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Hapgood et al.

[11] **3,776,148**

[45] **Dec. 4, 1973**

[54] **INCINERATOR**

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[73] Assignee: **Raytheon Company,** Lexington, Mass.

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[52] **U.S. Cl.** ..... **110/8 A,** 110/49 R

[51] **Int. Cl.** **F23g 5/00**

[58] **Field of Search** ..... 110/8 R, 8 A, 8 C, 110/18 R, 18 C, 49 R

[56] **References Cited**

UNITED STATES PATENTS

2,754,779	7/1956	Toepel	110/8
3,515,078	6/1970	Maitilasso	110/8
2,811,937	11/1957	Bouchard	110/8
3,538,865	11/1970	Lausmann	110/18

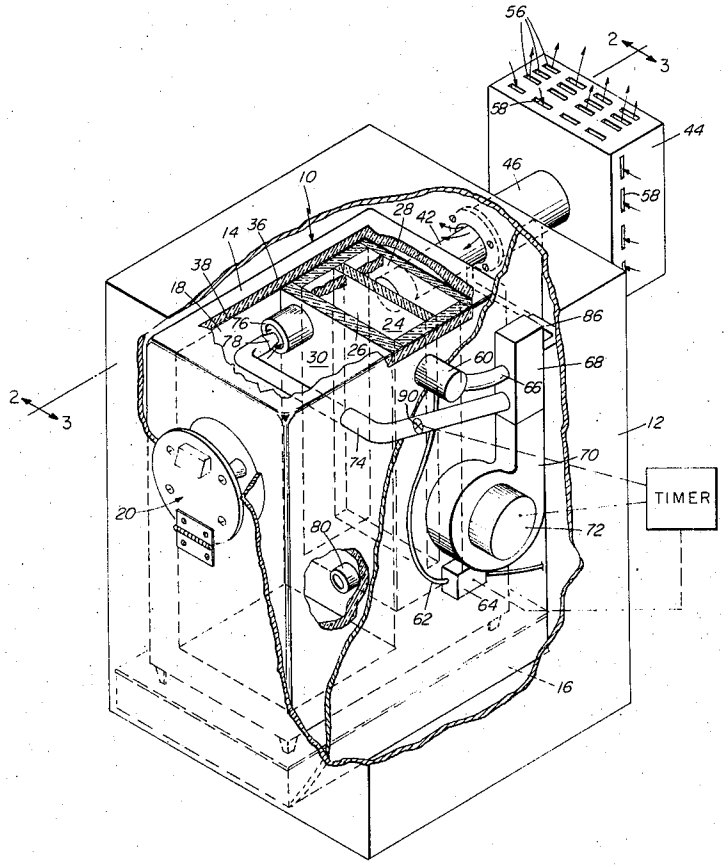
Primary Examiner—Kenneth W. Sprague

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[57] **ABSTRACT**

An incinerator particularly suitable for in-house under-counter installation and use comprising a well heat-insulated structure including combustion or trash chamber and a second or afterburner chamber divided into two volumes, one being a volatiles combustion chamber containing the burner and the other being an exhaust flue, and recirculating means whereby combustion products and smoke are directed out of the combustion chamber through the burner flame for incineration. Included also is a novel air flow system for providing circulating air for combustion simultaneously with jacket cooling, means for delaying the combustion process until the afterburner has become sufficiently preheated, and means for providing automatic combustion rate control whereby rate of combustion is automatically kept constant despite large variations in the type, heat content, and size of the charge being incinerated.

