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Eff

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[45] **July 3, 1973**

[54] **SOLID WASTE INCINERATOR**

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[73] Assignee: **General Electric Company,** Louisville, Ky.

[22] Filed: **Dec. 13, 1971**

[21] Appl. No.: **207,161**

[52] **U.S. Cl.** ..... **110/8 A,** 110/8 E, 110/18 C

[51] **Int. Cl.** **F23g 3/00**

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

[56] **References Cited**

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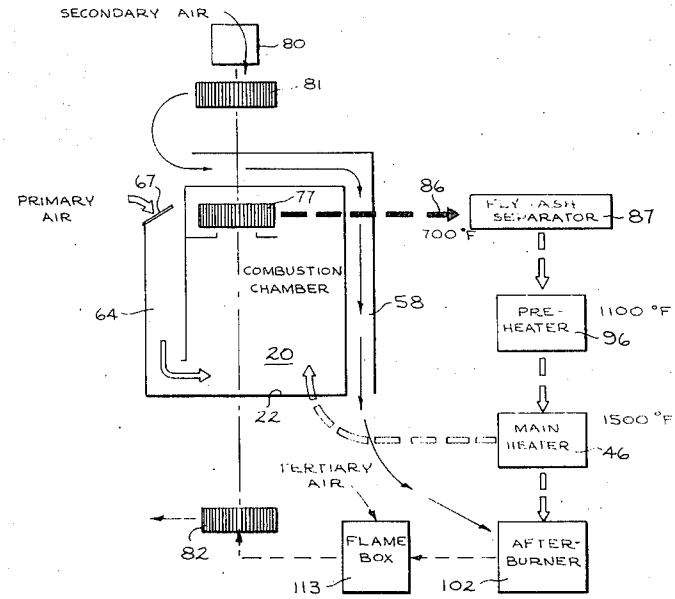
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Primary Examiner—Meyer Perlin
Assistant Examiner—Ronald C. Capossela
Attorney—Richard L. Caslin

[57] **ABSTRACT**

An incinerator for use in the kitchen with a heated air supply recirculating through an airtight combustion chamber in the absence of make-up air whereby during te initial stage of the operating cycle there is an oxygen starved condition to control combustion, vaporize the moisture and other volatiles and prevent backfires. Later in the cycle a supply of primary air is admitted to the combustion chamber. A blower is associated with the combustion chamber to recirculate a blast of air within the combustion chamber as well as to exhaust a portion of the air from the chamber. A fly ash separator is located downstream of this exhaust. A main heater means external of the combustion chamber is downstream of the fly ash separator, and it removes the smoke and odors and returns much of the heated air to the combustion chamber to complete the recirculation circuit and cause ignition of the solid combustibles. A portion of the heated air from the main heater means is fed to an afterburner wherein secondary air is admitted for replenishing the oxygen and completing the combustion of any volatiles that might remain in the exhaust gases, and then the gases are treated in a flame-box with a supply of tertiary air before the gases are returned to the atmosphere.

15 Claims, 9 Drawing Figures



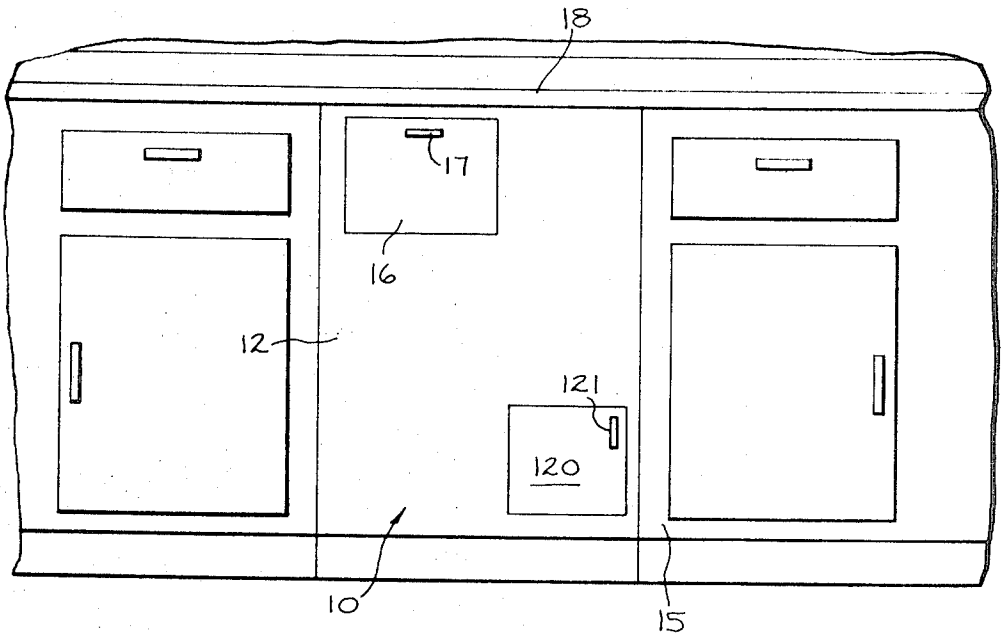

18
17
16
12
121
120
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15

FIG. 1

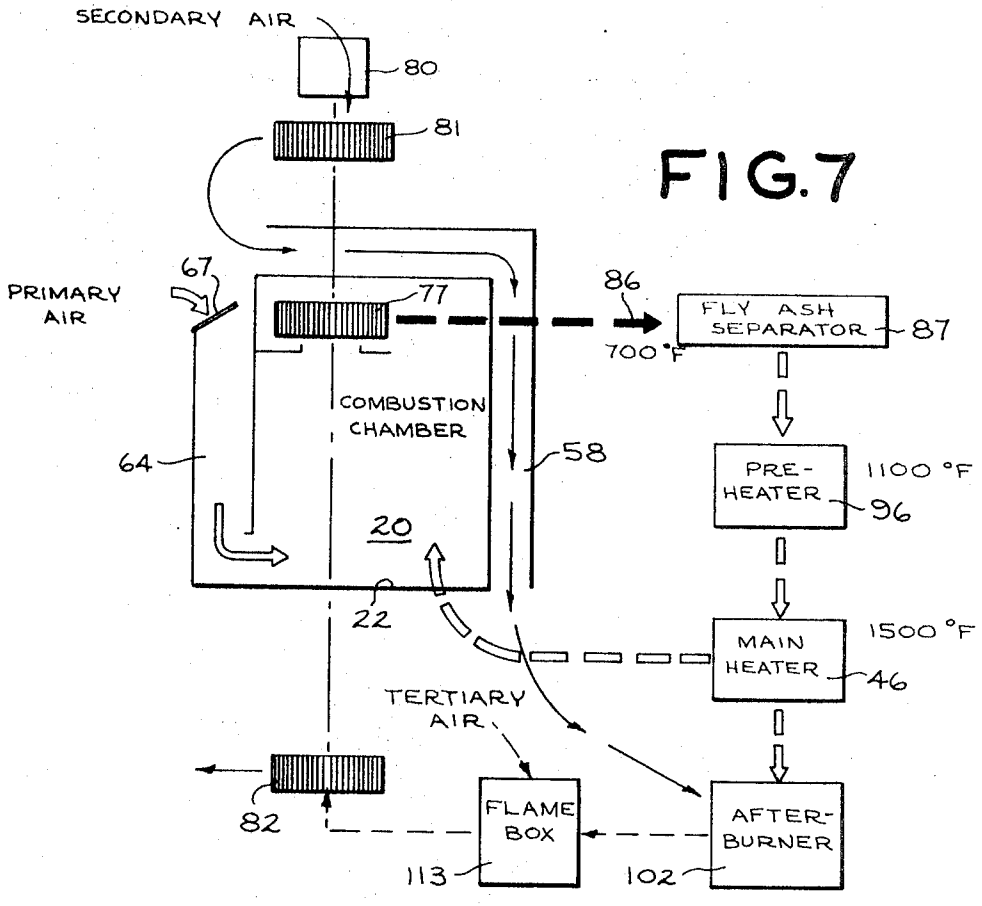

SECONDARY AIR
80
81
PRIMARY AIR
67
77
86
700°F
FLY ASH SEPARATOR
87
COMBUSTION CHAMBER
64
58
20
22
PRE-HEATER
1100 °F
96
MAIN HEATER
1500 °F
46
TERTIARY AIR
82
FLAME BOX
113
AFTER-BURNER
102

