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Kufrin et al.

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[54] **DISPOSAL OF WASTE BY INCINERATION**

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Related U.S. Application Data

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[52] **U.S. Cl.** ..... **110/9 R,** 4/131

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

[58] **Field of Search** ..... 110/9 R, 9 E; 4/131; 307/88.5; 317/148.5

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Primary Examiner—Kenneth W. Sprague
Attorney, Agent, or Firm—Hill, Sherman, Meroni, Gross & Simpson

[57] **ABSTRACT**

Waste is disposed of by incineration including burning solids, vaporizing liquids and converting any residual gases into elemental substantially odorless form. Discharge temperature of the treated gases is reduced to an acceptable level. Practice of the method is exemplified in an incineration apparatus such as a toilet utilizing a "soft" gas flame providing not only incinerating and vaporizing heat within a firebox but also gas consuming heat in a combustion passage leading from the firebox. Circulation of the products of combustion is promoted by an exhaust fan which draws them across a cooling air gap into a settling chamber before discharge from the apparatus. Various operating and safety structures and controls are provided.

23 Claims, 10 Drawing Figures

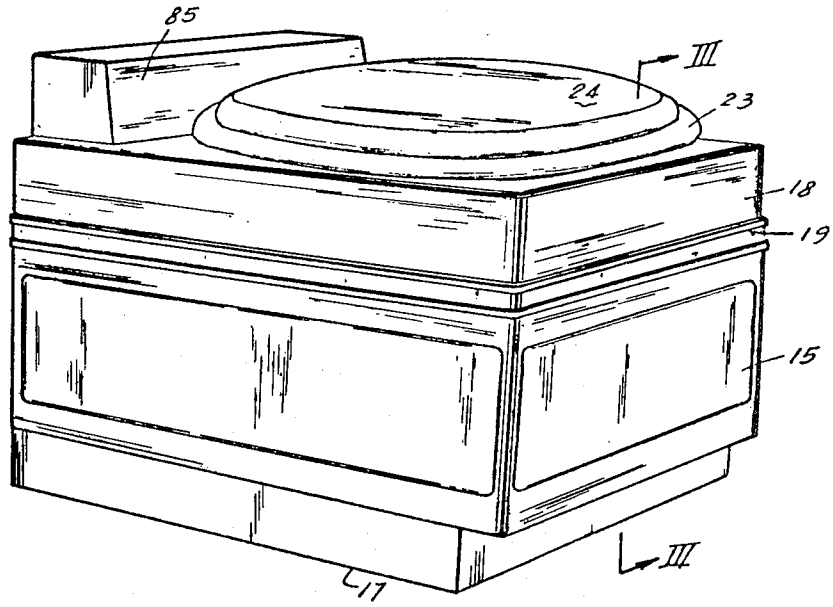


Fig. 1

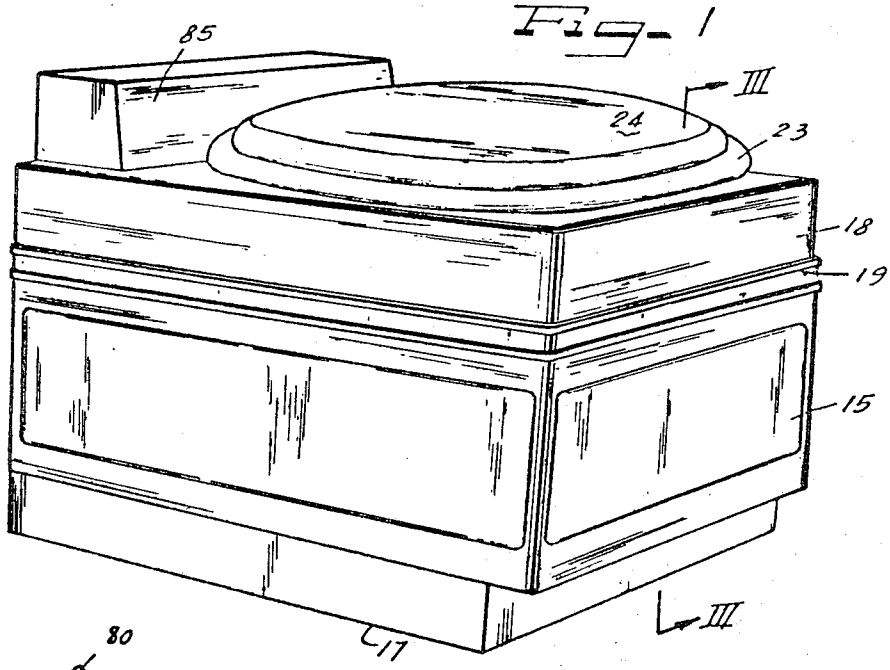
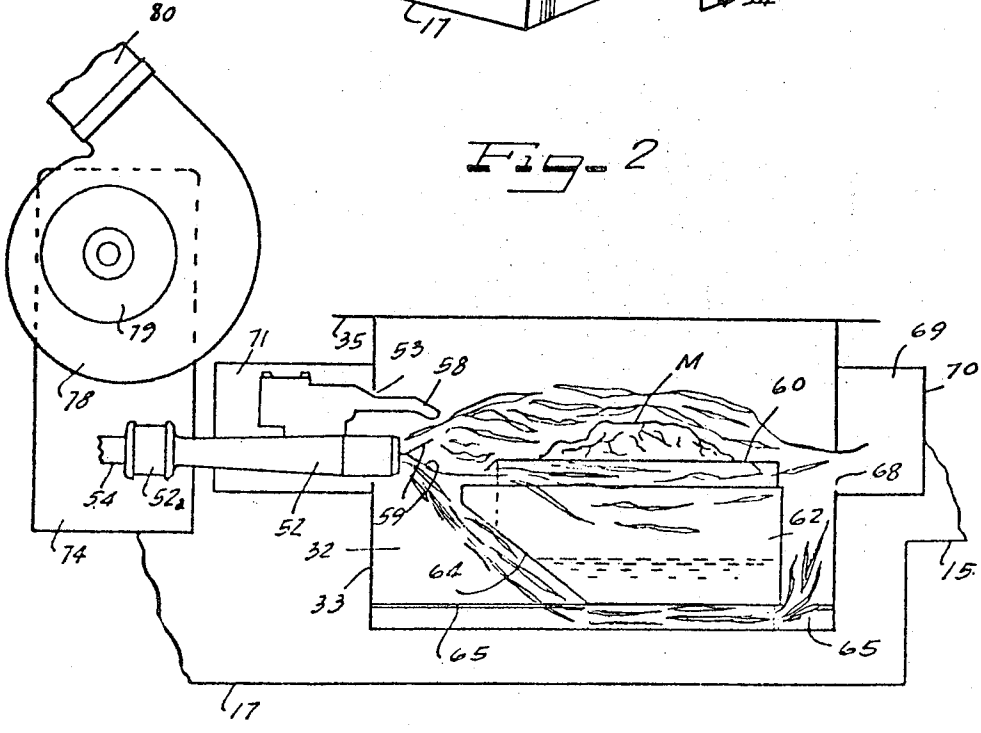