21 Claims, 5 Drawing Figures



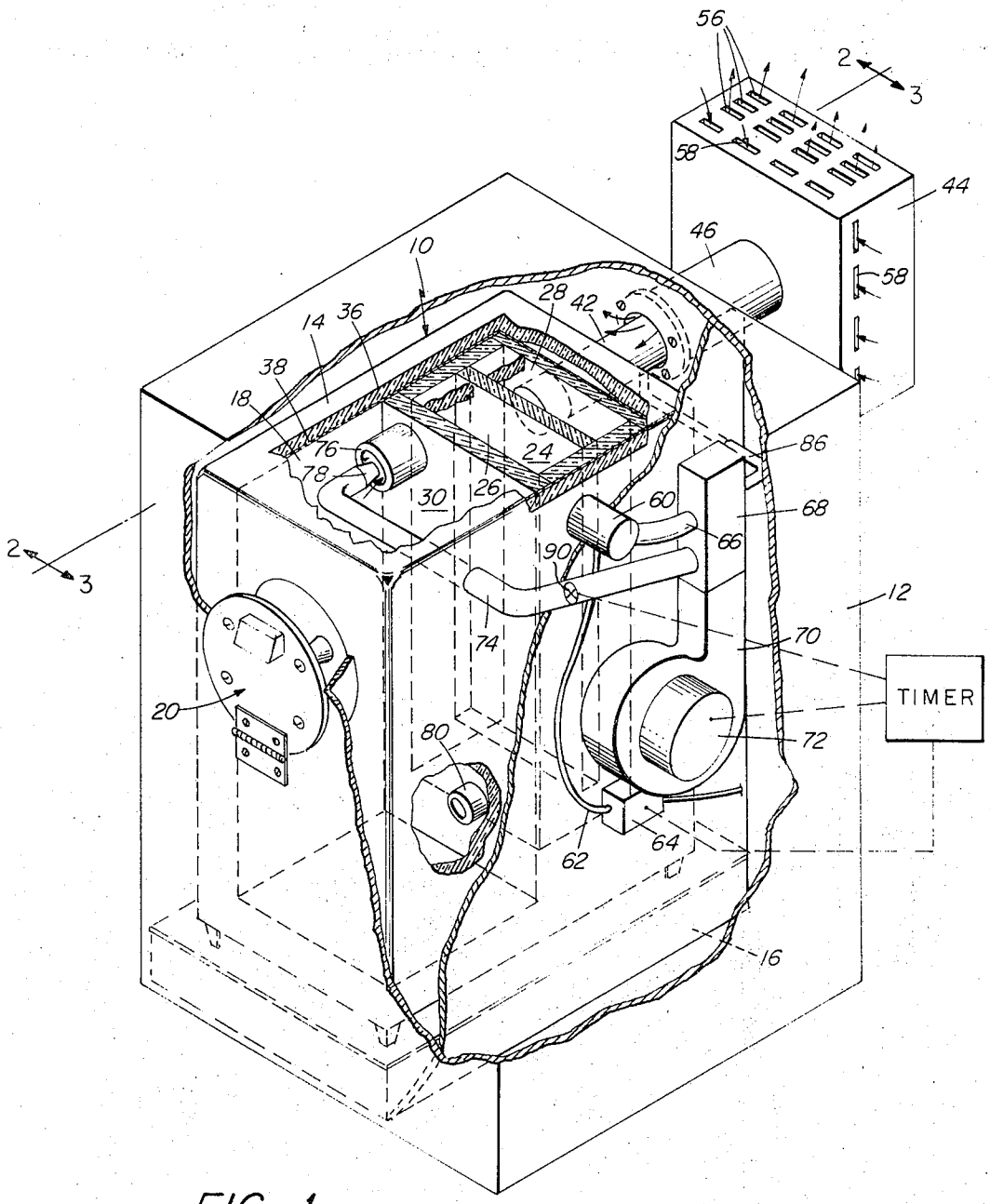

56
2
3
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44
46
10
28
42
14
36
38
18
76
78
24
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26
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66
68
86
90
12
70
74
TIMER
20
80
72
62
64
16

FIG. 1

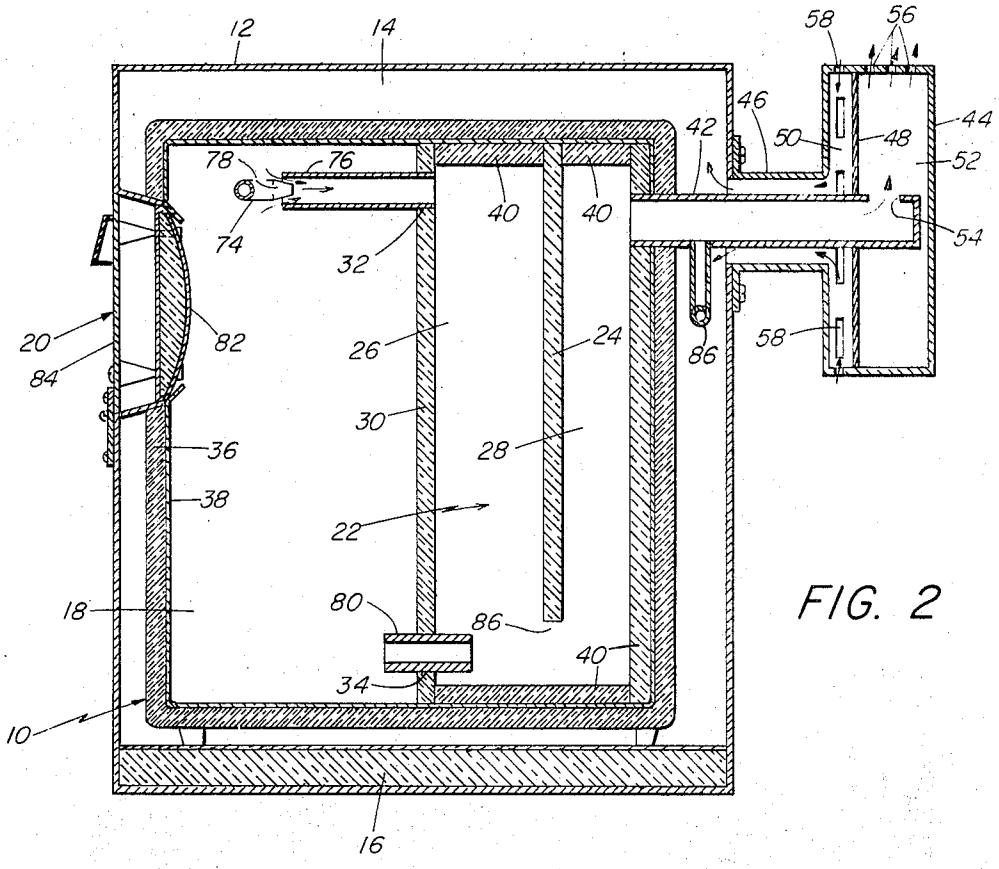

12
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74
32
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10
16

