Oct. 18, 1960 H. HARTMANN 2,956,526

INCINERATOR

Original Filed Aug. 22, 1955

FIG. 1.

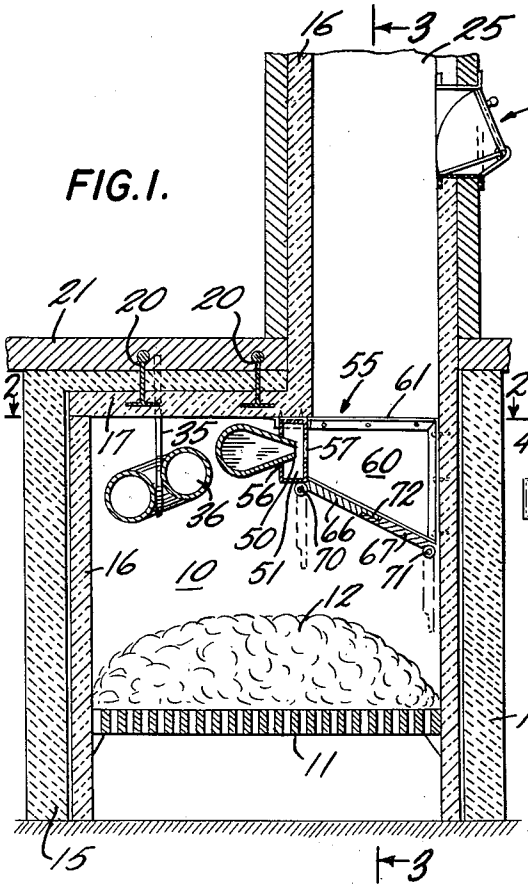
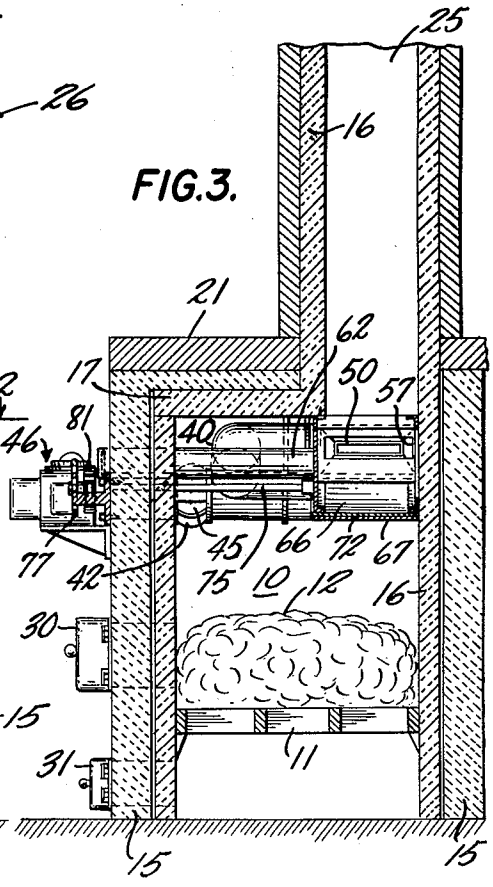


FIG. 3.



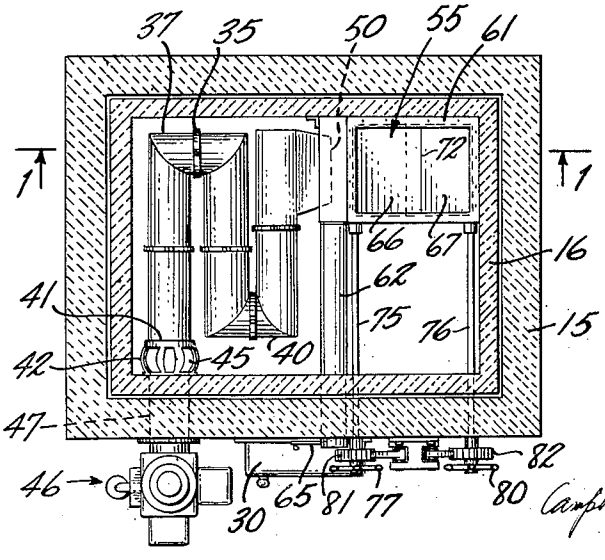


FIG. 2.

