United States Patent [19]

Schrage

[11] **3,785,305**

[45] **Jan. 15, 1974**

[54] **INCINERATOR**

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[73] Assignee: **Aqua-Chem, Inc.,** Milwaukee, Wis.

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[52] **U.S. Cl.** ..... **110/8 A,** 110/8 C

[51] **Int. Cl.** **F23g 5/12**

[58] **Field of Search** ..... 110/8 R, 8 A, 8 C, 110/18 C

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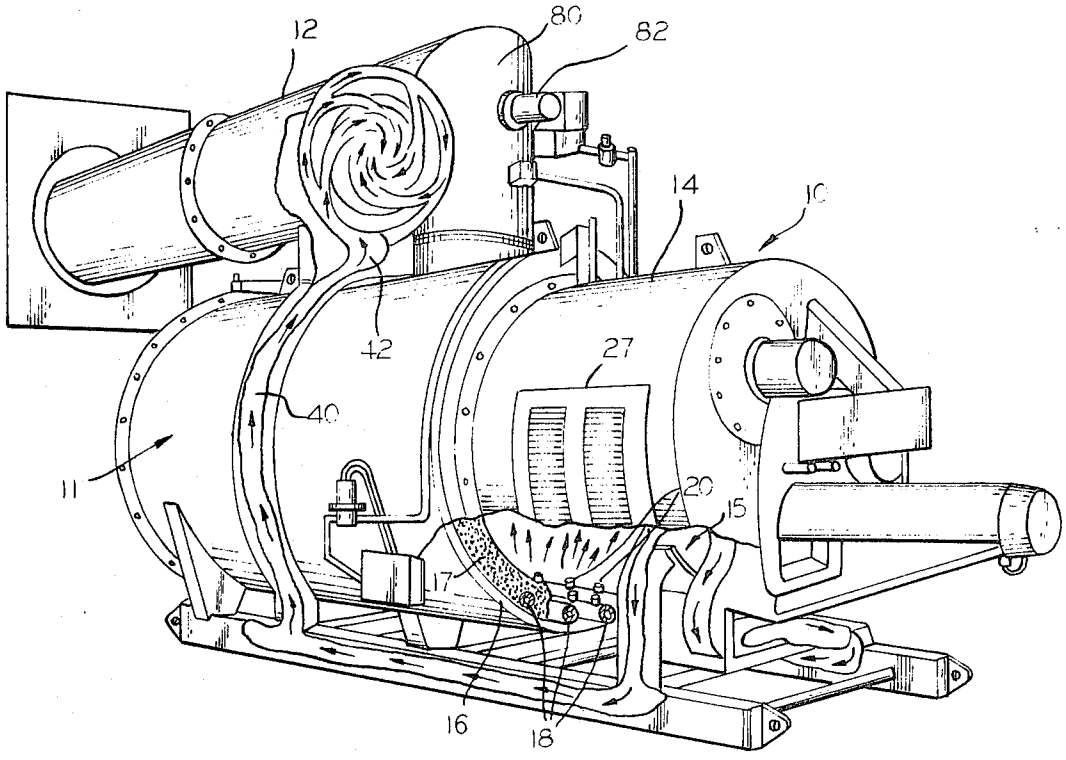
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Primary Examiner—Kenneth W. Sprague
Attorney—Fred Wiviott et al.

[57] **ABSTRACT**

An incinerator having a support assembly structure which also conducts combustion air to a main combustion chamber and an afterburner. Refuse is fed into the main combustion chamber by a compactor which includes a refuse receiving chute having a wall which pivots for refuse compaction. The afterburner air feed system includes a first tangential set of air passages for gas mixing, a venturi section to create a positive draft, and a combustion air feed system. A temperature control regulates the air feed and afterburner temperature by adjusting air feed and fuel.