FIG. 7

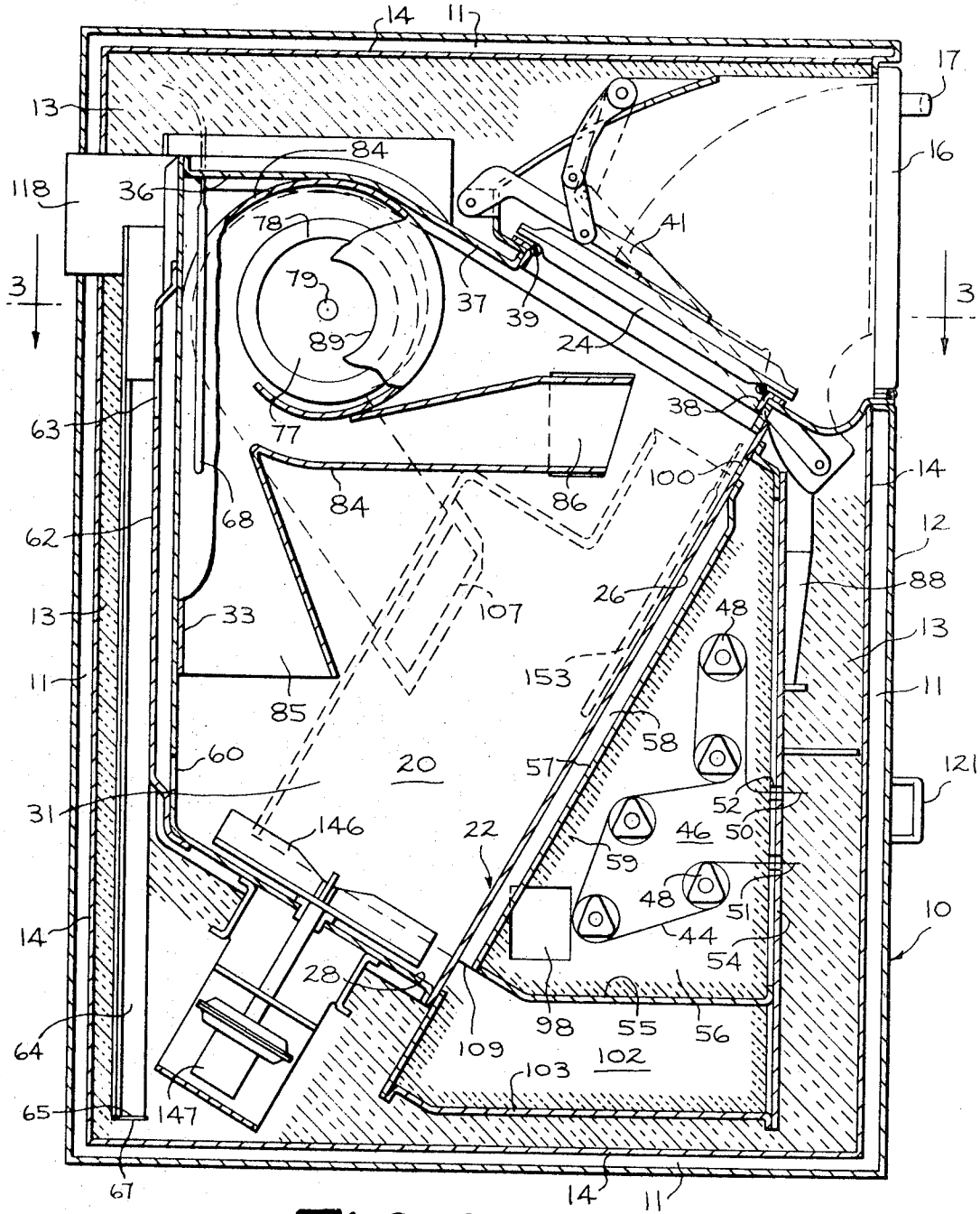

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57
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146
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11

