United States Patent

Kufrin et al.

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

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

[51] **Int. Cl.** **A47k 11/02**

[58] **Field of Search** ..... 4/118, 131; 110/9, 9 E; 307/290, 291

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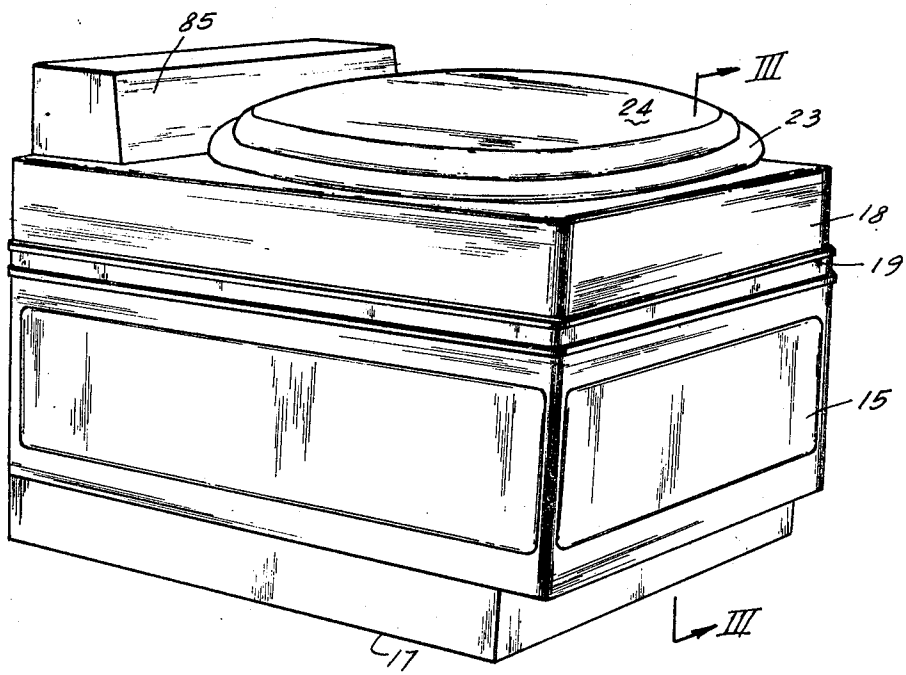
[57] **ABSTRACT**

Human 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 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.

42 Claims, 10 Drawing Figures



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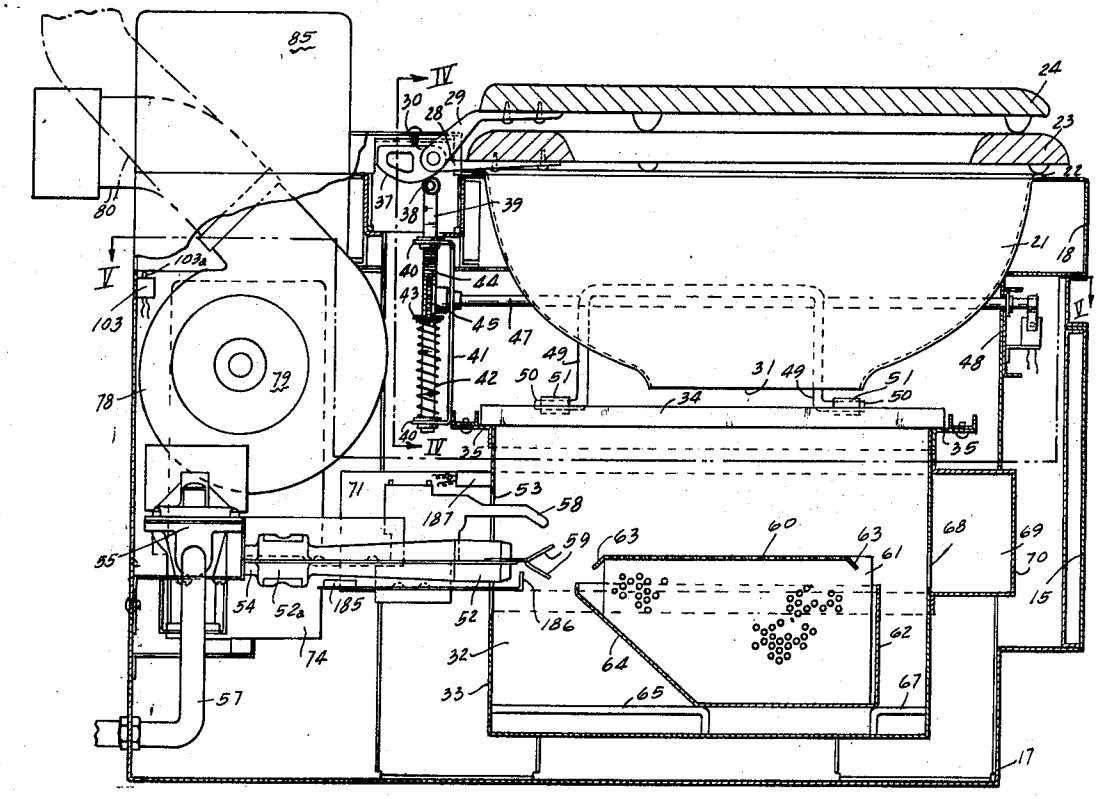