15 Claims, 8 Drawing Figures



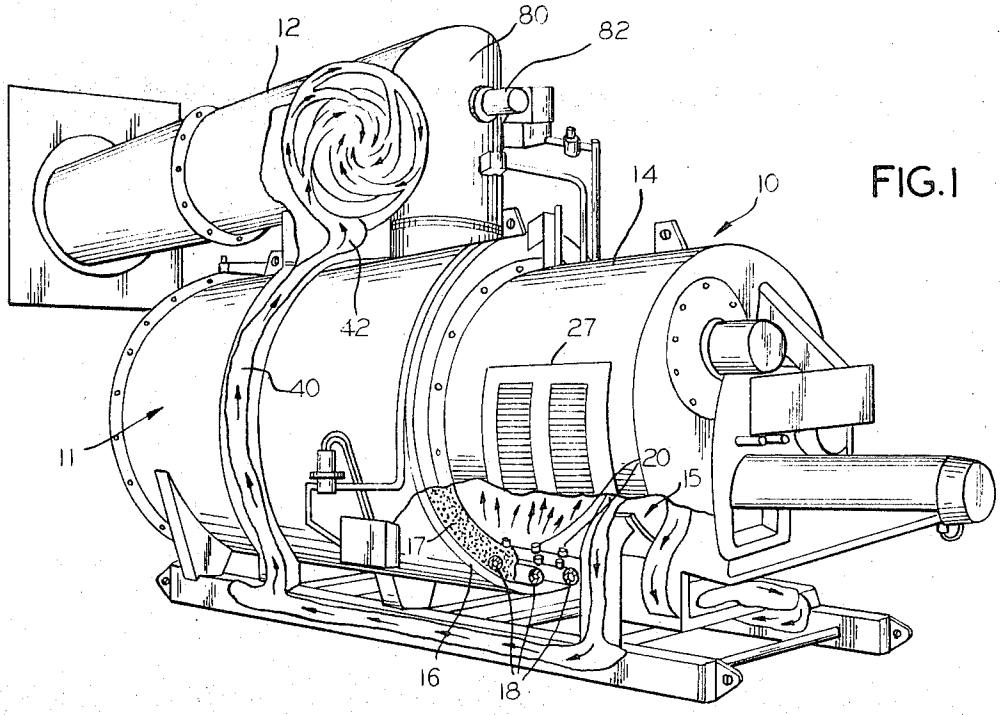

12
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FIG.1

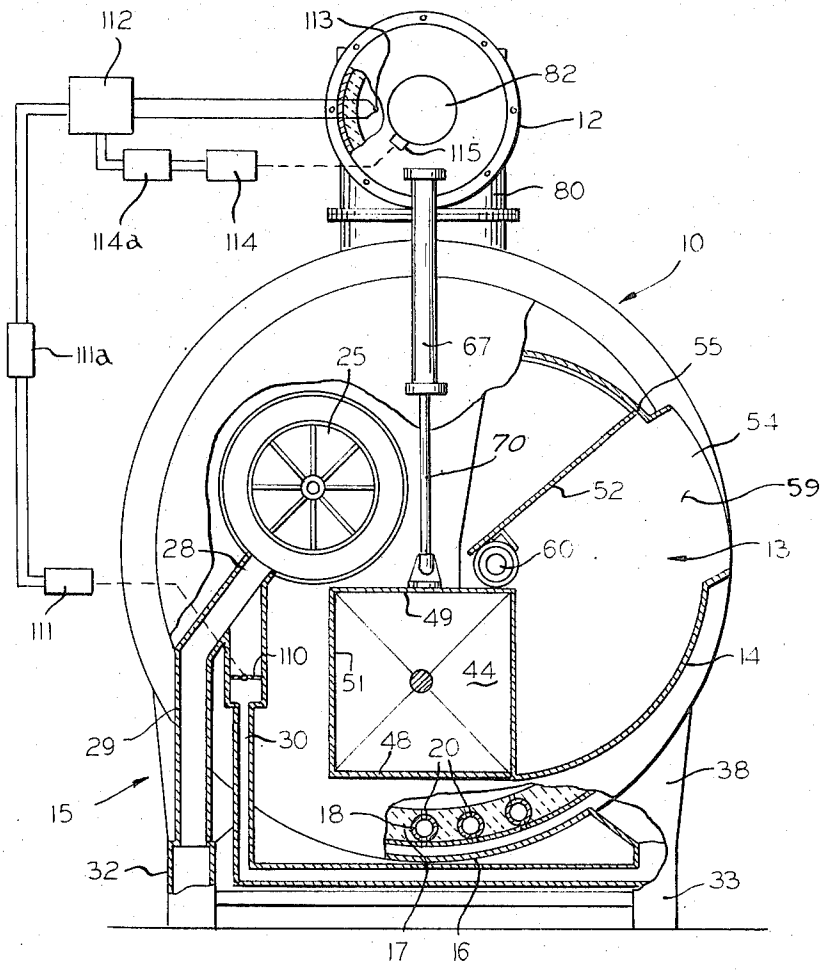

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FIG.3

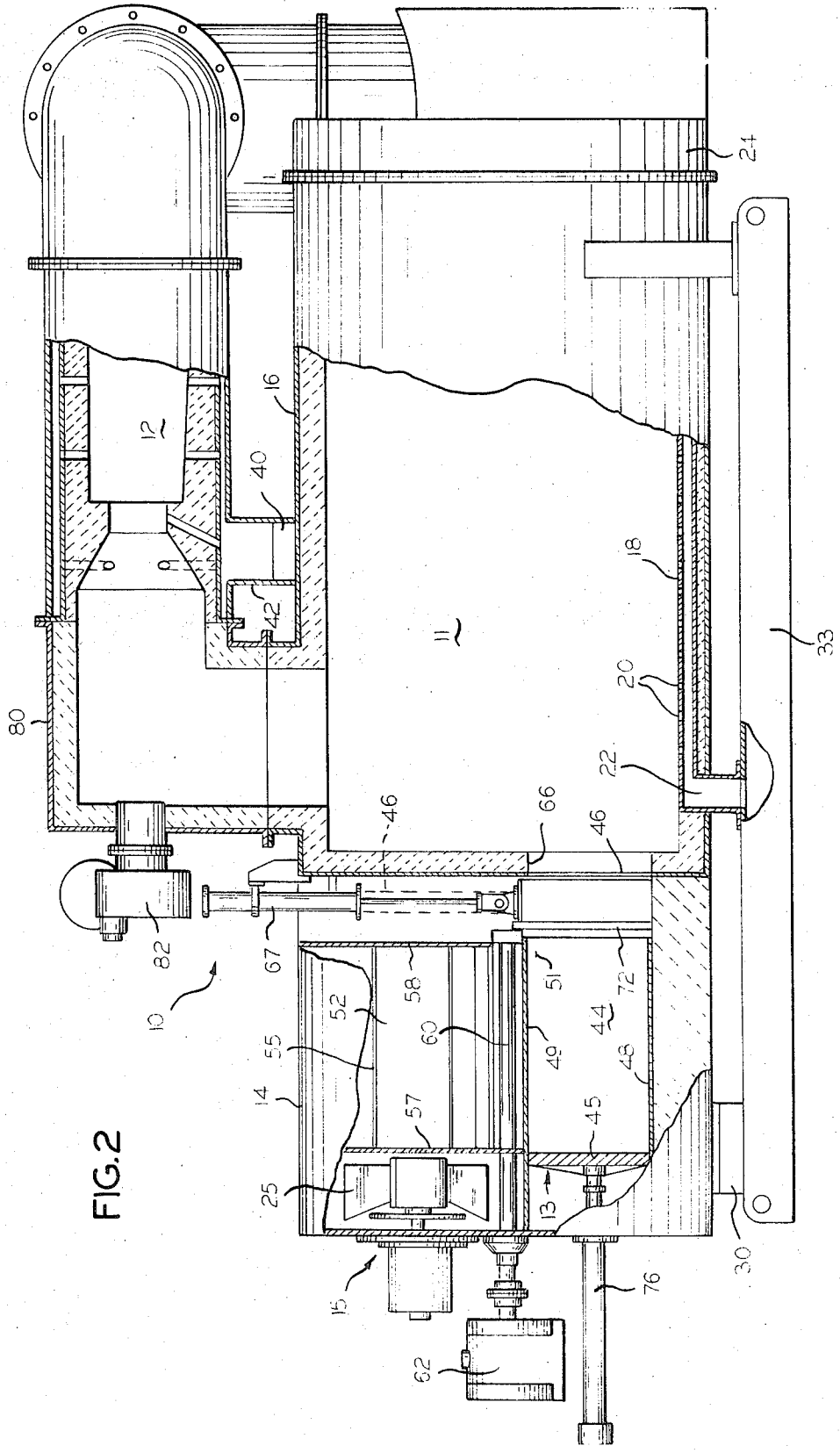

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FIG.2

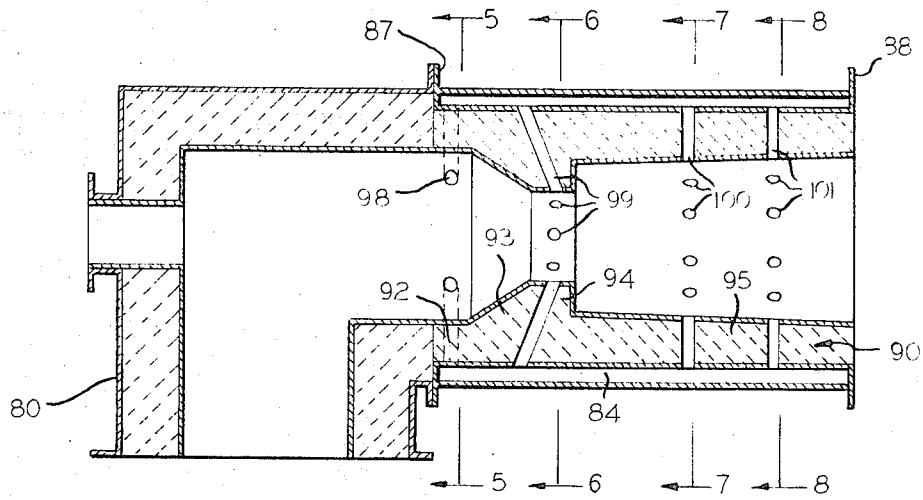


FIG. 4

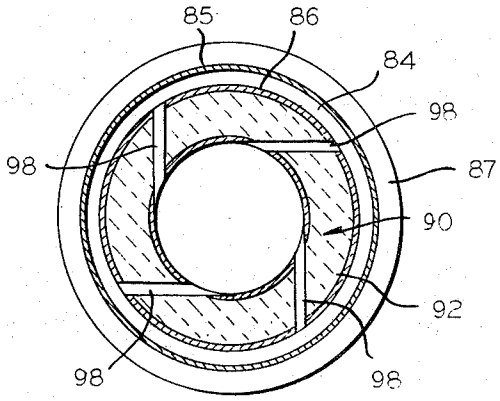


FIG. 5

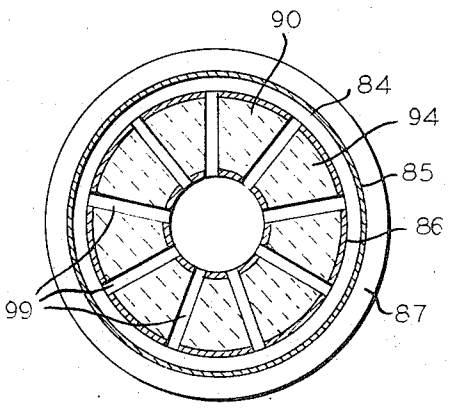


FIG. 6

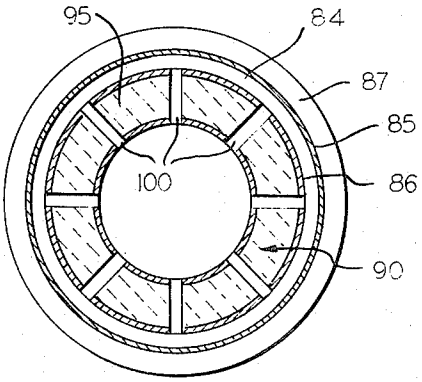


FIG. 7

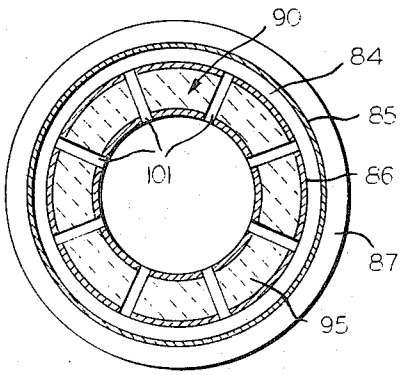


FIG. 8

INCINERATOR

BACKGROUND OF THE INVENTION

This invention relates to apparatus for the combustion of waste materials.

The elimination of solid waste materials has become a serious problem, particularly in crowded urban areas. While it was common practice, in the past, to incinerate such materials, many prior art incinerators were not satisfactory because they emitted gaseous and particulate pollutants. Many large and costly incinerating plants must discontinue operation because they fail to meet current pollution control standards. There has been a number of proposals to eliminate incinerator pollution by providing incinerators having a primary combustion chamber for the incomplete combustion of refuse and a secondary combustion chamber, or afterburner, for burning the combustible materials emitted from the primary combustion chamber. However, because of the variation in the materials to be burned and the intermittency of the material feed, many of these prior art devices did not completely incinerate gaseous and particulate pollutants prior to atmospheric discharge.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a new and improved refuse incinerating apparatus.

And her object of the invention is to provide refuse incinerating apparatus which minimizes the discharge of atmospheric pollutants.

A further object of the invention is to provide a combustion air system for incinerators which insures efficient combustion and minimizes pollutant discharge.

Still another object of the invention is to provide an incinerator afterburner which effectively burns combustible materials discharging from a primary combustion chamber.

