United States Patent

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[54] **INCINERATION PROCESS AND UNFIRED AFTERBURNER APPARATUS**
36 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** ..... **110/7 R,** 110/14, 110/119
[51] **Int. Cl.** **F23g 5/06**
[50] **Field of Search** ..... 110/7 R, 8 R, 8 A, 14, 15, 18, 119

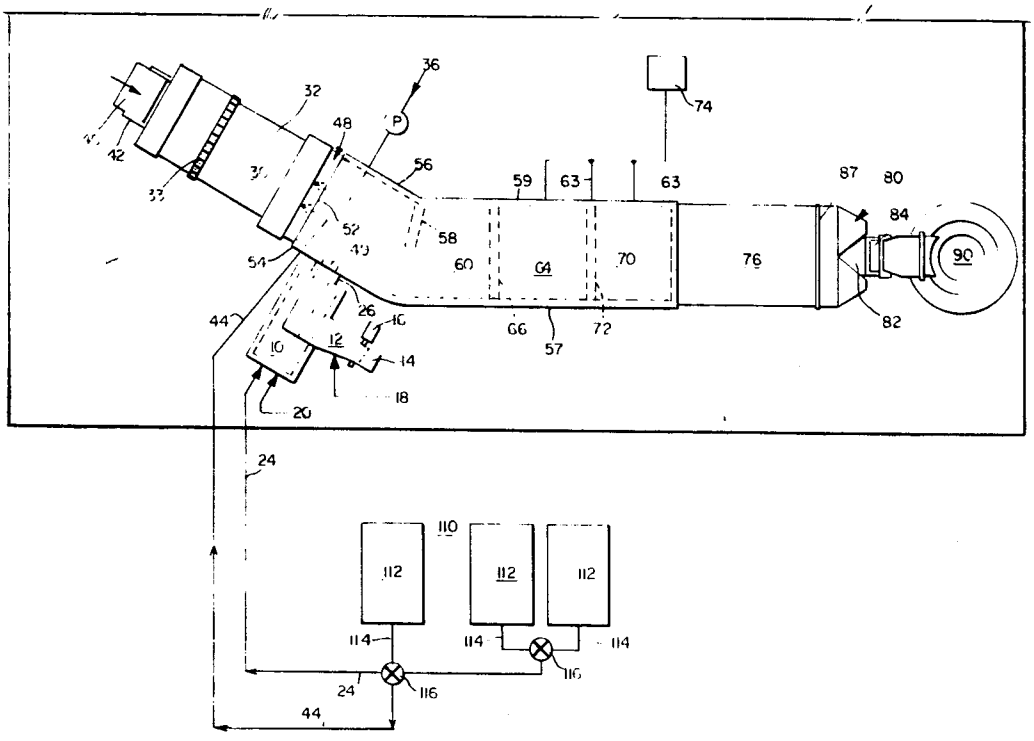
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ABSTRACT: Process for achieving complete and relatively inexpensive combustion of solid, semiliquid, and liquid combustible waste materials, and combinations thereof, having low heat value, by incompletely burning a combination of such materials in a first furnace to produce a combustible gaseous exhaust stream, achieving complete combustion in a second furnace of combustible high heat value waste materials to produce a noncombustible gaseous stream, intimately admixing the two streams in an unfired afterburner, without the addition of heat from an auxiliary heat source, while maintaining a minimum admixture temperature above the temperature required for autoignition of the combustibles in the first stream, whereby the heat produced by combustion of the high heat value waste materials is utilized for the spontaneous ignition and complete combustion of the incompletely burned materials. Liquid wastes of high heat value and of low heat value are separately stored, and are variously blended for feed to the first furnace and the second furnace in accordance with the heat requirements of the system to achieve complete combustion of all wastes being burned. The apparatus particularly adapted to perform the process comprises a pair of furnaces, a refractory-lined afterburner chamber having no auxiliary heat source, duct means interconnecting said afterburner chamber and each of said furnaces, and exhaust means defined by said afterburner for permitting exhaust of the burned gas stream after combustion is completed. The apparatus preferably includes appropriate draft handling, gas cooling, and particle removal means to render the gaseous atmospheric discharge relatively pollution-free.



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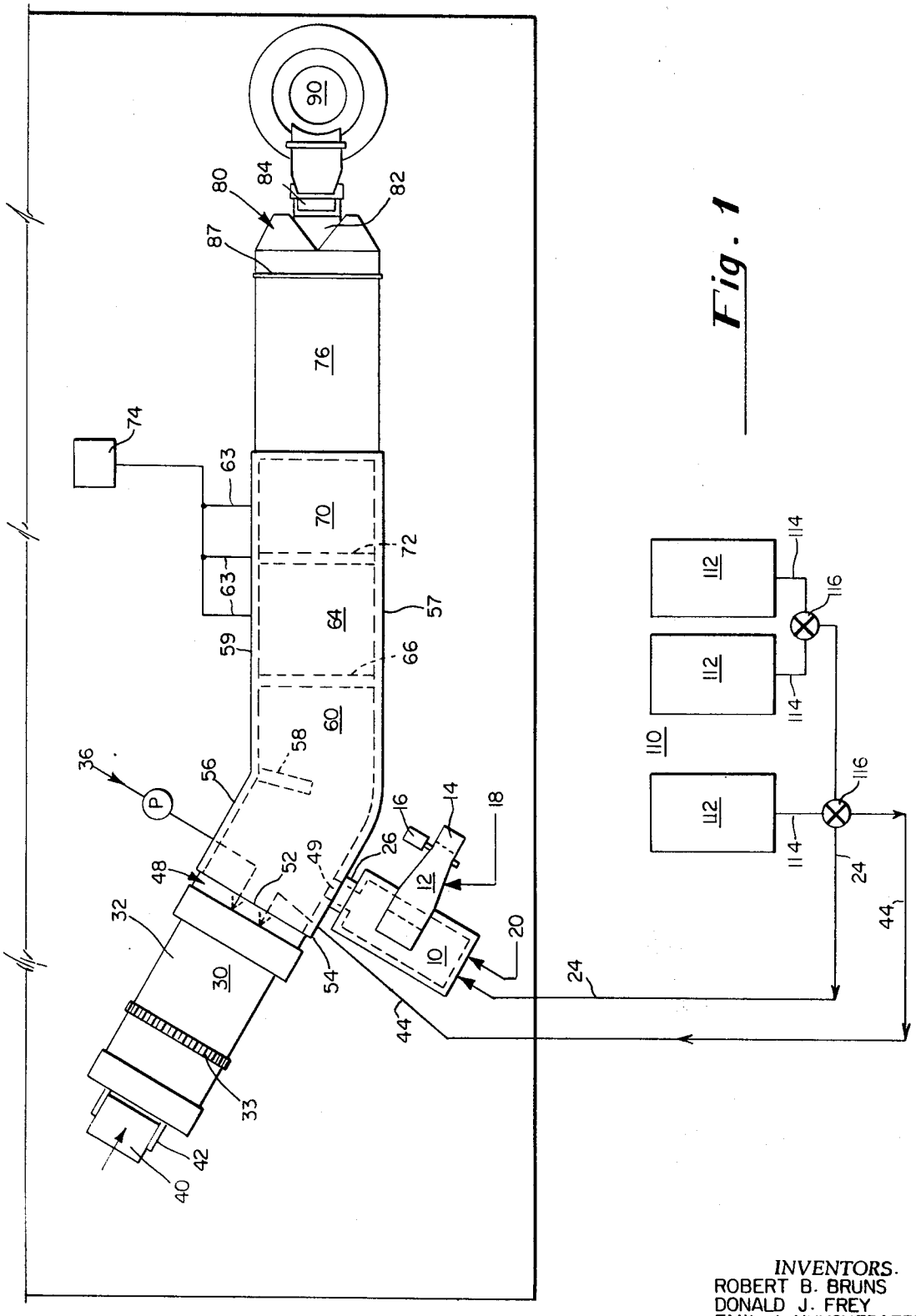


