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(54) METHOD FOR GASIFYING SOLID ORGANIC MATERIALS AND APPARATUS THEREFOR

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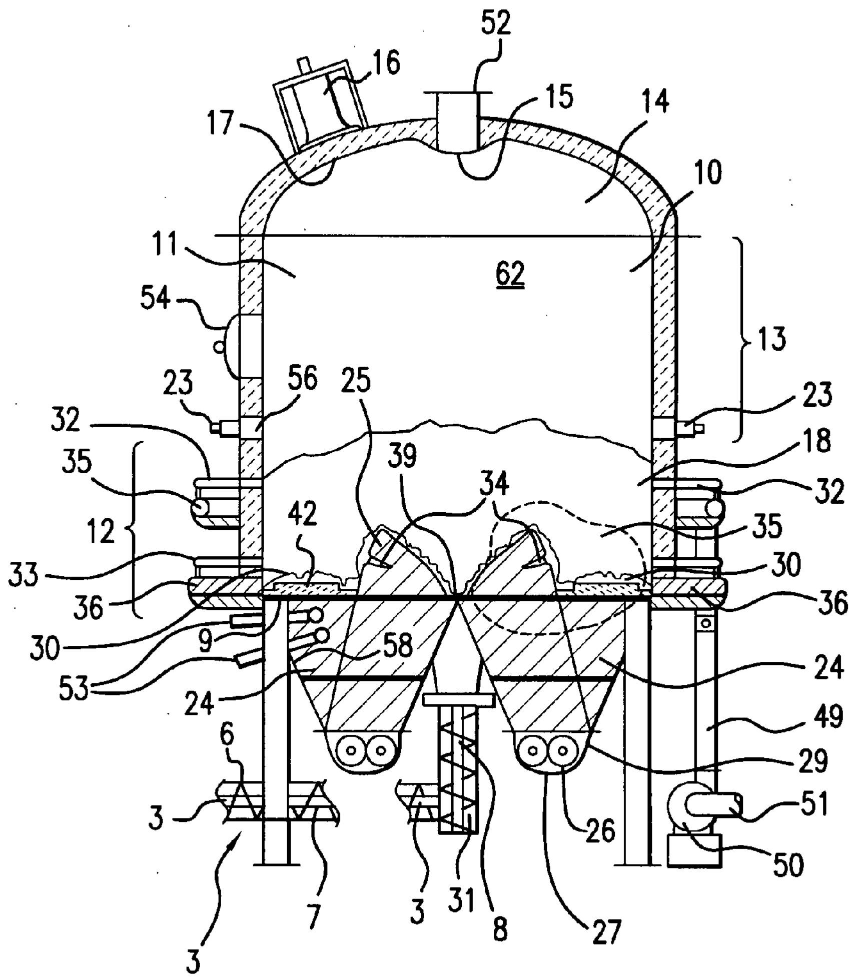
(57) **ABSTRACT**

A method for gasifying solid organic materials, a novel apparatus for that purpose, and a system therefor. A unique method and apparatus that produces a high energy, low temperature, low particulate-laden syngas by controlling the oxygen content in combustion air used for "starved air" combustion of biomass in a unique gasifier. Recirculated flue gas containing a predetermined amount of fresh air is utilized for the oxygen content therein and for controlling the method.