These and other objects and advantages of the instant invention will become more apparent from the detailed description thereof taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, with parts broken away, of an incinerator according to the preferred embodiment of the present invention;

FIG. 2 is a side elevational view, with parts broken away, of the incinerator illustrated in FIG. 1;

FIG. 3 is an end view, with parts broken away, of the incinerator illustrated in FIG. 1;

FIG. 4 is a vertical cross sectional view of the afterburner portion of the apparatus illustrated in FIG. 1;

FIG. 5 is a view taken along lines 5—5 of FIG. 4;

FIG. 6 is a view taken along the lines 6—6 of FIG. 4;

FIG. 7 is a view taken along the lines 7—7 of FIG. 4; and

FIG. 8 is a view taken along lines 8—8 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In general terms, the incinerator **10** according to the preferred embodiment of the invention includes a main combustion chamber **11**, an afterburner **12**, and a material feed system **13**. As will be described more fully hereinbelow, the material feed system **13** is disposed in a metallic housing **14** mounted on the main combustion chamber **10** and initially receives the refuse to be burned for compaction prior to feeding into the main combustion chamber **11**. The refuse is burned in the main combustion chamber **10** with less than the stoichiometric amount of oxygen. This forms gaseous combustion products which pass into the afterburner **12** where they are mixed with air for complete combustion prior to discharge into the atmosphere. The main combustion chamber **11** and afterburner **12** are supplied with combustion air by an air feed system **15**.

As those skilled in the art will appreciate, the main combustion chamber **10** may take any convenient shape. In the preferred embodiment of the invention, the main combustion chamber **10** is shown to be generally cylindrical about a horizontal axis and to include a suitable outer metallic casing **16** and an inner refractory lining **17**. A plurality of elongate air feed pipes **18** extend longitudinally along the bottom of the chamber **11** and below the refractory lining **17**. Extending upwardly from each of the pipes **18** are a plurality of short nozzles **20** which couple the air pipes **18** to the interior of the chamber **11**. The end of the pipes **18** are coupled to a manifold **22** which in turn is coupled to the air system **15** in a manner which will be described more fully below. Because of the large number of nozzles **20**, air passes upwardly into the combustion chamber at a relatively low velocity. This reduces turbulence which might otherwise entrain particulate matter in the flue gas stream. An access door **24** is suitably mounted at the end of main combustion chamber **11** to permit the removal of ashes and noncombustibles.

The air system **15** includes a motor driven fan **25** which draws combustion air into the housing **14** through a louvered panel **27** and forces the same downwardly into a plenum chamber **28**. The plenum chamber **28** is coupled by conduits **29** and **30** to the hollow skids **32** and **33** of the incinerator support assembly. A hollow support leg **38** connects the skid **33** to the manifold **22** whereby combustion air is provided to the nozzles **20** of the main combustion chamber **11**. A third conduit **40** extends upwardly from the hollow skid **32** and around the main combustion chamber **11** to open at its upper end into a hollow support housing **42** beneath the afterburner **12** and which opens into the afterburner air system as will be described more fully below. It can thus be seen that the support assembly consisting of the skids **32** and **33** and the support legs **35, 36, 37** and **38** function as an integral part of the air system for the main combustion chamber **11** and the afterburner **12**.

The material feed system **13** includes a generally rectangular enclosure **44** the opposite ends of which are formed by a ram plate **45** and the charging door **46** of the main combustion chamber **11**. The enclosure also includes a fixed bottom wall **48**, a top wall **49** and a side wall **51**. One side of the enclosure is normally open and may be closed by a side closure wall and compactor **52** which is pivotally mounted on top wall **49** and adjacent the edge of the open side. Side closure **52** is substantially the same size as wall **51** and closes the open side of the enclosure when it pivots from its full position as shown in FIG. **3** to its closed position therein shown by dashed lines. Ram plate **45** is slidably mounted for horizontal movement within enclosure **44** and its outer periphery is in substantial registry with the inner circumferential surface of enclosure **44**.

An access opening 54 is provided in the housing 14 for receiving trash to be burned. When the side closure 52 is in its open unpivoted position shown by full lines in FIG. 3, its remote edge 55 is slightly above the upper edge of the opening 54. A pair of sector shaped panels 57 and 58 extend radially inwardly from the housing 14 and adjacent the opposite sides of the access openings 54 to the sides of the enclosure 44 and to a position above the member 52. This forms a trash receiving chute 59 extending from the opening 54 to tne enclosure 44 and bounded by the closure member 52, the panels 57 and 58 and the housing 14.

The closure member 52 is mounted for pivotal movement on a horizontal shaft 60 which has one end journaled at bearing 61 and whose other end is coupled to a rotary hydraulic motor 62. The bearing 61 and motor 62 may be supported in housing 14 in any suitable manner well known in the art and will not be discussed in detail for the sake of brevity. The pivotal axis of shaft 60 is coincident with the axis of curvature of housing 14 and the width of member 52 is substantially equal to the radius of said housing. In this manner, actuation of the hydraulic motor 62 will pivot the member 52 to move end 55 along the inner surface of housing 14 to carry any trash between panels 57 and 58 into the enclosure 44. It will also be appreciated that this action will compact the trash in the enclosure 44 and the chute 59 into the volume of the enclosure 44 itself.