FIG. 2

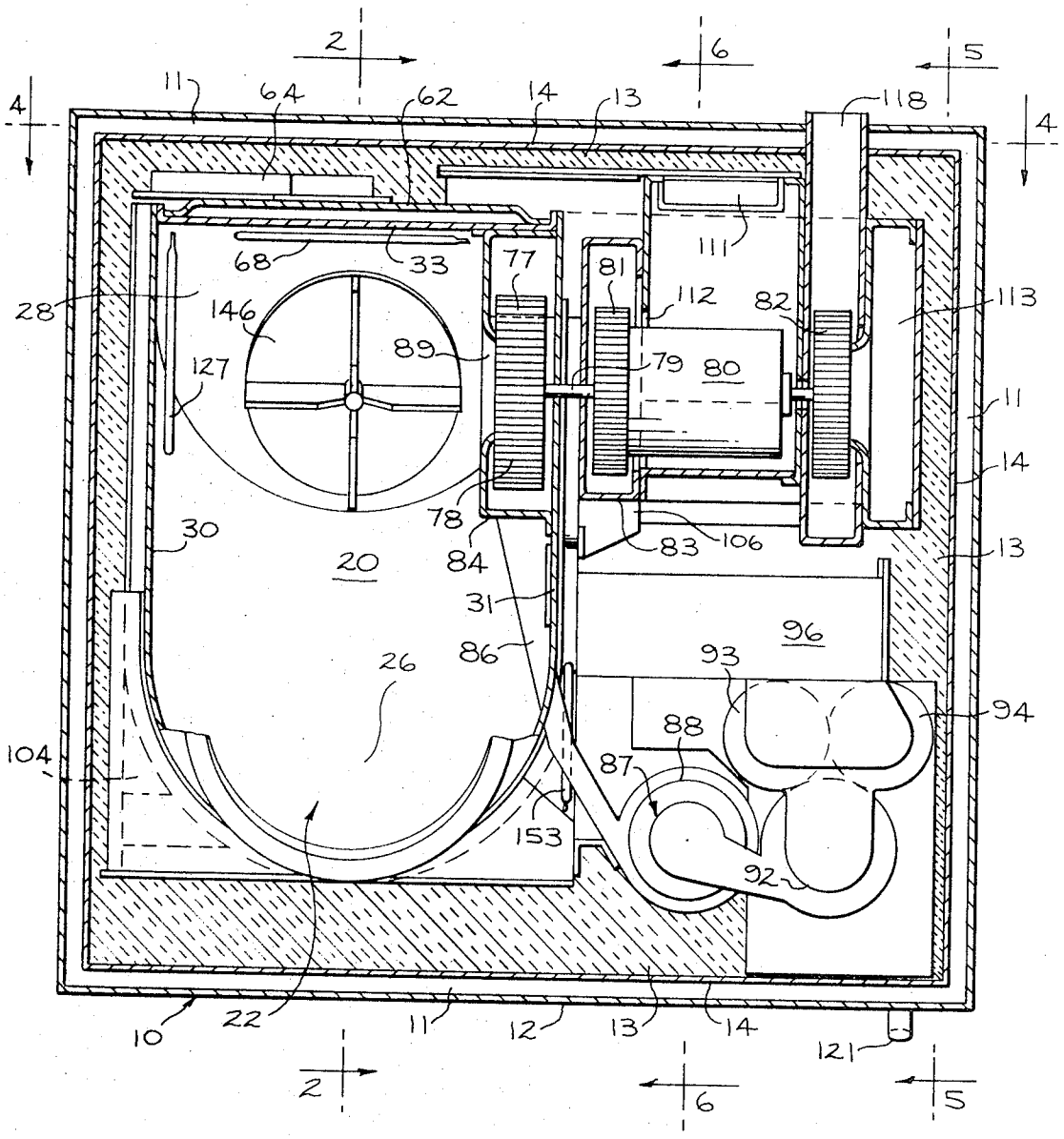

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FIG.3

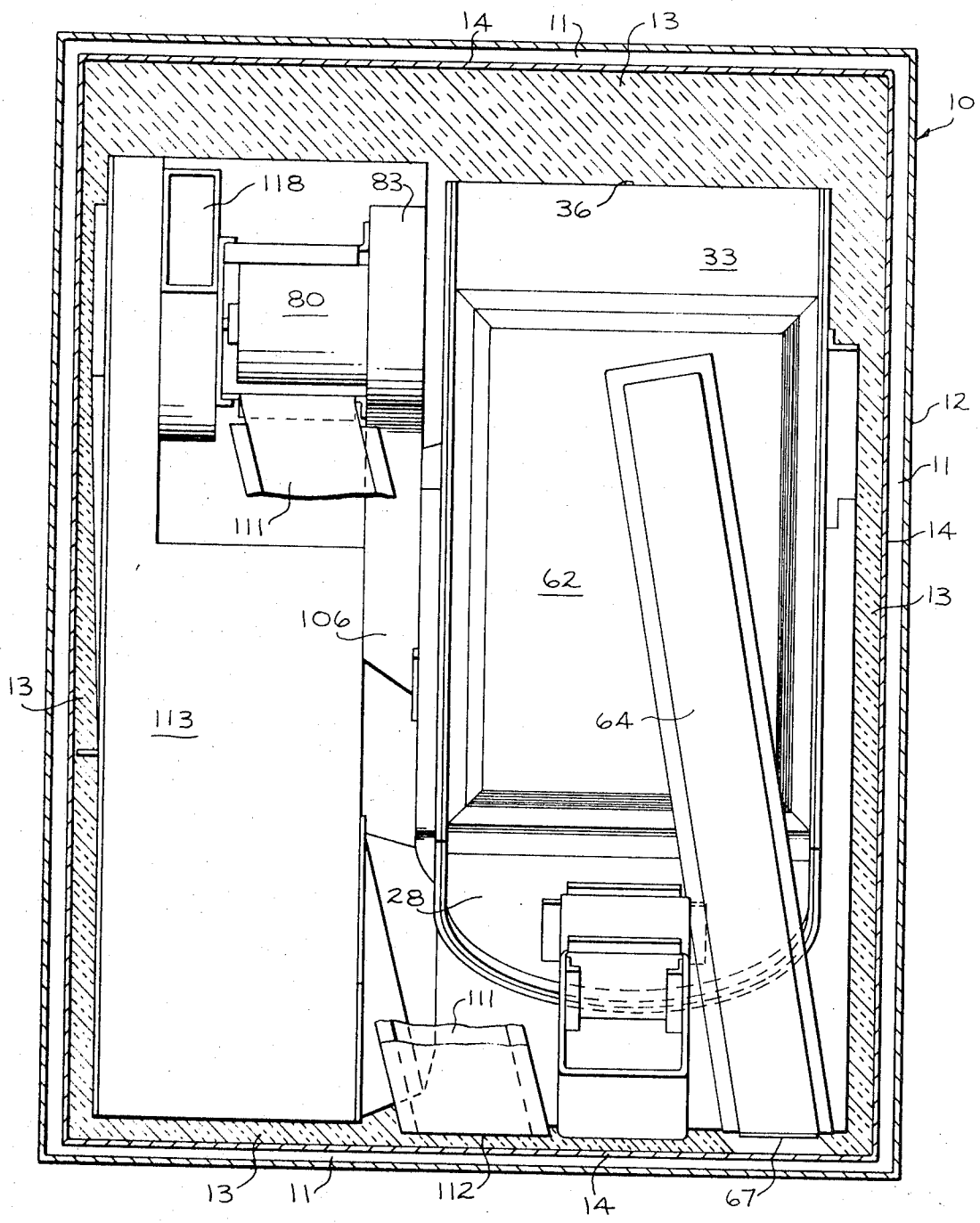

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112
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67