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INCINERATOR

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1 Claim. (Cl. 110—18)

This invention relates to an improved method and apparatus for burning refuse and, in particular, to burning or incinerating methods and devices to be used in areas where, due to density of population or proximity to densely populated areas, it is desirable to effect complete combustion of the waste without substantial residual smoke or odor.

Heretofore, it has been the practice to burn refuse in multiple-dwelling units such as apartment houses in incinerators comprising essentially a combustion chamber located in the vicinity of the basement of the building. In order to support the incinerator load the combustion chamber is provided with a grate. Extending from the top of the combustion chamber there is a flue to the roof of the building to carry away combustion products. A multiplicity of refuse feed chutes are supplied on the various floors of the building so that the refuse may be charged directly to the flue and thence into the combustion chamber. The combustion chamber may be provided with an auxiliary burner which is in constant operation to initiate and maintain combustion of the refuse.

There are many disadvantages attendant to the type of operation and apparatus heretofore employed. A serious problem is the tendency to form aerosols of unburned or incompletely burned refuse. Such aerosols are extremely objectionable to the environs because they are malodorous and also tend to soil household fabrics and furniture.

Efforts have been made to dispose of such aerosols by treating the flue products by incinerating them in a second stage incinerator at a point remote from the combustion chamber or by injecting a secondary flame into the combustion chamber at a point above the primary combustion zone. Secondary combustion in a zone remote from the primary combustion zone, in effect, requires the provision of two incinerators to take care of a single load of refuse, which increases the investment with no increase in capacity of the unit. Furthermore, the secondary combustion zone also requires its supply of auxiliary heat so that operating expenses, in effect, are also increased substantially. Moreover, known fume incinerators have not been designed for effective and economical operation.

Direct injection of a secondary combustion flame into the primary combustion chamber has not provided a satisfactory solution to the problem for several reasons, among them being the difficulty in producing complete combustion of the aerosols and difficulty in making all the aerosols pass through the secondary incinerating flame which is necessary to assure complete combustion of the aerosol. Furthermore, by use of the secondary flame there is no assurance that the temperature of the aerosol will be raised to the necessary level and will be maintained at the temperature level for time necessary to produce complete combustion. The tendency has been to use an excessive amount of secondary fuel in an effort to assure complete combustion of aerosols,

and this, in turn, has produced excessive temperatures in the flue ways and excessive drafts with consequent increase in amount of fly ash carried upward through the flue.

The advantages of the present invention include the provision of a method and apparatus which afford complete incineration of aerosols efficiently and economically. Another advantage is the avoidance of excessive temperatures of the flue gases. Still another advantage resides in the control of the draft in the incinerator to avoid fly ash suspension. Furthermore, the apparatus provided according to the invention is simple as compared with incinerators heretofore designed which have required the use of cumbersome baffles thought to be necessary to create turbulence.

The foregoing advantages are realized according to the invention by providing that the products of the basic combustion process of incineration including excess air and incompletely burned material, some of which may be in aerosol form, are induced to pass through a duct or flue described more fully hereinafter within the main combustion chamber. In this duct incineration of the unburned and/or incompletely burned material takes place within the confines of the main combustion chamber. The duct is in heat interchange relationship with the main combustion chamber so that heat given off in the latter promotes heating and combustion in the duct, and, conversely, heat produced within the duct may radiate back to the load in the main chamber and promote more uniform heating of the combustion products and dehydrating and more complete burning of the load. The design of the duct and associated portions of the incinerator are preferably such that, having in mind the amount and nature of material to be burned, optimum heat transfer conditions are maintained between the duct and the load in the main combustion chamber.