Fig. 1

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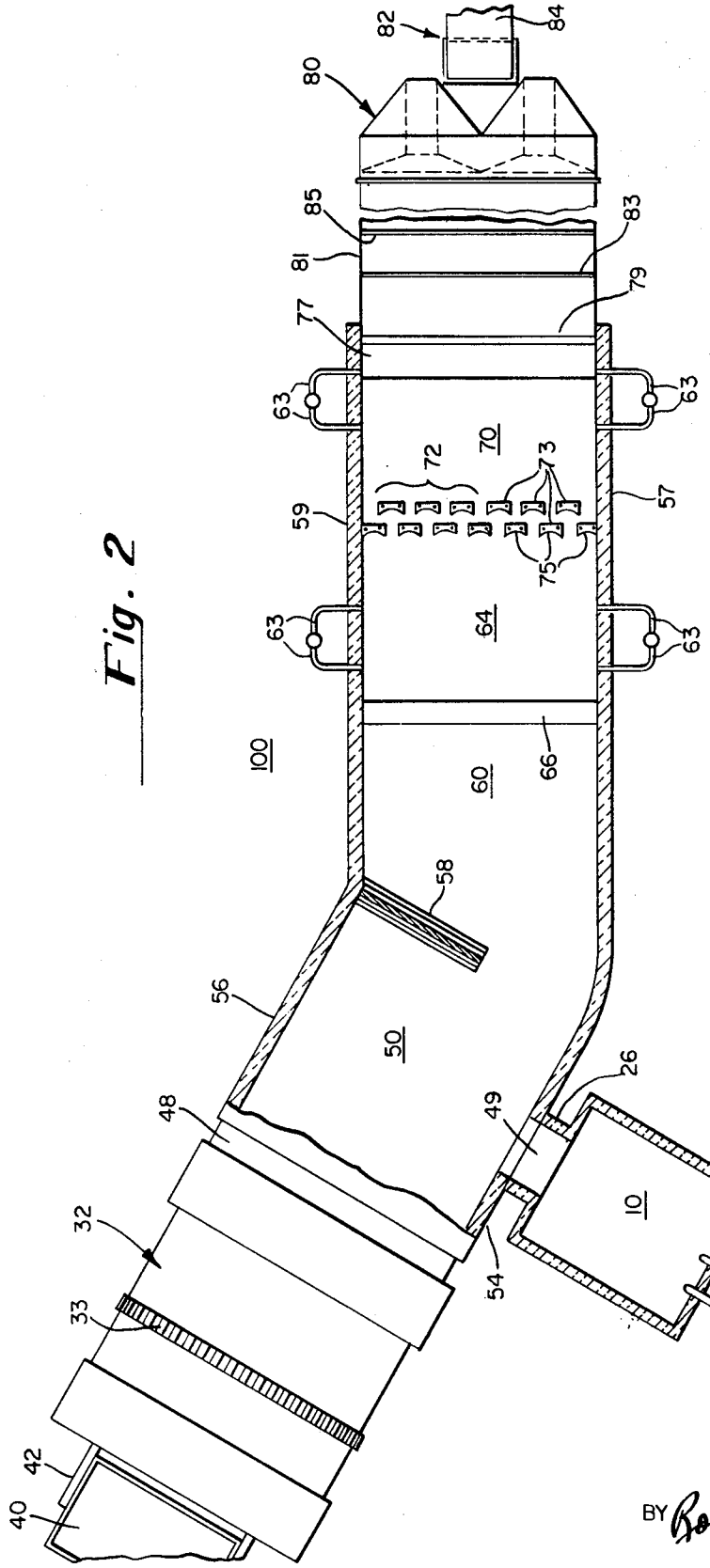


Fig. 2

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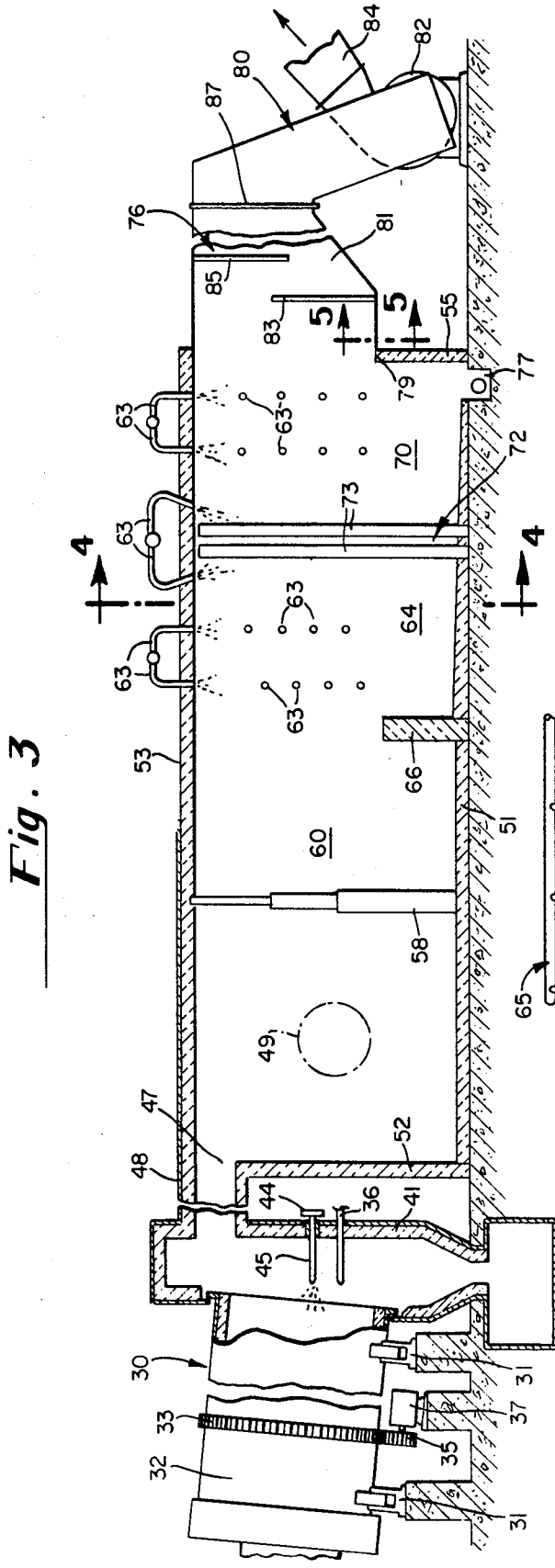


Fig. 3

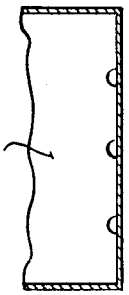


Fig. 5

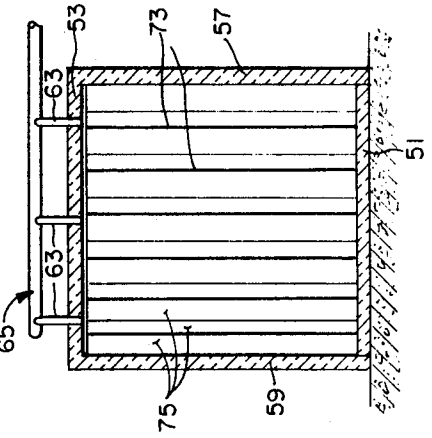


Fig. 4

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INCINERATION PROCESS AND UNFIRED AFTERBURNER APPARATUS

FIELD OF THE INVENTION

This invention relates to the field of incineration of organic and other combustible waste materials, such as the materials which are by-products of industrial chemical production processes. As is well known, recent pollution control laws prevent the disposal of industrial waste materials in manners which can contaminate public facilities. Therefore, a desirable and convenient way of disposing of organic and other combustible waste materials is by complete combustion of these materials, in such a manner that the only residue is a relatively lightweight ash, which may be trucked away and disposed of as land fill and the like. Any particulate materials which would otherwise exit the incineration process through the flue system may be suitably wet scrubbed with water to reduce the temperature of and remove entrained particles from the effluent stream, or electrostatically precipitated to remove entrained particles, in order that the gaseous discharge of the incineration process does not produce atmospheric pollution.

Since these incineration processes are nonproductive, and do not usually produce commercially useful byproducts, it is most desirable to maintain the construction cost of incineration systems, and the cost of operating these incineration systems, as low as possible, in order to achieve optimum economy of operation, while maintaining optimum efficiency of waste disposal within the limits of air pollution emission standards established by federal and state agencies.

In some instances, services may be provided for collecting liquid, semiliquid and solid organic and other combustible wastes from plant sites and other waste-producing sites at which it is not economical to build incinerators, and for trucking these collected wastes to central incinerator facilities at which the wastes from many industrial plants and/or other waste-producing facilities are incinerated, with each manufacturing plant and other facility paying a fee for the hauling away and incineration of its wastes. In other instances, large industrial plant complexes produce wide varieties of combustible wastes in large quantities which can economically justify the construction and operation of onsite waste incineration facilities. In these circumstances it is desired to achieve optimum combustion efficiency of combustible materials at the minimum initial cost for incineration equipment, and minimum operating cost for day-to-day operation of these incinerator units.

The process and apparatus of this invention relate to an improved process and improved apparatus for more efficiently achieving combustion of solid, semiliquid, and certain liquid combustible waste materials and combinations thereof, at minimum initial expenditure for incineration plant and minimum outlay for plant operating expense.

As used herein, a "waste material" is a combustible low viscosity liquid, a combustible solid, or a combustible high viscosity material which has substantially no economic value under the circumstances of its production (except as it may have economic value in the practice of the process of this invention). It is to be noted that some waste materials are substantially valueless as fuels, because of their low heat value, particularly when compared with the high cost of transporting them to a place where they might have utility as fuels. For example, a very low heat value fuel may have economic value if it is produced in a region which has no other sources of fuel and where a considerable cost premium must be paid to have efficient fuels transported into the region; thus, the economic value (or lack thereof) of a material must be evaluated in terms of its circumstances of production.

As used herein, a "high heat value" waste material is a waste material which, when ignited, produces sufficient heat to independently support complete combustion of the material. As used herein, a "low heat value" waste material is a waste material which, when ignited, does not have sufficient heat value to independently support complete combustion of the material. It is to be noted that a composition may, under some circumstances be a low heat value material as defined herein and under other circumstances may be a high heat value material. For example, a highly combustible material may have so great a quantity of water or of another compound admixed therewith that the combination is a "low heat value" material. Thus, particular combustible waste material compositions may be differently utilized, as "low heat value" materials or as "high heat value" materials, in the practice of the process of this invention, depending upon the other compounds or compositions with which they are admixed and the relative quantities thereof.