FIG. 2

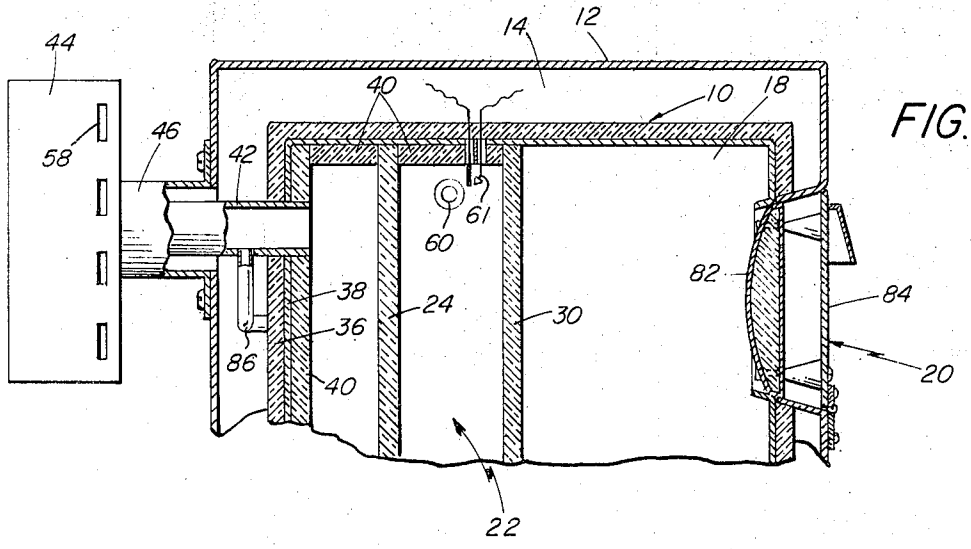

44
14
12
40
10
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61
60
82
84
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86
40
20
22