A cylinder 67 is suitably mounted by brackets 68 and 69 above the furnace charging door 46 and in a generally vertical direction. A connecting rod 70 couples a piston (not shown) disposed within cylinder 67 to the upper end of the furnace door 46. When cylinder 67 is actuated in a first sense, it moves furnace door 46 vertically upward from its position shown by full lines in FIG. 3 wherein opening 66 is covered to its position shown by dashed lines in FIG. 2 wherein opening 66 is uncovered. A pair of vertical guide rails 72 are mounted within housing 14 and engage the opposite front edges of furnace door 46 to guide the latter as it moves between its open and closed positions. Cylinder 67 is interlocked with hydraulic motor 62 and closure member 52 so that door 46 cannot be moved upwardly out of its closed position until closure member 52 is fully closed.

While in the preferred embodiment of the invention one of the vertical sides of enclosure 44 is open, a different side could be open without deviating from the inventive concept. For example, the top side could be open with the remaining three sides closed and closure member 52 pivotally mounted for downward movement to close said open top side.

As seen in FIG. 2, a second hydraulic cylinder 76 is suitably mounted on a bracket 77 below shaft 60 and in general parallelism therewith. A piston (not shown) within cylinder 76 is coupled to the ram plate 45 for moving said plate horizontally within enclosure 44 upon the actuation of cylinder 76. Cylinders 67 and 76 are interlocked so that cylinder 76 cannot begin moving ram plate 45 toward the furnace door until the latter has been raised to uncover the main combustion chamber charging opening 66.

A refractory lined elbow 80 is shown in FIG. 2 to couple the upper end of the main combustion chamber 11 at a point above the feed opening 66 to the afterburner 12. An ignition burner 82 of any suitable type well known in the art may be disposed in the vertical portion of elbow 80 and generally coaxially with afterburner 12. Referring now to FIG. 4, afterburner 12 is shown to include a generally annular plenum chamber 84 formed by a pair of spaced apart coaxial metallic shell members 85 and 86 which are retained in a spaced relation to being suitably secured at their opposite ends to a pair of annular rings 87 and 88.

The afterburner 12 also includes a shaped refractory lining 90 having a first relatively short, generally annular inlet portion 92, a frusto conical section 93 which terminates in a relatively short reduced diameter annular section 94 and a relatively long cylindrical section 95. The sections 93 and 94 form a venturi to create a positive draft between the main combustion chamber 11 and the afterburner 12. A plurality of air passages are formed through the various sections of refractory lining 90 to insure complete combustion of the gaseous products discharging from the main combustion chamber 11. More specifically, as seen in FIGS. 4 and 5, a first set of air passages 98 are formed through the inlet portion 92 of the refractory lining 90 and extend from the plenum chamber 84 in the direction generally tangential to the inside surface thereof of said section. The air passing through passages 97 therefore moves generally tangential to the inlet portion causing a thorough mixing of the combustible gases emanating from the main combustion chamber 11 and the afterburner combustion air passing inwardly from the plenum chamber 84.

As seen more particularly in FIGS. 4 and 6, a second plurality of air passages 99 extend from the plenum chamber 84 inwardly to terminate in the reduced diameter portion 94. The passages 99 extend generally inwardly toward the axis of the afterburner 12 and are inclined generally in the direction of the gas flow. This tends to cause a further mixing of the combustible gases and air as they pass through the venturi throat section 94 and into the afterburner combustion chamber 95.

As seen in FIGS. 4, 7 and 8, a third and a fourth plurality of air passages 100 and 101, respectively, extend through the refractory lining in the main combustion section 90 and are generally radially inwardly for providing oxygen to completely burn the gases exiting from the main combustion chamber 11. As those skilled in the art will appreciate, the exit end 102 of the afterburner 12 will be connected to an exhaust stack. Those skilled in the art will appreciate that the number, position and inclination of the air passages 97, 99, 100 and 101 are exemplary, and may vary with conditions without deviating from the invention.