Also, as used herein, a "low viscosity liquid" is a liquid which may be atomized; and a "high viscosity material" is a material, which may be a liquid or an amorphous material, which cannot be atomized. Atomization is a process for breaking up a liquid, which may have low viscosity or high viscosity, into sufficiently small particles that the surface area of the particles and the amount of air with which the particles may be mixed are sufficient to permit complete combustion of the particles if ample heat is provided for combustion. Atomization may be achieved in numerous ways. For example, some liquids may be atomized by the use of an atomizing nozzle; other more viscous, liquids may be atomized by the use of a rotating cup atomizer. In some circumstances, high viscosity materials may be atomizable, but the rate at which they may be atomized or the expense of atomizing may be such that these materials cannot be atomized economically for use in the process of this invention. Accordingly, whether a material is atomizable or not, may depend upon the particular circumstances of and equipment for treatment of the material.

STATE OF THE ART

Atomizable organic and other combustible wastes, having a high heat of combustion, are relatively easy to completely burn, with a minimum outlay for equipment and for operating expenses. Typically, low viscosity liquid wastes having high heat value may be burned in a cyclone-type furnace, into which the liquid is introduced in an atomized form, and which is burned in the presence of at last a stoichiometric quantity of air. Such a furnace will achieve substantially complete combustion of these liquid wastes, without the necessity for the use of any additional fuels, except the relatively nominal amount of fuel which may be used to initiate combustion, to preheat the air in the furnace, and perhaps to volatilize the liquid.

On the other hand, complete combustion of high heat value and low heat value solid organic and other combustible waste materials, high viscosity materials, low viscosity liquids having low heat value, and low viscosity liquids having substantial quantities of suspended solid, is substantially more difficult to achieve. With respect to the solids and high viscosity materials, this difficulty is due in part to the increased difficulty and inefficiency of oxidizing a large mass which cannot readily be atomized into small particles, such as rubber, for example. In the past, incineration of solid wastes, high viscosity wastes, and low heat value, low viscosity liquids has been achieved by the use of furnaces in which incomplete combustion is accomplished, and the unburned combustible materials are volatilized and entrained in the gaseous exhaust stream. The furnace exhaust, comprising completely burned combustible materials, is fed to an afterburner, in which combustion is completed. The afterburner consists of a refractory-lined chamber having an inlet conduit or conduits, an outlet conduit, and a source of auxiliary heat, which is usually provided by a gas or fuel oil burner located within the afterburner chamber and utilized to supply the additional heat of combustion necessary to complete combustion of the unburned materials in the exhaust stream of the furnace.

The afterburner chambers of the prior art are provided with a fuel-burning burner means located therein, in order to

complete combustion of incompletely burned wastes. Because the temperature of operation of an afterburner is quite high (on the order of at least 1,200° F.), the auxiliary burners utilized in afterburners have had to be constructed of high temperature alloys, in order to withstand the high temperatures of the afterburners' operation. The useful life of such fuel-fed auxiliary burners is usually rather short, since they must be replaced often due to the damaging effect of the high temperatures in which they operate. Too, these auxiliary burners must substantially constantly be supplied with commercial fuel, which represents a substantial and continuing expense of the operation of the afterburners which were heretofore necessary to complete the combustion of low heat value liquids, solids, and high viscosity materials in the incineration processes of the prior art.

BRIEF SUMMARY OF THE INVENTION AND ADVANTAGES OVER THE PRIOR ART

The process of this invention utilizes that heat produced by the substantially complete combustion of liquid waste materials having high heat value as the heat source for the completion of combustion of incompletely burned solids, high viscosity materials, and low heat value liquid waste materials, to avoid the need for an auxiliary fuel burner in the afterburner. In the process of this invention a furnace exhaust gas stream of substantially completely burned high heat value, low viscosity liquid waste materials is combined with the exhaust gas stream of a furnace for producing an exhaust of incompletely burned combustible materials, in intimate, turbulent admixture in an afterburner chamber without the further addition of extrinsic heat from an auxiliary burner. The admixture is regulated by maintaining the relationship between the heat rate and temperature of the completely burned exhaust stream and that of the incompletely burned exhaust stream such as to permit maintenance of the temperature of the admixture at a level above the spontaneous ignition temperature of the unburned components of the admixture, whereby the heat of the completely burned exhaust stream will supply the additional heat of combustion necessary to complete combustion of the unburned components of the other stream. In the process of this invention the combustion of the completely burned materials is desirably achieved in the presence of an excess of about 20 percent of air, based on the stoichiometric amount needed for complete combustion of the waste material. The exhaust stream of incompletely burned waste materials usually includes a limited excess of air, based on the stoichiometric amount needed for complete combustion of the combustible materials in the stream, in order to have sufficient air available in the afterburner Chamber for complete combustion of the unburned materials therein, without wasting heat or requiring an unnecessarily large fan for drawing the gases through the incinerator unit.

The apparatus of the invention comprises a pair of furnaces with exhaust ducting, preferably discharging their contents angularly with respect to each other, and connecting the furnaces with a refractory-lined afterburner chamber having an exit port and having no auxiliary burner unit to function as a source of extrinsic heat to the exhaust streams of the two furnaces which admix in the afterburner.

The process and apparatus of the instant invention avoid the shortcomings of the prior art process and apparatus for achieving complete combustion of solids, high viscosity materials, and low heat value, low viscosity liquids, by utilizing the exotherm of the complete combustion of high heat value, low viscosity liquid waste materials as the heat source for the completion of combustion of the low heat value wastes in an unfired afterburner chamber. Thus, by properly coordinating and combining the output stream of the furnace for completely burning low viscosity liquid waste materials having high heat value, and the output stream of another furnace with incompletely burns other wastes, and by adjusting the relative quantities and heat contents of the streams which commingle, in order to provide adequate heat from the former stream, the heat of the former stream is utilized to complete the combustion of the unburned waste materials in the latter stream. This completion of combustion is achieved in a refractory-lined afterburner chamber, in which an intimate and turbulent admixing of the two streams takes place, so that combustion of the combustible exhaust stream is completed in the afterburner chamber without the necessity of adding extrinsic heat from an auxiliary burner.

Thus, the completely burned exhaust stream is maintained at a temperature of at least about 1,200°F., preferably a temperature in excess of 2,000°F., and most preferably a temperature in the range from about 2,500°F. to about 2,800°F., and having a heat output in the range from about 15 million B.t.u./hr. to about 75 million B.t.u./hr. by proper selection of low viscosity liquid waste materials having a high heat value. This heat output is preferably achieved by a furnace output of up to about 85,000 pounds per hour of effluent gas stream.

The temperature of the exhaust of the furnace in which incomplete combustion takes place is maintained at least at about 850° F., and most preferably is in the range from about 1,200° F. to about 1,500° F. at a heat output in the range from about 15 million B.t.u./hr. to about 60 million B.t.u./hr. In the event that an exhaust temperature of at least 850° F. cannot otherwise be achieved, the furnace may be provided with a burner for heating the combustible materials therein to a temperature of at least about 850° F.

The two exhaust streams are intimately admixed under turbulent flow conditions in the afterburner chamber, and the temperature of the admixed gases in the afterburner chamber is maintained above the spontaneous combustion temperature of the combustibles in the admixture, while allowing a sufficient admixture residence time in the afterburner chamber to permit completion of combustion.

Thus, the heat produced by complete combustion of high heat value, low viscosity liquid waste materials is utilized for the completion of combustion of the other waste materials, in the afterburner, avoiding the initial expense of building an auxiliary burner unit into the afterburner, avoiding the costs for replacement of such auxiliary burners, and avoiding the recurring operating expense of gas or fuel oil for the operation of such a burner unit.

In the practice of the process of this invention, a variety of liquid waste materials which are produced from one or many chemical production facilities are separated into high heat value and low heat value liquid components and are separately stored according to their heat values. The high heat value components are preferably burned in a cyclone-type furnace, which is most preferably a cyclone furnace of the type described in U.S. Pat. No. 2,678,615. The low heat value, low viscosity liquids are burned, together with high viscosity materials and solid materials, in a furnace, such as a rotary kiln, which is designed to more efficiently burn such materials.

In most applications of this invention there will be a wide variety of types and quantities of liquid waste materials required to be burned. These variations may change frequently, depending upon the natures and amounts of the outputs of a large number of industrial plants or other facilities producing combustible wastes. The various liquids will preferably be stored in various storage tanks, depending on their amounts and heat contents. The contents of these storage tanks will then be combined, using appropriate piping and metering apparatus, to provide appropriate mixtures of high heat value liquids and low heat value liquids for respective input to the furnace which produces a noncombustible exhaust stream and the furnace which produces the combustible exhaust stream. Depending upon the demands of the system at any given time, and the relative amounts and heat contents of the available high heat value liquids and low heat value liquids, different ones of these liquids will be combined in varying proportions to produce a resulting high heat value liquid or low heat value liquid. Thus, for example, a particular compound or composition having a high heat value may, on

some occasions, be used as a component of a high heat value liquid, and on other occasions as a component of a low heat value liquid. This feature of the invention is important, because it provides the flexibility in blending waste material input streams to the furnaces which is required to efficiently use the waste materials as fuels, without utilizing commercial fuels, because of the variations in quantities and types of these waste materials required to be burned.

