

[54] **CONTROLLED ATMOSPHERE
INCINERATOR**

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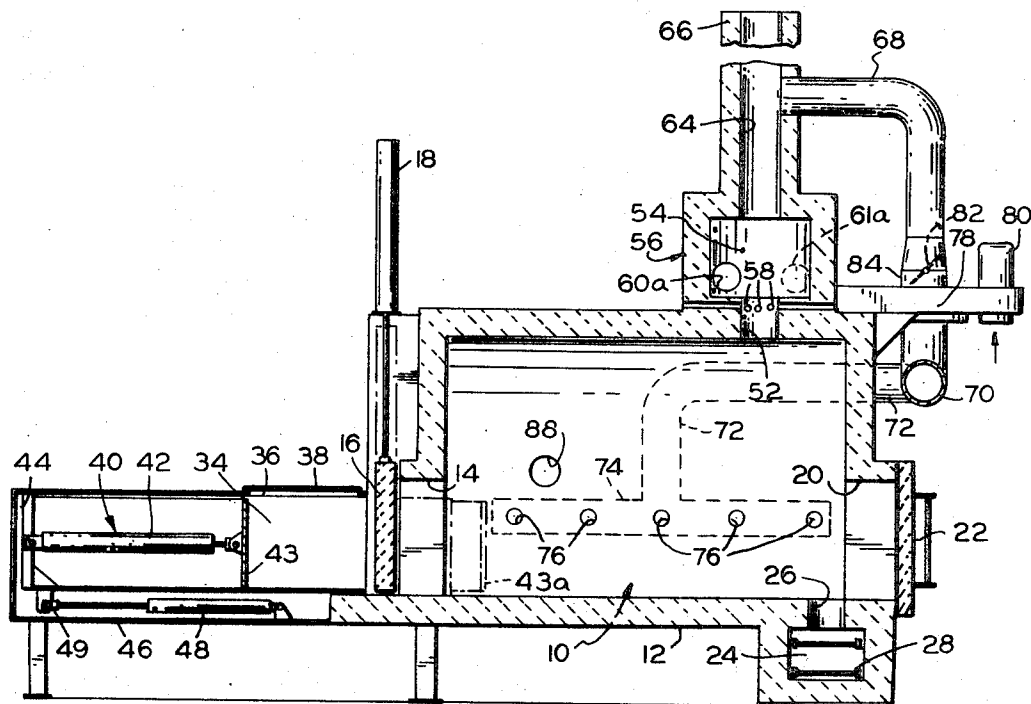
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[57] **ABSTRACT**

Combustible materials are burned within a primary combustion chamber in a controlled atmosphere consisting primarily of a large proportion of carbon dioxide and a smaller proportion of air. The controlled atmosphere is produced by afterburning the combustion gases from the primary burner in the presence of combustion air and then recirculating the hot afterburned gases mixed with controlled amounts of air back to the primary combustion chamber. By controlling the proportionate amounts of carbon dioxide and air in the mixture, the temperature and rate of burning in the primary chamber can be carefully regulated.