The nature of the invention may be more clearly understood by reference to the attached drawings considered together with the following description:

Figure 1 is an elevation view in the section, the section being taken on a plane indicated by line 1—1 of Figure 2 looking in the direction of the arrows;

Figure 2 is a horizontal section taken on a plane indicated by the line 2—2 of Figure 1 looking in the direction of the arrows; and

Figure 3 is a vertical section view taken on a plane indicated by a line 3—3 of Figure 1 looking in the direction of the arrows.

Figure 4 is a perspective view of another type of incinerator with a portion of the exterior walls broken away to show the interior of the apparatus.

Referring to the drawings, at 10 there is shown a main combustion chamber having a grate 11 which supports the incinerator load 12. The main furnace wall 15 which may be ordinary brick is completely lined with fire brick 16 within which the combustion chamber 10 is formed. The portion of the fire brick liner 16 which forms the roof 17 of the combustion chamber is supported by straps 20 from a beam 21. An upwardly extending flue is shown at 25 with charging chutes 26 for introduction of refuse thereto and eventually to the combustion chamber 10 in the manner presently to be described. Doors 30 and 31, respectively are provided for the purpose of observing the burning load and cleaning out ash from below the grate 11 and providing overfire and underfire air. So much of the apparatus has been heretofore known.

Supported within the main combustion chamber 10 by the braces 35 is a thin-walled duct or flue 36 which has two turns, one at 37 and the other at 40, with passageways on both sides of each turn thereby providing a tortuous path for gasses passing through it. The inlet

end 41 which is spaced from the refractory wall 16 is fitted with a collar 42 which provides a connection with the wall. The collar 42 has openings 34 which permit entry of the products of combustion of the main incinerator load 12 to the duct 36, while stopping large pieces of paper, etc. which may tend to be entrained with the gases. The collar 42 may have associated therewith an auxiliary burner 46 on the outside of the furnace which is connected to collar 42 by a pipe 47 passing through the walls 16 and 15.

The duct or flue 36 may be formed of any material that will withstand the temperatures prevailing and which has sufficiently high heat conductivity to fulfill the objects and provide the advantages of the invention. Thin-walled refractory material or high temperature metallic alloys may be mentioned as suitable materials of construction.

A frame 55 is mounted in an upper corner of the combustion chamber 10 secured to the refractory walls 16 and ceiling 17 in the manner shown. The frame 55 is most suitably formed of a metal which will resist the high temperature of the gases with which it comes into contact. Formed at one end of the frame 55 is an elongated mixing chamber 51 which has an elongated opening 56 that is in substantially gas-tight contact with the elongated and narrowed discharge end 50 of the duct 36. The mixing chamber 51 has an elongated rectangular discharge opening 57 which is in direct communication with the open central portion 60 of frame 55 and the open top 61.

One end of the mixing chamber 51 is connected in gas-tight fashion with a cooling air duct 62, shown most clearly in Figures 2 and 3. The duct 62 passes through the walls 15 and 16 and is provided at its inlet end with a damper 65 in order that the amount of air passing through it may be controlled for purposes hereinafter described.

At the lower portion of the frame 55 there are provided doors 66 and 67 mounted on hinges 70 and 71, respectively, and adapted to meet at their inward ends 72 in substantially gas-tight contact. The doors 66 and 67 may be opened or closed by means of rods 75 and 76 operated from outside the furnace by handles 77 and 80. Securing means 81 and 82 such as ratchet and pawl devices are provided outside the furnace which in cooperation with the rods 75 and 76 may be used to secure the position of the doors 66 and 67, respectively, in the closed position. The doors may be held open by gravity.