The types and quantities of input materials burned in the furnace which produces a combustible exhaust stream, will vary from time to time. The frequency and degree of such fluctuations cannot easily be predicted accurately or accurately controlled. Therefore, the amount of heat required to complete combustion of the combustible exhaust stream components will vary. Although these variations cannot easily be precisely predicted and controlled, they can be predicted and controlled with reasonable ease and economy within a broad range of amounts of heat required to complete combustion. It is desirable to avoid the necessity for accurately correspondingly varying the amount of heat required from the completely burned stream to complete combustion of the other stream. In a preferred embodiment of the process of this invention, the result of complete combustion of all waste materials is achieved by supplying to the furnace which produces a completely burned effluent stream an input of combustible waste materials having a substantially constant heat content which is adequate to supply the maximum amount of a range of heat amounts required for the completion of combustion in the afterburner chamber. Thus, if a range of heat amounts from about 50 million B.t.u./hr. to about 60 million B.t.u./hr. is required from the high heat value liquid furnace to complete combustion in the afterburner chamber, the high heat value liquid input to that furnace would be regulated to produce a heat output slightly in excess of 60 million B.t.u./hr. The wasted heat produced by this feature of the invention usually outweighs the additional expenses in manpower and equipment which would be required to more precisely and frequently regulate the heat output of the furnace which produces a completely burned exhaust stream.

Therefore, a primary object of this invention is to provide a process for the complete combustion of high heat value and low heat value waste materials, utilizing the exotherm of combustion of the low viscosity, high heat value waste materials to complete combustion of the other waste materials in an afterburner chamber having no auxiliary fuel burner.

Another object of this invention is provide a process for the complete combustion of solid waste materials, high viscosity waste materials, and low heat value, low viscosity liquid waste materials, utilizing a conventional furnace and an afterburner chamber which does not contain an auxiliary fuel burner to provide extrinsic heat.

Another object of this invention is to provide an incinerator apparatus comprising two or more discrete furnaces discharging into an afterburner chamber in which combustion of the exhaust from one of such furnaces is completed without heat supply from an auxiliary burner in the chamber.

An additional object of this invention is to provide a process for the combustion of a wide variety of liquid waste materials which utilizes a varying mixture of such materials for input to the furnaces used in the process, so as to obtain optimum utilization of the available heat from the wastes.

A concomitant object of this invention is to provide a process for economical combustion of a wide variety of waste materials, which achieves optimum efficiency of operation with a minimum amount of process controls and a minimum amount of manpower.

Yet another object of this invention is to provide an incinerator apparatus including an afterburner chamber and an integrated gas-processing chamber in which the afterburner output can be further processed to protect against the discharge of pollutants into the atmosphere.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan view of a schematic representation of the apparatus of this invention, including a schematic representation of a tank farm;

FIG. **2** is a horizontal partial cross-sectional view similar to FIG. **1** of the apparatus of this invention, but not showing the tank farm;

FIG. **3** is a vertical partial cross-sectional view of the apparatus of this invention taken along its centerline;

FIG. **4** is a cross-sectional view, taken along line **4—4** of FIG. **3**; and

FIG. **5** is a partial cross-sectional view taken along line **5—5** of FIG. **4**.

DETAILED DESCRIPTION OF THE INVENTION

Viewing FIG. **1**, the apparatus of this invention is seen to comprise a first furnace **10**, and a second furnace **30**, both of which are suitably connected to an afterburner section **50** of effluent gas-processing unit **100**, which also includes a heat utilization section **60**, and a spray chamber **64** which discharges into scrubber section **70**. Scrubber section **70** discharges its contents to mist eliminator **76** from which the exhaust stream is emptied into a stack **90** through which gas and some water vapor are discharged into the atmosphere. Tanks **112** of a tank farm **110** are suitably interconnected to supply varying blends of waste materials to furnaces **10** and **30**.

Furnace **10** is preferably of the cyclone type and comprises a cylindrical combustion chamber that is closed at one end and formed of a refractory material enclosed by a sheet metal casing. A combustion air inlet and preheater unit **12** is provided for supplying air to the combustion chamber and it is arranged to communicate with the chamber in tangential relation to the inner surface of the wall thereof to establish a cyclonic flow of gases within the chamber. The combustion air inlet unit contains a direct fired air preheater (not shown). A forced draft fan **14** operated by a motor **16** is employed to force air under pressure through the air inlet unit and into the combustion chamber. The air preheater is supplied with a fluid fuel through a fuel input line **18** that is suitably connected to a burner (not shown) for directly heating the air that is passed through the heater. Desirably, furnace input air temperatures in the range from about 365° F. to about 600° F., and preferably about 400° F., are maintained. Low viscosity, high heat value liquid waste materials are injected in atomized form under pressure into the combustion chamber of furnace **10** by means of an atomizing burner that is axially disposed at the closed end of the chamber. Supply pressure for the liquid waste material is preferably maintained at about 100 p.s.i., atomized with air at a higher pressure, and flow is maintained at a rate in the range from about 300 gallons per hour to about 1,500 gallons per hour through inlet line **24** from storage tanks **112**, to produce a heat content of up to about 75 million B.t.u./hr. A starting burner **21**, of well-known construction, and supplied with fuel from fuel line **20**, may be operatively disposed within the combustion chamber, for the purpose of initially vaporizing and igniting the liquid waste that is supplied to the furnace.

Because of the necessity for utilizing high heat value liquids in the furnace **10**, the input to the furnace maybe an accumulation of different liquid waste materials of different heat values (which may individually be low heat values and high heat values) from a plurality of storage tanks **112** in which the waste materials are stored, as seen in FIG. **1**, after they are separated from their more viscous components or their components having lower heat value. These various materials may be admixed in varying proportions, using proportioning equipment and pumps which are well known in the art and are schematically illustrated in FIG. **1**, to achieve a high heat value liquid input to furnace **10** which is preferably maintained at a substantially constant heat content, or which may be varied in

heat content in accordance with the needs of the system, as more fully described hereinafter.

The exhaust end of furnace **10** is connected, as by refractory-lined duct **26**, to an aperture **49** in wall **54** of gas-processing unit **100**, whereby substantially completely burned high heat value liquid wastes are discharged, in a gaseous stream, through duct **26** into the afterburner chamber **50**. The duct **26** is preferably quite short, and is preferably less than 5 feet long. The draft of the fan **14** is variable and is so regulated, in relationship to the amount and heat value of liquid waste pumped into the furnace **10**, that there is supplied to the furnace an excess of air of about 20 percent by volume, based on stoichiometric amount of air needed for complete combustion of the liquid waste in the furnace **10**, and the excess air which forms a component for the exhaust gas stream which enters afterburner chamber **50**.

The furnace **30**, for burning the solids, high viscosity waste materials, low viscosity, low heat value liquids, and low viscosity liquids containing amounts of large suspended solids, is preferably of the rotary kiln type. Alternatively, any form of furnace that is capable of effectively burning solids, semiliquids, and low heat value liquid waste materials can be considered for use in the present incinerator system. The furnace **30** is seen to comprise a large, elongated drum **32** rotatably mounted upon a plurality of roller mounts **31**, and having its axis slightly inclined to the horizontal. The drum consists of a cylindrical steel causing enclosing a refractory liner and defining an interior burning chamber. Means for imparting rotation to the drum include a ring gear **33** attached to the external surface of the drum **32**, and an operatively connected pinion **35** which is driven by a drive motor **37**. Suitable seals (not shown) may be provided at the ends of the drum in order to minimize air leakage into the interior of the kiln. The kiln is provided with a liquid input line **36** for introducing into the kiln a mixture of low viscosity liquids, which may contain suspended solid particles, and pumpable high viscosity materials, such as sludges and emulsions, all of which are pumped into the kiln **30** in admixture through the inlet line **36**. The liquid supplied to the kiln through line **36** is preferably introduced into the kiln interior through suitable spray nozzles with air or steam atomization, or in a rotary cup nozzle of a type which is well known in the art. The low heat value, low viscosity liquids and the pumpable high viscosity materials are stored in separate containers **112**, and are admixed by the use of suitable proportioners and pumps, of a sort which are well known in the art, to produce a pumpable input of controlled heat value for line **36**.

The kiln **30** has a door **38** in its front end, which can be opened so that the kiln may be manually loaded with solid materials, which are preferably dry, and which are charged into bucket **40**, which is mounted on loading arms **42** on the front of the kiln and can be tipped into the kiln to unload its solid contents. The kiln **30** has a pilot gas burner **45** which is fed with fuel through feed line **44** in a manner which is well known in the art, for initiating combustion of the kiln contents and to maintain a temperature of at least 850° F. in the kiln, if the temperature should drop below 850° F.

The design of the kiln is selected to achieve a minimum leakage of air into the kiln, which is, with presently available equipment, about a 100 percent excess of the stoichiometric amount of air necessary to achieve complete combustion of the combustible contents of the kiln. However, if rotary kilns with improved seals become available, it is preferable to limit the amount of excess air in the system to the amount needed to ensure complete combustion of all combustibles in the afterburner. The gaseous discharge of the kiln exits through refractory-lined duct **48** into an aperture **42** in wall **52** of afterburner **50**. The kiln contains a suitable ash bin **39** in its base for collecting ash from the combustion of its contents, and including means (not shown) for permitting periodic removal of the ash residue in a manner which is well known in the art.