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III

Fig. 2


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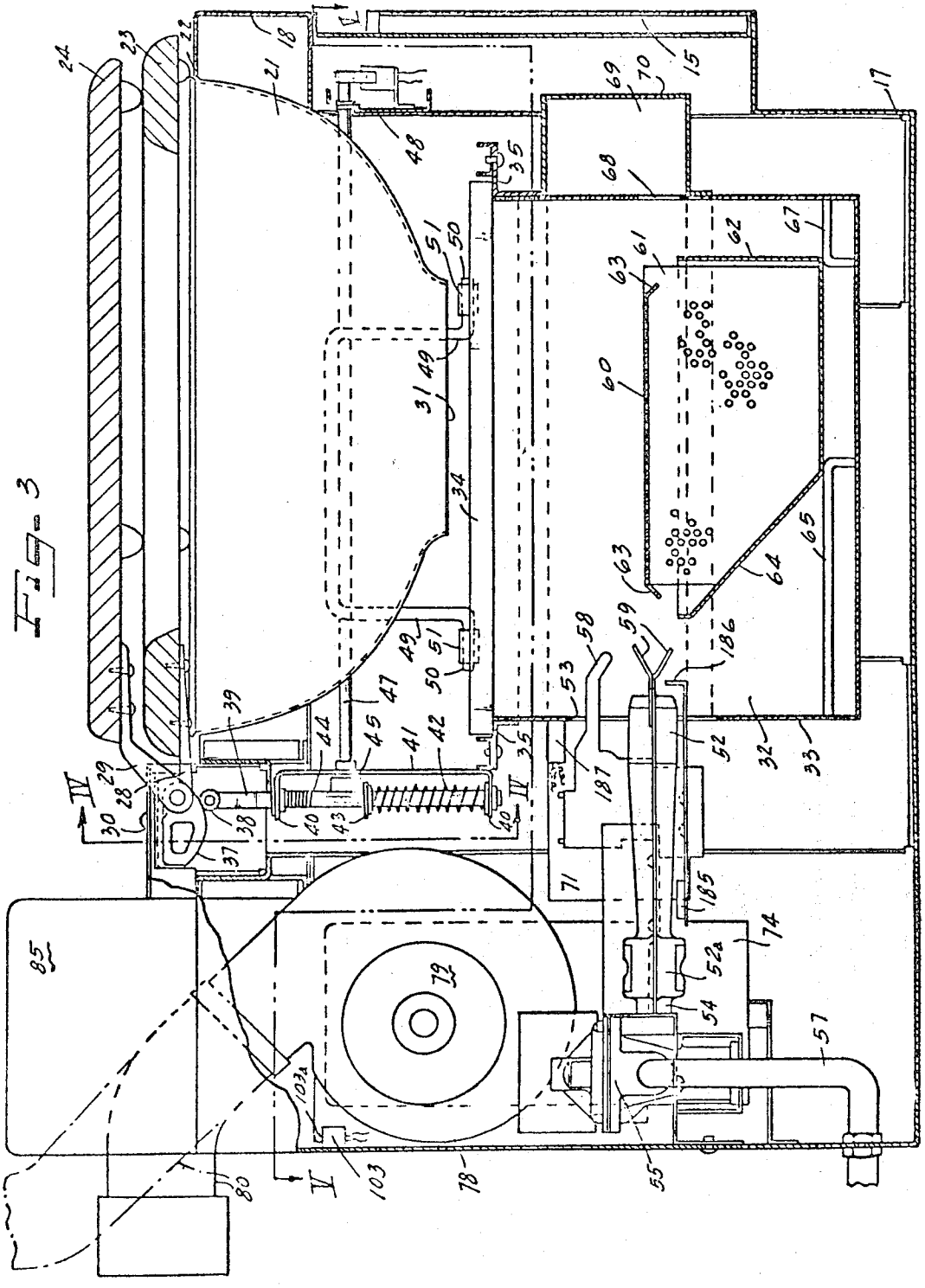