FIG. 3

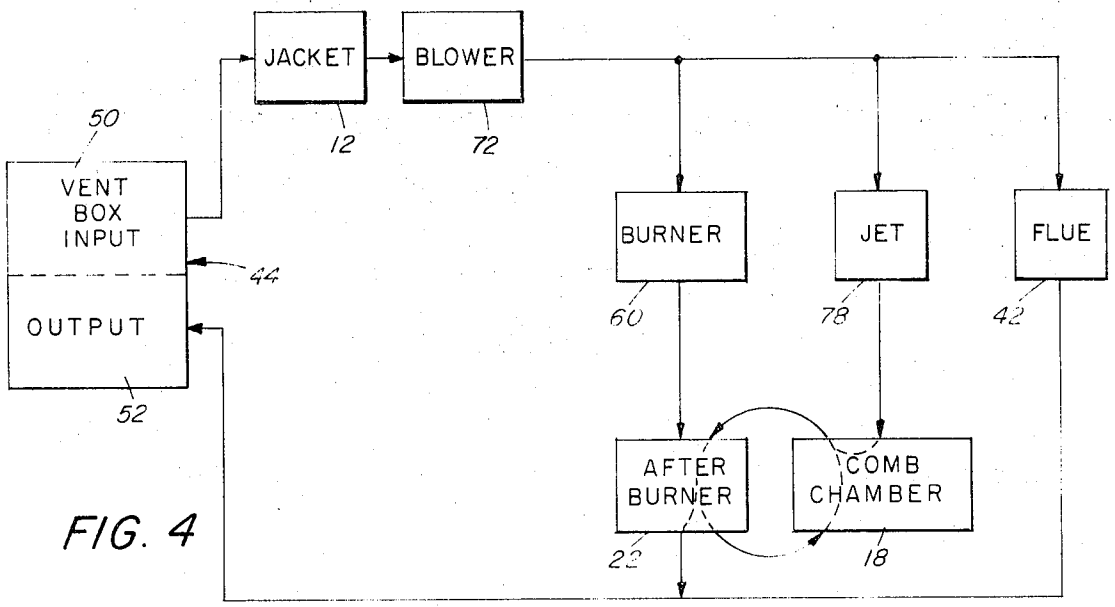

JACKET
BLOWER
12
72
50
VENT
BOX
INPUT
44
OUTPUT
52
BURNER
JET
FLUE
60
78
42
AFTER
BURNER
COMB
CHAMBER
22
18

FIG. 4

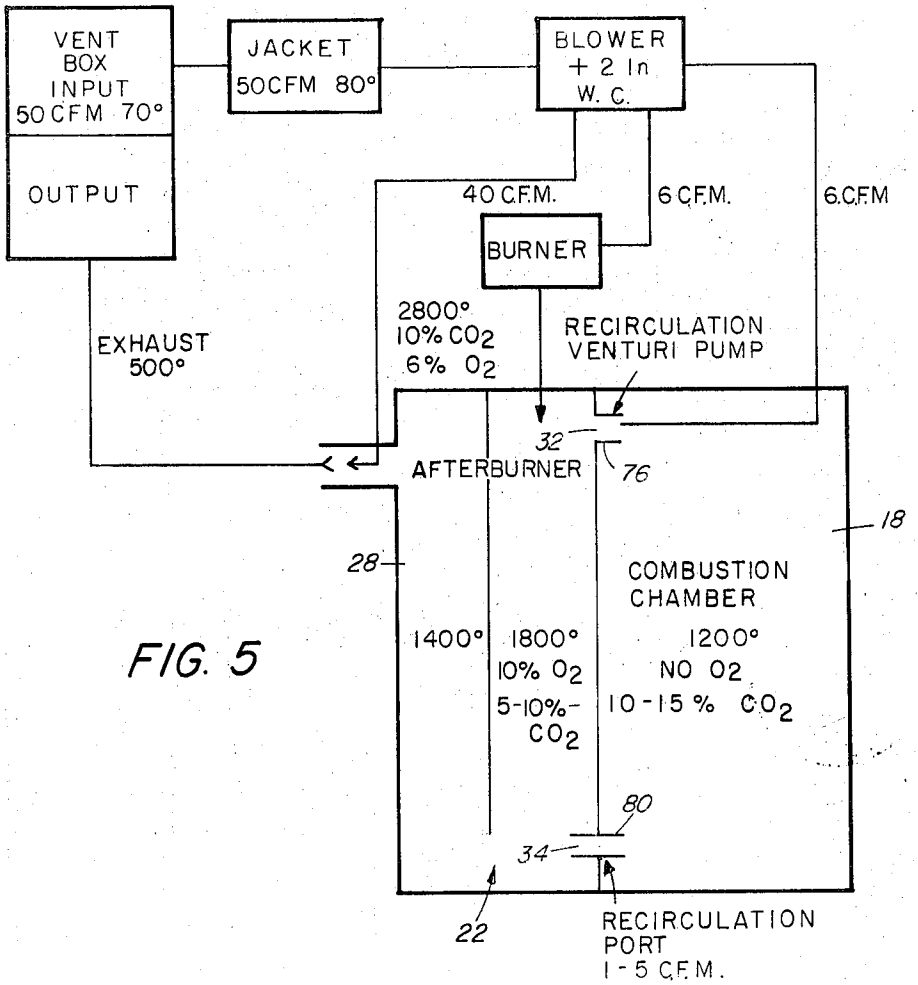

VENT
BOX
INPUT
50 CFM 70°
OUTPUT
JACKET
50CFM 80°
BLOWER
+ 2 In
W. C.
40 C.F.M.
6 C.F.M.
6 C.F.M
BURNER
EXHAUST
500°
2800°
10% CO2
6% O2
RECIRCULATION
VENTURI PUMP
32
AFTERBURNER
76
18
28
COMBUSTION
CHAMBER
1400°
1800°
10% O2
5-10%-
CO2
1200°
NO O2
10-15 % CO2
80
34
22
RECIRCULATION
PORT
1-5 C.F.M.

FIG. 5

INCINERATOR

BACKGROUND OF THE INVENTION

Incinerators designed for use in the home generally have been intended for use in a basement or like area such as a furnace room, usually an area where ready connection may be made into a chimney. In such incinerators generally no great effort has been devoted to the production of extremely efficient combustion of trash products with little residue, or to creation of efficient jacket cooling such as would allow the incinerator to be incorporated safely in the counter space in the kitchen as a built-in appliance.

In some known types of incinerators, considerable expense and complexity is involved in providing a trash chamber and an afterburner chamber with separate individual burners which necessitate separate fuel supply systems and controls.

In certain other incinerators combustion is prolonged and incomplete due to the fact that the systems are designed to commence combustion before the afterburner has been sufficiently preheated, thus producing undesirable smoke pollution during at least the early stages of the combustion process.

SUMMARY OF THE INVENTION

The above and other objections to known incinerators are overcome or improved upon by the present invention wherein a novel incinerator is provided which has a single air circulation system providing efficiently both cool air for jacket cooling and for combustion. The invention relates to an incinerator of the recirculating type wherein a single burner is located in an afterburner and is operated in a controlled manner to provide preheating of the afterburner to a controlled level prior to providing circulation into the trash chamber for burning of the contents therein. This is accomplished by means for keeping the air injection at a very low level for a controlled initial period such as **6** to **8** minutes, for example, thereby stalling combustion of the charge in the trash chamber until the afterburner temperatures reach predetermined levels.

