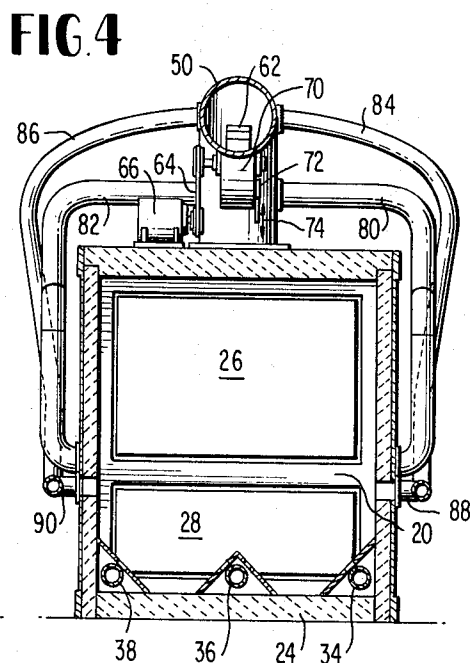
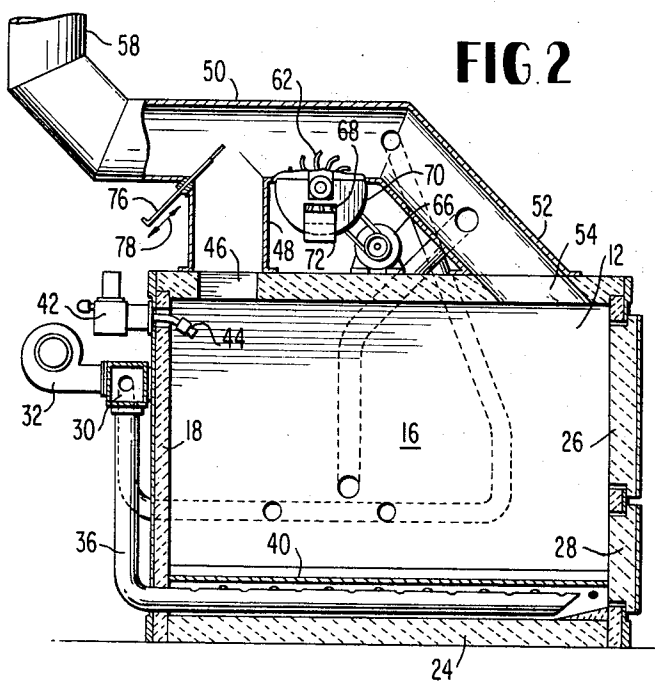
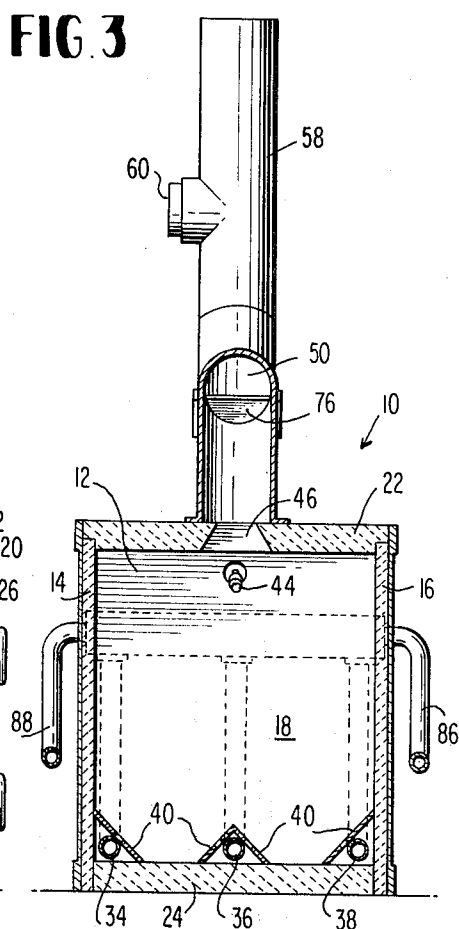
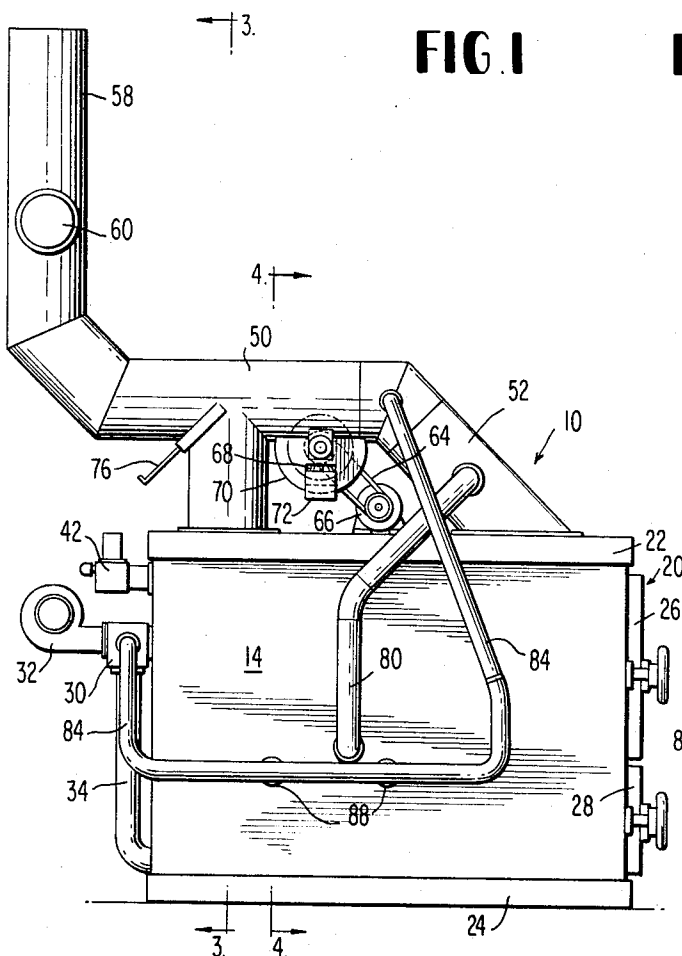
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ABSTRACT