Fig. 3

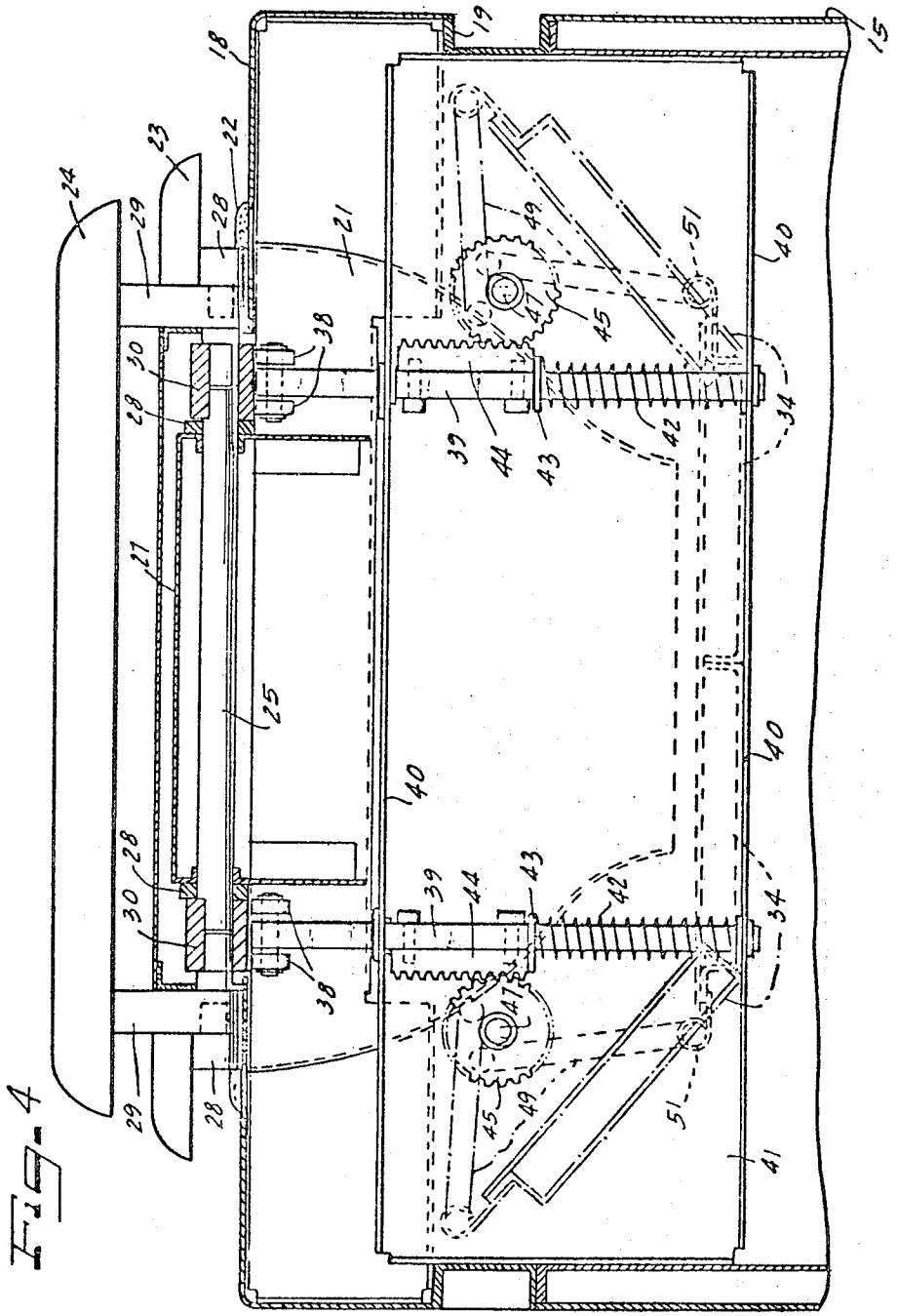


Fig. 4

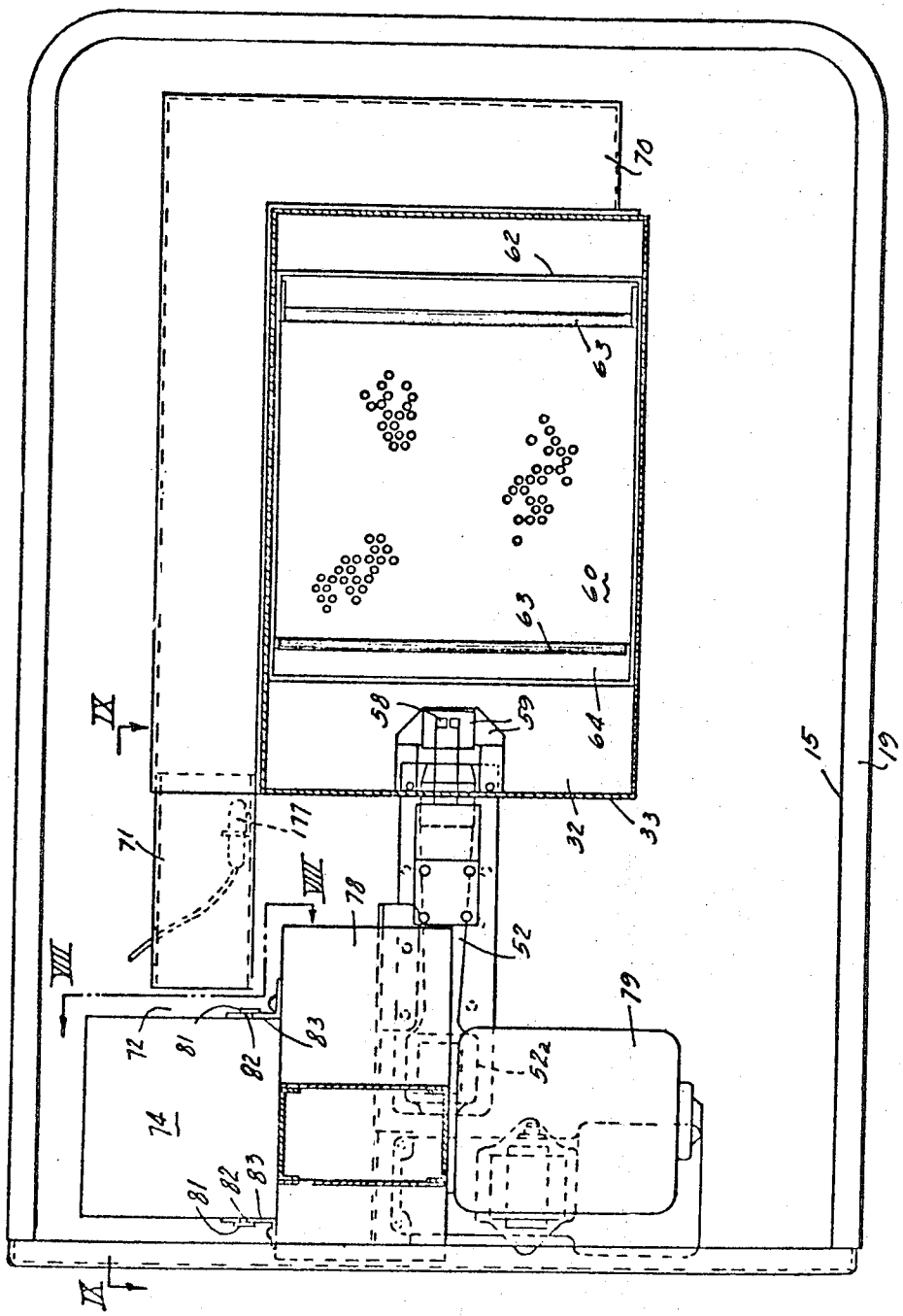

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FIG-5

Fig-7

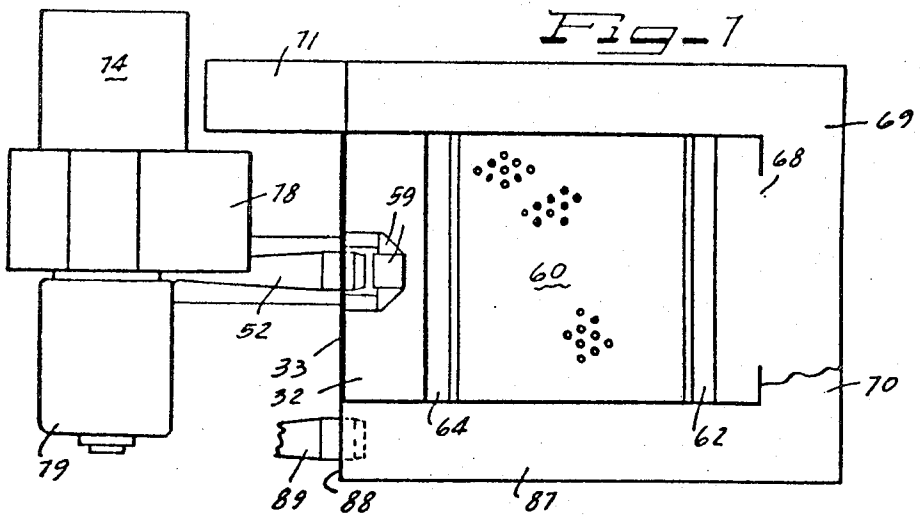

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Fig-6

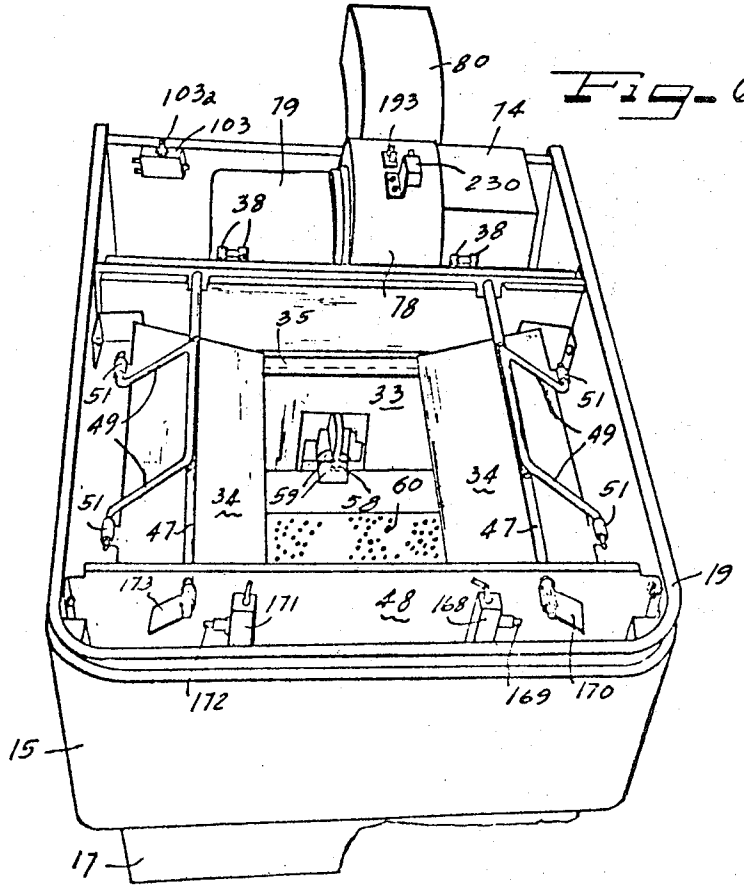

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Fig. 8

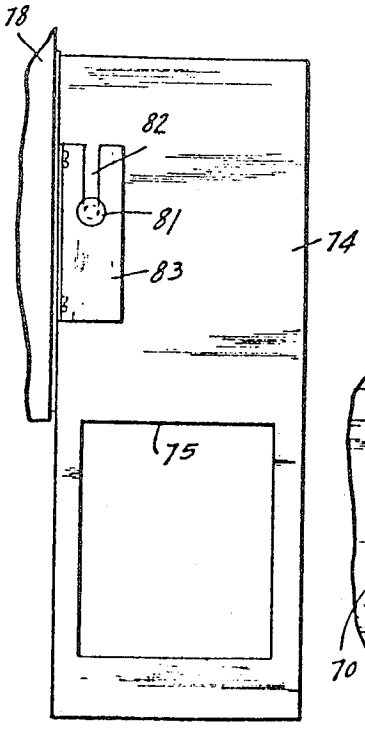
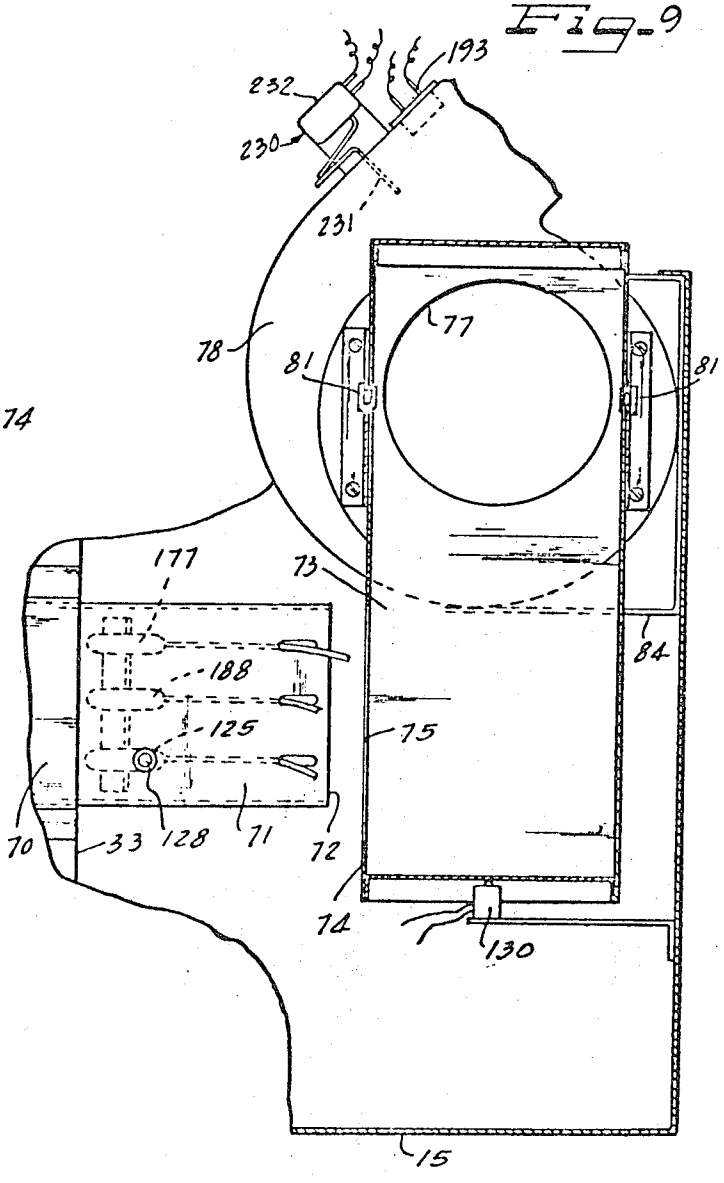