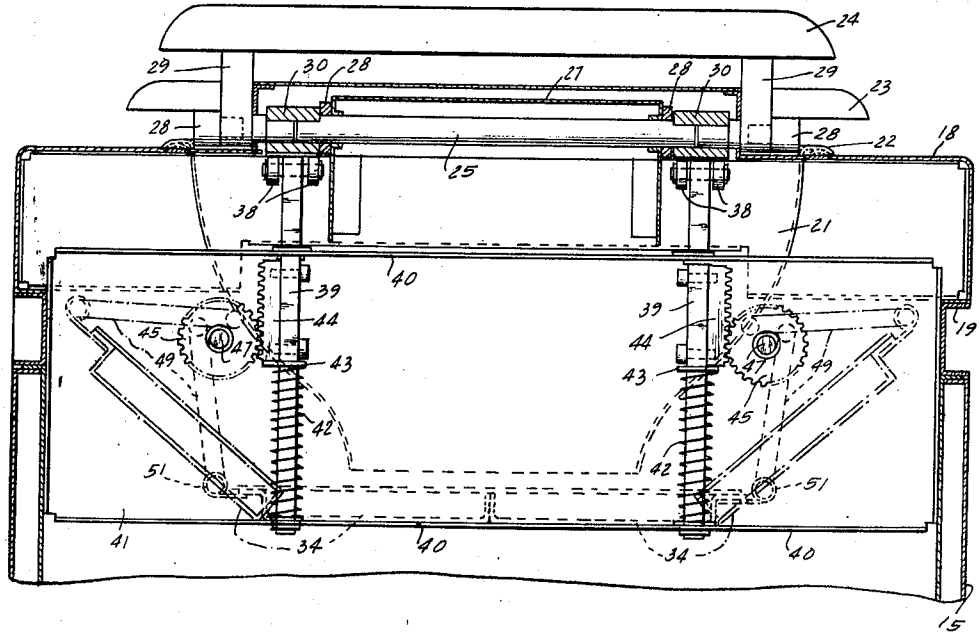

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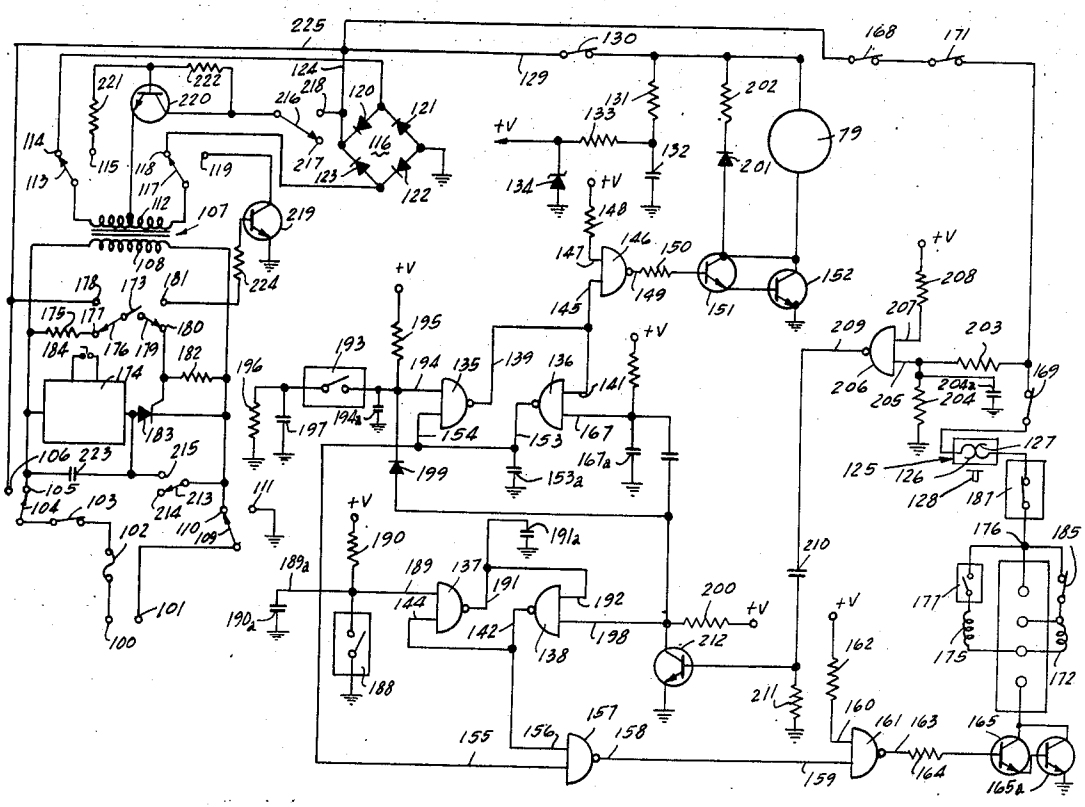

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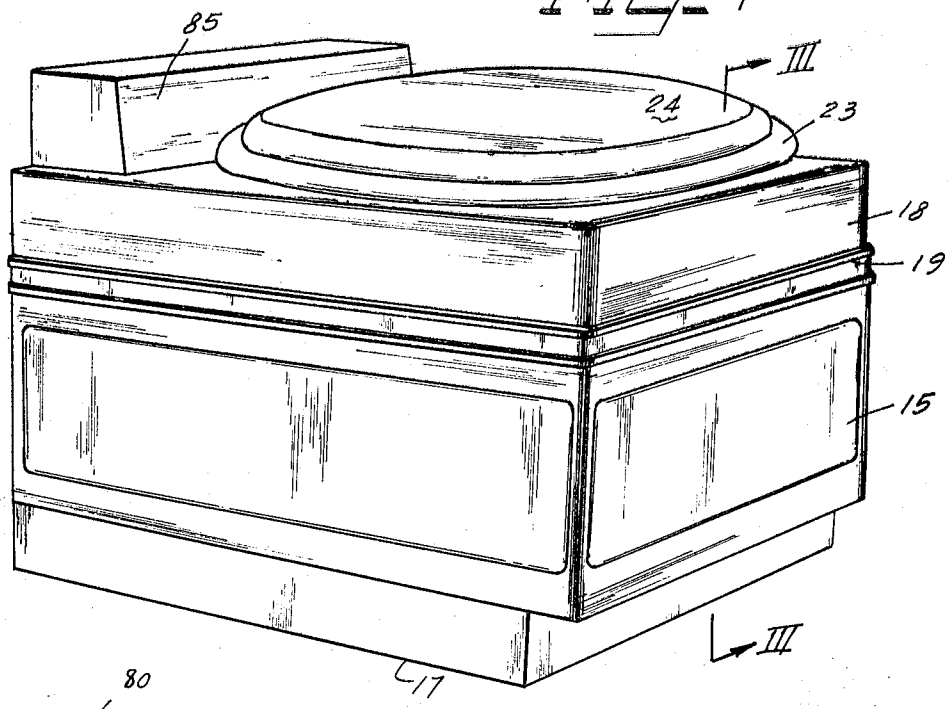
SHEET 1 OF 7