As seen more particularly in FIG. 3, a throttle valve 110 is disposed between plenum chamber 28 and the duct 30. Valve 110 is operated by a positioning motor 111 which in turn is coupled through a current to position transducer 111*a* to a control 112 responsive to a temperature measuring probe 113 disposed within the afterburner 12. Control 112 is also coupled to control through current to position transducer 114*a* to motor 114 which in turn controls the fuel supply metering valve 115 for the afterburner ignition 82. The temperature probe 113, control 112, transducers 111*a* and 114*a* and motors 111 and 114 will be constructed and arranged such that when the afterburner temperature rises a predetermined amount above a preselected temperature, such as 1,500° F for example, the valve 110 will be adjusted so that the air supply to the main com-

bustion chamber **11** will be throttled back as will the fuel to the ignition burner **82.** On the other hand, when the afterburner temperature falls a predetermined amount below the preselected temperature, valve **110** will be adjusted to increase the air flow while the fuel feed rate to burner **82** will also be increased. This insures that the afterburner **12** can effectively oxidize all of the combustible gases emanating from the main combustion chamber **11.**

In operation, the main combustion chamber **11** will be charged with combustible material which will then be ignited. Ignition may be accomplished either manually or by means of a burner, not shown. The fan **25** and the afterburner ignition burner will be actuated simultaneously or prior to ignition in the main combustion chamber. The air supply to the main combustion chamber **11** will be regulated so that less than the stoichiometric amount of oxygen is provided. As a result, gaseous combustion products, such as CO, are passed into the afterburner **12.** The venturi section **93–94** in afterburner **12** insures a positive draft through elbow **80** and the air passages **97** and **99** insure a complete mixing of the gaseous combustion products and combustion air. Complete combustion of the combustible gases occurs within the main afterburner section **90** to eliminate the discharge of smoke or polluting gases. Further, by controlling the temperature in afterburner **12** to about 1,500° F, the combustion rate in the primary combustion chamber can be regulated to a value which will insure complete combustion in afterburner **12.**

The components of the control system just discussed may be of any well known type available in the art. For example, control **112** may be a Model 537H–000-30–000–1–00 temperature control; motors **111** and **114** may each be Model No. 35–569A valve motors; and transducers **111***a* and **114***a* may be model 655A I to P transducers; all of such components being manufactured by the Barber-Coleman Company.

The transducers **111***a* and **114***a* are operative to receive a signal from the control **112** and to pass a second signal to the motors **111** and **114** respectively. When the signals received by the motors **111** or **114** are different than the signal corresponding to the motor position, the motors will be repositioned to either further open or close its respective valve.

Preferably, the motor **111** will be provided with a wider operating range than the motor **114.** In this manner, the fuel control valve **115** will move to its minimum fuel position while the valve **110** is in mid-range. This will provide substantial fuel savings because the valve **115** will be in its minimum position over a wide range of temperatures with adjustment within this range being accomplished by the valve **110.**

For example, the motor **114** and transducer **114***a* may be preset to operate over a range of 7–12 ma. range of signals from control **112** while motor **111** and transducer **111***a* may be preset to operate over a 2–12 ma. range of signals. When the temperature in afterburner **12** rises to a point where the signal from control **112** is less than 7 ma., the burner valve **115** will be in its minimum position and further temperature control will be achieved by adjusting valve **110.** When the temperature in the afterburner **12** falls below the point where the signal from control **112** exceeds 7 ma. both valves **110** and **115** will be adjusted to increase the air and fuel flow.

While refuse is being burned in the main combustion chamber **11,** trash can be loaded into chute **59.** When chute **59** fills, the compactor **52** may be actuated to compact the trash into enclosure **44.** The compacted trash need not be immediately charged into the main combustion chamber, but the compactor **45** may be returned to its open position, the chute **59** refilled and the compactor reactivated one or more times. Thus substantially more trash may be charged into the main combustion chamber **11** than merely the amount which the chute **59** and compartment **44** can hold in a single charging.

After the initial charge of refuse in the main combustion chamber **11** has been substantially consumed, the compactor **52** will be moved to its closed position shown by dashed lines in FIG. **3** to close compartment **44.** Piston **67** will then be operated to open furnace charging door **46** and piston **76** operated to actuate the ram plate **45** and thereby charge the compacted trash into the main combustion chamber **11.** The ram plate **45** may then be returned to its original position and furnace charging door **46** closed permitting the compactor **52** to be reopened whereby further trash may be fed into chute **59** and enclosure **44.**

As those skilled in the art will appreciate, the hot gases discharging from the afterburner **12** may be employed in a waste heat recovery boiler or the like.

The incinerator according to the invention provides a compact and economical waste disposal apparatus which effectively eliminates the discharge of pollutants.

While only a single embodiment of the invention has been shown and described, it is not intended to be limited thereby but only by the scope of the appended claims.

I claim:

1. An incinerator including a primary combustion chamber and an afterburner for burning the exhaust gases emitted from said primary combustion chamber, said afterburner including inlet means connected to said primary combustion chamber and an outlet, gas supply means for delivering an oxygen containing gas to said afterburner and including first gas delivery means adjacent said inlet for directing said oxygen containing gas tangentially around said inlet for mixing with said exhaust gases, and second gas delivery means between said first delivery means and said outlet for delivering combustion oxygen radially into said afterburner.