The furnaces **10** and **30** discharge their gas outputs into the afterburner chamber **50**. The afterburner **50** is preferably a section of the large, elongated, refractory-lined incineration unit **100** which, in the preferred embodiment of the invention, also includes heat utilization section **60**, a spray chamber **64**, a scrubber section **70**, and a mist eliminator **76**. The afterburner chamber **50** is formed with its longitudinal centerline at an angle of approximately 30° with respect to the centerline of the elongated portion of unit **100**.

The gas-processing unit **100** is intended to receive the combustion gases exhausted from the furnaces **10** and **30**, to complete combustion of the unburned combustibles entrained in the gaseous effluent streams, and to ensure that the discharge from the unit **100** will be free from harmful contaminants that would otherwise be detrimental to the atmosphere. The unit **100** comprises rectangularly arranged floor, roof, and sidewalls **51**, **53**, **54**, **56**, **57** and **59**, respectively, defining an elongated enclosure whose ends are closed by end walls **52** and **55**. Each of these wall members is preferably formed of a heat-resistant refractory material and is covered by a casing that may be stiffened by appropriate structural members (not shown). The interior of the gas-processing unit **100** is separated into a plurality of compartments **50**, **60**, **64**, and **70**, that are substantially disposed in open end-to-end relationship, each of which extends across the entire width of the unit **100**.

The compartment **50** is the afterburner chamber and serves to receive the gases discharged from the furnaces, **10** and **30**, through respective openings **47** and **49** provided in the end and sidewalls **52** and **54**. Opening **47** is located at the top of wall **52**, whereas opening **49** is located at about midheight of wall **54**, as seen in phantom in FIG. **3**. An upright baffle wall **58** is disposed in spaced, parallel relationship to the end wall **52** and extends part way across the width of the chamber from the sidewall **46**. This baffle wall **58** may be formed of solid, imperforate material or, alternatively, its structure may be somewhat perforate such as a construction commonly referred to as checker-brick. The wall **58** is disposed in facing relation to the opening **47** and extends from the wall **56**. The gases discharged from furnace **30**, that enter the compartment **50** through the duct **48** and opening **47**, are directed at a right angle to the direction of flow of exhaust gases from furnace **10**, which latter gases enter chamber **50** through duct **26** and aperture **49**, thus to effect turbulent, intimate mixing of the gases from ducts **26** and **48**. The baffle **58** is so located as to obstruct the flow path of the admixed gases, to enhance this turbulent mixing of the gases, and to insure an adequate residence time of the mixed gases in the compartment **50** for complete combustion of the unburned materials entrained in the effluent gas from the kiln. The turbulence created by this manner of introduction of the two gas streams into the afterburner compartment **50**, and the specific configuration of the chamber **50** and baffle wall **58** permits thorough admixing of the two exhaust streams, so that the exhaust stream entering through duct **48** is sufficiently intimately mixed with the exhaust stream entering through duct **26** that the former stream is uniformly provided with sufficient heat to permit the autoignition and complete combustion of substantially all unburned materials in the former exhaust stream. The intimate mixture of the two gas streams is also facilitated by the flow currents created by the drawing forces induced by the fan **82** which is located at the downstream end of the unit **100**.

The completely burned gases exit the afterburner compartment **50** through the space presented between the end of the baffle wall **58** and the sidewall **54**. A portion of the gases from the afterburner compartment may exit through the baffle wall **58** if checker-brick construction is employed therefor.

When the admixed effluent streams exit the afterburner section **50** combustion is completed, and the remainder of the sections of unit **100** further treat the gaseous stream to take out as many of the products of combustion as possible, and to regulate the condition of the gas stream such as by eliminating acidity and cooling the stream, to permit a substantially uncontaminated gas stream to be discharged into the atmosphere.

The following compartment, heat utilization section **60**, is provided with doors (not shown) to permit insertion into the compartment of objects which can utilize the exhaust stream heat, such as to burn insulation off electrical wires. Section **60** also serves as a quiescent zone to permit settling of some of the particles entrained in the gas stream exiting the afterburner chamber.

The following compartment is the spray compartment **64**, which contains means for wetting the hot gas stream flowing therethrough. Such wetting serves to lower the gas temperature and to remove some of the particulate contaminants that may be contained in the gas stream. As best seen in FIGS. **2** and **3**, the extent of the compartment **64** is defined at its upstream end by a low divider wall **66** and at its downstream end by the end wall **72**. The divider wall **66** extends upwardly for about 3 feet from the floor **51** of unit **100** and has its upper end spaced below the roof **53** to provide for the passage of gas. About the roof **53** and sidewalls **57** and **59** a number of sets of liquid supply nozzles **63** connect through appropriate header means to a source of coolant liquid that may be water or, alternatively, an aqueous solution of an alkaline material, such as 20 percent caustic solution, in order to neutralize some of the acids in the gas stream. These acids may be, for example, hydrochloric, nitric, or sulfuric acid, and can be produced during combustion of the waste materials.

A wetted baffle **72** separates compartment **64** from the next compartment, scrubber section **70**. The wetted baffle **72** is formed by a staggered row of spaced columns **73**, each formed of stacked bricks and preferably having a concave side **75** disposed in facing relation to the direction of flow of gases through gas-processing unit **100**. As shown in FIG. **4**, one set **65** of supply nozzles **63** is arranged to discharge coolant liquid, such as water, onto the top of the outer faces of the columns **73**, such that the liquid will descend the columns as a liquid film upon their external surfaces. This arrangement is utilized to further assure that all of the gases flowing through the unit **100** will be wetted by coolant liquid.

Scrubber section **70** is formed between baffle wall **72** and the gas-processing unit end wall **55**. Scrubber section **70** contains a plurality of liquid supply nozzles **63** mounted in the roof **53** and in the sides **57** and **59** of unit **100**. The nozzles are supplied with water from scrubber water tank **74**, which water is sprayed into the scrubber section to remove particles, including the salt particles formed by neutralization of acids in the spray chamber, from the effluent gas stream.

In order to accommodate drainage of liquids from spray section **64** and scrubber section **70**, the floor **51** lying within those two sections is inclined downwardly from the divider wall **66** toward a drainage trough **77** in the floor at the downstream end of scrubber section **70**. The trough **77** serves to conduct the liquid from unit **100**.

At the extreme end of the unit **100**, the demisting or drying section **76** is disposed. Within this section means are provided to remove any heavy liquid droplets entrained in the flowing gases. As shown, the compartment is formed as a longitudinal extension of the unit **100** by an enlarged sheet metal duct **81** that communicates with scrubber section **70** through an opening **79** in the end wall **55**. Oppositely extending baffles **83** and **85** are provided within the duct **81** to direct the effluent gases along a tortuous path whereby heavy liquid particles will be flung from the gas stream by reason of the forces generated in the fluids undergoing abrupt changes in direction.

Drainage of this compartment is provided by openings provided in the bottom of lower baffle **83**, where it is fastened to duct **81**, as seen in FIG. **5**, to permit passage of separated liquid in the upstream direction into the drainage trough **77**.

Downstream of the baffles **83** and **85** there may be disposed one or more perforate plates or screens **87**, that serve to atomize or otherwise diffuse any large droplets of water that may find their way through the baffles **83** and **85** prior to their being passed to the fan **82**. In association with the screen **87** it will be noted that the demisting section **76** forms a constricted flow passage of decreasing cross section upstream of the screen **87**. By reason of this decreasing cross section, an increase in velocity of the downstream flowing gases is obtained, such that liquid droplets entrained in the gas stream will impact screen **87** at relatively high velocity to ensure that they will be atomized as they pass through screen **87**.

The induced draft fan **82** is mounted at the lower end of duct **80** which intercommunicates fan **82** and demisting duct **81**. Fan **82** is preferably capable of developing a gauge pressure of about 12 inches of water, and is utilized to provide an adequate flow rate of gaseous effluent through unit **100**. Fan **82** discharges the gaseous effluent of unit **100** through conduit **84** into the base of stack **90**. Stack **90** is provided with a drain (not shown) at its base, in a manner well known in the art, to permit drainage of any condensed water vapor that falls out of the gas stream during passage up the stack.

In the preferred embodiment of the invention, the gas passage unit **100** is approximately 60 feet long along its centerline, and has a width of about 13 feet and a height of about 14 feet. The afterburner chamber **50** has an axial length of about 20 feet. The heat utilization, spray, and scrubbing sections each have a length of about 12 feet. The stack **92** has a base diameter of 11 feet, an inner diameter of 7 a feet, and a height of 100 feet. The material of the base of units **50** and **60** and the roof thereof is refractory material, capable of withstanding temperatures up to 3,000° F., such as the silica alumino type, as is the material of the walls of that unit. The spray chamber **64** and scrubbing chamber **70** are lined with acid brick. Ducts **26**, **48**, **76**, **80**, and **84** and stack **90** are lined with gunite cement.

The operation of the incinerator apparatus of the present invention is as follows.