Fig. 1



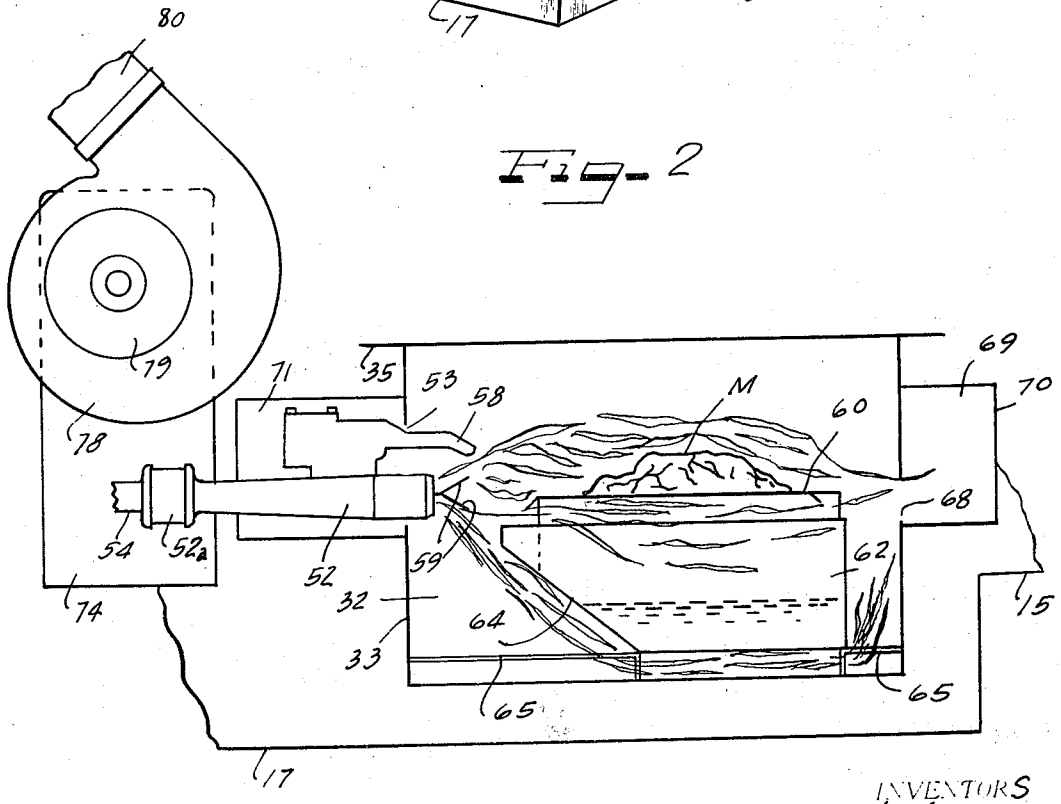


Fig. 2

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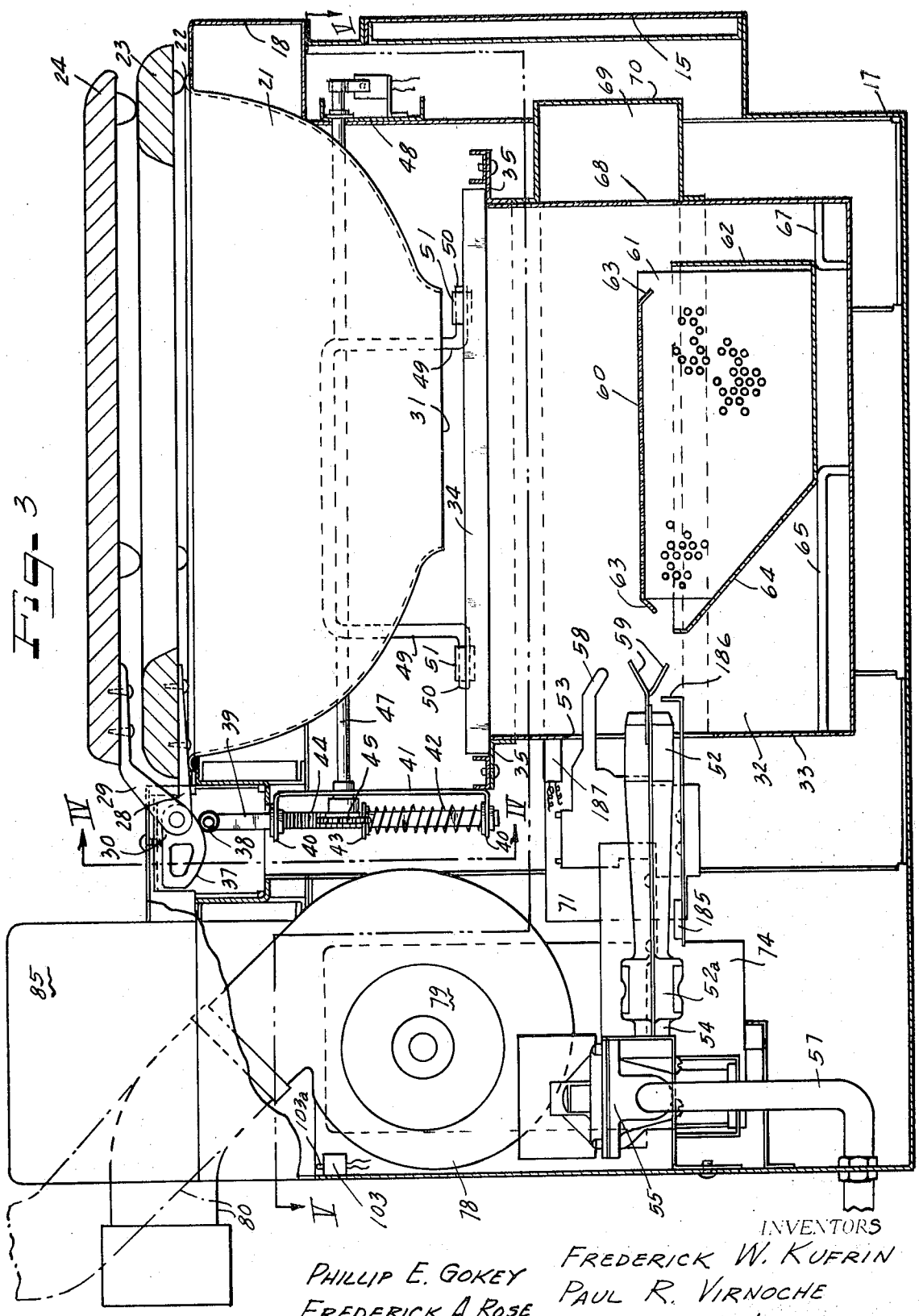