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Fig. 9


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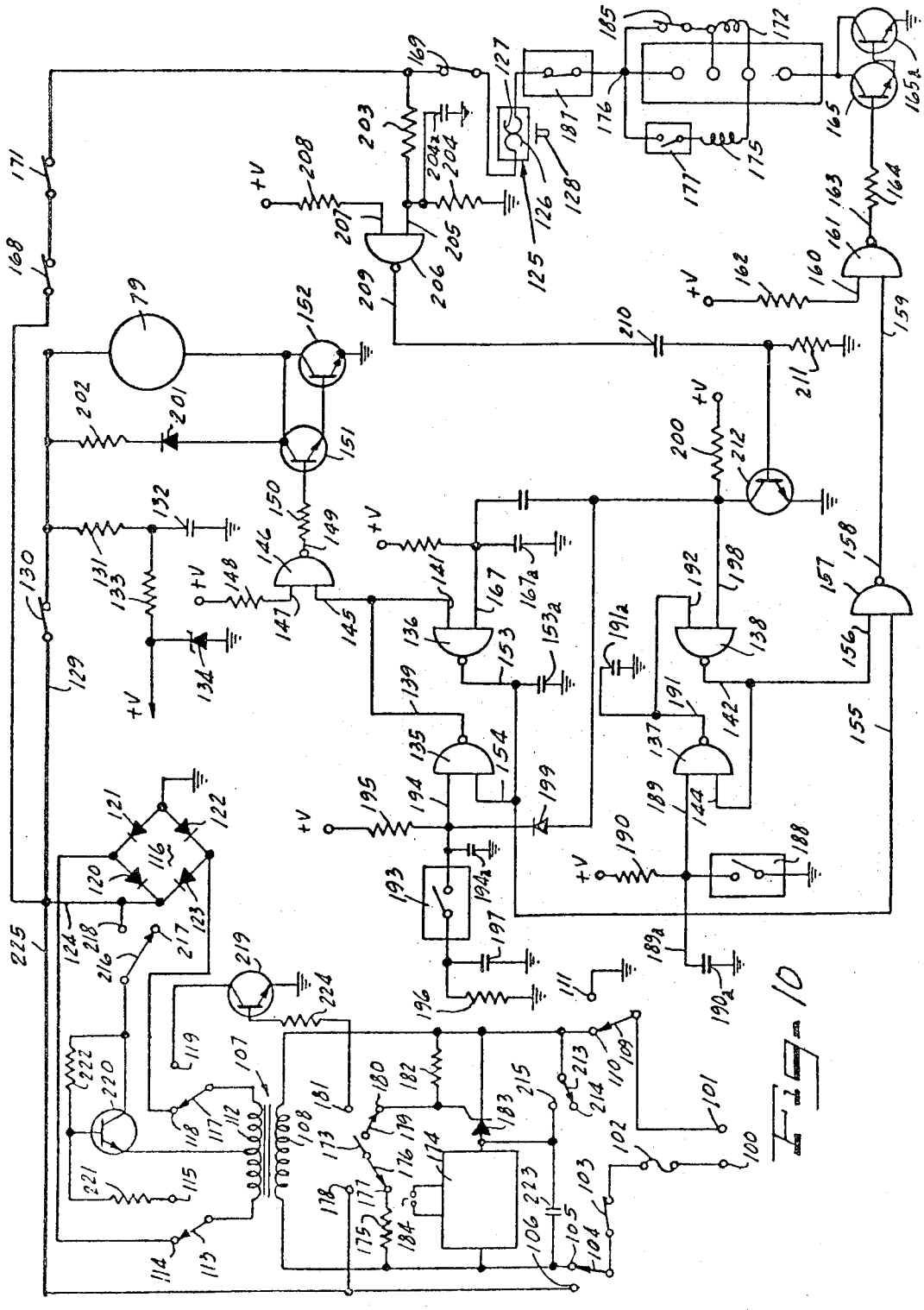

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Fig. 10

DISPOSAL OF WASTE BY INCINERATION

This a division, of application Ser. No. 20,319, filed Mar. 17, 1970, now Pat. No. 3,694,825, dated Oct. 3, 1972.

This invention relates to disposal of waste by incineration, and is more particularly concerned with a method and apparatus suitable for an incinerator toilet.

A major problem with incinerators, and especially incinerator toilets, has been the emission of noxious odors resulting from incomplete combustion or at least failure to reduce vapors to eliminate gases. It is, of course, necessary or at least highly desirable to effect incineration as rapidly as possible. In small incinerators such as toilets, space is generally limited, apparatus must be as simple and foolproof as possible, and economy both in the initial cost and in operation must be considered, in order to be practical for the intended purpose. To this end, it has heretofore been proposed to collect the waste material in a sump-like receptacle and drive a blow-torch-like flame generally downwardly thereagainst. Whereas this does accomplish rapid incineration within a relatively limited space or firebox, it has the disadvantage of merely vaporizing liquid constituents of the waste material with odorous discharge or exhaust.

According to the present invention, the foregoing and other disadvantages, shortcomings, inefficiencies and problems are overcome by the new and improved disposal method and means disclosed herein.

An important object of the present invention is to provide a new and improved method of for disposing of waste by incineration in a novel, rapid, efficient and safe manner.

Another object of the invention is to provide for the complete and efficient incineration of waste material in a manner to provide odorless exhaust.

A further object of the invention is to provide a new and improved method of for incineration utilizing a "soft" flame such as provided by an atmospheric burner.

Still another object of the invention is to provide new and improved incineration methods.

Yet another object of the invention is to provide a new and improved method for incineration disposal of waste including solids and liquids including superheating vapors to eliminate odors.

A yet further object of the invention is to provide new and improved method enabling practice in a compact efficient incinerator toilet apparatus liquidified with operating and safety controls therefor.

Other objects, features and advantages of the invention will be readily apparent from the following description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings, although variations and modifications may be effected without departing from the spirit and scope of the novel concepts embodied in the disclosure, and in which:

FIG. 1 is a perspective view of an incinerator in the form of a toilet and embodying features of the invention;

FIG. 2 is a schematic illustration showing the manner in which combustion is effected;

FIG. 3 is a vertical sectional detail view taken substantially along the line III—III of FIG. 1;

FIG. 4 is an enlarged vertical sectional detail view taken substantially along the line IV—IV of FIG. 3;

FIG. 5 is a sectional plan view taken substantially along the line V—V of FIG. 3;

FIG. 6 is a perspective view looking downwardly and rearwardly into the incinerator toilet with the top closure removed;

FIG. 7 is a more or less schematic top plan view similar to FIG. 5 but showing a modification;

FIG. 8 is a fragmentary elevational view taken substantially along the irregular line VIII—VIII of FIG. 5;

FIG. 9 is an enlarged fragmentary sectional elevational view taken sustantially along the line IX—IX of FIG. 5; and

FIG. 10 is an electrical schematic of the operating and control circuitry for the apparatus.

In accordance with the principles of the present invention, waste materials including solids and liquids are subjected to "soft" flame, i.e., such as that produced by an atmospheric burner in which combustible gas such as propane under ordinary tank pressure is released through a burner nozzle within which it is mixed with air at atmospheric pressure and ignited and the flame as thus produced utilized for incineration. Maximum exposure of the waste material to the flame is effected to attain thorough incineration of solids and evaporation of liquids, and the vapors are then superheated, causing breakdown of the vapors into elemental gases to eliminate odors. Finally, the odorless products of combustion are cooled by mixing ambient air therewith and exhausted to atmosphere. This method is particularly useful for incinerator toilets.

By way of example of apparatus in and by which the method is adapted to be practiced, an incinerator toilet (FIG. 1) is shown which includes an outer housing **15** having a base **17** and an upper closure **18** which is removably supported on a lateral supporting ledge flange **19.** In the top of the closure **18** is a suitable opening **20** (FIGS. 3 and 4) within which is suspended a removably supported funnel-like toilet bowl **21** having an upper out-turned marginal supporting rim flange **22** which engages on the closure **18** about the opening **20.** Over the bowl opening is mounted a toilet seat **23** and a cover **24** therefor both hingedly connected at the rear of the assembly to swing between open and closed positions about the axis of a shaft **25** rotatably mounted on a supporting bracket structure **27** carried by the closure **18.** For selective independent or joint raising and lowering of the seat and cover, the seat **23** is mounted by means of respective left and right brackets **28** which are freely pivotally connected to left and right mounting brackets **29** which are rigidly connected to the ends of the shaft **25** as by means of respective couplings **30.** Through this arrangement the cover **24** may be raised from the seat **23** as desired, and the seat **23** may be raised from the bowl rim **22** for whatever purpose desired such as for removing the bowl **21** for cleaning.

At its lower funnel end, the bowl **21** has a discharge opening **31** aligned with the opening in the seat **23,** and disposed to discharge into a combustion or incinerating chamber **32** provided by means of an upwardly opening box-like fire pot or chest **33** suitably supported permanently or removably, as preferred, in the lower portion of the cabinet housing **15** and spaced from the outer walls of the cabinet housing adequately to provide for the interposition of proper heat insulation to avoid any objectionable transfer of heat from the combustion chamber or firebox to the outer wall of the cabinet.