FIG. 4

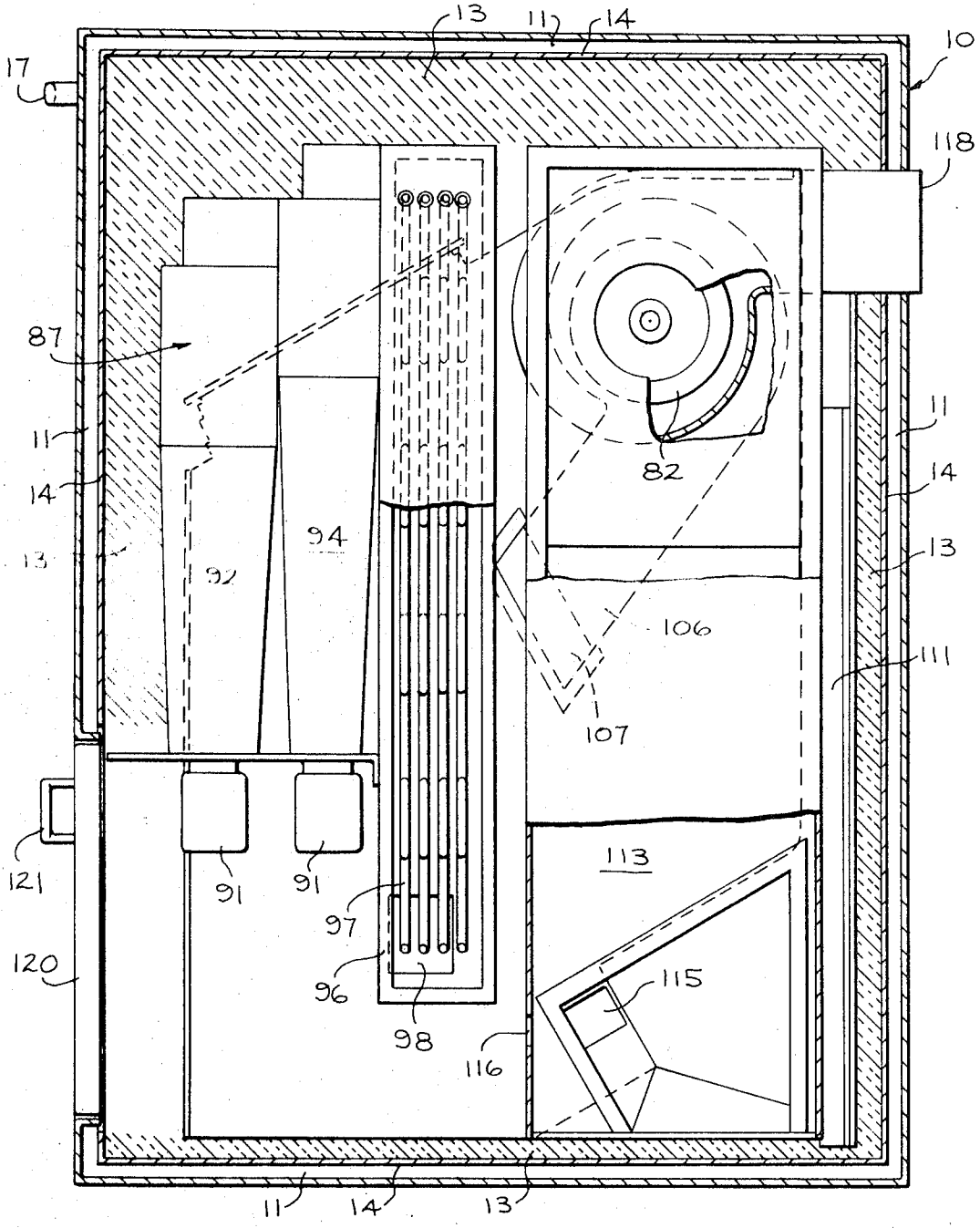

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FIG. 5

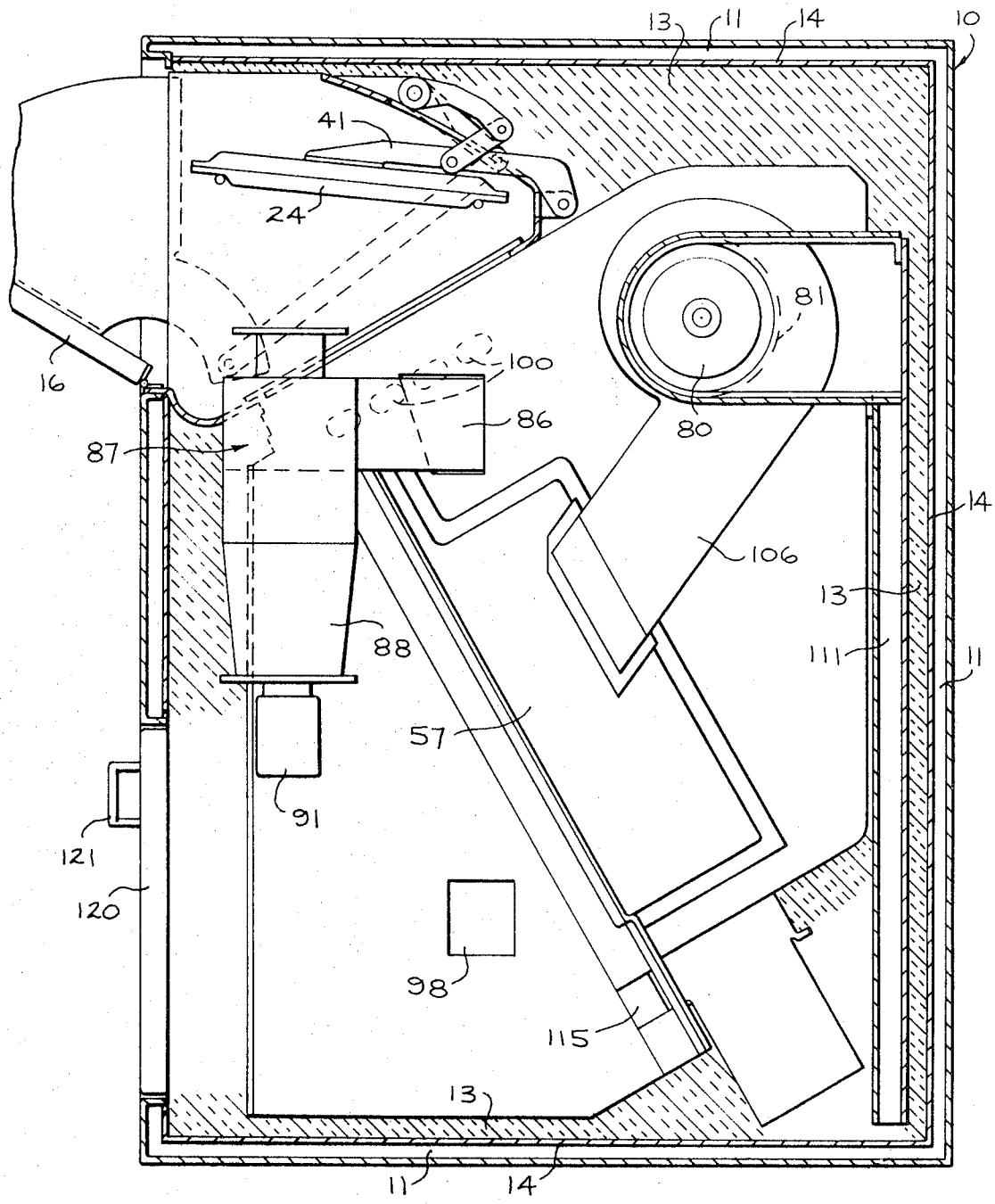

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115
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FIG. 6

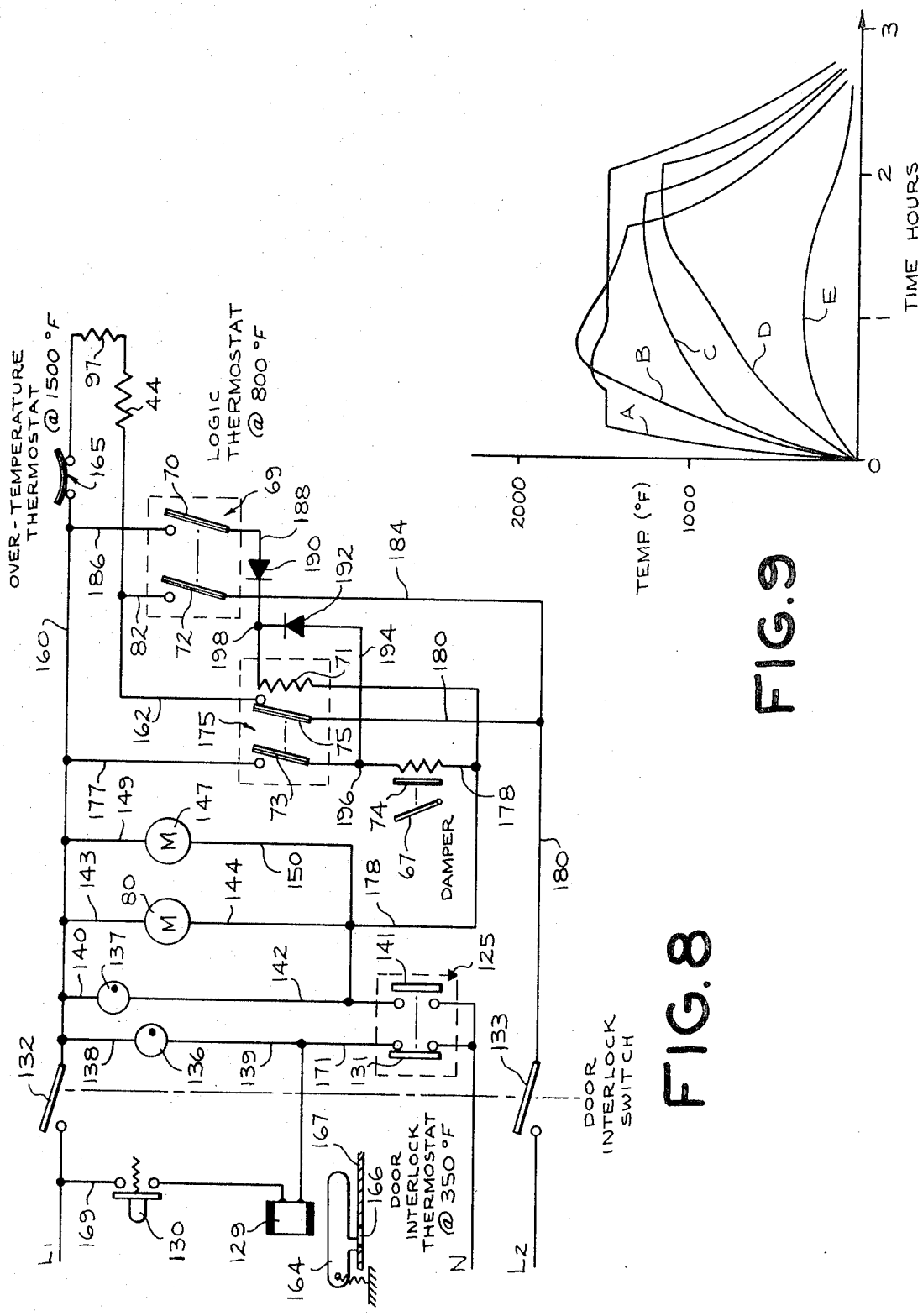

OVER-TEMPERATURE THERMOSTAT @ 1500 °F
LOGIC THERMOSTAT @ 800 °F
DOOR INTERLOCK THERMOSTAT @ 350 °F
DOOR INTERLOCK SWITCH
DAMPER
L1
L2
N
M
TEMP (°F)
2000
1000
0
1
2
3
TIME HOURS
A
B
C
D
E

FIG. 8

FIG. 9

SOLID WASTE INCINERATOR

BACKGROUND OF THE INVENTION

The present invention relates to the art of solid waste incinerators in general, and particularly to a domestic incinerator which would be installed in the kitchen and would easily consume the amount of solid combustibles which accumulate in the average-size household. There is an evergrowing trend to use more prepackaged and prepared foods, disposable consumer items and reading material, and the disposal of this household waste and trash has become a major problem to the average family. The waste collection agencies are severely overloaded in coping with the growing household trash accumulation, as well as grass clippings, leaves and shrubbery trimmings that accumulate in the yard.