An incinerator having a closed combustion chamber includes an exhaust gas separator for separating and directing the lighter inert exhaust gases into a stack and the heavier exhaust gases, including smoke and other solid materials, into a recirculation system for recirculation through the combustion chamber. Air required to support combustion is admitted into the recirculation system and mixed with and heated by the exhaust gases being recirculated before entering the combustion chamber, thereby permitting the temperature in the combustion chamber to increase to a level sufficient to assure complete burning of the combustible materials in the exhaust gases recirculated into the combustion chamber and to normally sustain combustion without auxiliary burners except during the beginning and end portions of a burning cycle. The exhaust gas velocity is reduced in the gas separator to facilitate separation and recirculation of the heavier exhaust gases and solids.

10 Claims, 4 Drawing Figures





INCINERATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fuel burners such as furnaces, boilers, and incinerators, and more particularly to such a fuel burner which includes means for separating and recirculating the heavier gases and unburned solids from the burner exhaust to thereby increase the efficiency of the unit and to reduce the smoke and other pollutants emitted therefrom. Since the invention is especially well adapted for use in incinerators of the type commonly employed to burn trash, garbage, and other waste products, it will be particularly described herein as incorporated in such an incinerator, it being understood that the invention is not so limited and that the term "incinerator" as used herein should be interpreted broadly enough to include furnaces and the like as well as waste material incinerators.

2. Description of the Prior Art

Various attempts have been made to recycle the combustion gases released from fuel such as trash and garbage burned in an incinerator in order to produce a clean, smokeless stack exhaust which is not repugnant to the smell and which meets increasingly stringent anti-pollution standards. Prior apparatus has usually attempted to reduce the particulate matter and unburned hydrocarbons and other noxious gases, commonly known as saturated gases, in the stack exhaust by placing a duct on the side of the stack or flue and employing a suction fan to withdraw a portion of the stack gases and unburned matter and reintroduce them into the combustion chamber. These devices have generally been unsuccessful in substantially reducing the saturated gases due to the fact that traveling particles, whether large or of molecular size, tend to travel in a straight line due to momentum. Thus, an attempt to withdraw the objectional gases from the total flow of gas in the stack has resulted in recirculating only a small portion of the heavier saturating gases which inherently are difficult to divert from their flow path due to their greater inertia. Due to this inability to separate and withdraw substantial portions of the heavier saturated gases, prior apparatus has been burdened with additional equipment such as secondary burn chambers where the exhaust gases are subjected, for example to natural gas flames, scrubbers, and electrostatic precipitators, which additional equipment has necessarily added to the expense and complexity of the device, and frequently has even added to one or another form of pollution. Further, these added features are still often not capable of removing an adequate amount of the saturated gases to meet modern emission standards.