Any objectionable upward escape of heat from within the firebox chamber **32** is avoided by upper end closure means therefor comprising a fire door structure desirably in the form of a pair of separable heat insulated fire doors **34** which are complementary in size to each other, and each over about half of the top opening into the combustion chamber. To enable convenient separation of the fire doors **34** when access into the chamber **32** is desired, they have end margins extending beyond opposite ends of the chest structure **33** and supported slidably on respective tracks provided by means comprising rails **35** carried by the upper end portions of the end walls of the chest.

Means are provided for automatically opening the fire doors **34** when the lid or cover **24** is swung open and for returning the fire doors to the combustion chamber closing relationship when the cover **24** is returned to the closed downward position. To this end, the couplings **30,** which are co-rotative with the shaft **25,** desirably provide respective operating cams **37** projecting rearwardly thereon and facing downwardly and adapted to be engaged by means of follower rollers **38** of motion transmission means comprising respective vertically extending plunger rods **39** which are desirably square in cross section and are vertically reciprocably slidably supported by and between vertically spaced rearwardly projecting horizontally extending flanges **40** of a transverse bracket bar **41** which they may comprise a frame bar within and secured to the inner walls of the upper rear portion of the cabinet **15.** Normally the plungers **39** are biased upwardly by means comprising respective coiled compression springs **42** engaged thereabout, having their lower ends bottomed on the lower bracket flange **40** and thrusting upwardly against respective shoulder flanges **43** fixed on the plungers. This causes the follower rollers **38** on the upper ends of the plungers normally to engage and follow the associated cams **37.** Conversion of vertically reciprocal motion of the plungers **39** into respective opening and closing movements of the fire doors **34** is effected by means of respective racks **44** on the plungers **39** above the shoulders **43** meshing with respective pinions **45** co-rotative with respective rock shafts **47** rotatably journalled on and between the bracket frame bar **41** and a transverse bracket frame bar **48** within and across the upper front portion of the cabinet **15.** Operating connection between the respective shaft **47** and the fire door sections **34** is effected by means of a pair of angular crank arms **49** rigidly attached to each of the shafts **47** and each pair of the arms having respective coaxial terminal end portion journals **50** engaged in suitable bearings **57** mounted on the outer side edges of the associated fire doors. Through this arrangement, as the seat cover **24** is raised, the cams **37** act through the followers **38** to depress the plungers **39** against the biasing springs **42** and thereby through the racks **44** rotate the respective pinions **45** and thereby the shafts **47** to swing the crank arms **49** sidewardly as shown in dot-dash outline in FIG. **4** and in full outline in FIG. **6,** whereby to pull the respective door sections **34** into open position wherein their inner edges are adequately clear of the discharge opening **31** from the bowl **21.** Swinging of the cover **24** to closed position results in corresponding return of the fire door sections **34** to the closed position by action of the biasing springs **42** which were compressed and loaded incident to downward thrusting of the plungers **39** when the cover was open.

Incinerating flame is introduced into the combustion chamber **32** by means comprising a flange discharging nozzle **52** having its tip projected through a suitable opening **53** in the rear wall of the firebox chest **33.** Preferably, the nozzle **52** is of the venturi mixing atmospheric burner type leading from an atmospheric air intake **52a**(FIGS. **2** and **3**) through which combustible gas is delivered by way of a duct **54** leading from a gas valve assembly **55** by way of which gas is supplied from a supply duct **57** located in the rear lower portion of the housing **15.** An ignitor **58** is associated with the flame tip of the nozzle **52.** In the preferred arrangement, the flame issuing from nozzle **52** is of the "soft" type comprising fuel gas such as propane, natural gas, or any other preferred combustible gas supplied to the nozzle **52** under ordinary line or tank pressure and mixed with the atmospheric air through the mixer **52a** so that instead of a jet or blowtorch-like flame propelled with substantial velocity, the flame will issue into the chamber **32** in a manner to enable it substantially to fill the chamber. To enhance such filling of the chamber, narrow divergent deflector blades **59** (FIGS. **2, 3, 5** and **6**) are mounted adjacently in front of the discharge end of the nozzle **52.** In addition, secondary air for improving combustion is adapted to enter th chamber **32** about the nozzle **52** through the opening **53** in the chamber wall.

Within the combustion chamber **32,** material to be incinerated is exposed to the flame in the most efficient manner. That is, solids are substantially enveloped in the flame and liquids separate from the solids are evaporated not only by heat from the top, but also heat applied thereunder from the flame issuing from the nozzle **52.** Efficiency in this respect is enhanced by receiving solids on an elevated grid or grate **60** desirably in the form of a perforated plate having preferably integral therewith depending coextensive opposite side supporting leg flanges **61,** desirably also perforated and removably supporting the grate in and over a liquid collecting evaporating sump pan **62.** As best seen in FIG. **3,** at its front and rear edges, the grate plate **60** desirably has relatively divergently downwardly oblique respective narrow deflector flanges **63.** Further, the plate **60** is desirably located above the upper edge of the pan **62** and is supported at an elevation about level with a horizontal axis on which the nozzle **52** is preferably located. Thereby flame from the nozzle **52** will efficiently envelop solid material M (FIG. **2**) on the plate **60** not only above, but also below through the perforations in the plate. Evaporation of liquids in the pan **62** is enhanced by diverting flame from the rear of the pan downwardly thereunder along a downwardly and forwardly sloping rear wall **64** which diverts some of the flame under the pan which is supported above the bottom of the chamber **32** as by means of bar brackets **65** and **67** to afford clearance under the pan. In addition, although the pan may be dimensioned to occupy space from side-to-side within the box **33,** as best seen in FIG. **5,** it is spaced not only from the rear wall of the box sufficiently to enable travel of heating flame therebeneath, but it is also spaced from the front wall for a good flue action between the front of the pan and the front wall of the box so that the flame heat from below the pan can readily join the flame heat, products of combustion

and vapors through an exit opening **68** in the front wall of the box, aligned generally with the grate plate **60.**

Operating temperature in the combustion chamber **32** is great enough to consume the material M and vaporize the fluids, and vapor and the products of combustion leave through the opening **68.** If directly discharged to atmosphere this effluvium would be detectable by its odor. Means are therefore provided for superheating the vapors to break them down into elemental gases and eliminate odor before discharging to atmosphere. In a simple, efficient arrangement, such superheating is effected in a chamber **69** into and through which all of the products of combustion and vapors must pass as a confined stream from the outlet **68.** In the simplest arrangement, the chamber **69** is provided within a duct **70** desirably horizontally along the front wall of the firebox **33** and then continuing angularly rearwardly along a side wall of the firebox. For this purpose, the duct **70** may be simply a sheet metal structure secured directly to the walls of the firebox **33** and in fact utilizing the associated area portions of the firebox walls as part of the duct wall structure. Thereby, not only is heat within the duct **69** derived from the continuing burning of gas and air started in the combustion chamber **32** and continuing through the outlet **68** and in the duct, but also by heat transmitted through the sheet metal wall of the firebox **33** and added to the heat directly circulated into the duct. This subjects the vapors in the duct to superheating, on the order of 1,000°F. so that by the time the stream has advanced through the chamber **69** to an exit extension **71** (FIGS. **5** and **9**) of the duct **70,** the stream will consist only of elemental gases and any slight incombustible fly ash that may be entrained therein.

At the extension **71,** the gases are too hot to permit safe discharge to atmosphere. Accordingly, means are provided for rapidly cooling the gases, in this instance accomplished by mixing therewith a large volume of atmospheric air as the gases are drawn across a substantial air gap **72** between the discharge end of the extension **71** and a mixing and settling chamber **73** provided in a vertically elongated box-like housing **74** preferably of generally rectangular form and having adjacent to but spaced above a bottom end thereof in a wall spaced from the end of the extension **71** an inlet opening **75** aligned with and of preferably larger size than the outlet end of the extension. For drawing the hot gases and cooling air into the chamber **73,** suction is applied to draw the cool gas and air mixture from the mixing chamber **73** through an exit opening **77** located in the upper portion of one of the vertical walls of the box casing **74.** As the air and gas mixture turns to move upwardly from the entrance or inlet opening **75** to the outlet **77,** fly ash or other solids entrained therein drop to the bottom or collecting floor of the casing within the chamber **73.** Exhaust suction is applied through the opening **77** by suitable means such as a fan which may be of the squirrel cage type rotatably mounted within a housing **78** and driven by a motor **79.** An exhaust duct **80** may lead from the fan housing **78** directly to atmosphere or to a stack, as preferred. For clean-out purposes, the mixing chamber box or casing **74** is desirably removably mounted, as best seen in FIGS. **8** and **9,** as by means of studs **18** engageable in upwardly opening vertical slots **82** in respective hanger brackets **83** secured to the blower casing **78** to receive the mixing chamber casing **74** therebetween. Support for the blower casing **78,** and thereby the mixing chamber casing **74,** is desirably provided by a bracket **84** carried by the cabinet housing **15** in the upper rear portion thereof. Normally covering the mixing chamber and blower is a hood **85** on the rear portion of the closure **18** and which may be permanently attached to or separable from the closure **18** as preferred but in any event removable for access to the area rearwardly from the seat and firebox area of the housing for servicing and clean-out purposes.