15 Claims, 2 Drawing Figures



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FIG. 1

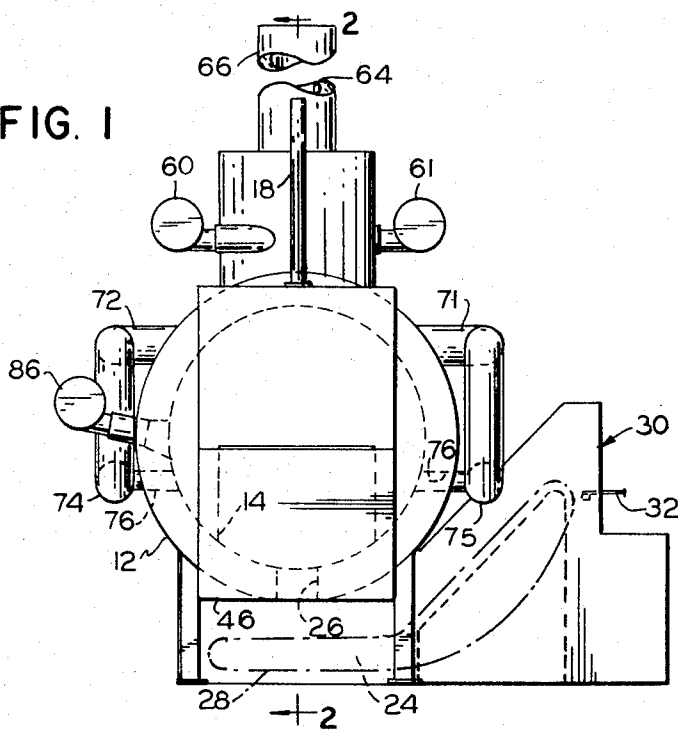
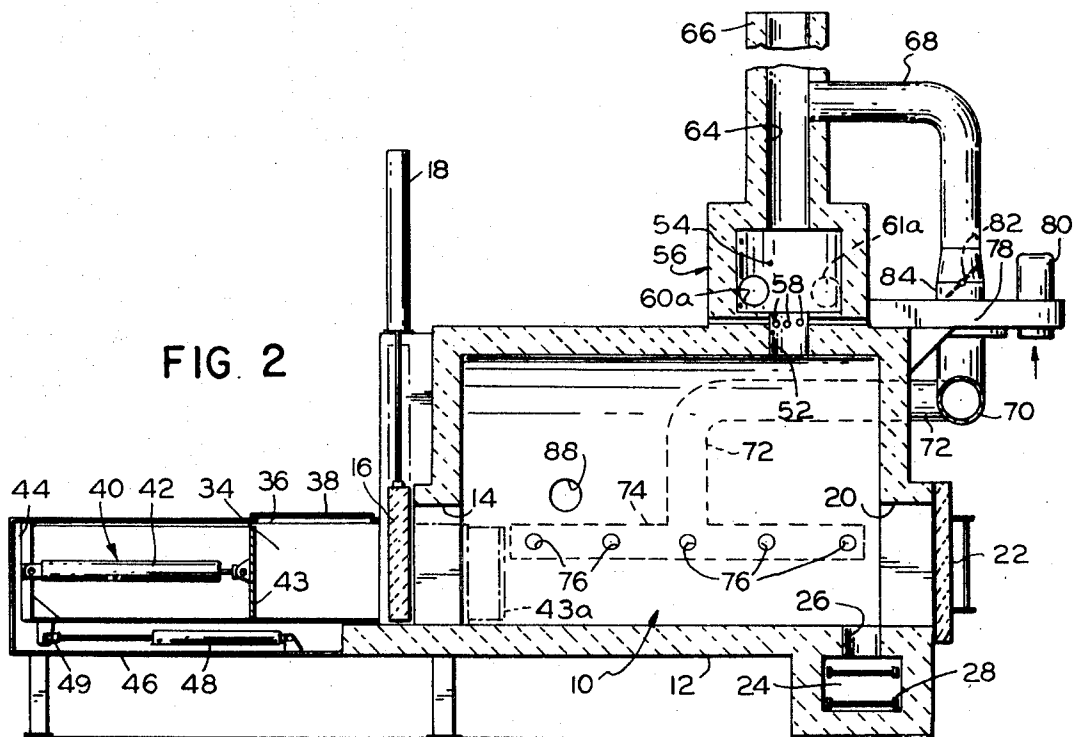


FIG. 2



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CONTROLLED ATMOSPHERE INCINERATOR**BACKGROUND OF THE INVENTION****1. Field of the Invention**

The present invention relates to the incineration of solid wastes while minimizing exhaust pollutants from such incineration.

2. Description of the Prior Art

In the past, excess volumes of cold outside air have commonly been introduced into furnaces in attempting to ensure complete combustion of solid wastes. However, this practice has several disadvantages, namely: (1) such large excesses of air tend to pick up noncombustibles and particulate matter before it is burned and force them out of the furnace in the exhaust gas stream, causing air pollution; (2) such air excesses promote rapid uncontrolled combustion, at rates in excess of the design capacity of the furnace; (3) the cold air introduced tends to cool down the furnace and produce erratic burning due to the fluctuating temperatures within the furnace; and (4) the heat required to maintain combustion must be generated by the burning material itself or from auxiliary fuel burners.

Others have attempted to control combustion solely by restricting the amount of combustion air admitted to the incinerator. This so-called "starved air" incinerating technique, while slowing the rate of combustion, also tends to produce incomplete combustion, requiring the burning of large amounts of auxiliary heat-producing fuels and resulting in inefficiency, high cost, and waste disposal and air pollution problems.

SUMMARY OF THE INVENTION

According to the present invention complete combustion of waste solids at a substantially uniform controlled rate is promoted by reintroducing hot combustion gases into the primary furnace after they have first been mixed with combustion air, afterburned, and then mixed with additional combustion air to provide a controlled atmosphere within the primary burner consisting primarily of carbon dioxide and secondarily of air at a controllable temperature.