Another disadvantage of prior incineration apparatus, particularly when used to destroy or burn waste material, has been the inability to sustain combustion without the use of auxiliary fuel furnaces. This problem has been aggravated by the quenching or cooling effect of the combustion air which is generally admitted into the combustion chamber at ambient temperature and in volumes greatly in excess of that required for the combustion of the material being burned. Further, when stack gases have been recirculated, they have generally been withdrawn at a point substantially removed from the combustion chamber and much of

their heat is lost before they are reintroduced into the combustion chamber.

SUMMARY OF THE INVENTION

5 The present invention overcomes the above and other disadvantages of the prior art by providing an incinerator with an exhaust gas recycling apparatus such that virtually all of the heavier gases and unburned solids are separated from the lighter stack gases and returned to the combustion chamber to be completely incinerated. Accordingly, it is a primary object of this invention to provide an improved incinerator which is highly efficient in operation and which emits a minimum of smoke and other pollutants.

10 Another object of this invention is to provide an incinerator wherein the heavier gases and unburned solids are separated from the exhaust gases and recycled through the combustion chamber.

15 It is another object of this invention to provide such an improved incinerator which eliminates the need for secondary exhaust gas combustion or scrubbing apparatus.

20 A further object of this invention is to provide such an incinerator which normally requires no auxiliary fuel burners for burning most combustible wastes once a minimum combustion chamber temperature is surpassed.

25 The foregoing and other objects are achieved in an improved incinerator according to the present invention which includes a combustion chamber for receiving a charge of material to be burned, air inlet means to admit air to support combustion and an exhaust outlet in communication with an exhaust stack for withdrawing the exhaust gases. A gas separation chamber connected to the exhaust outlet has two substantially opposed outlet ports, one of which is connected directly to the exhaust stack and the other is connected to a recycling duct. A constriction is located in the combustion chamber exhaust outlet adjacent the inlet to the separation chamber to produce a relatively high velocity in the exhaust gases as they enter the separation chamber. The increased cross-sectional area, or volume, of the separation chamber results in an abrupt and substantial reduction in the velocity of the exhaust gases as they pass from the exhaust outlet into the separation chamber. The reduction in velocity in the separation chamber facilitates separation of the heavy gases and unburned solids (saturated gases) from the remaining lighter exhaust gases, with the saturated gases being drawn into the recycling duct where they are mixed with a predetermined amount of ambient air and reintroduced into the combustion chamber for complete combustion. The lighter gases (inert gases) are exhausted to the atmosphere via the exhaust stack.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other details and advantages will be apparent from the following detailed description of the invention, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevation view of an incinerator embodying the invention;

FIG. 2 is an elevation view, in section, of the structure shown in FIG. 1;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 1; and

FIG. 4 is a sectional view taken along line 4—4 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in detail, an incinerator according to the present invention is indicated generally by the reference numeral 10 and includes a generally rectangular combustion chamber 12 defined by opposed side walls 14, 16, back wall 18, front wall 20, top 22 and bottom 24. The front wall 20 includes a large charging door 26 and a smaller clean-out door 28 adjacent the bottom of the incinerator. Doors 26, 28 are dimensioned to fit snugly into openings in the front wall to form a substantially air-tight closure during operation of the incinerator.