The invention also includes a feedback system whereby combustion rate control is accomplished so that added volume of combustion products or, more particularly, increase in the volume or pressure of gases generated by combustion, pyrolization, or vaporization will cause a proportionate decrease in input air flow, thus maintaining a substantially constant combustion rate. This is achieved by providing properly located communicating ports between the trash chamber and the afterburner, together with a novel pumping system for input air.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objectives and advantages of the invention will become apparent from the following description, taken in connection with the accompanying drawings, wherein:

FIG. **1** is an isometric view of an incinerator embodying the invention;

FIG. **2** is a vertical sectional view taken along the line 2—2 of FIG. **1** looking in the direction of the arrows;

FIG. **3** is a vertical sectional view taken along the same line in FIG. **1** looking in the direction of the arrows 3—3;

FIG. **4** is a diagram illustrating circulation in the incinerator of FIG. **1**; and

FIG. **5** is a diagram of the incinerator air flow.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring more particularly to the drawings wherein like characters of reference designate like parts throughout the several views, there is shown in FIG. **1** an incinerator embodying the present invention. This incinerator, indicated generally by numeral **10,** is intended primarily for use in a kitchen as an appliance built into a counter. However, it will be understood that the features of the invention may be applied to other incinerators such as, for example, commercial or industrial types.

The incinerator **10** is enclosed within an outer shell or jacket **12,** preferably metal, all four walls and top of which are spaced from the incinerator by a space **14** through which air can pass for cooling purposes, as will be described. The bottom of the incinerator may be supported as by legs on a base **16,** for example, whereby the air flow space is continued beneath the incinerator.

The incinerator **10** is of the recirculating type which comprises a trash chamber **18** in which the charge to be incinerated is deposited through a door **20.** Adjacent trash chamber **18** is an afterburner **22** (FIGS. **2** and **3**) which is divided by a vertically extending plate **24** into two regions, a volatiles combustión chamber **26** and an exhaust flue **28.** Plate **24** extends at its upper end all the way to the top wall of the incinerator. However, its lower end terminates short of the bottom wall of the incinerator, as shown in FIG. **2,** to provide communication between the chamber **26** and the flue **28.** It will be apparent, however, that other means may be provided for such communication if desired, such as by extending plate **24** all the way to the bottom of the incinerator and providing it with one or more openings or ports for communication between the two regions, for example.

The wall **30** between the trash chamber **18** and the afterburner **22** is provided with two ports or orifices, one port **32** being located near the upper end of the wall and the other port **34** being located near the bottom of the wall. The ports **32** and **34,** each of which individually comprise single or multiple orifices, thus provide for communication between both the upper and lower portions of the trash chamber and afterburner.

The walls of the incinerator **10** are made of heat insulating material **36** and the inner surface is lined with metal **38.** Wall or partition **30** and divider **24** are also formed of refractory material and the top, bottom and outer walls of the afterburner **22** are each provided with an additional layer **40** of heat resistant refractory material as shown.

The flue **28** is connected by an exhaust pipe **42** extending through the incinerator rear wall and the jacket **12** to an external vent terminal box **44** which is mounted on the rear of the jacket **12** by an outer pipe **46** which coaxially encircles the exhaust pipe **42** in spaced relation with it. A vertical baffle **48** in box **44** divides the interior of the box into two compartments **50** and **52.** Exhaust pipe **42** terminates within compartment **52** and has an upper vent **54** whereby exhaust products will pass from pipe **42** into compartment **52**

and then out through vents **56** in the box. Additional vents **58** in the box provide means whereby fresh cool air may flow into compartment **50** and then through the annular space between pipes **46** and **42** into the space between the incinerator **10** and jacket **12.**

The volatiles combustion chamber **26** in the afterburner **22** is designed to burn up all smoke, odor and other combustion products coming from the trash chamber **18.** It does this by means of a high-input, hot, turbulent flame generated in a tortuous insulated chamber. The flame is produced by a burner **60** of a fluid-fueled or electric type. The burner **60** is illustrated diagrammatically in FIGS. **1** and **3** as a gas-fueled unit mounted in one side wall of the chamber **26** near the top thereof. Burner **60** is supplied with fuel through piping **62** via a regulator valve **64** from any suitable source (not shown). The burner **60** may take any one of the several forms which are well known, either electrical or gas-fueled, and, therefore, is not described in further detail herein. If gas-fueled, the burner may be ignited by any suitable means such as a sparking device **61.** Air for the burner **60** is supplied through tube **66** from a plenum chamber or manifold **68** which is connected to a volute **70** having the usual motor **72** and fan (not shown) which thus forms a pump. The chamber **68,** volute **70** and motor **72** are mounted on the outside of the incinerator **10** between it and the jacket **12** so that air will be drawn in through tube **46** and compartment **50** in box **44.** The incoming air is drawn through tube **46** around tube **42** and cools the jacket **12** by flowing through space **14.**

For providing a controlled jet stream of air for circulation through the incinerator chambers, there is provided a piping **74** which has one end connected to the plenum chamber **66** and its other end extending into the trash chamber **18** and terminating adjacent one end of a conduit **76** which is mounted at its other end in upper port **32.** The inner end of pipe **74** has a nozzle **78** which is located adjacent the end of conduit **76,** as shown in FIG. **2,** and which is smaller in diameter than the inside of the conduit so that air may be injected directly from the nozzle into the conduit while circulation air and combusion products from the trash chamber will simultaneously flow into the conduit around the nozzle. This feature provides controlled oxygen levels and will be described more fully hereinafter.