Primary objectives and features of the invention therefore include:

1. incinerating at a uniform, controlled rate without the use of excess air but with sufficient oxygen to support complete combustion;
2. incinerating waste solids in a controlled atmosphere of primarily carbon dioxide and air;
3. using a preheated atmosphere to maintain a desired combustion temperature within the incinerator;
4. composing a desired atmosphere at a desired temperature for combustion externally of the furnace and then introducing it into the furnace to support combustion;
5. composing the desired atmosphere from afterburned furnace gases mixed with controlled proportionate amounts of air;
6. restricting as much as practicable the use of cool ambient outside air to support combustion; and
7. providing an incinerator with means for carrying out the foregoing objectives.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will become more apparent from the following detailed description which proceeds with reference to the accompanying drawings wherein:

FIG. 1 is an end elevational view of an incinerator in accordance with the invention; and

FIG. 2 is a vertical sectional view taken approximately along the line 2—2 of FIG. 1.

DETAILED DESCRIPTION

The incinerator of the invention as shown in FIGS. 1 and 2 includes a primary incinerator or combustion chamber 10 defined by cylindrical refractory walls 12. Such walls further define a solid waste material inlet opening 14 at one end of the chamber closed by a vertically movable refractory gate 16 operated by vertically disposed fluid-powered cylinder 18. Such walls further define at the opposite lower end of the chamber a clean-out opening 20 closed by a door 22. An ash trap 24 below the bottom of the chamber 10 and connected thereto by floor opening 26 includes a drag chain 28 which automatically removes material from the trap and transfers it to an enclosed ash cart chamber 30 for disposal. Chamber 30 includes an ash quench spray nozzle 32 connected to the source of water for quenching the hot ashes as they arrive within the chamber.

Waste material to be burned is fed from an outside source into a charging chamber 34 through an opening 36 normally closed by a lid 38 to minimize the introduction of cold outside air into the primary combustion chamber. With lid 38 closed and gate 16 raised, waste material is pushed into the primary combustion chamber 10 by a charging ram 40. Ram 40 includes a horizontal long-stroke fluid-powered cylinder 42 pivoted at its piston rod end to a vertical ram plate 43 and at its opposite end to an end wall of a ram housing 44. Housing 44 itself is mounted for horizontal reciprocation within an end housing 46. The bottom wall of housing 46 mounts a second horizontal power cylinder 48 having its rod end pivoted at 49 to an outer end portion of ram housing 44. Retraction of cylinder 48 moves the entire ram housing including ram plate 43 toward the right in FIG. 2 toward the inlet opening 14 of the primary combustion chamber. Therefore upon extension of ram cylinder 42, plate 43 moves through inlet opening 14 into the dashed line position 43a within primary combustion chamber 10, pushing waste material ahead of it. Thereafter extension of cylinder 48 and retraction of cylinder 42 returns ram plate 43 to its full-line retracted position shown.

An upper portion of wall 12 of the primary combustion chamber includes a combustion gas outlet opening 52 leading into a chamber 54 of an afterburner housing 56. Combustion air inlets 58 are provided adjacent to the entrance of afterburner chamber 54 within passage 52. A pair of auxiliary afterburner devices 60, 61 burning auxiliary fuel such as oil, natural gas, propane or any other suitable fuel from an external source (not shown) direct auxiliary flame and thus heat tangentially into afterburner 54 at inlets 60a, 61a. These burners fire combustion gases and gas-borne solids entering the afterburner chamber from the primary combustion chamber.

Combustion gases from the afterburner escape upwardly through exhaust passage 64 and eventually to

exhaust stack 66, where they escape to atmosphere. However, just upwardly from the base of exhaust outlet 64 a pipe 68 defining a recirculation passage leads a portion of the exhaust gases from the afterburner back toward the primary incinerator. At a juncture 70 pipe 68 divides into a pair of return pipes 71, 72 which divide the return gas flow from the afterburner and direct it to a pair of return manifolds or headers 74, 75 including a multiplicity of return gas inlets 76. These inlets introduce the gas into the primary combustion chamber at horizontally spaced points along opposite sides of the chamber.

Just upstream from the return pipe juncture 70, an induced draft fan 78 driven by a motor 80 draws the return flow of afterburner gases from exhaust passage 64 and forces such gases back to the return manifold and through inlet 76 into the combustion chamber. At the same time the induced draft fan draws in outside combustion air and mixes it with the return flow of afterburner gases in a predetermined desired proportionate amount to obtain a controlled atmosphere at a controlled high temperature for introduction into the primary combustion chamber. The proportionate make-up of afterburner gases and combustion air may be controlled by any suitable control device such as the damper 82 in the venturi section 84 of return pipe 68 at the fan.