An elongated generally rectangular air manifold 30 is mounted on the rear wall 18 and an auxiliary air blower 32 of conventional construction is provided to supply air to the manifold. Three air supply tubes 34, 36, 38 are mounted in fluid communication with manifold 30 and extend through the rear wall 18 adjacent the bottom thereof for supplying combustion air within the combustion chamber 12 along the bottom wall 24. Suitable cover plates 40, each having air openings at spaced intervals therealong, are provided above the air supply tubes along the bottom wall 24 to distribute air along the full length of the combustion chamber adjacent each side and along the center thereof.

A conventional fuel burner assembly 42, including a fuel nozzle 44, is mounted on the rear wall 18, with the nozzle 44 being positioned to direct a flame downwardly and toward the front wall of the combustion chamber during operation of the burner. The fuel burner 42 incorporates a pyrometer or other temperature sensor for sensing the temperature within the combustion chamber and for stopping the fuel burner when the combustion chamber temperature reaches a predetermined level and for again igniting the burner when the temperature subsequently falls below the predetermined minimum as combustion of the incinerator charge nears completion.

An exhaust outlet 46 is provided in the top wall 22 adjacent the rear central portion thereof to provide an escape for the combustion gases from the combustion chamber. Mounted on the wall 22 above the opening 46, and in fluid communication therewith, is a short vertically extending conduit or pipe section 48 which, in turn, is connected directly into the side of a short horizontally extending conduit or pipe section 50. The pipe sections 48, 50 are assembled in the form of a pipe tee, with the tee section forming a separation chamber for the exhaust gases as described more fully hereinbelow.

One leg of the pipe 50 extends toward the front of the incinerator above wall 22 and is connected to a downwardly inclined pipe section 52 connected to a return opening 54 in wall 22 to provide a recirculation path or duct leading back into the recirculation chamber 12 for a portion of the gases exiting through outlet 46. The opposite end of the pipe 50 is directly connected, through an elbow 56, to an exhaust stack 58 having a barometric damper 60 mounted therein for admitting air and thereby controlling the pressure within the stack.

A conventional draft inducing fan or blower 62 is mounted on the conduit 50 in position to induce a draft through the recirculation duct 52 back into the com-

bustion chamber 12. The fan 62 is driven, through belt 64 by a conventional electric motor 66 mounted on the top of wall 22. An opening 68 is provided in the blower housing 70 to admit combustion air to be drawn into the fan to be mixed with and heated by the exhaust gases being recirculated before the mixture is reintroduced into the combustion chamber. The volume of combustion air introduced into the combustion chamber may be controlled by a movable cover plate 72 slidably mounted on the housing 70 in position to cover the opening 68. As indicated by the arrow 74 in FIG. 4, the cover plate 72 may be moved up or down, as desired, to cover any portion of the opening 68 to thereby provide the desired volume of flow between the recirculation duct 52.

An adjustable baffle 76 is slidably mounted within the pipe section 50 at the intersection of conduit 48 to provide an adjustable obstruction to the flow of gases out the exhaust stack 58. As indicated by the arrow 78, the position of the baffle 76 may be adjusted to provide the desired balance of flow between the recirculation duct and the exhaust stack, depending upon burning conditions.

In order to provide a more even distribution of the gas being recirculated into the combustion chamber 12, and to provide for more even distribution of the combustion air admitted through blower 68, a plurality of branch conduits are provided leading from the recirculation duct 52 to convey a portion of the recirculated gas-air mixture into the combustion chamber at different points. Thus, a pair of conduits 80, 82 leading from the duct 52 enter the chamber through the side walls 14, 16, respectively, and a second pair of conduits 84, 86 lead from the duct 52 to the opposed ends of the manifold 30, with branch outlets indicated generally at 88, 90 leading through the side walls 14, 16. Thus, the recirculated gases passing through the ducts 84, 86 will be divided, with a portion reentering the combustion chamber through the branch outlets 88, 90 and the remainder passing from manifold 30 through the air supply tubes 34, 36 and 38. Thus, while most of the recirculated gases and combustion air mixture enters the combustion chamber through opening 54, a sufficient quantity of this mixture is admitted at other points to assure uniform complete combustion.