At the same time, air and water pollution are serious national problems. Together, waste disposal and environmental pollution present a dual problem that to date has defied adequate solutions. Over the years, most solid waste has been burned in municipal incinerators or used for land fill. Each method, however, contributes to pollution. The usual alternative to incineration, that is land fill, also faces increasingly severe limitations. Some major metropolitan areas are running out of space in which to dump solid waste. An estimated two-thirds of the cost of waste disposal is its collection. As labor costs increase and per capita generation of waste increases, these costs are due to increase. Many local building codes require Class "A" flues for domestic incinerators, and this has been a deterrent to the growth rate of such incinerators. Today, the concern over air pollution also is an additional limiting factor. In working toward a solution to the total problem of solid waste disposal, domenstic incinerators have so far played a minor role. Admittedly, a domestic incinerator can only handle solid waste combustibles like paper, cardboard and cellulose materials in general, plastics, food waste and the like, and not such things as glass, metal cans, aerosol cans, liquid volatiles, and the like, which should be disposed of by some other method. If the option of on-site incineration is eliminated by governmental restrictions, future costs of waste disposal would rise even higher. It behooves the appliance industry to perfect a practical domestic incinerator that does not contribute to existing air pollution problems.

In a typical metropolitan area, residential waste accounts for almost forty per cent of all tonnage generated. It is collected either by municipal collecting agencies or by private trash collectors. The basic problem in collecting and disposing of solid waste appears to be one of reducing volume without contributing to air and water pollution, and retaining the value of the land into which the residue is dumped. The use of domestic trash compactors installed in or near the kitchen is also growing in acceptance as an aid to the trash collection process. The food waste disposer has been of significant help in reducing the amount of waste. It has been estimated that food waste accounts for approximately sixteen per cent of the household waste.

BRIEF DESCRIPTION OF THE DRAWINGS

My invention will be better understood from the following description taken in conjunction with the accompanying drawings and its scope will be pointed out in the appended claims.

FIG. 1 is a front elevational view of an electric incinerator of the present invention installed in a line of kitchen base cabinets.

FIG. 2 is a right side, cross-sectional elevational view with some parts broken away to show an improved incinerator with a large combustion chamber capable of being sealed by a top access cover that is connected to a front loading door as well as showing the main electric heating means near the front of the housing for reheating the exhaust gases and returning them to the combustion chamber so as to ignite the solid combustibles therein by means of a recirculating heating system. An afterburner is located beneath this heating compartment.

FIG. 3 is a top, cross-sectional, plan view taken generally along the line 3—3 of FIG. 2 and looking down into the combustion chamber at the left, and showing a group of four fly ash separators in the form of cyclone separators in the lower right-hand corner of the view, and a preheater mounted directly behind the separators, and finally a single motor supporting on its shaft three blower wheels to provide the proper air flow patterns of primary, secondary, and tertiary air and finally exhaust air from the incinerator. Notice that FIG. 2 is taken on the line 2—2 of FIG. 3 generally through the center line of the combustion chamber.

FIG. 4 is a cross-sectional, elevational view through the back of the incinerator taken on the line 4—4 of FIG. 3 and showing at the left side the flamebox which extends up from the bottom of the incinerator to the exhaust blower through which the exhaust gases are returned to the atmosphere, as well as showing at the right side of the view a primary air inlet duct for make-up air entering the combustion chamber.

FIG. 5 is a left side, sectional elevational view taken on the line 5—5 of FIG. 3 showing the cyclone separators at the left, with the elongated preheater mounted directly behind the separators, as well as the motor-blower unit in the top corner of the incinerator housing.

FIG. 6 is a cross-sectional elevational view taken on the line 6—6 of FIG. 3 generally through the center of the motor and the first cyclone separator, showing the loading door and access cover in an open position.

FIG. 7 is a block flow diagram showing the main elements of the incinerator system and the various flow patterns for the primary, secondary, and tertiary air streams.

FIG. 8 is a schematic circuit diagram showing the means for controlling the electric heating means and the various control components of the incinerator.

FIG. 9 is a representative time-temperature graph of an incineration cycle of the present invention showing the variation in temperature, as a function of time, of the main heater compartment, the afterburner, the combustion chamber, the bottom wall of the combustion chamber and finally the exhaust temperature.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to a consideration of the drawings, and in particular to FIG. 1, there is shown a domestic incinerator 10 embodying the present invention that is a built-in appliance installed in a base cabinet 15 beneath a kitchen counterop 18, somewhat in the manner of a built-in automatic dishwasher. The incinerator 10 is adapted to be front loaded through a loading door 16

adjacent the top of the incinerator and near the left side thereof. This door **16** is hinged along its bottom edge and it is adapted to be locked by a door handle **17** which may be turned for uncloking the door and gaining access to the interior of the incinerator. It should be understood however that this invention may be employed in a large commercial or industrial size incinerator without departing from the scope of the present invention.

Referring now to the right side, cross-sectional, elevational view of FIG. **2**, for a detailed explanation of the structural aspects of the incinerator **10**, there is an outer incinerator housing **12** of sheet metal, box-like construction that defines the outer limits of the appliance and forms the supporting structure for the operational components of the incinerator system. It will be appreciated that an incinerator is a high temperature device reaching temperatures above 1,500° F. in some areas, and that thermal insulating means must be provided within the housing **12** to insure that the external surface temperatures of the incinerator do not exceed the regulations of Underwriters' Laboratories, Inc., for electric appliances that are to be installed in a living area such as the kitchen, as distinguished from the basement, the porch or the garage. An air space **11** is formed behind each outer wall of the housing **12** by means of an insulation guard **14** which has associated therewith a layer of theremal insulation **13.** This allows for the circulation of cooling room air through the entire air space **11** for restricting the external temperatures of the housing **12.** This air space exhausts out through a duct that encircles the exhaust duct **118** of the incinerator.

The incinerator has a combustion chamber **20** formed by an inner liner **22** and a removable, top access cover **24** for loading the combustion chamber with solid waste combustibles through the front-loading door **16.** The inner liner **22** has a forwardly inclined semicylindrical front wall **26** as is best seen in FIGS. **2** and **3** with a generally perpendicular, imperforate bottom wall **28,** generally parallel side walls **30** and **31,** a generally vertical rear wall **33** and a top wall **36** that has a downwardly inclined front portion **37.** The removable top cover **24** cooperates with an opening **38** in the inclined top wall **37.** Moreover, the removable cover **24** is provided with a sealing gasket **39** which is adapted to be compressed tightly against the peripheral flange of the opening **38** for rendering the combustion chamber **20** generally airtight and preclude the escape of heated gases, smoke, odors, vapors and the like, into the kitchen. A suitable linkage **41** connects the loading door **16** with the access cover **24** such that for each movement of the loading door there is a similar movement of the access cover so that it is not necessary to handle both the door **16** and the cover **24** separately as this would be very inconvenient. Usually the trash would be held in one hand and the loading door **16** would be opened with the other hand and the cover **24** would move simultaneously such that the trash could be inserted through the opening **38** and lowered into the combustion chamber **20.**

It has been deemed preferable to locate the incinerator heating means so that it will be in direct contact with the trash or solid combustibles. The heating means could be located within the combustion chamber **20** adjacent the top of the inner liner **22** and away from the opening **38.** However, I have chosen to locate the heating means in the form of an open resistance heating element **4** in a main heater compartment **46** which is positioned at the front of the incinerator housing generally beneath the forwardly inclined semispherical front wall **26** of the inner liner **22.** This bare resistance heating element **44** is of wire form, such as nichrome wire, that is supported on a series of ceramic insulators or spools **48** in such a way that it is wound a plurality of turns on each spool and then joined to the adjacent spool **48** and again a plurality of turns are wound on the spool before leading the wire **44** to the next spool. The wattage of this heater wire **44** is about **3000** watts. As shown in the drawing of FIG. **2,** there are five insulator spools supporting a nichrome wire before the two heater terminals **50, 51** extend out through insulating bushings **52** in the inner wall **54** that forms the front wall of the main heater chamber **46.** This main heating chamber **46** also has a bottom wall **55** and opposite side walls **56, 56** and an inclined semispherical rear wall **57** that is spaced slightly from the inclined, semispherical front wall **26** of the inner liner **22** of the combustion chamber to form a cooling air channel **58** for handling a flow of secondary room ambient air for cooling down the walls of the inner liner **22** as will be more thoroughly explained with relation to the air flow block diagram of FIG. **7.** A layer of insulation **59** covers the inner surface of the walls forming the main heating chamber **46.**