For startup and in the event it should be found necessary or desirable under certain burning conditions or with certain materials, the primary combustion chamber is provided with an auxiliary fuel burner 86 directing a flame into the chamber at an opening 88.

METHOD OF OPERATION

The incinerator described may be continuously operated as successive batches of waste material are introduced periodically into the primary incineration chamber. Operation of the incinerator is as follows: For startup, and assuming waste material to be burned is present in the primary combustion chamber, auxiliary burner 86 is used to raise the temperature of the primary chamber to a desired predetermined level sufficient to support combustion. At the same time a minimum of outside combustion air for startup may be admitted through inlet 76 by operation of induced draft fan 78. Initially the atmosphere within the primary combustion chamber will be primarily outside combustion air. However, after startup the proportion of combustion air in the mixture is reduced considerably as fan 78 recirculates afterburner gases to the primary combustion chamber.

Now with combustion occurring in the primary chamber, additional waste material is introduced into such chamber by raising lid 38 to place the waste first in charge chamber 34. Then lid 38 is closed and gate 16 opened, after which cylinder 48 retracts and cylinder 43 extends so that plate 43 pushes material through inlet opening 14 into the chamber, at the same time forcing any ash buildup on the floor of the chamber into ash trap 24 where it is automatically removed by drag chain 28 to the ash-quenching and -removal chamber 30.

As burning proceeds continuously within primary chamber 10, combustion gases primarily consisting of carbon monoxide escape through outlet 52. There they are mixed with combustion air entering through inlets 58 to form carbon dioxide and again subjected to high

temperature burning within afterburner chamber 54 to destroy any remaining combustible gases and suspended solids. Thereafter a portion of these afterburner gases escaping through exhaust passage 64 toward stack 66 are drawn into recirculation pipe 68 by the drawing action of fan 78. These such gases, primarily carbon dioxide, are mixed with combustion air also drawn in by the fan in an approximate ratio of 3:1. This second mixture of combustion gases and air is then forced to return headers 74, 75 and forced through return inlets 76 into the combustion chambers 10 to provide such chamber with a carefully regulated atmosphere. This atmosphere, primarily air and carbon dioxide, contains sufficient oxygen to support combustion. The atmosphere is also hot so that it supplies the combustion chamber with an external source of heat. The atmosphere therefore enables the burning of combustibles within the primary chamber at a relatively slow, uniform rate corresponding to the design capacity of the incinerator.

It is emphasized that in the incineration process described, there is no direct introduction of cold outside combustion air into the primary combustion chamber except for small amounts which may enter with the introduction of waste material through inlet opening 14 and the amounts that may be used during the initial startup of the incinerator. However, even at startup, the combustion air entering through inlet 76 may be preheated by firing afterburners 60, 61 before starting fan 78.

As previously indicated, for most solid combustibles it is believed that a ratio of approximately 75% afterburner gases or carbon dioxide and 25 percent outside combustion air will prove to be the most desirable mixture to make up the atmosphere within the primary combustion chamber. However, other ratios may prove more desirable under various operating conditions and with various waste materials.

The recirculation of afterburner gases and outside air to the primary combustion chamber not only supplies the oxygen necessary to support combustion, but also supplies an external source of heat to maintain a sufficient temperature within the primary chamber to support combustion. Thus the heat generated by the burning material within the incinerator itself is not the sole source of heat. In this way the primary combustion chamber may be maintained at a fairly even desired high temperature and at a substantially uniform constant atmosphere to maintain a uniform rate of burning in accordance with the design capacity of the incinerator.

Under typical operating conditions, the temperature of the afterburner gases as they leave the afterburner may range somewhere upwardly of 1200° F. and will probably be cooled to a temperature of roughly 900° F. by mixture with outside air before they are returned to the primary combustion chamber. However, these temperatures are not critical, being just examples that may be varied to suit individual requirements.

Having described what is now a preferred embodiment of our invention, it should be apparent to those skilled in the art that the same permits of modification in arrangement and detail without departing from the spirit of the invention. I claim as my invention all such modifications as come within the true spirit and scope of the following claims.