Inasmuch as the mixing chamber **73** is within the housing **15,** the blower induced draft thereinto serves to ventilate the interior of the housing during use. While incineration is proceeding, the ventilating action not only draws ambient cooling air into the housing through various openings, but also withdraws heated air from within the housing, thereby supplementing the heat insulation in and about the housing walls in maintaining the exterior surfaces of the housing cool.

Where for any reason, such as heavier loads, unusually large volume of liquid waste, frequent use, and the like, larger volumes of vapor are produced or liable to be produced in the combustion chamber **32** than may efficiently be superheated in the superheating chamber **69** by the heat produced by the primary flame introduced by the nozzle **52,** additional heat may be supplied to the second or superheating chamber **69** by after-burner means as indicated in FIG. **7.** For this purpose, the duct **70** is desirably provided with a lead-in section **87** which may conveniently be provided as an angular integral portion of the duct mounted on the opposite side of the fire box **33** from that along which the lead-out portion of the duct extends to the terminal portion **71.** An open entrance **88** into the duct portion **87** permits combustion-promoting air to enter about a gas flame nozzle **89** serving as a secondary or afterburner to project into the duct flame having a B.T.U. capacity when mixed with the air entering through the entrance opening **88** to supplement the heat derived from the primary burner through the firebox exit opening **68** to superheat the vapors sufficiently to convert them into primary gases free from odor. If preferred, of course, electrically energized heating means may be provided, but generally a gas flame to supply the additional heat may be found more convenient, especially where the primary flame is supplied by gaseous fuel.

In order to insure safe and efficient operation of the incinerator toilet described above, it is provided with an electrical control circuit for monitoring and controlling the operation thereof. A monitoring circuit for this purpose is exemplified in FIG. **10** as comprising a pair of input terminals **100** and **101** for connection to a conventional electrical supply, for example **125** volts AC at 60 Hz. Terminal **100** is connected to one terminal of a primary winding **108** of a step-down transformer **107** over a series path including a fuse **102,** a normally closed switch **103** and a switch contact **104** engaged with a switch contact **105.** The terminal **101** is connected to the other terminal of winding **108** over a series path including a switch contact **109** which is engaged with a switch contact **110.** The voltage is therefore stepped down at a secondary winding **112** of the transformer **107** whereupon it is impressed across a bridge rectifier **116** over a first path including a switch contact **113** in engagement with a switch contact **114,** and over a second path including a switch contact **117** in engagement with a switch contact **118.** The bridge

rectifier **116** includes a plurality of diodes **120–123** which are connected for full-wave rectification of the alternating wave. A pair of diodes **121** and **122** have their anodes commonly connected and in turn connected to ground while another pair of diodes **120** and **123** have their cathodes commonly connected, and in turn connected by way of a conductor **124** to a normally closed switch **130** which is utilized to signal positive box replacement.

The resistor **131** is serially connected to ground by way of a capacitor **132** and is connected to the cathode of a zener diode **134** by way of a resistor **133.** Inasmuch as it was found advantageous in a working embodiment of the invention to employ integrated circuits, in one case for example the Motorola MC 7400 P, which requires 4.7 volts DC for operation, the resistors **131** and **133** and the capacitor **132** and the zener diode **134** provide a filter regulator having an output voltage +V of 4.7 volts DC. Of course, other circuits and voltages could be employed as required or desired.

Attention is invited at this point that the switch **103** performs an interlock function and is mounted at the rear upper portion of the outer housing **15** (FIG. **6**) and includes an operating plunger **103***a* for operational engagement with the top closure **18.** It should also be pointed out that the switch **125** (FIG. **9**) is mounted at the extension **71** to sense the temperature of the elemental gases passing thereby. This thermostat switch is rated at a temperature of approximately 1,400°F and will operate to open the powering connection to the control circuit and the burner upon detection of excessive exhaust temperature. This thermostat must be manually reset before the unit may again be operated, reset being effected by depression of the push-button **128.**

The aforementioned integrated circuits include, and other circuits may realize, a plurality of dual input positive "NAND" gates for controlling the operation of the incinerator toilet. In the circuit illustrated herein a first pair of such gates **135** and **136** are connected in a well-known manner to form a set-reset multivibrator. Another pair of dual gates **137** and **138** are also connected to form a set-reset multivibrator. The gate **135** has an output **139** connected to an input **141** of the gate **136.** Likewise, the gate **138** has an output **142** connected to an input **144** of the gate **137.**

When power is applied, a pair of capacitors **153***a* and **191***a* hold their respective sides of the multivibrators (outputs **153** and **191,** respectively) at the power supply level momentarily, thereby forcing the multivibrators into the desired initial state. In this state, the output **139** and the input **141** of the gates **135** and **136** respective are at the high level. Accordingly, an input **145** to a gate **146** is placed at a high level, another input **147** of the gate already being at a high level by virtue of its connection to the supply +V over a resistor **148.** The gate **146** includes an output **149** which is therefore at a low level. The output **149** is connected to the base of a transistor **151** by way of a resistor **150.** The transistor **151** has its emitter connected to a base of a transistor **152** and its collector connected in common with the collector of the transistor **152.** The emitter of the transistor **152** is connected to ground and its collector is returned to the DC voltage at conductor **129,** in this case **12** volts DC, by way of the motor **79.** The low level at the output **149** of the gate **146** is therefore ineffective to render the transistors **151** and **152** conductive. The motor **79** is therefore not energized.

The gate **136** has an output **153** which is connected to an input **154** of the gate **135.** At this time in the operational sequence the output **153** is at a low level and this low level is connected to an input **155** of a gate **157.** Similarly, the high level at the output **142** of the gate **138** is connected to an input **156** of the gate **157.** With a high level at the input **156** and a low level at the input **155,** the gate **157** is effective at an output **158** at a high level. The output **158** of the gate **157** is connected to an input **159** of a gate **161.** The gate **161** includes a further input **160** which is connected to the supply +V by way of a resistor **62.** The gate **161** includes an output **163** which is effective at a low level due to the high level at its inputs **159** and **160.** The output **163** is connected by way of a resistor **164** to the base of a transistor **165** connected to a Darlington configuration with a second transistor **165***a.* The low level at the output **163** is ineffective to render the transistors **165** and **165***a* conductive at this time.

The transistors **165** and **165***a* are connected in circuit with the burner circuit of the incinerator toilet. At the present time in the sequence the motor **79** is not operating to provide a flow of air and the burner is not yet operated.

The first step in the operating sequence is initiated by the application of power or the previous opening of the fire doors **34,** which will be explained in detail below, whereby the +V potential at the collector of a transistor **212** is impressed on an input **167** of the gate **136** as a pluse and effects a change of state of the multivibrator so that the output **139** goes to a low level and the output **153** goes to a high level. The resulting low level at the input **145** of the gate **146** renders the gate **146** effective at a high level at its output **149,** which in turn renders the transistors **151** and **152** conductive to provide an energizing path for the motor **79.** The motor **79** is therefore energized and an air flow is established by way of the blower apparatus. The establishment of air flow is sensed by a sail switch **230** which is disposed on the blower casing **78** (FIG. **9**) and includes a vane **231** remotely coupled to a contact which **232.** Closure of the switch **230** therefore verifies air flow.

The high level now present at the output **153** of the gate **136** is effective at the input **155** of the gate **157** to shift the output **158** thereof to a low level. In turn, this low level is effective at the input **159** of the gate **161** to render the gate **161** operable at a high level at its output **163.** The high level at the output **163** is effective over the resistor **164** to render the transistors **165** and **165***a* conductive. The transistors **165** and **165***a* do not, however, render the burner unit operative in that the cover **24** is still raised and the fire doors **34** are open; hence, power is not yet available to the burner unit.

The control circuit will remain in the status last discussed and nothing further will happen until the toilet cover **24** is lowered. The lowering of the cover **24** is effective as discussed above to close the fire doors **34.** One of the fire doors has a switch **168** associated therewith and mounted on the transverse bracket frame bar **48.** The switch **168** includes an operating plunger **169** for operation upon closure of the corresponding fire door **34** by a protruding portion **170** of the respective shaft **47.** The other fire door has a switch **171** similarly associated therewith and mounted on the transverse bracket frame bar **48** and includes a plunger **172** for

operation by a protruding portion **173** of the respective shaft **47.** The switches **168** and **171** are electrically connected in series in the burner circuit to insure complete closure of both fire doors **34** before ignition and operation of the burner.