Solid combustible waste materials are collected and discharged into the hopper **40** at the inlet end of the rotary kiln **30**, and liquid wastes are pumped into the kiln **30** through inlet **36**, for burning within the interior of the drum **32**. Combustion of the materials may be initiated by ignition provided by the auxiliary fuel burner **45** supplied by fuel line **44**. As combustion of the waste material proceeds, the drum **32** is slowly rotated to provide a tumbling action to the contents thereof for the purpose of enhancing the combustion process. The ash resulting from the process is discharged through the opening **43** at the bottom of the outlet compartment **41** and passes into the ash collector **39**. Combustion gases generated within the drum **32** are passed into the compartment **41** and thence are discharged through the duct **48** and opening **47** into the afterburner chamber **50** of the gas-processing unit **100**.

Simultaneously with the burning of solid wastes, high viscosity wastes, and low heat value, low viscosity liquid wastes in furnace **30**, a stream of low viscosity, high heat value liquid waste materials is fed to the furnace **10** while combustion air is admitted to the air heater unit **12**. Substantially complete combustion of the high heat value liquid waste materials occurs in the cyclone-type furnace **10**. It is contemplated that, by employing high heat value waste materials such as resins, oils, greases, or other selected waste materials, as fuel for furnace **10**, the temperature of the gas discharged from the furnace **10** will normally be elevated to about 2,600° F., and that it will produce a heat output of up to about 75 million B.t.u./hr.

Since rotary kilns of the type employed in the instant invention characteristically operate at relatively low temperatures, from about 850° F. to about 1,400° F., due in part to the large amount of air leakage into the drum at its end seals, the effluent gases discharged from drum **32** normally contain a large amount of unburned combustibles that would otherwise be passed from the system giving rise to the danger of polluting the surrounding atmosphere. Heretofore, elaborate separating equipment or supplementary burning through the use of an auxiliary burner utilizing a commercial fuel supply was required to remove these pollutants prior to their discharge to the atmosphere; however, by means of the present invention, the effluent gases from the rotary kiln **30** are caused to be inti-

mately mixed with the high temperature gases from the cyclone-type furnace **10** in the afterburner chamber **50** of the gas-processing unit **100**, with controlled quantities of heat to effect completion of combustion of the combustible matter entrained in the effluent gas stream without using an auxiliary burner.

The gases resulting from the burning that occurs in the afterburner chamber **50** are caused to pass in series through heat utilization section **60**, spray section **64**, scrubber section **70**, and demisting section **76**, under the influence of the induced draft fan **82**, prior to being discharged from the stack. Within the spray section **64**, the completely burned gases are wetted by coolant liquid from the first sets of nozzles **63**, in the form of a fine spray through which the gases must pass. This spray may contain an alkaline material to neutralize any acids in the effluent stream. This is followed by further wetting of the gases by the coolant liquid from the set of nozzles **63** which discharge liquid that flows as a liquid film down the columns **73** of baffle **72**. The gases then enter scrubber section **70**, and come in contact with the liquid introduced through nozzle units **63** therein, to provide a substantial further reduction in temperature. In passing from afterburner section **50** to demisting section **76**, the effluent gas temperature is preferably reduced to about 700° F. or less, which temperature is well within the range of temperatures that is capable of being handled by the fan **82** without danger of damaging the fan. Such temperature is also below the temperature that could possibly cause thermal pollution of the surrounding atmosphere.

An additional set of nozzles **63** may be incorporated, if desired, in section **64** or section **70**, or both of them, intended to be operated in response to the actuation of an appropriate temperature sensor (not shown) disposed to monitor the fluid temperature at the inlet of the fan **82**, so that additional coolant liquid will be added to the gas stream downstream of baffle **66**, when it is sensed that the temperature of the gases being admitted to the fan is too high.

The applications of liquid coolants to the flowing gases, in addition to lowering their temperature, are also effective to remove particulate matter that may be entrained therein. By so removing solid particles entrained in the gas stream, a discharge of relatively pure, uncontaminated gas to the atmosphere is ensured. The particles separated from the gas are removed from the spray chamber **64** and scrubber section **70**, together with the liquid coolants, through the drainage trough **77**.

Within the demisting section **76** the processed gases are operated on to remove any liquid droplets that may be entrained therein prior to passing the gases to the inlet of the fan **82**. The oppositely spaced baffles **83** and **85** cause the gases to flow along a tortuous path, whereby the heavier liquid droplets are removed by the centrifugal action produced by the abrupt changes in direction imposed upon the flowing fluid. Additionally, the gas stream velocity is substantially increased by the constricted nature of the dryer section, and the fluid is passed through screen **87** whereby entrained liquid droplets will be atomized and thereby rendered ineffective to cause impact damage to the fan impeller.

FIG. **1** schematically illustrates a tank farm, generally designated as **110**, which includes a substantial number of liquid storage tanks **112**. These tanks may vary in their types of construction and materials of construction, depending upon the types of liquids which they are intended to hold, such as corrosive or noncorrosive liquids. These tanks are interconnected by suitable pipes **114**, and their flow controlled by suitable proportioning valves **116**, of a sort which are well known in the art. The number and manner of possible interconnections of the various tanks is numerous, and may be changed, depending upon the types and quantities of liquids being stored in the tanks. The tanks are ultimately connected to the liquid waste input lines **24** and **36** of the respective furnaces **10** and **30**, to permit regulation of the admixture of the contents of the tanks to produce a high heat value liquid input to furnace **10** and a low heat value input to furnace **30**. As noted elsewhere herein, any specific high heat value liquid or low heat value liquid may be used as part of the input to furnace **10** or the input to furnace **30**, depending upon the heat needs of the system at any particular time, and the tank farm is flexible to permit these variations.

The process of this invention has particular application for the disposal of a wide variety of industrial waste materials of a combustible nature, although it may be used, in whole or in part, to dispose of suitable combustible nonindustrial wastes, too. Some large industrial chemical manufacturing complexes, such as petrochemical plants, produce a wide range of combustible liquid, semiliquid, and solid waste products, which must be incinerated, since there is no other practical way of satisfactorily disposing of the enormous volumes of these wastes which are produced, in compliance with current pollution control laws. Also, there are many small industrial plants which produce combustible wastes which must be disposed of, and which cannot be economically disposed of at the individual plants, because of the prohibitive costs of setting up an adequate incinerating facility. To account for this latter situation, it has been proposed to establish, in areas of particular demand, private facilitates to haul liquid and semiliquid combustible waste material in tanker trailers, railroad tank cars, or the like, to a central incinerating facility, where the wastes are properly burned. In both of these situations, large petrochemical complex or central incinerating facility, the large variety of the numerous waste materials to be burned may vary greatly in their ease of burning and the amount of heat necessary to accomplish such burning.

The process of this invention permits the complete and relatively inexpensive incineration of wide variety of such combustible materials. These may be solid combustible materials, such as rubber and plastics, semiliquid combustible materials, such as sludges and resins, high viscosity liquids, such as tars and greases, and low viscosity liquids such as oils, solvents, monomers, and the like. Although the materials which are treated by the process of this invention will usually be organic materials, combustible inorganic materials, such as sodium sulfahydrate, may also be treated by the process hereof.

The various types of liquid waste materials to be utilized in the practice of the process of the invention would usually be stored in a plurality of liquid holding tanks **112**. These various materials would be tested to assess their water content and required heat of combustion, and the contents of the various tanks could then be blended and supplied to the furnace **10** for burning high heat value materials or to the furnace **30** for burning low heat value materials, depending upon the particular combustion characteristics of the wastes in question and the needs of the system. In the practice of the invention, a minimum amount of liquid high heat value materials is always necessary for burning in the high heat value furnace. However, to the extent that there is excess high heat value material above the amount needed for proper combustion of unburned materials in the afterburner under the conditions of this invention, some of the low heat value material could be mixed in with the high heat value material for burning in furnace **10**, so long as it would not lower the combustion characteristics of the resulting mixture (as to the temperature and heat content output) below the minimum necessary to achieve spontaneous ignition and complete the combustion of the output of the low heat value material furnace **30**, when the two effluent streams are admixed. Alternatively, if excess high heat value liquid waste is available, it could be mixed with the low heat value liquid waste for input into the furnace **30** for incinerating the low heat value material.

In the practice of the process of the invention, the heat produced by the combustion of the high heat value material in a first furnace, which is preferably a cyclone-type furnace, is controlled so as to provide an adequate amount of heat to achieve spontaneous ignition of the unburned component of effluent stream from the low heat value material furnace, when the two streams are intimately intermixed in the after-

burner, and to complete combustion thereof. The purpose of the afterburner chamber **50** is to provide an insulated environment for this spontaneous ignition and combustion to occur, and the afterburner chamber **50** is designed to provide a turbulent and intimate admixture of the two effluent streams, and to permit adequate residence time of those streams in the afterburner chamber to enable combustion of the unburned materials to be completed.

In controlling the combustion characteristics of the two furnaces preferably used in the practice of this process, it is important to keep in mind the particular characteristics of the waste materials being burned. Thus, the important relationship which is required to be maintained between the effluent of the furnace **10** and furnace **30** is that the heat content available from the high heat value furnace **10** and the temperature of its effluent stream be sufficient, considered in light of the temperature and heat content of the low heat value effluent stream from furnace **30** and the amount of heat required to complete combustion of the contents of the latter stream, that the two streams, when intimately admixed in the afterburner chamber for an adequate residence time, will produce an admixture which is above the autoignition temperature of the combustible materials in the admixture, and which has adequate heat content to effect the combustion thereof during the residence time without the need for introducing additional heat into the afterburner chamber from an auxiliary burner. The residence time for any segment of the admixed streams in the afterburner chamber is desirably in the range from about 0.3 to about 0.6 second, and is most preferably about 0.5 second.