The operation of the apparatus described according to the invention is carried out as follows. A load of combustible material is introduced to the chamber 10 supported on the grate 11 either through the doors 26 opening to the flue 25 (while doors 66, 67 are open), or through the door 30 in the main furnace wall. Before the combustion in the chamber 10 has been established, the doors 66 and 67 are closed by manipulating the handles 77 and 80, respectively, thereby to prevent by-passing of combustion products from the combustion chamber 10 into the chimney 25. Combustion may be initiated manually or by suitable means not shown. The combustion products comprising excess air and some unburned material, a major portion of which is most frequently in aerosol form, then will be obliged to pass through the openings 45 in the collar 42 and the inlet end 41 of duct 36. The gasses are mixed by turbulence as they enter the duct to produce a more uniform temperature, and are then heated by heat from the burning load transmitted through the wall of the duct. Secondary combustion of the unburned material takes place, and duct 36, therefore, becomes very hot. It will be observed that the duct is in direct unobstructed radiation and convection heat interchange relation throughout its length with the burning load so as to facilitate combustion in the primary combustion chamber and also in the secondary combustion zone. Some of the heat generated within the duct 36 passes through the walls of the duct and is transmitted by radiation back to the load 12 so as to assist materially in maintaining combustion of the load. Some of the heat from the duct also passes through the wall and is transmitted by convection to the gases in the primary combustion chamber. Alternatively, such gases may supply heat to the duct by convection and radiation, according to local conditions.

The design of duct 36 is dependent on the quantity of unburned material such as aerosols in the combustion products entering the duct. The velocities, the length of the passage through the duct, and the number of turns traversed yield the proper time, temperature and turbulence required to incinerate the aerosols within the confines of the combustion chamber, i.e., inside of the duct 36. To promote heat transfer from the burning load to the gases inside the duct 36 and also in a reverse direction, i.e., from the hot products of secondary combustion inside the duct 36 through the walls of the duct and back to the load, the duct 36 is most suitably constructed of material which has a highest feasible heat transmission rate, i.e., thin-walled refractory or high temperature metallic alloy. Furthermore, inasmuch as heat transmission rate is improved by turbulence of the gases flowing through the duct 36, the duct is most preferably formed with at least one turn such as those shown at 37 and 40 of Figure 2.

If desired, the secondary combustion taking place inside the duct 36 may be initiated and/or maintained by an externally disposed auxiliary burner 46 which is adapted to inject a flame of burning oil or gas through the pipe 47 and directly into the inlet end 41 of the duct 36. The stream so intoduced may produce some asperating effect and thereby draw combustion products through the openings 45 and assist in maintaining flow in the desired direction through the duct 36. However, the main motivating force for the flow of gases through the duct 36 is draft produced by the chimney 25 or by mechanical means not shown. The air to support secondary combustion may be added through the pipe 47 and/or from below or above the grate 11.

The products of secondary combustion pass through the discharge end 50 of the duct 36 into the mixing chamber 51. At this point cool outside air, the flow of which is controlled by the damper 65 and which enters through the duct 62, is mixed with the hot combustion products so that they become cooled to a substantially lower temperature as desired. The introduction of air through the duct 62 also provides a control of the draft in the combustion chamber 10, thereby minimizing the suspension of fly ash in the combustion products. Cooled gases leave the mixing chamber 51 through outlet port or opening 57, thence into the central portion 60 of the frame 55 and through the open top 61 of the frame into the flue or chimney 25. The outlet gases thereby are delivered to the flue or chimney substantially free of undesired aerosols and odors and in a substantially cooled condition so as to involve minimum inconvenience and hazard from overheated chimney flues.

As previously indicated, the doors 66 and 67 are closed to prevent the direct by-passing of combustion products from the combustion chamber 10 into chimney 25. If any refuse is charged to the chimney 25 during the incineration process it will rest on the doors out of the path of the gaseous flue products from the mixing chamber 51, ready to be charged to the combustion chamber 10 for a subsequent incineration cycle.

Referring to Figure 4, the incinerator shown was exterior refractory wall 90 formed by four vertical wall portions 91, 92, 93 and 94. The four walls and ceiling 95, and a grate not shown in the drawing, form a primary combustion chamber to burn a load of refuse 97. A chimney 99 is built above the furnace as shown, and suitable partitions that are in part shown as broken away and in part are not shown, are provided to prevent direct

flow of the gas from the primary combustion chamber to the chimney.