The burner includes two solenoid valve to allow for modulation of input. A first of these is not illustrated herein but is effective between the collector of the transistor **165** and the junction **176.** The modulating one of the valves is represented by the winding **175** in series with a 950°F thermostat **177** which is physically disposed on the exhaust exit extension **71** (FIG. **9**). Upon closure of the switches **168** and **171** by operation of the fire doors **34,** a relay, preferably a reed relay, including a winding **172** is energized to close its contacts **173** associated with the ignitor circuit **174.** Closure of the contact **173** effects a voltage divider including a resistor **175,** a contact **177** engaged by a contact **176,** the switch **173,** a contact **179** in engagement with a contact **180** and a resistor **182** across the commercial supply. One terminal of the resistor **182** is connected to the gate electrode of a silicon controlled rectifier **183** for energization of the ignitor **174** to provide ingition at the gap **184.**

The circuit includes a "flame proven" switch **185** having a flame sensor **186** (FIG. **3**) and opens upon the detection of an adequate flame to deenergize the relay winding **172** and open the contacts **173** thereof and deenergize the ignitor **174.**

The electrical circuit of the blower further includes a 150°F flame blow back switch **187** (FIG. **3**) disposed above and behind the opening **53** and connected in series with the fire door switches **168, 171** and the solenoid valves of the burner. This switch is normally closed and operative upon an adverse draft condition to prevent a sustained flame of reverse direction.

Also, the electrical circuit of the blower includes a normally closed, thermally operated and manually resettable switch **125** (FIG. **9**) in series with the switch **187.** The switch includes contacts **126** and **127** which part at a predetermined temperature, say 1,350°F., to protect against excessive heat or thermal overload of the apparatus. A reset button is provided to reclose the contacts **126** and **127.**

At room temperature, the 950°F. thermostat **177** is closed causing the burner to operate at maximum heat input, for example 30,000 Btu hr, until the temperature at this thermostat is sensed to be 950°F. At this temperature, the thermostat contacts open to deenergize the winding **175** and decrease the heat input to a lower level, for example 25,000 Btu, hr.

During normal "burn" operation, temperatures in the unit remain constant until all waste materials are gone, that is, disposed of by the heat input. Thereupon, the heat input is automatically discontinued responsive to detected temperature variance in the enclosure of the unit. To this end, when all waste material is gone temperatures rise rapidly and at 1150°–1200°F. contacts of a thermostat switch **188** close to place ground potential, the low level, on an input **189** of the gate **137.** Previously the input **189** was maintained at the potential of the supply +V by way of a resistor **190.** The gate **137** includes an output **191** connected to an input **192** of the gate **138.** The low level placed on the input **189** by the thermostat switch **188** reverses the state of the multivibrator **137, 138** so that the input **142** of the gate **138,** and hence, the input **156** of the gate **157** are at a high level. Since the input **155** remains at a low level, the output **158** is at a high level. A high level at the input **160** and at the input **159** of the gate **161** places a low level at the output **163** to render the transistor **165** non-conductive. The burner unit is therefore deenergized by the effective open circuit at the non-conducting transistor **165.** The motor **79,** however, continues to run to exhaust air and initiate cooling of enclosure within the incinerator toilet. Thereby, maximum efficiency, with minimum fuel and power expenditure are attained because the control system automatically responds to waste load disposal requirements, i.e. short duration for small loads and proportionally larger duration for larger loads.

As the unit cools down to a temperature of 150°F. contacts of a limit thermostat **193** close to place a low level signal on an input **194** of the gate **135.** Previously the input **194** was maintained at the supply voltage by way of a resistor **195** connected to the supply +V. The low level now applied to the input **194** is derived over a resistor **196** having a capacitor **197** connected in shunt therewith. The closure of the contacts of the limit thermostat **193** also places a low level on an input **198** of the gate **138** by way of a diode **199.** The input **198** was previously maintained at the potential of the supply +V by way of a resistor **200.** The grounding of the inputs **194** and **198** resets both multivibrators to effect a low level at the output **149** of the gate **146** to render the transistors **151** and **152** non-conductive. The motor **79** is therefore deenergized and ceases to operate.

The energy remaining the the rotating motor upon deenergization is dissipated by way of a diode **201** and a resistor **202** connected in shunt with the motor **79.** This energy discharge path prevents a reverse voltage building up across the transistors **151** and **152.** Upon deenergization of the motor the incinerator toilet is ready for the next cycle of operation.

If operation is interrupted during the incinerating cycle at any time by raising the cover **24,** the fire doors **34** are opened and the switches **168** and **171** are opened to deenergize a voltage divider comprising a resistor **203** and a resistor **204** and therefore place an input **205** of a gate **206** at a low level or gound potential. A capacitor **204***a* across the resistor **204** serves to smooth the ripple due to the fuel wave rectified supply. The gate **206** includes a second input **207** which is maintained at the supply potential +V by way of a resistor **208.** The gate **206** further includes an output **209** which jumps to a high level upon the opening of either or both of the switches **168** and **171.** The output **209** is connected to the base of a transistor **212** by way of a capacitor **210** and the base of the transistor **212** is further connected to ground by way of a resistor **211.** The capacitor **210** and the resistor **211** form a differentiator to differentiate the voltage change at the output **209** into a pulse for rendering the transistor **212** momentarily conductive. This same operation is also effective in opening the fire doors to utilize the toilet whereby the voltage shift at the elements **204–205** is translated into a setting pulse at the collector of the transistor **212.**

Conduction of the transistor **212** momentarily places the input **198** of the gate **138** at ground or low level potential and insures that the state of the multivibrator **137, 138** is proper for restarting the sequence regardless of the time during the cycle at which the cover **24** was opened. The collector of the transistor **212** is connected to the diode **199** which prevents resetting of the

multivibrator **135, 136** and subsequent deenergization of the motor **79** due to the momentary grounding of the input **198.** The same diode **199,** however, as previously explained, permits the multivibrator **137, 138** to be reset along with the multivibrator **135, 136** by the action of 150°F. thermostat **193.**

A plurality of capacitors **167***a*, **189***a* and **194***a* have been provided to suppress transient at the respective inputs **167, 189** and **194** of gates **136, 137** and **135.** Also, attention is invited that the switch **193** is not connected directly to ground, but utilizes a shunt connected resistor and capacitor, inasmuch as the contacts of the switch **193** remain closed until temperatures in the incinerator toilet rise. If the input **194** were connected directly to ground during this condition, the multivibrator would not change waste when the cover switch **166** was closed. When the 150°F. limit switch **193** opens, the resistor **196** is employed for the purpose of discharging the capacitor **197** so it will be ready for the next closing of the contacts.

Attention is again directed to the left-hand portion of the circuit illustrated in FIG. **10.** Although the circuit has been described for operation from a commercial alternating supply, the circuit is also operable from a conventional direct current supply such as a **12** volt battery. For operation on direct current, the circuit is provided with a switch or changeable terminal strip represented by the contacts **104–106, 109–111, 113–115, 117–119** and **177–181,** all of which have been previously pointed out. In addition the switch or terminal strip further includes contacts **213–218.** These switch contacts are illustrated as they would be engaged for AC operation: for DC operation their opposite engagement is effected.

In DC operation a suitable supply is connected to the input terminals **100** and **101.** The terminal **101** is connected to a reference, here ground, by way of closed contacts **109** and **111.** The terminal **100,** however, is connected to the switch **125** by way of the fuse **102,** the interlock switch **103,** and contacts **104** and **106.** The direct current potential necessary for operation of the gates and transistors is therefore made available directly from the external supply. The ignition circuit is, however, modified for DC operation. In order to provide the necessary high voltage for reliable ignition at the gap **184,** means are provided for generating the required voltage. To this end, an oscillator inverter is provided comprisin a transistor **220,** the transformer **107,** a resistor **221,** a resistor **222,** and a capacitor **223.**

Upon a demand for ignition and the corresponding closure of the relay contacts **173,** the base of the transistor **219** is connected by way of a resistor **224** and switch contacts **181, 179, 173, 176, 178, 106, 104** and switch **103** and fuse **102** to the input terminal **100.** The transistor **219** is therefore rendered conductive and establishes a path to ground for the emitter of the transistor **220** by way of the winding **112** and the contacts **117** and **119.** Also, the direct current potential is further applied to the collector of the transistor **220** by way of the conductor **225,** the conductor **124** and the contacts **218** and **216.** The same potential is applied to the base of the transistor **220** by way of the resistor **221** and the emitter of the transistor **220** is further connected to the base of the transistor by way of the winding **112** the switch contacts **113,** and **115** and the resistor **221.** The transistor **220** is therefore rendered operative in an oscillatory mode wherein the previously designated secondary winding **112** is now effective as a primary winding and the previously designated primary winding **103** is effective as a secondary winding, the switch contacts **213** and **215** being effective to place the capacitor **223** across the winding **108** and across the ignitor **174.** The left-hand portion of the winding **112** and the resistor **221** effect a positive feedback for the transistor **220** to sustain oscillations. Attention is especially invited to the fact that the transformer **107** is being employed in this instance as a step-up transformer; whereas, in AC operation it was employed as a step-down transformer. The application of the required high level alternating voltage across the ignitor **174** energizes the ignitor to provide the necessary spark at the gap **184.** At this point the burner ignites and the flame sensor **186** operates to open the switch **185** and deenergize the winding **172.** Deenergization of the winding **172** opens the contact **173** to remove the enabling bias for the transistor **219** and turn off the oscillator.