Fig. 3

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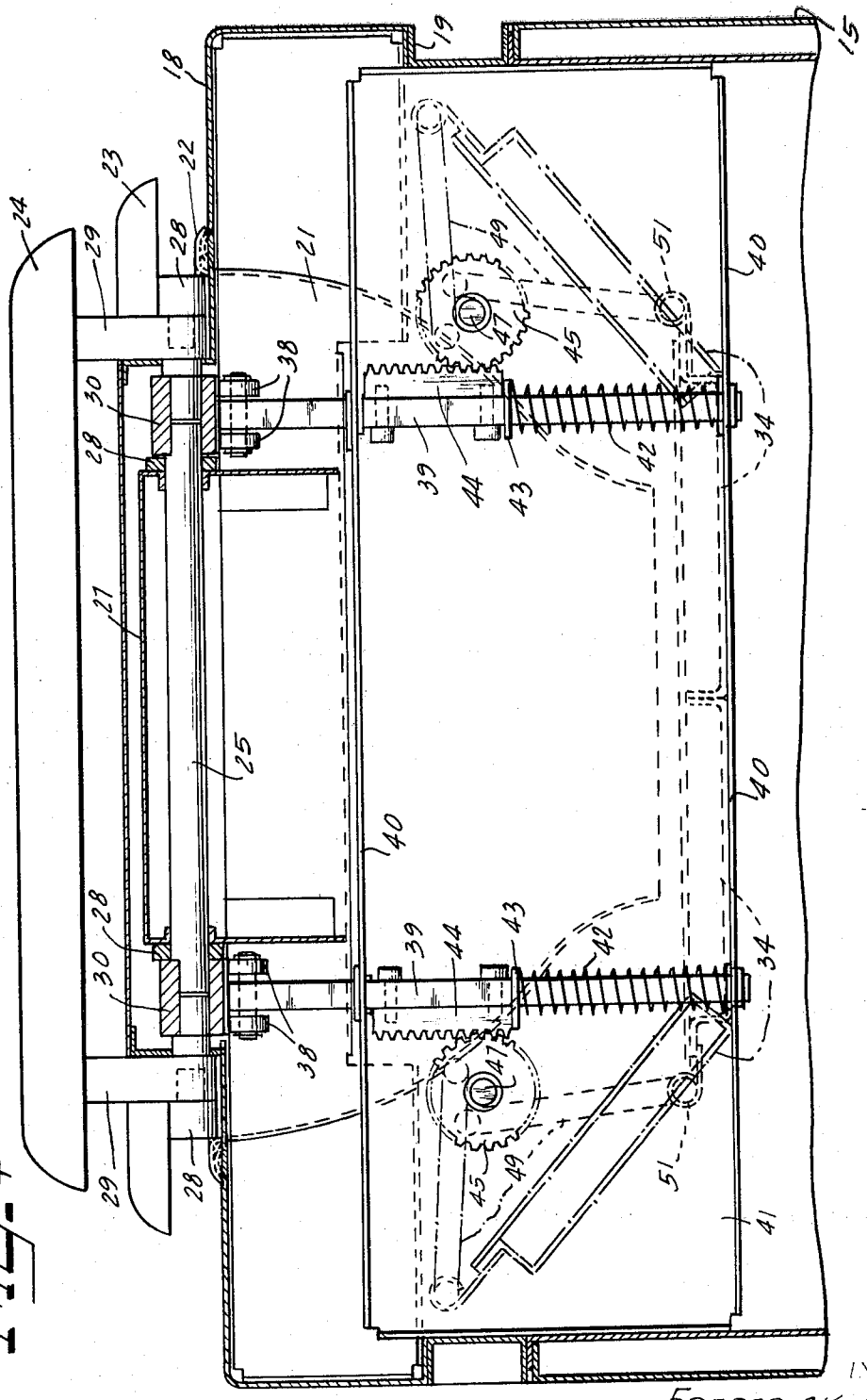

Fig. 4

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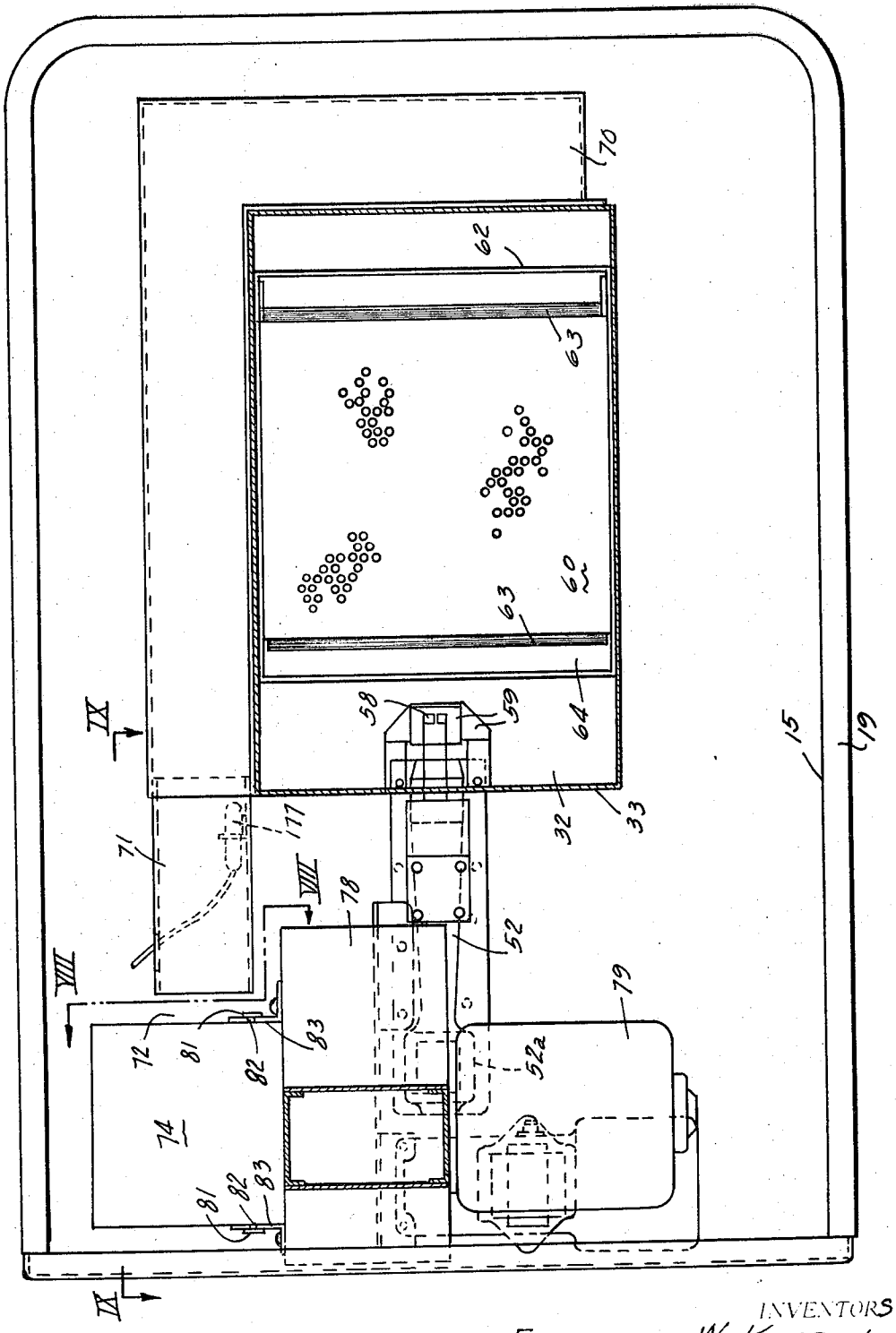

FIG. 5

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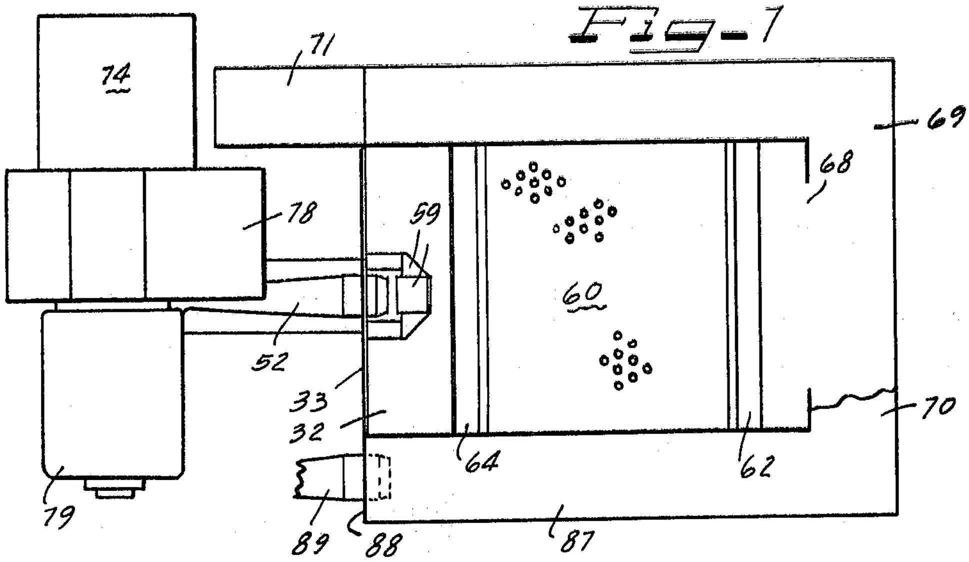