I claim:

1. A method of controlling the rate of combustion in a continuous combustion process comprising:
burning a quantity of combustion materials in a furnace with a controlled atmosphere comprising a controlled-temperature mixture of afterburned gases and air by mixing gaseous products of combustion from said burning with air to form a first gas-air mixture, afterburning said first gas-air mixture to generate hot afterburned gases, taking at least a portion of said hot afterburned gases and mixing them with a quantity of air in an amount to produce a second gas-air mixture at a desired proportion and temperature, and then introducing said second gas-air mixture into said furnace to support said burning.
2. The method of claim 1 wherein said combustible materials are introduced into said furnace while minimizing the entry of outside air at the same time.
3. The method of claim 1 wherein the atmosphere within said furnace is controlled so that said gaseous products of combustion from said burning comprise primarily carbon monoxide, said afterburned gases comprising primarily carbon dioxide.
4. The method of claim 3 wherein said second gas-air mixture comprising said controlled atmosphere comprises roughly 75 percent carbon dioxide and 25 percent air.
5. The method of claim 1 wherein said second gas-air mixture comprises roughly 75 percent afterburned gases and 25 percent air.
6. A controlled atmosphere incinerator comprising, a primary combustion chamber including a normally closed combustible material inlet, a combustion gas outlet, and controlled atmosphere inlets, an afterburner chamber above said primary combustion chamber and connected to the latter by said combustion gas outlet, afterburner means for providing a source of flame within said afterburner chamber, combustion air inlet means leading into said afterburner chamber, exhaust gas outlet passage means leading from said afterburner chamber, recirculation gas passage means leading from said exhaust gas outlet passage means into said primary combustion chamber, and means for inducing a flow of exhaust gases from said afterburner chamber through said recirculation passage means into said primary combustion chamber and mixing said flow within said recirculation passage with a controlled proportion of air in a manner so that said primary combustion chamber can be continuously supplied with an atmosphere consisting of a controlled proportion of air at a controlled temperature.
7. An incinerator according to claim 6 including ram-type charging means for injecting combustible materials into said primary combustion chamber through said material inlet while minimizing the entry of air through said inlet at the same time.
8. An incinerator according to claim 6 wherein said inducing means includes an induced draft fan means in said recirculation passage means.
9. An incinerator according to claim 6 wherein said recirculation passage means terminates at said primary combustion chamber in a gas return manifold means

including a plurality of gas inlets leading into said primary chamber.

10. An incinerator according to claim 6 wherein said manifold means includes a pair of return manifolds, one extending along each of the opposite sides of said primary chamber.

11. An incinerator according to claim 6 including a material-charging means associated with said material inlet, said charging means including normally closed power-operated gate means movable between open and closed positions to open and close said material inlet, a material-charging chamber on the opposite side of said gate means from said primary combustion chamber, means defining a normally closed charge opening for introducing material to be burned into said charging chamber, charging ram means in said charging chamber and movable toward and away from said gate means for pushing material to be burned through said inlet into said primary combustion chamber when said gate means is open, said charging ram means being retractable to a position clearing said charge opening to enable introduction of material to be burned into said charging chamber ahead of said ram means, whereby material can be introduced first into said charging chamber with said gate means closed and said charging ram means retracted and then introduced into said primary combustion chamber with said charge opening closed and said gate means open upon extension of said ram means to minimize the introduction of outside air into such primary combustion chamber through said inlet.

12. An incinerator according to claim 6 including means for varying the proportion of exhaust gases and air in said recirculation gas passage means for introduction into said primary combustion chamber.

13. An incinerator according to claim 6 wherein said primary combustion chamber is of generally cylindrical shape, said material inlet being provided in one end wall of said chamber, said combustion gas outlet being in an upper cylindrical wall portion of said chamber, said controlled atmosphere inlets being provided along opposed cylindrical sidewall portions of said primary combustion chamber, combustion gas outlet passage means interconnecting said combustion gas outlet of said primary combustion chamber and said afterburner chamber, said combustion air inlet means being provided in said combustion gas outlet passage means between said primary combustion chamber and said afterburner chamber, said means for inducing a flow of exhaust gases from said afterburner chamber through said recirculation passage means into said primary combustion chamber including fan means in said recirculation passage means, and air inlet means at said fan means for introducing air into said recirculation passage means.

14. The method of claim 1 including introducing said second gas-air mixture into a primary combustion chamber of said furnace, and controlling the rate and temperature of burning in said primary combustion chamber by controlling the proportion and temperature of said second gas-air mixture.

15. The method of claim 14 wherein said second gas-air mixture provides the only substantial source of air for supporting burning within said primary combustion chamber.

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