The combustion chamber **20** is first loaded with solid waste combustibles and the cover **24** is closed and sealed to render the chamber substantially airtight. At the beginning of the cycle, ambient air is precluded from entering the combustion chamber to control the combustion process and vaporize the moisture and other volatiles of the charge of waste. However, when the temperature within the combustion chamber reaches about 800° F. after about 1 to 2 hours, a source of primary air is tapped so that there is a continuous flow of primary air or make-up air in order to support combustion of the waste for the reaminder of the incinerating cycle. Looking at FIG. **2,** here is a primary air inlet at **60** comprising a series of three or four small holes arranged horizontally in the back wall **33** of the combustion chamber near the bottom thereof. Behind the back wall **33** is a spaced wall **62** having an air opening **63** adjacent the top thereof. Fastened to this wall **62** is a generally vertical duct **64** having an air inlet opening **65** only at its bottom which is controlled by a bimetal operated damper **67** that is normally closed at temperatures within the combustion chamber below about 800° F. and open thereabove. This temperature is measured by a temperature probe **68** shown mounted against the back wall **33** of the combustion chamber **20** adjacent the top portion thereof and is part of a logic thermostat **69** found in the schematic circuit diagram of FIG. **8.** This thermostat **69** has a normally open switch **70** which is connected in series with a hot wire **71,** as well as a normally open switch **72** connected in series with the heating elements **44** and **97** and to be in parallel with the relay switch **75.** When the temperature sensed by the thermostat probe **68** of the thermostat **69** reaches about 800° F., the logic thermostat switch **70** will close thereby energizing the hot wire **71** which has a time lag of about **15** minutes after which it closes a normally open bimetal switch **73** thereby energizing a second bimetal actuator **74** that serves to open the damper **67,** as well as opening a normally closed bimetal switch **75** in series with the main heater

44 and preheater 97. Simultaneously, the thermostat 69 closes the switch 72 to energize the heaters 44 and 97, thereby placing these heaters under the control of the logic thermostat 69.

As the primary air is introduced into the combustion chamber 20 after the damper 67 has been opened, it will be drawn into a blower 77 located in the upper portion of the right side wall 31 of the combustion chamber 20 as is best seen in FIGS. 2 and 3. This blower 77 has a blower wheel 78 mounted on the shaft 79 of an electric motor 80. This same motor shaft 79 also carries a second blower wheel 81 and an exhaust blower wheel 82 for reasons which will be explained hereinafter. The first blower wheel 78 is mounted in a split scroll 84 which has two discharge openings; namely, a downwardly inclined discharge opening at 85 within the combustion chamber 20, as seen in FIG. 2, and a generally horizontal discharge duct 86 which leads out through an opening in the side wall 31 of the inner liner 22 of the combustion chamber 20 and discharges into a fly ash separator in the form of a series of four cyclone separators. The first cyclone separator 88 is seen in plan view in FIG. 2. The first discharge duct 85 is for sending a blast of air down into the combustion chamber at a high velocity so that the air is able to reach the many isolated air pockets within the solid combustibles and to support the combustion thereof. Hence, there is an air stream from the combustion chamber 20 drawn into an air inlet opening 89 in the side of the scroll 84 of the first blower 77. One part of this air stream is divided out to return to the combustion chamber through the vertical air duct 85, and the remaining part of the air stream is led off through the horizontal duct 86 to pass into the first cyclone separator 88.

It is important to separate the fly ash from the flue gases as they exit from the combustion chamber 20 through the discharge duct 86. Rather than provide a single fly ash separator, I have elected to adopt a more efficient system of a grouping of four cyclone separators, each of generally standard design characteristics, and each with its own removable ash collector at the bottom, such as the quart jar 91 shown in FIG. 5. Looking at FIG. 3, there are two fly ash separators 88 and 92 of about equal size, and they are connected in series, and then there are two smaller separators 93 and 94 which are arranged in parallel and are both connected directly to the exhaust of the second separator 92. As an example, for every 10 pounds of solid waste combustibles consumed in the combustion chamber there would be about four ounces of fly ash in the various removable jars 91 that are mounted on the bottom of each separator 88, 92, 93 and 94.

Understandably, there would have to be a small access door 120 built into the front wall 12 of the incinerator housing in the vicinity of the lower portion of the four fly ash separators 88, 92, 93 and 94 so that access could be gained to the removable fly ash collectors or jars 92 mounted on the bottom of each separator. Then the fly ash may be emptied periodically and the container replaced for future use. A suitable handle 121 could be located adjacent the top edge for locking the door in place and for opening it.

Turning attention to the gas flow block diagram of FIG. 7, the gas passes from the fly ash separator 87 to a preheater unit 96 which is vertically mounted just behind the fly ash separator, as is best seen in FIGS. 3 and 5. The purpose of this preheater unit is to raise the temperature of the gas to a maximum of about 1,100° F. before the gas is delivered to the main heater chamber 46 where the gas is heated further to a maximum of about 1,500° F. and most of the smoke, odors and vapors are comsumed. The preheater unit 96 is supplied with a plurality of metal sheathed resistance heating elements 97, shown as four in number as in FIG. 5, which are of serpentine configuration and extend almost the entire height of the incinerator housing so that the gas is exposed to these heaters 97 for as long a time as possible as the gas passes down the unit and exits through an opening 98 adjacent the bottom of the preheater which is in communication with the main heater chamber 46, as is best seen in FIG. 2. The total preheater wattage is about 3,000 watts. This degree of temperature of 1,500° F. would be damaging to most metal sheathed resistance heating elements. Hence, the heaters 44 of the main heater 46 are of bare resistance heater wire wound on the insulating spools 48 as described heretofore.

From the main heater chamber 46, the gas is returned to the combustion chamber 20 through the upper opening 100 shown in FIG. 2 where the heated gas is drawn into the first blower means 77 and is separated by the split scroll 84 such that part of the gas is blasted down into the combustion chamber through the duct 85 and the remainder is exhausted from the combustion chamber through the exhaust duct 86 to the fly ash separator 87. Thus, it will be understood that gas is recirculated within the combustion chamber 20 through the first blower 77 and the air duct 85, while there is a second recirculation system for the combustion chamber as is best understood from the block diagram of FIG. 7 comprising the exhaust duct 86, the fly ash separator 87, the preheater unit 96 and the main heater unit 46. The air flowing back through the combustion chamber to continue this recycling action for removing as much of the fly ash from the flue gases as is possible and consuming the smoke, odors, vapors and volatiles entrained therein and reheating the air for the ignition of the solid waste combustibles.

It will be understood by those skilled in this art that it is technically feasible to combine the preheater unit 96 with the main heater 46 in order to raise the temperature of the gases in one step as they pass from the fly ash separator 87 and are returned to the combustion chamber 20. As a practical matter, this is a function of temperature of the heating means and time that the gases are exposed to the heaters before they are returned to the combustion chamber 20. The combination of the preheater and the main heater is preferred to enable the use of metal sheathed heaters at the lower temperatures experienced within the preheater. It will also be understood that during the initial phase of the combustion cycle when the primary air inlet damper 67 is closed, that most of the oxygen present in the air and gases existing within the sealed combustion chamber is consumed by the ignition of the combustibles and is not replenished during the recylcing through the fly ash separator, preheater and main heater and back to the combustion chamber. This oxygen starved condition served to control the combustion process and prevent backfires as the volatiles within the solid combustibles are driven off. Primary air is allowed to enter the combustion chamber only after the temperature within the combustion chamber reaches about 800° F. as sensed

by the temperature probe **68** arranged adjacent the back wall **33** of the inner liner **22.**

Again looking at the block diagram of FIG. **7,** it will be noticed that an afterburner **102** is located downstream of the main heater **46** so that all of the gases passing through the main heater chambef **46** are not returned to the combustion chamber **20.** A small amount of the gases is passed to the afterburner **102** by way of a triangular shaped, vertical duct **104** shown along the left side of the plan view of FIG. **3,** which empties down into the afterburner **102** that is located beneath the main heater chamber **46,** as is best seen in FIG. **2.** A layer of insulation **103** covers the walls forming the afterburner chamber **102.** Since there is a reduced amount of oxygen in the gases discharging from the main heater chamber **46,** a supply of secondary air is provided for the afterburner **102** so as to oxidize the combustibles that might still remain in the flue gases. This secondary air is brought into the incinerator housing by means of the second blower wheel **81** shown in FIGS. **3** and **6.** Leading from the scroll **83** around this second blower wheel **81** is an inclined exhaust duct **106** which enters the air channel **58** shown in FIG. **2** through an opening **107** in the wall **57** that parallels the front wall **26** of the inner liner **22.** This secondary air is in contact with the semicylindrical front wall **26** of the inner liner **22** for cooling down the walls of the combustion chamber as well as for preheating the secondary air before it enters the afterburner **102** as through a lower opening **109** shown in FIG. **2.**

Looking at the rear view of the incinerator of FIG. **4,** you will notice the upper and lower fragments of an inclined secondary air duct **111** which has an intake opening **112** near the floor and which has an upper opening adjacent the motor **80** so that room ambient air is first drawn over the motor for cooling the windings thereof before being drawn into the blower opening **112** of the second blower wheel **81** as is best seen in FIG. **3.** Thus, the function of the secondary air is to cool the windings of the motor **80** as well as to cool down the walls of the combustion chamber **20** by passing secondary air through the air chamber **58,** and then to supply oxygen to the afterburner **102** for oxidizing the conbustibles in the flue gases after they exit from the main heater chamber **46** when the gases become separated from the recirculating cycle.