Fig-7

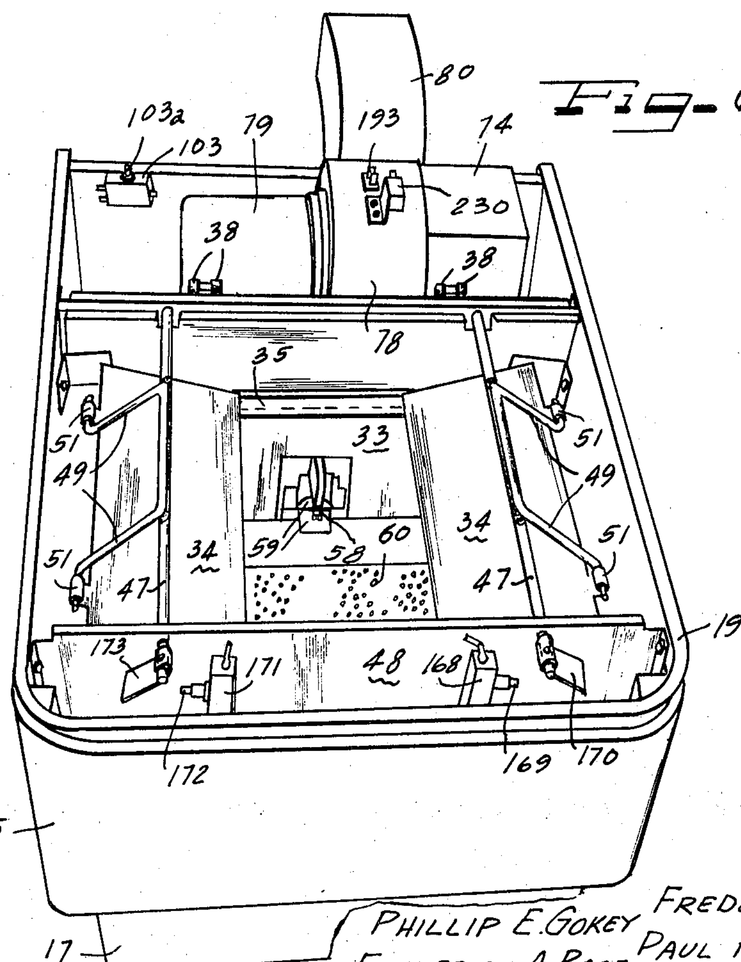

Fig-6

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Fig-8

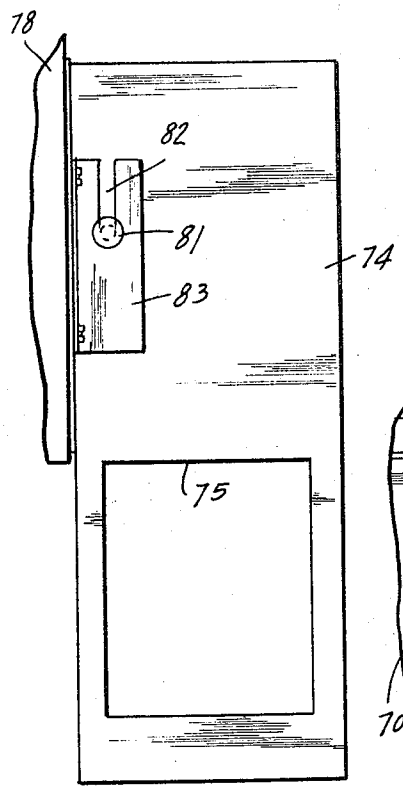
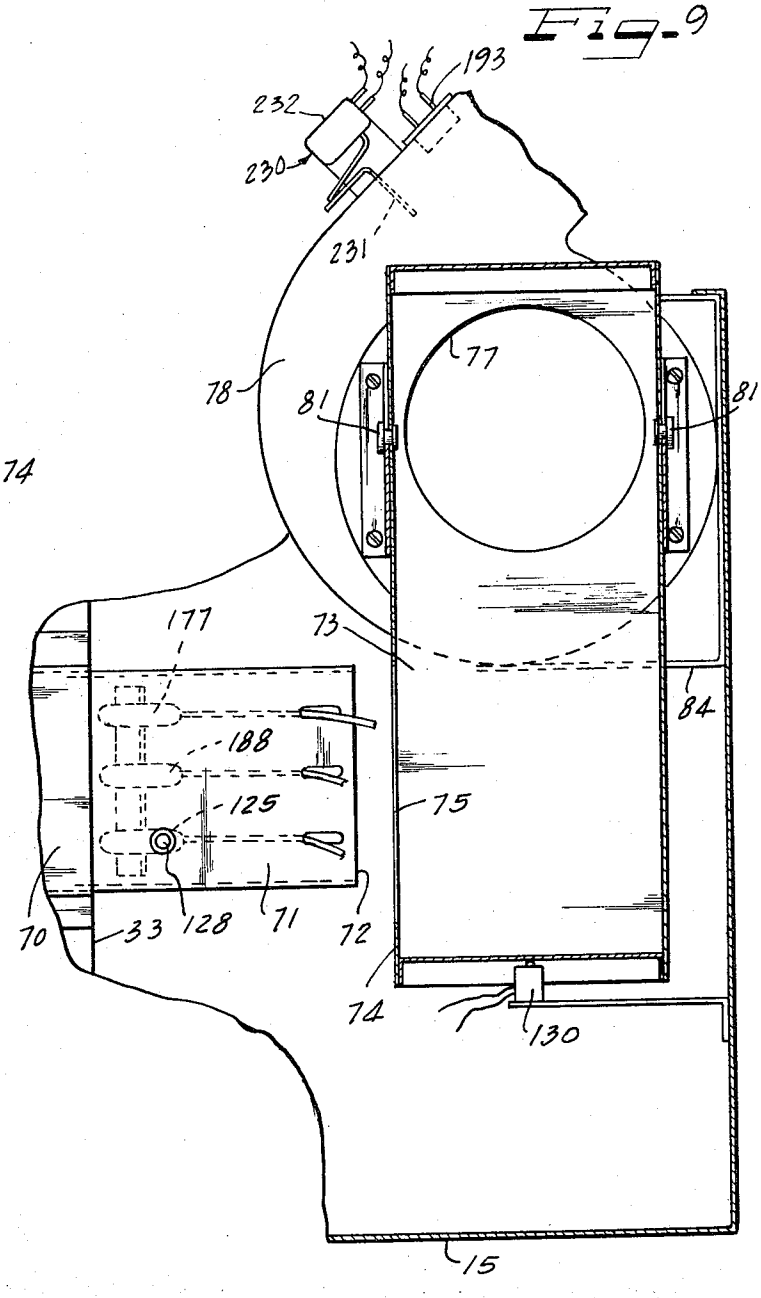