To complete the air circulation system, air within the volatiles combustion chamber **26** will recirculate back into the trash chamber through a conduit **80** which is located within the lower port **34.**

The door **20** is an assembled structure which includes an inner insulated closure panel **82** which interfits within an opening in the incinerator wall **36–38.** The outer exposed door panel **84** is located substantially flush with the adjacent jacket wall and connected in spaced relation to panel **82** by bolts so that an insulating air space is provided between the panels. The door assembly **20** is hinged to the jacket and provided with a suitable handle for manual operation.

It has been found in operation of this apparatus that when the burner **60** is operated simultaneously with blower **72,** hot burner gases are directed downwardly within the volatiles combustion chamber **26,** through the open space **86** beneath dividing wall **24** into the flue **28,** and also simultaneously some thereof are directed back into the trash chamber in a recirculating pattern through lower ports **34** and **32.** All gases from the trash chamber **18** pass through upper port **32** into the afterburner and mix with the burner flame, effecting complete combustion of smoke and odors. As described above, part of this mixture of combusted gases passes through the lower port **34** back to the trash chamber and becomes the source of heat by means of which the trash is heated and burned. Thus, only a single burner is required for the incinerator.

The porting arrangement described allows the trash or combustion chamber **18** to be rapidly heated up at the beginning of a cycle without initial combustion of trash until the afterburner has warmed up to the desired operating level, as will be described hereinafter.

Referring to FIG. **4,** there is shown a diagram which illustrates air flow in the presently described device. All air to be used in the system enters through vent box **44** and, as described, passes into the space **14** between the jacket **12** and the incinerator **10** where it is drawn into the blower **72.** From the blower the air is split into three separate streams, one stream being directed to the burner **60** for mixing with the fuel in the formation of a flame, a second stream being directed through pipe **74** and nozzle **78** into upper port **32** where it is mixed with combustion products, and a third stream being passed through a pipe **86** into the outlet flue pipe **42,** and thence into the vent box outlet **52.**

The recirculation system is also diagrammatically illustrated in FIG. **4** wherein the burner **60** is shown as being associated with the afterburner **22** and the jet piping **74** is associated with the combustion or trash chamber **18.** Air from the afterburner **22** passes into the vent box outlet **52,** and recirculation occurs between the afterburner **22** and combustion chamber **18.**

In further accordance with this invention, the described incinerator is provided with automatic combustion rate control, that is, a feedback control system whereby the rate of combustion is automatically kept fairly constant despite large variations in the type, heat content, and size of the charge. Such control is achieved without the use of any moving parts by the use of properties of the combustion process itself.

Referring to FIG. **5,** the combustion rate control of this invention is diagrammatically illustrated. The incinerator comprises three chambers, one of which is the trash or combustion chamber **18** of approximately 2 cubic feet, for example, for the charge. The afterburner **22** includes the other two chambers, one of which is the volatiles combustion chamber **26** in which the burner flame, the smoke and other combustion products from the charge, and air are mixed and burned, and the flue **28** which is a final passive chamber for final burnout of smoke particulate matter.

The feedback control system of the invention includes the trash chamber **18** and the volatiles combustion chamber **26** which are thermally insulated from each other except at the two ports **32** and **34.** The structure of the pipes or conduits **78** and **76** in the upper port **32** forms a venturi pump which is a jet pump operated by low temperature, medium pressure air from the blower **72.** Its function is to pump a constant volume of gas from the trash chamber **18** to the volatiles combustion chamber **26.**

The driving air supply mixes with the smoke and other combustion products rising from the trash chamber and is the excess air supply used for combustion of these products in the volatiles combustion chamber **26.** The driving air supply and the pumped gas supply are

approximately the same quantity, such as about six to eight cubic feet per minute, for example, and therefore a substantial pressure rise can be achieved in the jet pump. For example, with a 2-inch water column pressure available for the driving air, a pressure rise of 1/10 inch water column is easily achievable.

The mixture of combustion products from the trash chamber **18** and air from the pump **76** passes to the volatiles combustion chamber **26** where the burner adds sufficient heat to bring it to ignition temperature. The combustion products burn in this chamber **26,** resulting in an additional temperature rise.

The lower port or ports **34** allows the hot gas from the volatiles combustion chamber to enter the trash chamber, bringing oxygen, heat, and a source of ignition to the trash.