A thin-wall duct **100** is mounted in the primary combustion chamber and is formed of three substantially straight passageways **101, 102** and **103**. The respective passageways are connected by the turns **105** and **106**. The duct **100** is mounted within the primary combustion chamber by suitable supports, not shown, the inlet end **107** of the duct **100** being provided with an expanded metal screen **108** having apertures **109** to permit the entrance of gases from the primary combustion chamber to the duct. It will be noted that the inlet end **107** is mounted so that it is spaced from the walls **91, 92**.

At the outlet end of the duct **100**, there is a grating **110** to permit access of the duct effluent to the chimney **99** and to prevent the entry of refuse into the duct. By means of the partitions referred to, the gases leaving the primary combustion chamber, therefore, are constrained to flow into the duct **100** through the openings **109** and thence directly into the chimney through the grating **110**.

The auxiliary burner **112** is mounted outside the furnace wall **92** and is connected by suitable piping extending through the wall to the inlet end **107** of the duct **100**. The burner **112** is connected to a supply of gas or other fuel and adapted to inject a flame substantially axially into the inlet end of the duct **100** to initiate or support secondary combustion.

A horizontal sliding door **114** is mounted in a pair of channels **115** and is supported on a pair of rollers **116** that travel on the upper portions of the channels **115**. The gaskets **115'** which are around the edges of the door **114** provide a seal. A long rod **117** is connected to the door and has a handle **118** for manipulation and adjustment by the operator. It will be observed that the door **114** also is necessary to complete the seal between the primary combustion chamber and the chimney so as to require the gases to flow through the duct **100** and prevent the escape of aerosols to the chimney.

In the upper portions of the chimney **99** there are provided one or more access chutes (not shown in the drawing) in the same manner as described and shown in connection with Figure 1. The refuse, therefore, may be charged to the incinerator through the chimney directly to the primary combustion chamber during the non-burnoff period, while the sliding door **114** is retracted. When it is desired to start the incinerator, the operator slides the door **114** closed. Thereafter, the operation may begin.

A duct **120** is provided in the brickwork construction to provide communication of the chimney **99** with the outside. An adjustable door or damper **121** is mounted at the inlet end of the duct **120** to control the flow of air. By adjusting the door **121**, the amount of cool air introduced into the chimney can be controlled, the cooled air mixing with the hot combustion products leaving the grate **110** in a mixing zone at the position shown approximately at **123** in the lower portion of the chimney **99**. In this way the temperature of the chimney gases is reduced, the draft is controlled, and the amount of fly ash is maintained at a minimum, as described in connection with the other embodiment of the invention.

Below the duct **120** there is another duct **125** having an entrance **126** below the level of the grate, a damper with control handle **127**, a bend **130**, and a horizontal portion **131** terminating in a discharge port **132** located at a point in the furnace remote from the inlet end **107** of the duct **100**. The purpose of the duct **125** is to regulate the amount of and the point at which overfire air is introduced.

A door **135** is mounted in the front wall **92** of the furnace which also may be used for the introduction of overfire air. Another door **135'** is also mounted in the wall **92** below the door **135**. The purpose of the latter door is to provide the necessary amount of underfire air for combustion.

The operation of the incinerator shown in Figure 4 is similar to that described in connection with the other figures. After the load of refuse has been charged to the incinerator and is lighted, the underfire and overfire air are controlled by the damper **127**, the door **135**, and the door **135'** previously described for underfire air. The amount of air is sufficient to provide oxygen for primary combustion in the primary combustion chamber, and for secondary combustion in the duct **100**. Some secondary air may be added at or near the location of the burner **112**. Thus, an annular space (not shown) around the burner where it passes through the wall may be provided to allow the entry of secondary air. The primary combustion products and secondary air enter the duct **100** through the openings **109**, after which they are mixed within the duct to a substantially uniform temperature. The achieving of the necessary temperature and turbulence to maintain complete combustion of the aerosols within the duct is facilitated by the tortuous path of the gases through the duct provided by the turns **105, 106**. Accordingly, the heat generated in the duct **100** by secondary combustion of the aerosols flows through the thin duct walls to heat the surrounding aerosol containing gases and the load **97** by convection and radiation.