Fig-9



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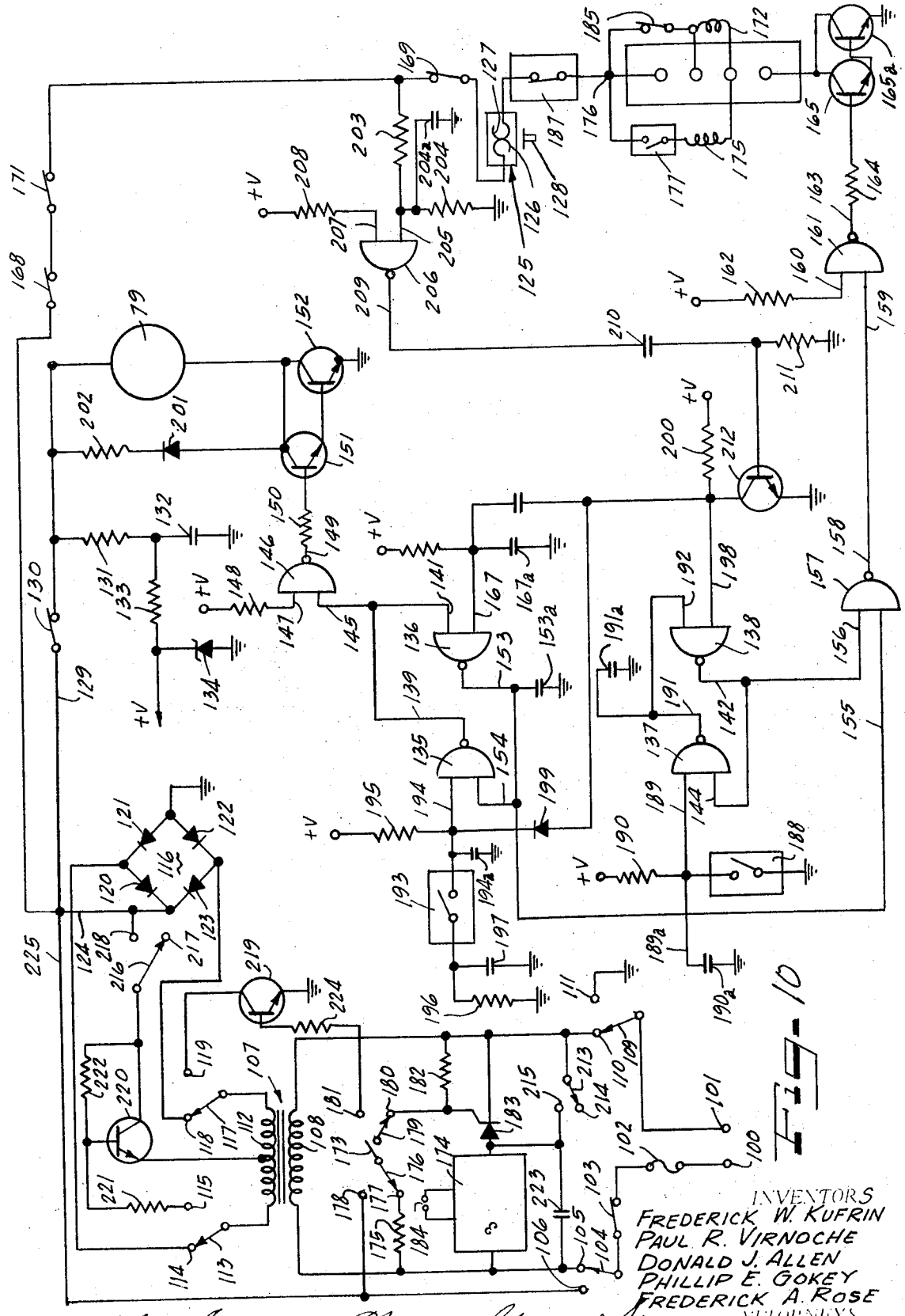

Fig. 10

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DISPOSAL OF HUMAN WASTE BY INCINERATION

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

A major problem with 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 incinerator 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 and means for disposing of human 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 human waste material in a manner to provide odorless exhaust.

A further object of the invention is to provide a new and improved method of and means 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 toilet apparatus.

Yet another object of the invention is to provide new and improved apparatus for incineration toilet 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 compact efficient incinerator toilet apparatus and 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 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 substantially 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 materials 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 insu-

lated 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 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 shafts 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 51 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 flame 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 52*a* (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 the 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 52*a* 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 the 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 81 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 **162**. 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 in 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 pulse 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 switch **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 valves 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 ignition 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°–1,200° 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 output 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 in 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 buildup 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 ground 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 **203–205** 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 state 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 comprising 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 **108** 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. Incinerator toilet apparatus for human waste disposal comprising:

a combustion and vaporizing first chamber receptive of waste to be incinerated and having a wall;

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

an after burner, said after burner comprising

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 into which products of combustion and vapor from the first chamber are further directed for super-heating the vapor and conversion thereof into odorless gases.

2. Apparatus according to claim **1**, in which said means for producing heat comprises a burner nozzle for introducing flame into said first chamber, and means supporting solid waste in spaced generally

horizontal alignment with the burner nozzle to be enveloped above and below by flame from the nozzle for incineration of the waste thereon.

3. Apparatus according to claim 2, including means for containing liquid waste separate from the solid waste and elevated within said chamber below said supporting means for vaporization by heat from the flame and adapted to receive heat thereunder as well as thereabove.

4. Apparatus according to claim 1, wherein said means for producing heat comprises a burner providing a "soft" flame to substantially fill said first chamber.

5. Apparatus according to claim 1, including means for supporting solid waste material at an elevation in said first chamber, said means for producing heat comprising a gas flame nozzle aligned in spaced relation in a generally horizontal direction with said supporting means, and deflector structure between said nozzle and supporting means controlling a flame from the nozzle to move upwardly onto and downwardly under said supporting means and envelop said supporting means and thereby the material thereon to be incinerated.