It is also to be noted that the solid waste materials which are to be burned in furnace **30** and which are loaded into the furnace through the door **38** in the front thereof, are partially burned and partially volatilized in the furnace, and will be present in the effluent stream in the form of a gaseous fraction and as small particles which are entrained in the gas stream. It is also to be noted that the solid residue of the burning in the low heat value furnace **30** collects in the ash collector **39** of the furnace **30**, and may periodically be withdrawn by suitable manual or conveyor means (not shown) to a storage facility from which the ash may be transported to be dumped or buried.

It is preferred, in the practice of the process of this invention, to maintain a substantially constant heat output from the high heat value furnace **10**, which heat output is adequate to complete combustion of the unburned contents of the effluent stream of furnace **30** within a substantial range of amounts of additional heat required to complete such combustion. For example, the amount of heat required to complete combustion of the unburned contents of the effluent stream from furnace **30** might vary between about 2.5 million B.t.u./hr. to about 25 million B.t.u./hr. This might require an effluent gas flow rate from furnace **10** of up to about 85,000 pounds per hour. By adjusting the input fuel flow and combustion conditions for furnace **10** to produce about 25 million B.t.u./hr. precise measurement and correlation of the operating conditions of the two furnaces is avoided. In this event, appropriate regulating of the input fuel stream **24** to furnace **10**, by regulating the admixture of the contents of tanks **112**, to produce a liquid waste input having substantially constant heat value of at least 25 million B.t.u./hr. relatively simply and inexpensively enables the heat output of furnace **10** to be maintained substantially constant and to completely burn all combustibles in the afterburner. Alternatively, it may be desired to produce a more variable heat output from furnace **10**, so that the heat output of furnace **10** corresponds more closely to the needs for combustion of the unburned contents of the furnace **30** effluent stream. In the latter event, appropriate effluent stream measurements of the furnace **30** effluent will need to be made frequently, to determine the amount of heat needed from furnace **10**; the fuel input to and combustion conditions of furnace **10** would be adjusted accordingly to supply enough heat to complete combustion of the combustible components of the furnace **30** effluent stream.

In a specific embodiment of the invention, the high heat value furnace **10** is a cyclone-type furnace. This type of furnace is desirable because of its ability to produce an effluent stream having a heat content of up to 75 million B.t.u./hr. The amount of heat produced by the furnace is controlled by varying the amount of air fed into the furnace, which is preferably about 20 percent above the stoichiometric amount for combustion of the waste material therein, by controlling the amount of preheating of that air (which is preferably at a temperature of at least 400° F.), and by controlling the rate of feed of high heat value waste material to the furnace, which is preferably fed at a rate of about 300 to about 1,500 gallons per hour having an average heat value of about 7,000 BTU per pound to about 50,000 BTU per pound. Most preferably, about 1500 gallons per hour of high heat value fuel having an average heat value of about 50,000 BTU per gallon will be utilized. The temperature of the exhaust stream of the cyclone furnace is preferably in the range from about 1,800° F. to about 3,000° F., and most preferably in the range from about 2,500 ° F. to about 2,800° F. Its heat content is preferably in the range from about 15 million B.t.u./hr. to about 75 million B.t.u./hr. depending upon the heat requirement for the combustibles in the kiln exhaust stream.

The kiln selected for use in the invention is most preferably a rotary kiln. This type of kiln is selected because of its efficiency in achieving substantial combustion of solid, semiliquid, and low heat value, low viscosity liquid materials at a reasonably high rate. The kiln is preferably supplied with air in excess of the stoichiometric amount for the waste material, and about 100 percent excess of air is supplied by leakage through the seals at the edges of the cylindrical rotating portion of the kiln, since it is extremely difficult to limit such leakage below that amount. However, it is desirable to prevent much more than 100 percent excess of air from entering the kiln, since this extra air does not contribute any benefit to the functioning of the process, and does require the use of a greater horsepower fan to draw the gaseous stream through the incinerator unit. If rotating kilns with improved end seals which limit leakage below a 100 percent excess are available, it is desirable to use such kilns and to limit air leakage as much as possible so long as enough air is provided to achieve complete combustion of the furnace **30** contents, part of which combustion occurs in the furnace **30**, and the rest of which occurs in afterburner **50**. The materials burned in the kiln, in a preferred embodiment of the invention, produce an output gas stream having a heat content of approximately 55 million B.t.u./hr. at a temperature in the range from about 850° F. to about 1,500° F., and most preferably in excess of about 1,200° F. The heat content of the kiln output stream will typically be in the range from about 15 million B.t.u./hr. to about 60 million B.t.u./hr.

The autoignition temperature of the low heat value material in the afterburner chamber may range from about 1,200° F. to about 2,500° F., and may typically be about 2,000° F., and the temperature in the afterburner chamber is maintained above that autoignition temperature, and is preferably in the range from about 1,500° F. to about 2,800° F., and most preferably in the range from about 1,500° F. to about 2,500° F. Preferably, the heat content of the completely burned gas stream will be about twice the heat content of the incompletely burned gas stream, in order to achieve complete combustion of the contents of the latter stream.

It is important to note that the precise heat and flow relationships to be utilized in operating an incinerating facility employing the process of this invention can readily be determined and varied by a skilled combustion engineer according to the particular details of the system in question, such as the heat capacities of the furnaces and the nature of the wastes being burned.

In practicing the process of this invention, and utilizing the apparatus of this invention, it will be appreciated that a substantial number of variations can be made in the details of the invention disclosed herein. For example, more than two furnaces could be used to supply inputs to the afterburner

chamber, such as by using two cyclone furnaces, each of which produces half of the heat output which would otherwise be required by one furnace. It might be desired to precisely regulate the heat content and temperature of the high heat value furnace output, in response to variations in the heat of combustion required for complete incineration of the output of the low heat value furnace. In such a situation, sensors could be provided in the output duct of the kiln to measure the temperature and heat content thereof and to measure the amount of additional heat required to complete combustion of that stream. These sensors could be used to operate appropriate control mechanisms for controlling the waste input into the high heat value furnace, the nature of such input as to heat of combustion, its rate of input, and the other conditions of combustion in that furnace, so that they could appropriately correspond to the conditions of the kiln output stream. However, this feature would require additional, expensive instrumentation, and a preferred aspect of the process of this invention is to maintain a substantially constant heat content output from the high heat value furnace which can accommodate the range of heat of combustion needs of the low heat value furnace effluent, thereby to avoid a requirement for such additional expensive instrumentation.

Although the furnace of choice in the practise of the invention is a cyclone-type furnace for the high heat value materials, because of the efficiency with which it produces a high heat output, and a kiln-type furnace for the low heat value materials, because of the efficiency with which kilns incinerate low heat value materials as well as solids and semiviscous materials, other types of furnaces could be used for the purpose of incinerating the waste materials utilized in the practice of this invention.

What is claimed is:

1. An incineration process comprising the steps of:
   a. burning a high heat value, low viscosity liquid waste materials in a first furnace to produce a substantially completely burned first effluent stream;
   b. burning combustible waste materials in a second furnace to produce a substantially combustible second effluent stream;
   c. removing said streams from said furnaces; and
   d. completing combustion of the unburned material in said second effluent stream by turbulently, intimately admixing said first and second streams.

2. A process as set forth in claim 1, wherein the combustible waste materials are selected from the group consisting of solids, high viscosity materials, low heat value, low viscosity liquids, and combinations thereof.

3. A process as set forth in claim 1, wherein the waste materials include a variety of high heat value, low viscosity liquids and low heat value, low viscosity liquids, and wherein said process includes the initial step of combining selected amounts of said liquids to produce a first input stream for feed into said first furnace and a second stream of low heat value for feed into said second furnace.

4. A process as set forth in claim 1, wherein the amount of heat required to achieve complete combustion of the combustible components of said second stream is not constant, and including the step of regulating the flow rate and composition of the input to said first furnace and the conditions of combustion thereof such that the temperature of said first effluent stream and its heat content are sufficient to achieve autoignition of all combustible materials in said second stream throughout the range of temperatures and heat contents required to achieve such autoignition.

5. A process as set forth in claim 1, wherein the temperature of said first stream is in the range from about 2,500° F. to about 2,800° F. and its heat content is in the range from about 15 million B.t.u./hr. to about 75 million B.t.u./hr.

6. A process as set forth in claim 1, wherein combustion in said first furnace takes place in the presence of an excess of the stoichiometric amount of air required for complete combustion of said high heat value waste liquid, and combustion in said second furnace takes place in the presence of an excess of the stoichiometric amount of air required to achieve complete combustion of the materials in said second furnace.

7. A process as set forth in claim 6, including the step of preheating said air for said first furnace to a temperature of at least about 400° F. prior to introducing said air into said first furnace.

8. A process as set forth in claim 1, wherein the temperature of said admixture is at least about 2,000° F.

9. A process as set forth in claim 1, wherein said first stream and said second stream are introduced at substantially right angles to each other in an insulated afterburner chamber.

10. A process as set forth in claim 9, wherein the average residence time of any portion of the admixture in the afterburner is in the range from about 0.3 second to about 0.6 second.