The effluent of the duct **100** flows into the mixing zone **123** where it is mixed with cooled air entering through the duct **120**. The relative positions of the lower duct **125** (for introducing overfire air) and duct **120** (for introducing cooled air to the chimney) contribute to the desired functions of the two ducts. Thus, the horizontal portion **131** of duct **125** absorbs heat from the burning load **97**, thereby preheating the overfire air and facilitating maintenance of high and uniform temperatures in the primary combustion chamber. This tends to keep the air in the duct **120** cooler so that it performs its function of cooling the effluent gases very effectively and protects the material of the duct and door from overheating.

It will be apparent that the conditions maintained within the secondary combustion zone are those under which substantially all of even the most refractory aerosols are burned, and that such conditions are produced by mixing the gases so that there is uniformity by maintaining the gases at the required temperature for the necessary time. The time is held as short as possible by increasing turbulence and temperature.

The gases containing aerosols flowing outside the duct, which may be at a temperature somewhat below the temperature of incineration and ignition of the aerosols, flow into the end of the duct and thence to the secondary combustion zone, where the ignition is initiated by an auxiliary flame and the aerosols are burned. The heat of combustion flows through the thin-walled duct to preheat the external gases by radiation and convection, thereby tending to maintain the desired conditions within the duct by heating the gas toward the ignition temperature. If the incoming gases are substantially below the ignition temperature of the more refractory aerosols (1500° F.), the auxiliary burner will be needed to initiate and maintain combustion in the duct. However, if the temperature of the gases, air and aerosol mixture entering the duct is high enough, the part of the heat that is returned to the incoming gases will be sufficient to continue complete incineration without any auxiliary fuel.

Although specific embodiments of the invention have been described in the preceding presentation, it will be apparent to those skilled in the art that the invention has many modifications and equivalents within its spirit and scope. For example, the duct or flue **36** may be heated electrically rather than by an external auxiliary burner as shown. The process and apparatus described may be applied to other incineration processes in industrial and

commercial applications. Accordingly, it is intended that all such modifications and equivalents shall be included within the scope of the appended claim of the invention as defined in the appended claim.

I claim:

An incinerating system having a primary combustion chamber for burning a load of refuse and a chimney for exhaust gases through which refuse may be charged to said primary combustion chamber, comprising a duct completely confined within said chamber and in heat interchange relation with said burning load, said duct having an inlet adapted to receive the products of combustion of said load and an outlet for discharging gases, an auxiliary burner mounted outside of said primary combustion chamber and adapted to inject a flame axially into the inlet end of said duct and thereby initiate and maintain secondary combustion therein, said duct having at least one turn to provide a tortuous path for gases flowing through it, a mixing chamber between the discharge end of said duct and said chimney and adapted to receive gases discharged from said duct, an air duct adapted to convey

cool air to said mixing chamber so as to lower the temperature of said gases in said mixing chamber before they are discharged to said chimney and control the draft in said primary combustion chamber to reduce the amount of suspended fly ash rising therefrom, and an outlet from said mixing chamber to discharge said cooled gases to said chimney, a door controlled from outside the system so mounted that it prevents the by-passing of primary combustion products from said primary combustion chamber to said chimney when it is closed, and permits charging of refuse deposited in said chimney to said primary combustion chamber when it is opened.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,956,526 October 18, 1960

Henry Hartmann

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 3, for "34" read -- 45 --.

Signed and sealed this 11th day of April 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

ARTHUR W. CROCKER
Acting Commissioner of Patents