6. Apparatus for waste disposal comprising:

an upwardly opening housing;

an upwardly opening fire pot mounted within a lower portion of the housing;

a downwardly opening toilet bowl over and discharging into said fire pot;

a seat above said bowl;

a cover arranged to be moved between closing relation to said seat and open relation;

fire door means movable between open and closed position between said fire pot and said seat by respectively opening and closing of said cover;

an elevated generally horizontal grate in said fire pot adapted to receive material thereon from said bowl;

an atmospheric burner operating on ordinary or tank pressure; and

means for mixing air with the gas of the burner and cooperable with said burner for producing a "soft" flame, said burner being positioned to direct the "soft" flame toward said one edge to envelop the grate above and underneath and thereby envelop material deposited thereon.

7. Apparatus according to claim 1, wherein said first chamber has front, rear and side walls, said means for producing heat comprising a flame producing burner extending through an opening in said rear wall, said front wall having an exit opening, said duct communicating with said exit opening and extending on said front wall to one of said side walls and then extending rearwardly on and along said one side wall, and suction and exhaust means communicating with the rear end of said duct.

8. The apparatus of claim 1 wherein the flame capacity of said afterburner chamber and its heat transfer relation to the combustion chamber are such as to provide for superheating the vapors therein to a temperature on the order of 1,000° F.

9. The apparatus of claim 1 further characterized by means for assuring superheating temperature on the order of 1,000° F. in said duct means.

10. The apparatus of claim 1 further characterized by the afterburner second chamber having a wall in heat transfer relation to the combustion chamber to provide for temperatures therein in a range from 950° to 1,200° F.

11. The toilet of claim 1 further characterized by said afterburner including a second heating means to assist in the combustion of gases.

12. Apparatus according to claim 1, said duct means having a wall which is common with the first chamber wall so that heating of said first chamber wall by said means for producing heat will be directly effective in said second chamber.

13. An incinerator toilet comprising:

a housing including a receptacle for receiving waste;

movable door means for providing access to said receptacle and closing said housing during incineration;

heating means energized to supply incinerating heat to the waste and exhaust means having a blower means for carrying off products of combustion; and

a control circuit including first switching means operated by said door means;

a first bistable circuit connected to said first switching means and to said blower means for energizing said blower means when conditioned to one of its bistable states by said first switching means, a second bistable circuit; and

second switching means connecting said first and second bistable circuits to said heating means and operated by said first and second bistable circuits to prepare an energizing circuit for said heating means;

said first switching means, including first switch contacts, serially connected in said energizing circuit and operated by said door means upon closure thereof to complete said energizing circuit and effect energization of said heating means.

14. An incinerator toilet according to claim 13, including a normally closed thermostat switch serially interposed in said energizing circuit of said heating means and disposed to sense the temperature of the exhaust gases, said normally closed thermostat switch operated to open said energizing circuit and terminate operation of said heating means upon detection of a predetermined temperature.

15. An incinerator toilet according to claim 13, comprising an electrical supply conductor connected to said energizing circuit of said heating means, and a manually resettable normally closed heat sensitive switch serially interposed in said conductor and disposed to sense the temperature of the exhaust gases, said heat sensitive switch being operable to disable said control circuit until manually reset upon detection of a predetermined temperature.

16. An incinerator toilet according to claim 13, comprising an exhaust detection switch having a movable switch operating member disposed to detect the flow effected by said blower means, said exhaust detection switch serially connected in said energizing circuit and normally open to prevent energization of said heating means until such flow has been established.

17. An incinerator toilet according to claim 13, comprising electrical circuit means connected to said energizing circuit for electrically detecting the opening of said door means, said electrical circuit means con-

nected to said second bistable circuit for reversing the state thereof and deenergizing said heating means upon the opening of said door means.

18. An incinerator toilet according to claim 13, wherein each of said bistable circuits includes a reset input, and comprising low temperature thermostat switch means connected to said reset inputs and disposed to sense exhaust temperature and operable to reset said bistable circuits upon cooling of the exhaust flow to a predetermined temperature.

19. An incinerator toilet according to claim 18, comprising electrical circuit means connected to said energizing circuit for electrically detecting the opening of said door means, said electrical circuit means connected to said reset input of said second bistable circuit to effect a state reversal thereof upon the opening of said door means for deenergizing said heating means, and isolation means connected between said two reset inputs to prevent resetting of said first bistable circuit and deenergization of said blower means upon the opening of said door means.

20. An incinerator toilet according to claim 13, comprising a removable chamber included in said exhaust means for collecting solids in the exhaust flow, and a switch serially connected in said energizing circuit and disposed to be closed by said chamber when said chamber is properly positioned.

21. An incinerator toilet according to claim 13, wherein said housing includes a removable cover and a cover interlock connected in series in said energizing circuit to prevent energization of said heating means with said cover removed.

22. An incinerator toilet according to claim 13, including means forming a draft passageway for said heating means and a normally closed thermostat disposed upstream of said heating means in said draft passageway and serially connected in said energizing circuit for disabling said heating means upon detection of a predetermined temperature due to a down draft condition.

23. An incinerator toilet according to claim 13, comprising a cycle termination thermostat disposed to detect exhaust temperature, said cycle termination thermostat connected to said second bistable circuit and operable to reverse the state thereof and automatically terminate the incineration cycle upon detection of a predetermined exhaust temperature.

24. An incinerator toilet comprising:
an upwardly opening housing;
an upwardly opening fire pot mounted within a lower portion of the housing;
a toilet seat mounted on said housing over the fire pot;
a cover pivotally movable between open and closed positions on said seat;
a fire door mounted for movement into and out of protective relation between said seat and said fire pot;
a rotary shaft;
crank means connecting said shaft with said fire door; and
transmission means operative between said cover and said shaft to effect rotation of said shaft and operation of the crank means to open the fire door when the cover is moved to open position, and to enable rotation of the shaft to operate the crank means to return the fire door to closing position when the cover is closed.

25. An incinerator toilet according to claim 24, said transmission means including a vertically reciprocably guided plunger, a pinion corotatively carried by said shaft, a rack on said plunger meshing with said pinion, spring means normally biasing said plunger upwardly whereby to drive said shaft through said rack and pinion to operate said crank to close the fire door, a follower on the upper end of said plunger, and an actuating cam operatively connected with said cover and engaging said follower and operative when the cover is opened to act on said follower to depress said plunger in opposition to said biasing spring for thereby effecting rotation of said shaft by means of said rack and pinion to operate said crank means to open said fire door.

26. Apparatus for waste disposal comprising:
an upwardly opening housing;
an upwardly opening fire pot mounted within a lower portion of the housing;
a downwardly opening toilet bowl over and discharging into said fire pot;
a seat above said bowl;
a cover arranged to be moved between closing relation to said seat and open relation;
fire door means movable between open and closed position by respectively opening and closing of said cover;
an elevated generally horizontal grate in said fire pot adapted to receive material thereon from said bowl;
means generally horizontally aligned in spaced relation to one edge of said grate for directing flame toward said one edge to envelop the grate above and underneath and thereby envelop material deposited thereon;
a pan under said grate to receive liquid waste; and
means supporting said pan spaced above the bottom said fire pot;
said means for directing flame being located to direct the flame also against and under said pan to vaporize the liquid waste.