When combustion is occurring in the trash chamber gases are given off. If combustion is complete in the trash chamber, then hydrocarbons are burning to water vapor and carbon dioxide. Often, due to excess of fuel, combustion will not be complete in the trash chamber, and carbon monoxide, hydrocarbons, aldehydes, organic acids and other volatile products of partial combustion or thermal cracking will be driven off. These processes are accompanied by the liberation of heat in varying amounts.

The feedback of this invention is accomplished in two stages. A constant volume of smoke and volatiles is fed to the volatiles combustion chamber and this puts an upper limit on the amount of combustion and heat release which will occur in the volatiles combustion chamber. More important, however, is the fact that as the rate of volatiles generation in the trash chamber increases, the pumping rate of the jet pump remains constant. Therefore, the flow rate of gases through the lower recirculation ports back into the trash chamber must decrease. In other words, the total volume flow into the trash chamber equals the flow out, minus the internal volume generation. As the input decreases, so does the supply of both oxygen and heat. The limitation of oxygen limits the combustion rate, and the limitation of heat limits the volatilization rate of materials such as plastics and oils.

Control of both heat and oxygen is important. Oxygen must be controlled since oxygen can result in combustion and, with it, output of both heat and smoke. Heat must be controlled because, even in the absence of oxygen, heat will result in cracking, thermal decomposition, and volatilization of many organic compounds. This is the reason for the thermal insulation **30** between the trash chamber **18** and the volatiles combustion chamber **26.** It limits the inputs which are required for combustion to the one source, the recirculation ports **32** and **34,** and allows complete control by controlling the flow through these ports. This flow is automatically controlled by sensing the gas generation rate in the trash chamber, and decreasing the input flow through the recirculation ports whenever the vapor generation rate increases. The consequence is that the amount of smoke passing to the afterburner is held below a maximum for which the volatiles combustion chamber **26** is designed.

The second aspect of the feedback control depends on the temperature rise which occurs during combustion. As combustion rates increase, the temperature of the gases leaving the trash chamber ineases. As this hot smoke burns in the volatiles combustion chamber **26,** an additional temperature rise occurs. The gases presented to the recirculation ports are hotter during periods of burning, and a lower mass flow rate will result through the recirculation ports. The result of this is an increase in the heat input to the trash, but a decrease in the oxygen input. As smoke combustion increases in the volatiles combustion chamber, the oxygen level naturally lowers so that a smaller mass of gas which is lower in oxygen content flows to the trash chamber **18.** These effects are additive to the effect of decreased flow into the ports, so that the amount of oxygen available for trash combustion can easily decrease by an order of magnitude during a period of maximum burning. This is sufficient control to limit smoke generation to a rate which a small volatiles combustion chamber can handle, and also to limit heat generation to a level which will not damage the incinerator components.

It has been also that the up-start time in an incinerator cycle is the most critical time period in terms of smoke production. This is for the most part due to the smoke burning chamber **28** being initially too cool to adequately handle the smoke produced, this smoke being of greatest magnitude in the few minutes following the initial ignition of the charge.

In the presently described incinerator, heat is applied directly to the afterburner chamber **26** by a power burner **60** and delivered to the trash chamber **18** via recirculation. The invention utilizes a constant displacement pump/air injection system to control recirculation, and hence combustion rate, as has been described.

To reduce the amount of smoke normally produced in the first few minutes of incineration, this invention also includes a delay in the ignition of the charge until the afterburner has been sufficiently preheated. This is done by delaying recirculation by keeping air injection at a very low level for the predetermined initial time period. Low level air injection, as opposed to no air, prevents a reverse recirculation from occurring which could prematurely ignite the charge. This initial period will be on the order of 6 to 8 minutes. At this time the temperatures in the upper portion of the volatiles combustion chamber **26** will be about 2000° F and in the upper portion of the flue or exhaust chamber will be about 1400° F. During this initial period air injection through venturi **76** will be only about one or two cubic feet per minute, after which it will be increased to six to eight cfm.

The means by which the air injection is initially reduced to a low level may take any of several forms. For example, the entire incinerator is operated in controlled time cycles by means of a conventional timer (FIG. **1**) which is operatively connected with the blower **72,** the gas valve **64,** and with a solenoid-operated valve **90** in the pipe **74,** as indicated by dash lines. The timer may also be connected to door locking mechanism (not shown). Therefore, the valve **90** may be operated by the timer to reduce input air flow during the initial controlled time period, and to increase input air flow to normal operating levels at the conclusion of the initial time period.

From the foregoing it will be apparent that a novel and efficient incinerator has been made in accordance with the objectives of this invention. It is also apparent, however, that various modifications and changes in the structure shown and described may be made by those skilled in the art without departing from the spirit of the

invention as expressed in the accompanying claims. Therefore, all matter shown and described is to be interpreted as illustrative and not in a limiting sense.

We claim:

1. An incinerator comprising an insulated housing containing trash and afterburner chambers, a wall between said chambers, port means in said wall, and pump means having a portion located in one chamber for causing inspiration of gases therefrom through the port means into the other chamber and thence back into said one chamber through the port means.