The third blower wheel **82** is part of an exhaust means which is arranged downstream of the afterburner **102.** But first, it is well to insure that there are no combustibles in the flue gases exhausting from the afterburner that might reach the blower wheel **82.** This assurance is provided by a flamebox **113** that is generally an elongated box-like construction formed up the back side of the incinerator housing generally behind the preheater **96** and beneath the motor **80** and blower units as is best seen in FIG. **4.** A lower opening **115** connecting the afterburner **102** to the flamebox **113** is shown in FIG. **5.**

It is also desirable to provide a source of room air or tertiary air for the flamebox. A tertiary air inlet opening **116** is located in the front wall of the flamebox as is shown in FIG. **5.** This tertiary air is drawn into the flamebox by means of the exhaust blower **82** to further oxidize the combustibles in the flue gases and insure that the gases are free of all smoke, odors, vapors and volatiles before the gases are returned to the outside atmosphere. Leading from the exhaust blower **82** is an exhaust duct **118** that protrudes slightly beyond the back wall of the incinerator housing **10** and is adapted to be coupled to a vent system (not shown) extending through a kitchen wall or alternately up through the wall to the roof when the incinerator **10** is slid back into place beneath the kitchen counter **14.**

Most of the structural elements of this incinerator design have been described above in some detail. Attention will now be given to the circuit diagram of FIG. **8.** This incinerator model is provided with a three-wire electrical service nominally of 240 volts, single phase, 60 cycle A.C. which is usually available in the average residence having adequate wiring. This voltage source has a pair of line wires L_1 and L_2 and a grounded neutral conductor N, there being 120 volts measured between either line L_1 or L_2 and netural N, and 240 volts measured between the two line wires L_1 and L_2. The preheater **97** and the main heater **44** are connected in series across lines L_1 and L_2 at 240 volts by means of leads **160** and **162.**

A first door interlock switch **132** is connected in lead **160,** and a second door interlock switch **133** is connected in lead **180.** These two normally open switches are connected together to act in unison. When the incinerator loading door **16** is closed and locked, the two door interlock switches will be closed. The incinerator loading door **16** has a door lock **17,** with the lock mechanism not shown, but its function is to insure that the incinerator cycle cannot be initiated unless the door **16** is first closed and locked. The lock mechanism cooperates with the door interlock switches **132** and **133** to close these switched when the door is fully locked. Once the incinerator temperature rises above about 350° F. the door interlock thermostat **125** operates to de-energize a door latching solenoid such that it is not possible to unlock the door when the temperature within the combustion chamber is above 350° F. This type of door lock system would be similar to that taught in the Getman Reissue U.S. Pat. No. 26,944, which is assigned to the same assignee as is the present invention. The door lock mechanism **17** has an automatic locking bolt **164** shown diagrammatically in FIG. **8.** This automatic locking bolt is a pivoted, spring biased member that automatically engages within the leeper **116** of a rod **167** of the door lock mechanism when it is in the closed position. This locking bolt **164** is acted upon by a solenoid **129** which is adapted to be energized across line L_1 and neutral lead N by lead **169** through a momentary contact switch **130** in series therewith and by lead **171** through a normally closed switch **131** of a door interlock thermostat **125.** This thermostat **125** is set to operate when the temperature within the combustion chamber rises above about 350° F. This causes the switch **131** to stay open, thereby deactivating the solenoid **129** such that the door lock **17** and its rod **167** cannot be released from the automatic locking bolt **164.** The indicator lights **136** and **137** are connected across line L_1 and neutral line N such that the first indicator light **136** indicates when it is possible to open the load door **16** and the second indicator light **137** operates alternately with the first light such that is indicates when the temperature in the combustion chamber is above 350° F. at which time it is not possible to unlock and open the door **16.** This lighting arrangement is obtained by connectong the first indicator light **136** or OPEN light to line L_1 by means of lead **138** and to be in series with the thermostat switch **131** by

means of lead 139 connected to lead 171, such that this OPEN light 136 is energized whenever the door interlock thermostat switch 131 is in its normally closed position at temperatures below 350° F. The second indicator light 137 or LOCKED light is connected to line L_1 by means of lead 140 and by lead 142 to be in series with a normally open switch 141 of the door interlock thermostat 125 such that at a temperature above about 350° F. after the door interlock thermostat functions the thermostat switch 141 will close thereby completing the circuit through the LOCKED light 137 to indicate that it is no longer possible to unlock the incinerator door until the temperature within the combustion chamber drops below the critical temperature of about 350° F.

The blower motor 80 is arranged to be connected in parallel with the LOCKED light 137 and to be in series with the thermostat switch 141 of the door interlock thermostat 125 such that the motor 80 is energized after the door interlock thermostat 125 operates at its critical temperature of about 350° F. The motor 80 is connected to line L_1 by lead 143 and to the thermostat switch 141 by means of lead 144 connected to lead 142.

An agitator 146 is shown mounted in the bottom of the inner liner 22. This agitator is driven by a geared-down motor 147 which is connected in parallel to work in unison with the blower motor 80 by means of lead 149 and lead 150 that is connected with lead 144.

There is an overtemperature protective thermostat 165 connected in lead 160 in series with the preheater 97 and main heater 44. This thermostat is normally closed and it opens when the temperature within the main heater compartment 46 reaches about 1,500° F. The temperature probe for this thermostat 165 is shown in FIGS. 2 and 3 as element 153 and located in a generally vertical position adjacent the insulated curved wall 57 that surrounds the front wall of the inner liner 22. This protects the incinerator from runaway conditions and de-energizes the heating elements whenever the tmeperature within the main heater compartment becomes excessive.

The third thermostat, a logic thermostat 69, which had been mentioned previously, is utilized to control the primary air damper 67 that is located at the inlet of the primary air duct 64. The opening of the damper 67 is controlled by a bimetal actuator 74 that is connected in series with a normally open switch 73 of a bimetal relay 175 to be connected across line L_1 and neutral N by lead 177 and lead 178 that is in turn connected in series with the normally open switch 141 of the door interlock thermostat 125. The relay 175 also has a normally closed switch 75 that is connected in series with the preheater 97 and the main heater 44 by lead 162, and connects these heaters at high voltage across lines L_1 and L_2 by lead 180. The operation of the relay 175 is controlled by the logic thermostat 69. As mentioned previously, the logic thermostat 69 is calibrated to operate at a temperature within the combustion chamber 20 of about 800° F. When it does trip it energizes the bimetal 71 of the relay 175. This bimetal heater 71 has a delay time of about 15 minutes after which it actuates the two bimetal switches 73 and 75 to connect the damper bimetal heater 74 directly across line L_1 and neutral N.