Generally then, an incinerator toilet that is both efficient and safe has been set forth in an exemplary embodiment which may be controlled by connection to either AC or DC electrical supplies.

Of course, many changes and modifications of the invention may be become apparent to those skilled in the art without departing from the true spirit and scope of the invention, and it is to be understood that we wish to include within the patent warranted hereon all such changes and modifications as may be reasonably and properly included within the scope of our contribution to the art.

We claim as our invention:

1. A method of waste disposal such as in an incinerator toilet, comprising:

supporting solid waste material on a grate separate from and above liquid waste; and

directing flame from an atmospheric burner operating on ordinary line or tank pressure mixed with atmospheric air toward one edge of the grate to envelop it and the solid material thereon both thereabove and therebelow and to evaporate the liquid waste by heat from the flame below the grate.

2. A method according to claim **1,** including providing the incinerating and vaporizing heat by substantially filling a grate enclosing combustion chamber with "soft" flame.

3. A method according to claim **1,** including cooling the odorless gases before exhausting them to atmosphere.

4. A method according to claim **1,** including mixing the odorless gases with cooling air and then exhausting the cool mixture to atmosphere.

5. A method according to claim **1,** including drawing said odorless gases and cooling air into a mixing chamber, and exhausting the mixture from the mixing chamber.

6. A method according to claim **1,** comprising issuing the flame from a nozzle horizontally aligned in spaced relation to said edge of the grate.

7. A method according to claim **1,** wherein said grate and burner are located within a fire pot having a wall spaced beyond the opposite edge of the grate from the edge toward which the flame is directed, and conducting the flame and products of combustion and vapor through an opening in said wall into a superheating chamber.

8. A method according to claim 1, wherein said grate and burner are located within a fire pot having a wall spaced beyond the opposite edge of the grate from the edge toward which the flame is directed, conducting the flame and products of combustion and vapor through an opening in said wall into a superheating chamber, and in said chamber controlling the temperature in a range of 950°F. to 1,200°F. for rendering the gases odorless to the human sense of smell before exhausting such gases to atmosphere.

9. A method according to claim 1, wherein said grate and burner are located within a fire pot having a wall spaced beyond the opposite edge of the grate from the edge toward which the flame is directed, conducting the flame and products of combustion and vapor through an opening in said wall into a superheating chamber, and in said chamber maintaining a temperature on the order of 1,000°F.

10. A method according to claim 1, wherein said grate and burner are operatively located in respect to a combustion and vaporizing first chamber having a wall and duct means of substantial length extending along said wall to provide a second chamber contiguous and in heat-exchange relation throughout most of its length to said first chamber, conducting products of combustion and vapor from the first chamber through said second chamber duct means, and in said second chamber superheating the products of combustion and vapor into odorless gases.

11. A method according to claim 1, including deflecting part of the flame from the burner to more upwardly onto the grate and the material thereon, and deflecting part of the flame to move under the grate.

12. A method according to claim 1, wherein said grate and burner are operatively located in respect to a combustion and vaporizing first chamber having a wall and duct means of substantial length extending along said wall and providing a second chamber contiguous and in heat-exchange relation throughout most of its length to said first chamber, conducting products of combustion and vapor from the first chamber through said second chamber duct means, in said second chamber superheating the products of combustion and vapor into odorless gases, and receiving the gases from the duct means in a mixing chamber and therein mixing the gases with cooling air before release to atmosphere.

13. A method of waste disposal such as in an incinerating toilet, comprising:

depositing solid waste material on a grate;

collecting liquid waste in a receptacle below the grate;

mixing air with fuel at ordinary line or tank pressure and producing flame thereby from an atmospheric burner; and

directing flame from the burner toward one edge of the grate to envelop it and the material thereon both thereabove and therebelow with the flame and evaporating the liquid waste in the receptacle by heat from the flame below the grate.

14. A method according to claim 13, including conducting products of combustion and vapor through a superheating chamber and therein converting the products of combustion and vapor to odorless gases, mixing the odorless gases with cooling air, and exhausting the cooled odorless gases to atmosphere.

15. A method according to claim 13, including conducting products of combustion and vapor through a superheating chamber and therein converting the products of combustion and vapor to odorless gases, introducing heat in addition to heat derived from said burner into said chamber to accelerate superheating of the products of combustion and vapors, mixing the odorless gases with cooling air, and exhausting the cooled odorless gases to atmosphere.

16. A method according to claim 13, including conducting products of combustion and vapors through a duct chamber and therein superheating and converting the same into odorless gases, and controlling said burner in response to temperature variance detected in respect to said duct chamber.

17. A method of waste disposal such as in an incinerator toilet including an upwardly opening housing and an upwardly opening fire pot mounted within a lower portion of the housing, with means for directing material downwardly into the fire pot, comprising:

moving a pair of fire door from a closed edge-to-edge position from between said fire pot and an upper portion of said housing into spaced apart position, depositing material to be incinerated into the fire pot with said fire doors in the spaced apart position;

moving said fire doors into closed edge-to-edge position;

operating heat-producing means to incinerate the material in the fire pot, and

electrically controlling said heat-producing means by said fire doors individually to become inoperative when the doors are open and operative only both of when the doors are completely closed.

18. A method according to claim 17, wherein said doors have respective shafts, and operating respective electrical control switches through rotation of said shafts between door open and door closed positions and thereby electrically controlling said heat-producing means.

19. A method of waste disposal such as in an incinerator toilet and including a combustion and vaporizing first chamber receptive of waste to be incinerated and having a vertical wall structure with an outlet opening, comprising:

producing heat in said chamber to incinerate and vaporize the waste;

directing products of combustion and vapor from said first chamber through said opening into a second chamber within an afterburner duct of substantial length extending generally horizontally along said wall structure from said opening in contiguous and heat-exchange relation throughout most of its length to said first chamber; and

in said second chamber superheating the vapor and converting it into odorless gases.

20. A method of waste disposal such as in an incinerator toilet and including a combustion and vaporizing first chamber receptive of waste to be incinerated and having a wall, comprising:

producing heat in said chamber to incinerate and vaporize the waste;

directing products of combustion and vapor from said first chamber into a second chamber providing an afterburner duct of substantial length extending along said wall in contiguous and heat-exchange relation throughout most of its length to said first chamber;

in said second chamber superheating the vapor and converting it into odorless gases;

supporting solid waste within said first chamber in spaced generally horizontal alignment with a burner nozzle;

and enveloping the solid waste above and below by flame from the nozzle and thereby incinerating the waste.

21. A method according to claim **20,** including collecting liquid waste separate from the solid waste, and directing flame heat into vaporizing relation to the liquid waste both thereabove and therebelow.

22. A method of waste disposal such as in an incinerator toilet and including a combustion and vaporizing first chamber receptive of waste to be incinerated and having a wall, comprising:

producing heat in said chamber to incinerate and vaporize the waste;

directing products of combustion and vapor from said first chamber into a second chamber providing an afterburner duct of substantial length extending along said wall in contiguous and heat-exchange relation throughout most of its length to said first chamber;

in said second chamber superheating the vapor and converting it into odorless gases;

supporting solid waste material at an elevation in said first chamber;

directing the flame from a gas burner nozzle aligned in spaced relation in a generally horizontal direction with the supported solid waste;

and deflecting flame from the nozzle to move upwardly onto and under the supported solid waste material and thereby enveloping the same to effect incineration.

23. A method of waste disposal such as an incinerator toilet and including a combustion and vaporizing first chamber having front, rear and side walls and receptive of waste to be incinerated, comprising:

producing heat in said chamber by flame from a burner extending through an opening in said rear wall to incinerate and vaporize the waste;

directing products of combustion and vapor from said first chamber through an exit opening in said front wall into a second chamber within an afterburner duct of substantial length extending along said side wall;

effecting heat transfer from said first chamber into said second chamber duct through said side wall;

in said second chamber superheating the vapor and converting it into substantially odorless gases;

and effecting exhausting suction with said second chamber duct at its end remote from said front wall opening.

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