2. An incinerator comprising an insulated housing containing trash and afterburner chambers, a wall between said chambers, spaced first and second ports in said wall, and pump means having a portion located in said trash chamber adjacent said first port for introducing air under pressure through said first port and causing combustion products generated in the trash chamber to flow by inspiration therewith through the first port into the other chamber and thence back into said trash chamber through the second port.

3. An incinerator as set forth in claim 2 wherein a burner is located at least partially within the afterburner chamber.

4. An incinerator as set forth in claim 2 wherein said pump means is located in the trash chamber adjacent said first port.

5. An incinerator as set forth in claim 2 wherein a venturi is disposed in said first port, and the pump means includes a jet disposed adjacent one end of the venturi.

6. An incinerator comprising an insulated closed housing containing adjoining trash and afterburner chambers, a first wall between said chambers having a communicating opening between the chambers, said afterburner chamber comprising a volatiles combustion compartment and a flue separated by a second wall, said second wall having an opening adjacent one end for communication between adjacent end portions of said compartment and flue whereby exhaust from the compartment can flow into one end portion of the flue, an exhaust outlet havine one end penetrating the closed housing from the opposite end portion of the flue, and a vent box at the other end of the outlet, said vent box and outlet having means for passing exhaust outwardly from the flue and for simultaneously passing cool air inwardly to the housing.

7. An incinerator as set forth in claim 6 wherein said housing is disposed within and in spaced relation with a shell, and said exhaust outlet is enclosed within a conduit, and a passageway between the conduit and outlet, said passageway communicating at one end with the space between the housing and shell, and at the other end with the interior of said vent box.

8. An incinerator as set forth in claim 7 wherein said vent box is divided into two compartments in communicating relation respectively with said exhaust outlet and said passageway.

9. An incinerator as set forth in claim 8 wherein an air blower system is connected to the incinerator and includes means for directing air under pressure into the exhaust outlet.

10. An incinerator as set forth in claim 7 wherein an air blower system is connected to the incinerator and includes means for delivering air under pressure to the interior of the incinerator.

11. An incinerator comprising an insulated housing containing adjoining trash and afterburner chambers, a first vertically extending wall between said chambers having spaced upper and lower ports therein, pump means in one of said chambers for circulating air through said chambers via said ports, said afterburner chamber comprising a volatiles combustion compartment and a flue separated by a second vertically extending wall, said second wall having an opening adjacent its lower end for communication between adjacent lower end portions of said compartment and flue whereby exhaust from the compartment can flow into the lower end portion of the flue, and an exhaust outlet penetrating the housing from the upper end portion of the flue.

12. An incinerator as set forth in claim 11 wherein a burner is located at least partially within the volatiles combustion chamber adjacent one of said ports.

13. An incinerator as set forth in claim 11 wherein said pump means is located within the trash chamber adjacent said upper port, and a blower means is connected with the pump means for circulating air through the chambers.

14. An incinerator as set forth in claim 13 wherein a venturi is disposed in said first port, and the pump means includes a jet disposed adjacent one end of the venturi.

15. An incinerator comprising an insulated housing containing first and second chambers separated by a wall, a pair of spaced openings in said wall, means for introducing input air into said chambers through one of said openings, and means for varying the rate of gas flow between the chambers through the other opening in response to changes in volume or pressure of gas generated by incinerator action on products within said chambers.

16. An incinerator as set forth in claim 15 wherein a burner is associated with one of said chambers for generating heat within the chambers, and said means for varying rate of gas flow operates in response to changes in volume or pressure of gases generated by action of said heat upon products in the other chamber.

17. An incinerator as set forth in claim 16 wherein said means includes a venturi located in one of said ports, and a jet pump having an outlet end disposed adjacent one end of the venturi.

18. An incinerator as set forth in claim 17 wherein said wall is vertical, and said ports are disposed in vertically spaced relation in respective opposite upper and lower end portions of the wall.

19. An incinerator comprising a housing containing separate first and second chambers, communicating openings between said chambers, burner means in one of said chambers, means for injecting air under pressure into one of said chambers and for creating circulation of gas between the chambers, means for maintaining the air injection at a predetermined level during the initial period of a burning cycle and for maintaining air injection during subsequent periods at a relatively higher level.

20. An incinerator comprising a housing, a primary chamber and an afterburner chamber within the housing, a wall between said chambers, ports in said wall, means for injecting air into one of said chambers for circulation between the chambers through the ports, means for producing a flame within the afterburner chamber for incineration of products in the primary

chamber and of combustion products which flow from the primary chamber into the afterburner chamber, and control means for maintaining said injection of air at a level lower than necessary to ignite the products in the primary chamber during an initial time cycle required to preheat the afterburner and to thereafter raise said level to that required for ignition of said products.

21. An incinerator as set forth in claim **20** wherein said control means comprises a time-controlled valve in said air injection means.

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