11. An incineration process comprising the steps of:
   a. burning combustible waste materials in a first furnace to produce a substantially combustible gaseous first effluent stream;
   b. burning low viscosity, high heat value combustible waste materials in a second furnace to produce a substantially noncombustible gaseous second effluent stream having a substantially higher temperature and heat content than said first stream;
   c. regulating the composition and combustion rate of said high heat value waste material such that the temperature and heat content of said second stream when admixed with said first stream are sufficient to raise the temperature of said first stream above its autoignition temperature and to complete combustion thereof without the addition of further heat;
   d. removing said streams from said furnaces; and
   e. turbulently, intimately admixing said first and second streams to permit substantial completion of combustion of said first stream.

12. A process as set forth in claim 11, wherein the temperature of said first stream is in the range from about 1,200° F. to about 1,500° F., the temperature of said second stream is in the range from about 2,500° F. to about 2,800° F., and the temperature of said admixture is at least about 2,000° F.

13. A process as set forth in claim 11, wherein the amount of heat required to achieve complete combustion of the combustible components of said first stream is not constant, and including the step of regulating the flow rate and composition of the input to said second furnace and the conditions of combustion thereof such that the temperature of said second effluent stream and its heat content are sufficient to achieve autoignition of all combustible materials in said first stream throughout the range of temperatures and heat contents required to achieve such autoignition.

14. A process for achieving substantially complete combustion of liquid and solid combustible waste materials, comprising the steps of:
   a. substantially completely burning in a first furnace a low viscosity combustible liquid having a high heat value;
   b. withdrawing from said first furnace a substantially burned gas stream having a temperature of at least about 2,000° F.;
   c. burning in a second furnace combustible materials selected from the group consisting of high viscosity materials, solids, and low heat value, low viscosity liquids and combinations thereof, to achieve partial combustion of such materials;
   d. withdrawing from said second furnace a gaseous stream comprising unburned and partially burned combustible materials at a temperature substantially less than 2,000° F; and
   e. turbulently intimately admixing said gaseous streams in an insulated afterburner chamber to achieve the substantial decomposition by combustion of the combustible material in said second stream without the extrinsic introduction of heat.

15. A process as set forth in claim 14, wherein the average residence time of any portion of the admixture of said streams in said afterburner chamber is at least about 0.3 second.

16. A process as set forth in claim 14, wherein the temperature of said first stream is at least about 2,500° F., the heat content of said first stream is substantially constant, the temperature of said second stream is at least about 1,200° F., and the temperature of the admixture is substantially greater than 2,000° F.

17. A process as set forth in claim 14, wherein the waste materials include a variety of high heat value, low viscosity liquids and low heat value, low viscosity liquids, and wherein said process includes the initial step of combining selected amounts of said liquids to produce a first input stream for feed into said first furnace and a second stream of low heat value for feed into said second furnace.

18. A process for achieving substantially complete and inexpensive combustion of combustible waste materials, comprising the steps of:

a. substantially completely burning in a first furnace a low viscosity liquid combustible material having a heat value with an excess of air above the amount necessary to achieve complete combustion thereof;

b. incompletely burning in a second furnace combustible materials selected from the group consisting of low viscosity, low heat value liquids, high viscosity materials, solids and combinations thereof with an excess of air above the amount necessary to achieve complete combustion thereof;

c. withdrawing a gaseous stream of substantially completely burned materials from said first furnace at a temperature in the range from about 2,000° F. to about 3,000° F. and a heat content in the range from about 15 million B.t.u./hr. to about 75 million B.t.u./hr.

d. withdrawing a gaseous stream containing incompletely burned combustible materials from said second furnace at a temperature in the range from about 1,000° F. to about 1,500° F. and a heat content in the range from about 15 million B.t.u./hr. to about 60 million B.t.u./hr.

e. intimately admixing said streams in a proportion such that the temperature of the admixture is in excess of 2,000° F.; and

f. maintaining said admixture in an insulated afterburner chamber until combustion of said second stream is substantially complete.

19. A process as set forth in claim 18, wherein said first furnace is a cyclone-type furnace and said second furnace is a rotating kiln, and including the steps of intermittently heating said kiln with burning fuel to maintain a kiln temperature of at least 850° F., and preheating the air entering said furnace to a temperature of at least about 400° F.

20. A process as set forth in claim 18, including the step of maintaining the heat content of said first stream at a level of at least twice the heat content of said second stream.

21. An apparatus for achieving substantially complete combustion of liquid, semiliquid, and solid waste materials, comprising:

a. a first furnace adapted to achieve substantially complete combustion of high heat value, low viscosity liquid waste materials;

b. a second furnace adapted to achieve substantially incomplete combustion of combustible materials selected from the group consisting of low heat value, low viscosity liquids, high viscosity materials, and solids and combinations thereof;

c. an afterburner chamber comprising an enclosed chamber having an interior lined with a refractory material, said chamber defining two inlet ports and an outlet port and having no means for the extrinsic introduction of heat;

d. duct means interconnecting each of said furnaces and a corresponding one of said inlet ports;

e. whereby intimate admixture in said afterburner chamber of a substantially noncombustible gas stream from said first furnace and a combustible gas stream of incompletely burned material from said second furnace may be so regulated as to temperature and heat content that autoignition and complete combustion of said second stream can be achieved in said afterburner without the use of an auxiliary heat source.

22. Apparatus as set forth in claim 21, wherein said duct means are oriented at substantially right angles with respect to each other.

23. Apparatus as set forth in claim 21, wherein said first furnace is a cyclone furnace and said second furnace is a kiln.

24. Apparatus as set forth in claim 22, including a baffle located in alignment with one of said inlet ports and adjacent to said outlet port.

25. Apparatus as set forth in claim 21, including means to turbulently, intimately admix said gas streams.

26. Incinerator apparatus for burning waste material, comprising, in combination:

a. first furnace means for burning solid and liquid waste materials, including means for discharging the effluent gases therefrom;

b. second furnace means for burning liquid waste materials, including means for discharging the effluent gases therefrom;

c. gas-processing means disposed downstream from said first and second furnace means, including a burner compartment wherein the effluent gases from said first and second furnace means can be burned by the intimate mixture thereof;

d. means for passing the effluent gases from said first and second furnace means to said gas-processing means and thence to the atmosphere; and

e. means for operating said second furnace means to produce an effluent gas having a temperature sufficient to render the resultant gas temperature in the burner compartment of said gas-processing means above the autoignition temperature of the effluent gas from said first furnace means.

27. Apparatus as set forth in claim 26, wherein said gas-processing means comprises:

a. rectangularly disposed walls defining an elongate, substantially closed chamber;

b. means defining openings in a pair of spaced walls communicating with said first and second furnace means for the passage of effluent gas therefrom into said burner compartment; and

c. means in said burner compartment to turbulently, intimately admix the effluent gases from said first and second furnace means.

28. Apparatus as set forth in claim 27, wherein said effluent gas discharge openings are disposed in adjacent walls of said chamber and said last-named means comprises an upright baffle extending transversely of said chamber in spaced relation to said openings, said baffle being operative to direct the gas flow from one of said openings toward the wall containing the other of said openings.

29 Apparatus as set forth in claim 26, wherein said gas-processing means comprises:

a. rectangularly disposed walls defining an elongate, substantially closed chamber;

b. means dividing said chamber into an afterburner compartment, a spray compartment, and a demisting compartment, said compartments extending across the entire width of said chamber end thereof for discharge of end-to-end gas therefrom to said afterburner therethrough;

d. means in said afterburner compartment for turbulently, furnace admixing the effluent gases from the respective furnace means;

e. means in said spray compartment for injecting liquid coolant into direct heat exchange relation with gases flowing through said chamber; and

f. means in said demisting compartment for removing excess liquid from gases flowing through said chamber prior to their discharge to the atmosphere.

30. Apparatus as set forth in claim 29, wherein said spray compartment includes:

a. a plurality of upstanding columns disposed in staggered relationship in two rows across the width of said chamber and extending the full height thereof;

b. liquid spray nozzles mounted in said chamber for discharging liquid coolant rows said columns to create a liquid film on the surface thereof; and

c. means for draining liquid coolant from said chamber.

31. Apparatus as set forth in claim 30, wherein each of said columns is provided with a concave surface in facing relation to the direction of gas flow through said compartment.

32. Apparatus as set forth in claim 30, wherein said spray compartment further comprises a pair of independently operated sets of spray nozzles disposed on alternate sides of said columns and arranged to discharge a diffused spray of liquid coolant into said compartment, one of said sets including means for continuously operating said set to lower the temperature of the flowing gases to a predetermined level, and the other of said sets including means for operating the same when the gas temperature at the outlet of said chamber exceeds a predetermined level.

33. Apparatus as set forth in claim 29, wherein said demisting compartment comprises

a. baffle means defining a tortuous path for imparting abrupt changes of direction in gas flow through said compartment; and

b. means for draining separated liquid from said compartment to the exterior of said chamber.

34. Apparatus as set forth in claim 29, including induced draft fan means communicating with said chamber at the discharge end thereof for passing the resultant gases through said chamber for ultimate discharge to said atmosphere.

35. Apparatus as set forth in claim 34, wherein said first furnace means comprises a rotary kiln.

36. Apparatus as set forth in claim 34, wherein said second furnace means comprises a furnace of the cyclone type.