27. Apparatus according to claim 26, said pan having a diagonal wall sloping from said flame introducing means to facilitate movement of the flame to pass thereunder.

28. Apparatus for waste disposal comprising:
an upwardly opening housing;
an upwardly opening fire pot mounted within a lower portion of the housing;
a downwardly opening toilet bowl over and discharging into said fire pot;
a seat above said bowl;
a cover arranged to be moved between closing relation to said seat and open relation;
fire door means movable between open and closed position by respectively opening and closing of said cover;
an elevated generally horizontal grate in said fire pot adapted to receive material thereon from said bowl;
means generally horizontally aligned in spaced relation to one edge of said grate for directing flame toward said one edge to envelop the grate above

and underneath and there-by envelop material deposited thereon;

said fire pot having a wall provided with an opening;

said flame directing means comprising a burner nozzle located at said opening and pointing toward said edge of the grate; and

an opposite wall of the fire pot having an outlet opening therein horizontally aligned with said grate.

29. Apparatus according to claim **28**, including a horizontal duct mounted on and extending along the wall of said fire pot in heat exchange relation and aligned with said outlet opening to receive products of combustion and vapors therefrom and providing a superheating chamber in which the vapors are converted into odorless gases.

30. Apparatus according to claim **29**, in which said duct has an exit end, means providing a mixing chamber having an opening aligned with said exit end, and means providing a draft into said mixing chamber to draw the gases from said exit end and cooling air into the mixing chamber.

31. Apparatus according to claim **30**, including means supporting said mixing chamber means removably so that it can be removed from the apparatus and cleaned.

32. Incinerator toilet apparatus for human waste disposal, comprising:

a combustion and vaporizing first chamber receptive of waste to be incinerated and having a wall;

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

duct means extending along said wall and providing a second chamber contiguous and in heat exchange relation to said first chamber into which products of combustion and vapor from the first chamber are directed for superheating the vapor and conversion thereof into odorless gases;

said chamber has front, rear and side walls, said means for producing heat comprising a flame producing burner extending through an opening in said rear wall;

said front wall having an exit opening;

said duct communicating with said exit opening and extending on said front wall to one of said side walls and then extending rearwardly on and along said one side wall;

suction and exhaust means communicating with the rear end of said duct;

said suction and exhaust means comprising a vertically extending mixing chamber having provision in the lower portion thereof for communication with the rear end of the duct and for entry into the mixing chamber of cooling air;

the upper portion of the mixing chamber having an exhaust opening therefrom; and

exhaust suction blower fan means communicating with said exhaust opening.

33. An incinerator toilet, including:

a grate for maintaining solid waste material separate from and above liquid waste;

a flame producing atmospheric gas burner operating on ordinary line or tank pressure and having a nozzle horizontally aligned in spaced relation to the grate;

means for mixing air with the gas of the burner and cooperable with said burner for producing a "soft" flame, and

means for controlling the flame from the nozzle to envelop the solid waste material on said grate both thereabove and therebelow and to evaporate the liquid waste by heat from the flame applied below the grate.

34. An incinerator toilet, including:

a combustion and vaporizing first chamber receptive of waste for incineration;

a flame producing atmospheric gas burner operating on ordinary line or tank pressure and having a nozzle positioned in said first chamber for incineration of wastes;

means for mixing air with the gas of the burner and cooperable with said burner for producing a "soft" flame;

means for controlling the flame from the nozzle to incinerate the solid waste material and to evaporate the liquid waste by heat from the "soft" flame when applied thereto;

an afterburner, said afterburner comprising:

duct means providing a second chamber into which products of combustion and vapor from the first chamber are further directed for superheating the vapor, and

means for controlling the temperature in the second chamber of the afterburner in the range of 950° to 1,200° F. for rendering the gases odorless to the human sense of smell before exhausting such gases from the afterburner to atmosphere.

35. The toilet of claim **34** further characterized by said afterburner including a second heating means to assist in the combustion of gases.

36. The toilet of claim **35** further characterized by said heating means including a gas flame nozzle.

37. Incinerator toilet apparatus for human waste disposal comprising:

a combustion and vaporizing first chamber receptive of waste to be incinerated and having a wall;

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

an afterburner comprising 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 into which products of combustion and vapor from the first chamber are further directed for superheating the vapor and conversion thereof into odorless gases;

means defining a vertically extending mixing chamber;

means effecting communication between said duct means and the lower portion of said mixing chamber and with cooling air for mixture of the cooling air with heated gases from said duct means; and

suction and exhaust fan means communicating with the upper portion of said mixing chamber.

38. An incinerator toilet comprising:

means including a generally horizontally disposed perforated grate for receiving material to be incinerated thereon;

means defining a combustion chamber housing said grate;

an atmospheric gas burner operating on ordinary line or tank pressure and having a nozzle horizontally aligned in spaced relation to one edge of said grate; and

means for mixing air with the gas of the burner and cooperable with said burner for producing a "soft" flame directed toward said one edge of the grate to envelop it above and underneath and thereby envelop material deposited thereon.

39. An incinerator toilet according to claim **38**, including deflector baffle means on and in front of said nozzle to deflect flame therefrom partially over and partially under the grate.

40. An incinerator toilet according to claim **38**, wherein said means defining a combustion chamber comprises a fire pot having an exit opening spaced from an edge of said grate opposite to the edge toward which the nozzle is directed, and a superheating chamber comprising a duct communicating with said exit opening and extending horizontally in heat-exchange relation along a wall of the fire pot for heat transfer through the wall into the superheating chamber.

41. An incinerator toilet comprising:

an upwardly opening housing;

an upwardly opening fire pot mounted within a lower portion of the housing;

means for directing material downwardly into said fire pot;

electrically controlled means operable to provide heat to incinerate such material in the fire pot;

a toilet seat supported by said housing over said directing means;

a cover arranged to be moved between closing relation to said seat and an open relation;

a pair of fire doors movable between and open spaced apart position and a closed edge-to-edge position between said fire pot and said seat;

means normally biasing said fire doors into said closed position;

means for effecting movement of the fire doors and including a pair of vertically movable plungers each of which has a follower on its upper end and respective driving apparatus connecting the plunger with its fire door;

respective cams connected with said cover and cooperating with said followers for actuating the plungers to open said doors in opposition to said biasing means when the cover is opened and enabling closing of the doors by action of said biasing means when the cover is closed; and

respective electrical control switches for said electrically controlled means, one mounted to be operated by one of the doors and the other mounted to be operated by the other of said doors, and said switches being closed by complete closing of the respective doors which therefore must both be in said closed position before said electrically controlled means can operate.

42. An incinerator toilet according to claim **41**, including respective rotary shafts, crank means carried by the shafts and pivotally connected with the respective fire doors, means effecting respective operative driving connections between the plungers and the shafts, and means operated by the shafts for controlling the control switches in the operation of said fire doors.

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