The logic thermostat 69 has a pair of normally open switches 70 and 72. Switch 72 was described above. Switch 70 is connected in series with the door interlock switch 132 and line L_1 by leads 186 and 160, and joined to the hot wire 71 of the relay 175 by lead 188. A solid-state rectifier or diode 190 is arranged in lead 188 to pass current only between the switch 70 and the hot wire 71. Likewise a second diode 192 is arranged in a lead 194 to pass current in a direction from a point 196 in between the bimetal switch 73 and the damper bimetal 74 with a point 198 in lead 188 between the diode 190 and the hot wire 71. These diodes 188 and 192 serve to prevent feedback circuits through the logic thermostat 69. The normally closed contact on bimetal 75 supplies power to heaters 97 and 44 through leads 160, 162 and 180 between lines L_1 and L_2. It now opens and will remain open for the remainder of the incineration cycle due to heat from bimetal heater 71 that stays energized through the simultaneous closing of normally open contact on bimetal 73 and lead 194 through rectifier 192 connected at points 196 and 198. The heater 71 will not lose this energy before interlock thermostat contacts 141 open. It should be noted that contact 72 of logic thermostat 69 closes well before the contact 75 in the bimetal relay 175 opens so as to transfer the circuit for the two heaters 97 and 44 through leads 182 and 184. This condition continues until the sensor 68 of FIGS. 2 and 3 of the logic thermostat 69 senses a temperature well below 800° F. thereby causing contacts 70 and 72 to open. At the opening of contact 72 the power to heaters 97 and 44 is interrupted and the combustion chamber 20 will cooldown until the door interlock sensor 127 shown in FIG. 3 is below about 300° F. at which time switch 141 opens in the door interlock switch 125, and the power to the blower motor 80 and agitator motor 147 and door LOCKED light 137 is interrupted.

Looking at the temperature curves of FIG. 9, it is clear that an average operating cycle is between 2 and 3 hours. The first curve A is the temperature within the main heater chamber 46 with a maximum temperature of about 1,500° F. The second curve B is the temperature within the afterburner chamber 102 and it takes longer to reach its maximum temperatre and its temperature drops off quicker than that of curve A. The third curve C shows the temperature variations of the combustion chamber 20 as experienced by the sensor 153 of the overtemperature protective thermostat 165. The fourth curve D indicates the temperature of the bottom wall 28 of the combustion chamber 20 which is very slow to reach its maximum temperature indicating that much of the burning action takes place toward the top of the load of waste within the combustion chamber and works its way downward. The last curve E indicates the relatively cool nature of the incinerator exhaust.

Modifications of this invention will occur to those skilled in this art, therefore, it is to be understood that this invention is not limited to the particular embodiments disclosed, but that it is intended to cover all modifications which are within the true spirit and scope of this invention as claimed.

What is claimed as new and desired to be secured by Letters Patent of the United Stats is:

1. An incinerator comprising a housing enclosing a combustion chamber, an access cover for loading the chamber with solid combustibles, and means for sealing the cover during the operating cycle, heating means external of the chamber, primary air inlet means to the

chamber, a first blower means associated with the chamber for both recirculating a blast of air within the chamber and for discharging a portion of the air from the chamber to a fly ash separator means, and a preheater means for receiving the air discharged from the separator means and raising the temperature tereof, the air passing from the preheater means to the said external heating means and then re-entering the combustion chamber at a high temperature to ignite the solid combustibles, an afterburner means associated with the external heating means for receiving some of the discharge from the said heating means, flamebox means downstream of the afterburner to complete the combustion of any volatiles that might remain in the air, and an exhaust blower means associated with the flamebox for discharging the air stream to the atmosphere.

2. An incinerator as recited in claim **1** with a third blower means for passing a stream of secondary air over a portion of the walls forming the combustion chamber, said secondary air being introduced to the said afterburner to assist in supporting combustion and oxidizing the combustibles in the air stream entering from the external heating means.

3. An incinerator as recited in claim **2** with an ambient air inlet means to the flamebox for introducing a supply of tertiary air to further oxidize the combustibles therein and extinguish all flames before the air stream is drawn through the said exhaust blower means.

4. An incinerator comprising an outer housing enclosing a combustion chamber formed by a drum-like container with a removable cover for loading the container with solid combustibles, means for sealing the cover to the container during the operating cycle, heating means external of the chamber, primary air inlet means into the chamber, double blower means associated with the chamber for directing a blast of primary air back into the combustion chamber as well as for discharging a portion of the primary air from the chamber, a fly ash separator means downstream of the discharge of the double blower means, the said heating means being downstream of the fly ash separator means for raising the temperature of the air, an air reentry means from the heating means to the combustion chamber for igniting the solid combustibles in a closed heating cycle, and an afterburner associated with the heating means for bleeding off a portion of the air from the heating means, and a second blower means for passing a stream of secondary air around a portion of the incinerator combustion chamber for restricting the maximum temperature thereof, said secondary air being introduced to the afterburner for oxidizing the combustibles in the exhaust gases passing therethrough, and an exhaust means from the afterburner to the atmosphere.

5. An incinerator as recited in claim **4** with a preheater means interposed between the fly ash separator means and the heating means for assisting in raising the temperature of the exhaust gases before they are returned to the combustion chamber.

6. An incinerator as recited in claim **4** with a flamebox interposed downstream of the afterburner, and an ambient air inlet means in the flamebox to introduce tertiary air to further oxidize the combustibles in the flamebox and extinguish all flames, and an exhaust blower means downstream of the flamebox for exhausting the flamebox to the atmosphere.

7. An incinerator for solid combustibles comprising an outer box-like housing enclosing a combustion chamber formed by an inner liner and a top-opening access cover, sealing means for rendering the cover substantially airtight, air heating means external of the inner liner for heating the outflow from the combustion chamber and returning it to the combustion chamber for igniting the solid combustible load, a controlled primary air inlet means in the combustion chamber including a normally closed temperature-responsive damper at inner combustion chamber temoeratures below a temperature somewhere between 600° F. and 900° F. so that the initial operation of the incinerator is in an oxygen-starved condition so as to have controlled combustion and avoid backfires.

8. An incinerator for solid conbustibles as recited in claim **7** with a recirculating blower means associated with the combustion chamber for circulating a blast of primary air within the combustion chamber.

9. An incinerator for solid combustibles as recited in claim **8** wherein the said recirculating blower means also has a partial discharge of the primary air representing the said outflow from the combustion chamber, a fly ash separator means for receiving this outflow, the said air heating means being downstream of the fly ash separator means for receiving the discharge thererom, and an afterburner downstream of the air heating means for receiving a portion of the air flow therefrom, and a second blower means associated with the afterburner for introducing secondary air into the afterburner for oxidizing the gaseous combustibles in the primary air passing therethrough, and an exhaust means from the afterburner to the atmosphere.

10. An incinerator for solid combustibles as recited in claim **9** wherein the said exhaust means includes a flamebox downstream of the afterburner for receiving the discharge thererom, and a third blower means associated with the flamebox for introducing tertiary air into the flamebox and completing the combustion of any volatiles in the air before it passes back into the atmosphere.

11. An incinerator for solid combustibles as recited in claim **10** wherein the said three blower means are driven by a single motor drive.

12. A domestic incinerator for solid combustibles comprising an outer box-like housing enclosing a combustion chamber formed by an inner liner and a top-opening access cover, sealing means for rendering the cover substantially airtight, a controlled primary air inlet means for the combustion chamber including a temperature responsive damper that is normally closed at inner combustion chamber temperatures below about 600° F. so that the initial operation of the incinerator is in an oxygen-starved condition so as to have controlled combustion and avoid backfires, a first blower means downstream of the air inlet means for recirculating a blast of air within the combustion chamber, said blower means also discharging a portion of the air from within the combustion chamber, a fly ash separator downstream of this blower discharge, an electric heating means downstream of the fly ash separator for raising the temperature of the air above about 1,400° F., and hot air return means from the heating means to the combustion chamber for igniting the solid combustibles therein, and an afterburner means associated with the heating means for receiving a portion of the air flow through the heating means, and a second blower

means for passing a stream of secondary air over a portion of the combustion chamber for restricting the maximum external temperatures of the housing, said secondary air then being introduced into the afterburner means for oxidizing the combustibles in the primary air passing therethrough, and a third suction blower means downstream of the afterburner means for exhausting the products of combustion to the atmosphere.

13. A domestic incinerator for solid combustibles as recited in claim **12** with a flamebox interposed between the afterburner means and the suction blower means, and an ambient air inlet opening in the flamebox for introducing tertiary air into the flamebox to further oxidize the combustibles in the air therein, as well as to extinguish all flames and cool down the exhaust.

14. A domestic incinerator for solid combustibles as recited in claim **13** with an electric preheater means interposed between the fly ash separator and the said heating means for raising the tmperature of the air discharging from the fly ash separator means to about 1,000° F. before it passes onto the main heating means.

15. A domestic electric incinerator for solid combustibles as recited in claim **14** wherein the said three blower means have a common drive means.

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