2. The incinerator set forth in claim **1** and including venturi means formed adjacent said inlet to create a positive draft in said primary combustion chamber.

3. The incinerator set forth in claim **1** and including a burner adjacent said inlet.

4. The incinerator set forth in claim **1** wherin said afterburner includes a refractory lining, said first and second gas delivery means, each comprises a plurality of passages formed through said refractory lining, said first plurality of passages having their inner ends directed tangentially to the inner surface of said lining, and said second plurality of passages having their inner ends directed radially relative to said afterburner.

5. The incinerator set forth in claim **4** and including a metallic shell surrounding said lining and spaced therefrom to form a plenum chamber therearound, said first and second passages being connected to said plenum chamber, and coupling means coupling said plenum chamber to said gas supply means.

6. The incinerator set forth in claim 5 wherein said lining has a venturi adjacent said inlet and formed by a first frusto conical portion and a second adjacent reduced diameter portion to create a positive draft in said primary combustion chamber.

7. The incinerator set forth in claim 6 and including a third plurality of passage means formed through said refractory lining at said reduced diameter portion and being inclined from their outer ends toward said outlet.

8. The incinerator set forth in claim 7 and including a burner adjacent said inlet.

9. The incinerator set forth in claim 8 wherein said second plurality of passages comprises two spaced apart sets of passages, each set of passages comprising a plurality of passages spaced around the periphery of said lining, and extending generally radially inwardly relative to said afterburner.

10. An incinerator including a primary combustion chamber and an afterburner for burning the exhaust gases emitted from said primary combustion chamber, said afterburner including inlet means connected to said primary combustion chamber and an outlet, gas supply means for delivering an oxygen containing gas to said afterburner and including first gas delivery means adjacent said inlet for directing said oxygen containing gas tangentailly around said inlet for mixing with said exhaust gases, second gas delivery means between said first delivery means and said outlet for providing combustion oxygen, said afterburner including a refractory lining, said first and second gas delivery means each comprising a plurality of passages formed through said refractory lining, said first plurality of passages having their inner ends directed tangentially to the inner surface of said lining, a metallic shell surrounding said lining and spaced therefrom to form a plenum chamber therearound, said first and second passages being connected to said plenum chamber, coupling means coupling said plenum chamber to said gas supply means, said lining having a venturi adjacent said inlet and formed by a first frusto conical portion and a second reduced diameter portion adjacent thereto to create a positive draft in said primary combustion chamber, a third plurality of passage means formed through said refractory lining at said reduced diameter portion and being inclined from their outer ends toward said outlet, a burner adjacent said inlet, said second plurality of passages comprising two spaced apart sets of passages, each set of passages comprising a plurality of passages spaced around the periphery of said lining, and support means for said primary combustion chamber and said afterburner, said support means including a hollow portion coupled between said gas supply means and said plenum chamber.

11. The incinerator set forth in claim 1 and including a burner adjacent said inlet, fuel supply means for said inlet, fourth gas delivery means coupled to said gas supply means for delivering said oxygen containing gas to said primary combustion chamber, temperature measuring means in said afterburner and means for controlling said fourth gas delivery means and said fuel supply means in accordance with the temperature in said afterburner.

12. An incinerator including a primary combustion chamber and an afterburner for burning the exhaust gases emitting from said primary combustion chamber, said afterburner including an inlet connected to said primary combustion chamber and an outlet, said afterburner also including a refractory lining and a metallic shell surrounding said refractory lining and spaced therefrom to form a plenum chamber therearound, said lining having a venturi adjacent said inlet and formed by a first portion having a frusto conical inside surface and a second portion formed by a reduced diameter inside surface, a first plurality of passages formed through said lining adjacent said inlet and a second plurality of passages formed in said lining between said venturi and said outlet, said passages connecting said plenum chamber to the interior of said refractory lining, said first plurality of passages extending generally tangentially relative to said afterburner and said second plurality of passages extending generally radially relative to said afterburner.

13. The incinerator set forth in claim 12 including a third plurality of passages extending between said plenum chamber and the reduced diameter portion of said lining, said third plurality of passages being inclined toward said outlet.

14. An incinerator having a primary combustion chamber, gas inlet means for introducing an oxygen containing gas into said primary combustion chamber, and gas supply means coupled to said gas inlet means, a plurality of support members disposed below said primary combustion chamber, a plurality of support legs engaging said support members and said combustion chamber for mounting said primary combustion chamber on said support members, at least one of support members and at least one of said legs being hollow and coupling said gas supply means to said gas inlet means.

15. The incinerator set forth in claim 14 and including an afterburner mounted on said primary combustion chamber and including gas inlet means coupled to said hollow support members.

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