In operation of an incinerator according to the present invention, the combustion chamber is completely charged through the door 26 with a load of material to be burned, and the door 26 is replaced and sealed. Burning is commenced by operation of the auxiliary burner to ignite the charge of material and to assist in the combustion until the temperature within the combustion chamber reaches the desired temperature. Also, at the beginning of the burning cycle, the blower 32 is operated to supply combustion air into the bottom of the combustion chamber, thereby assuring an adequate supply of combustion air to initiate and sustain full combustion of the fuel during operation of the auxiliary burner.

The draft control or recirculation fan is continuously driven to create a draft in the recirculation duct 52 so that all combustion gases and any excess combustion air exits the combustion chamber 12 through the outlet 46. The cross-sectional area of the outlet 46 is substantially less than the area of the pipe 48, and is particularly less than the combined areas of the opposed ends of the horizontally extending pipe 50 so that the veloc-

ity of the exhaust gas is substantially reduced as it passes from the restricted outlet 46 to the separation chamber defined by the pipe sections 48 and 50. Further, as indicated in FIG. 3, the constricted exhaust outlet 46 may have its walls inclined to produce a Venturi effect, thereby accelerating the gases as they pass through the outlet. The abrupt velocity change as the gases pass through the constricted outlet 46 produces a tendency for the lighter or inert gases to separate from the heavier gases and unburned solids, apparently due to a "snow fence" effect, which separation facilitates the removal and recirculation of the saturated gases while permitting the inert gases to escape up the stack 58. The gas separation in the separation chamber is in two stages, the first taking place immediately following the exhaust outlet 46 and the second stage produced by the further velocity reduction and direction change taking place as the gases enter the tube 50 and separate into two flow paths. The effect of the baffle 56 also is to impart a velocity component to the heavier gases and solids in the direction of the recirculation duct rather than toward the exhaust stack. This velocity component combined with the draft induced by fan 62 results in the heavier gases being recirculated while the lighter inert gases are permitted to escape up the stack.

As the temperature within the combustion chamber 12 reaches a level to sustain combustion without the aid of the auxiliary fuel, burner 42 is automatically shut-off and at the same time blower 32 is stopped. Since the combustion chamber is essentially sealed, the only combustion air entering the chamber is admitted through the opening 68 in the housing 70 of the draft inducing blower 62. This combustion air is thoroughly mixed with the very hot exhaust gases and reintroduced into the combustion chamber at a relatively high temperature so that there is little quenching effect by the introduction of the combustion air. This preheating of the combustion air, coupled with the careful control of the volume of combustion air admitted during this phase of the operation, permits operation of the incinerator throughout the major portion of the burning cycle without the use of auxiliary fuel. The amount of air required for complete, smoke-free combustion can readily be determined by experiment or by reference to available publications. The optimum amount of combustion air will depend upon the type of fuel being burned, the temperature within the combustion chamber and other variables which may readily be determined to maintain the desired combustion air flow into the incinerator while at the same time assuring against excessive air flow which reduces the burning temperature and may increase the amount of smoke and other solids such as fly ash in the exhaust.

An important feature of the invention also resides in a carefully controlled balance between the pressures within the exhaust stack and the pressure within the recirculation chamber. Obviously, excessive draft in the stack would overcome the effect of the draft inducing fan 62 while too little draft would result in poor combustion and eventual failure. The barometric damper 60 can readily be adjusted to maintain the desired control by admitting greater or lesser amounts of ambient air into the stack to control the draft. Thus, during initial start up, the damper 60 will normally be closed, but will gradually open as temperature of the exhaust gases builds up to increase the draft.

While I have disclosed and described a preferred embodiment of my invention, I wish it understood that I do not intend to be restricted solely thereto, but that I do intend to include all embodiments thereof which would be apparent to one skilled in the art in which come within the spirit and scope of my invention.

What is claimed is:

1. In an incinerator of the type including an enclosed combustion chamber for receiving a charge of material to be burned and having air inlet means for admitting air to support combustion and an exhaust outlet, and an exhaust stack connected in fluid communication with said exhaust outlet for withdrawing exhaust gases from said combustion chamber, the improvement comprising a gas separation chamber having an inlet connected to said exhaust outlet and first and second outlet ports, said first outlet port being connected to said exhaust stack, recycling duct means including a conduit having one end connected to said second exhaust port and its other end connected to a recycling port in said combustion chamber to permit recirculation of saturated exhaust gases from said separation chamber into said combustion chamber, means producing a substantial reduction in velocity of the exhaust gases between said exhaust outlet and said separation chamber to thereby facilitate separation of the saturated gases from the combustion chamber for recycling thereto, said recycling duct means includes a plurality of conduits each communicating with said combustion chamber for delivering the recycled gases into said combustion chamber at different points, blower means connected in said recycling duct for withdrawing only a portion of the exhaust gases from said separation chamber and recirculating the withdrawn portion through said duct into said combustion chamber, vent means connected to said blower for admitting a controlled amount of ambient air into said recycling duct means whereby air from said vent and the recirculated exhaust gases are mixed in said recycling duct before entering said combustion chamber, and barometric damper means for admitting air into said stack, said damper being operative to control the pressure in said stack and thereby the pressure at said first outlet port of said separation chamber to enable said blower to withdraw and recirculate said saturated gases.

2. The incinerator as defined in claim 1 wherein said means producing said reduction in velocity of the exhaust gases comprises means defining a constriction in said exhaust outlet to produce a relatively high velocity past said constriction, said separation chamber having a substantially larger cross-sectional area than said constriction whereby the gas velocity is substantially reduced as it passes from said constriction into said separation chamber.

3. The incinerator as defined in claim 1 wherein said first and said second outlet ports are positioned in substantially opposed relation to one another and on opposed sides of said exhaust outlet and lie in planes generally parallel to the direction of flow of the exhaust gases through said exhaust outlet whereby the exhaust gases entering said separation chamber from said exhaust outlet must alter directions substantially before exiting through either of said outlet ports.

4. The incinerator as defined in claim 3 further comprising baffle means in said separation chamber for deflecting gases passing through said exhaust outlet toward said second outlet port, said baffle means being

adjustable to vary the extent of deflection of said gases passing through said exhaust outlet.

5. The incinerator as defined in claim 3 further comprising auxiliary burner means operable to initiate combustion within said combustion chamber and to maintain the temperature in said combustion chamber above a predetermined minimum.

6. An incinerator comprising, in combination, an enclosed combustion chamber for receiving a charge of combustible material to be burned therein, means sealing said chamber to prevent the uncontrolled flow of air into the chamber, an exhaust outlet in said chamber, a gas separation chamber having an inlet connected to said exhaust outlet and a pair of outlet ports, said outlet ports being spaced from one another and offset with respect to said inlet whereby exhaust gases entering said separation chamber from said combustion chamber through said exhaust outlet are compelled to materially change directions before passing through either of said outlet ports, an exhaust stack connected to one of said outlet ports for withdrawing exhaust gases from said separation chamber, a recirculation duct having one end connected to the other of said outlet ports and its other end connected to a recirculation port in said combustion chamber, blower means connected to said recirculation duct and operable to withdraw a portion of the exhaust gases from said separation chamber and to recirculate the withdrawn portion through said duct and into said combustion chamber, vent means for admitting air into said combustion chamber at a controlled rate, said vent means including means admitting

air into said recirculation duct at a point to be mixed with and preheated by said portion of the exhaust gases being recirculated and before entering said combustion chamber, and barometric damper means for controlling the pressure in said stack at said first outlet port.

7. The incinerator as defined in claim 6 further comprising gas velocity control means producing a substantial reduction in velocity of the exhaust gases within said separation chamber to thereby facilitate separation and recirculation of the heavier gases and particulate material from the exhaust gases entering said separation chamber from said combustion chamber.

8. The incinerator as defined in claim 7 wherein said velocity control means comprises means defining a constriction in said exhaust outlet, said constriction being operable to produce a high exhaust gas velocity through said constriction, said separation chamber having a cross-sectional area immediately adjacent said constriction which is substantially greater than the cross-sectional area of said constriction.

9. The incinerator as defined in claim 6 wherein said constriction defines means defining an elongated generally rectangular orifice positioned within the path of the exhaust gases at said exhaust outlet.

10. The incinerator as defined in claim 9 further comprising auxiliary burner means operable to initiate combustion within said combustion chamber and to maintain the temperature in said combustion chamber above a predetermined minimum.

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