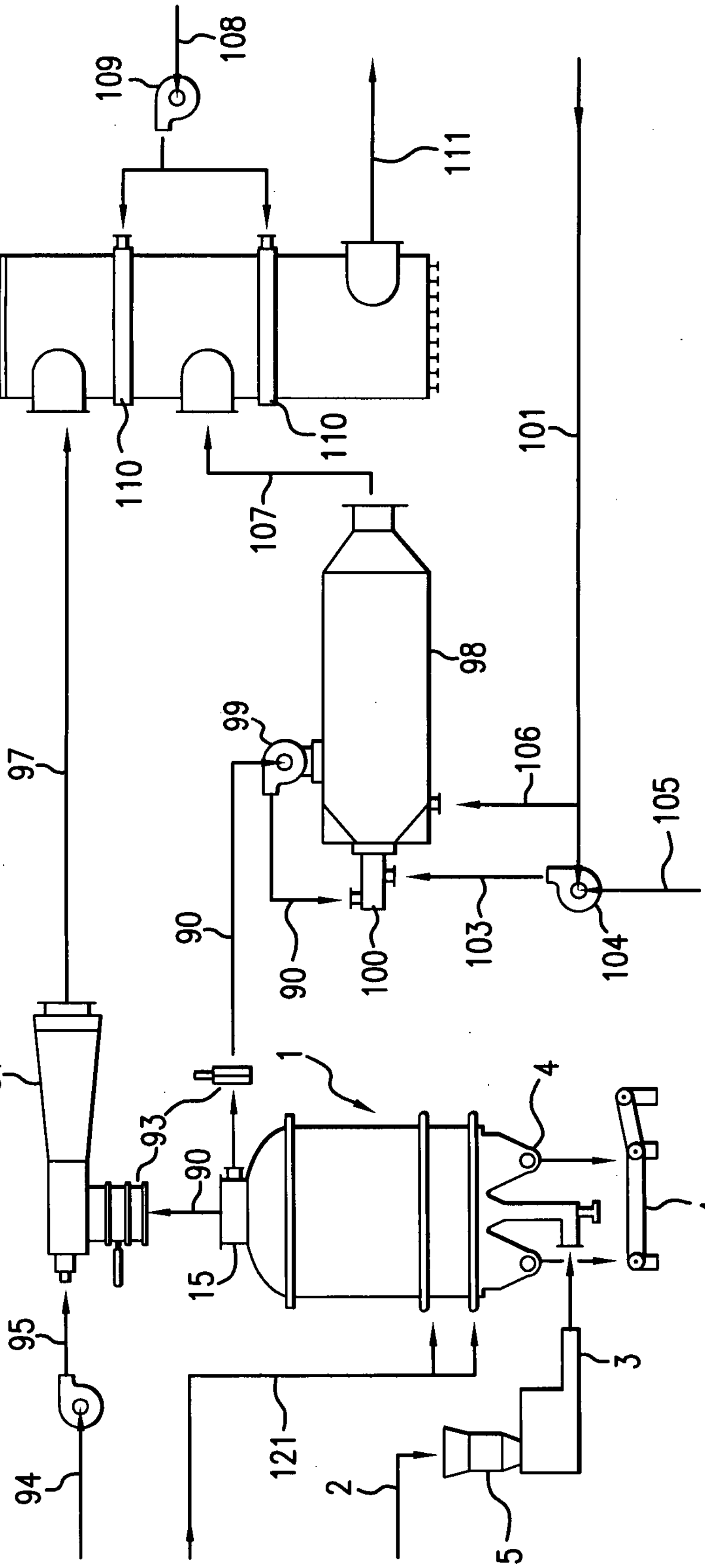


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FIG. 1A

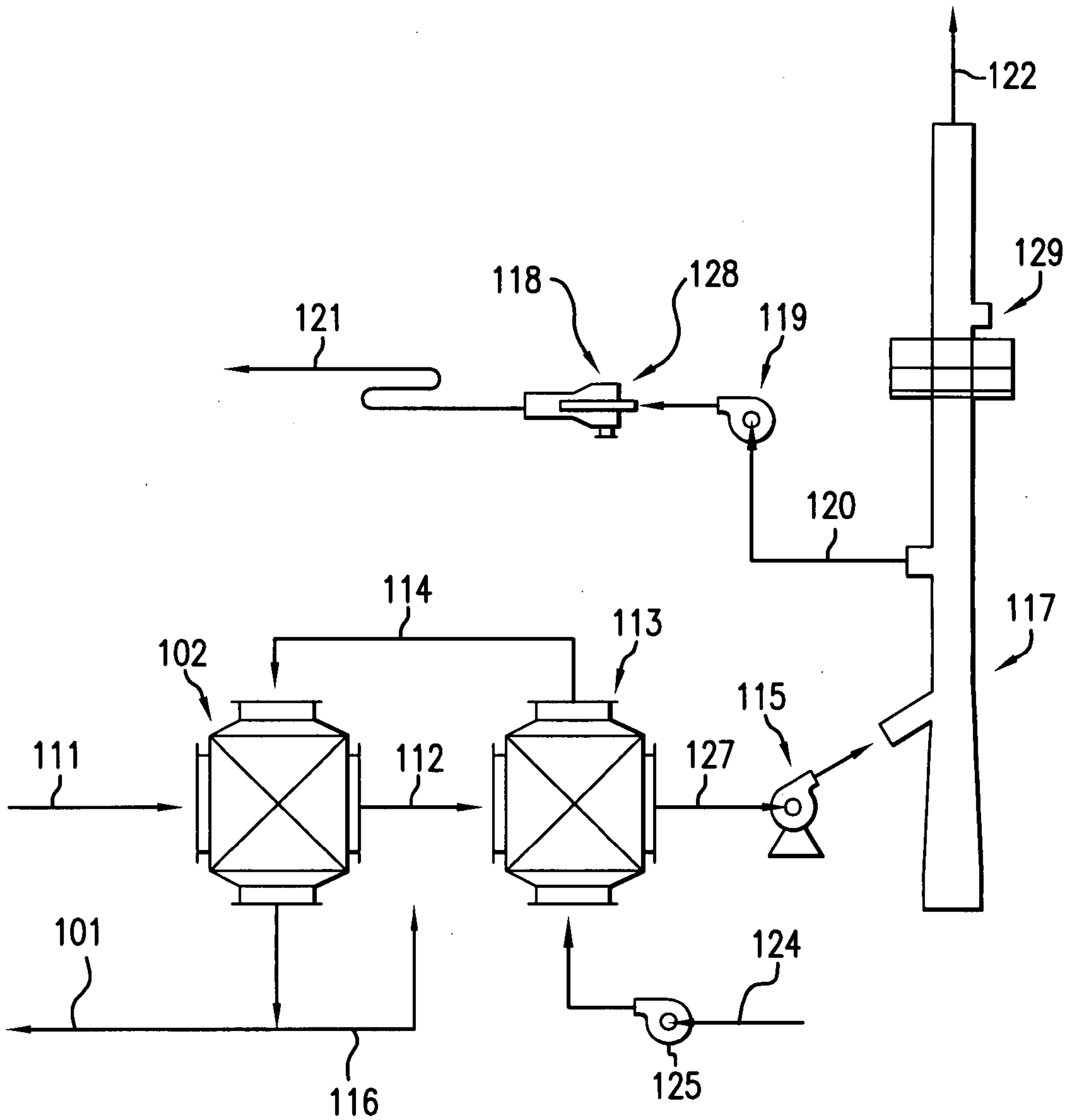
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FIG.1B

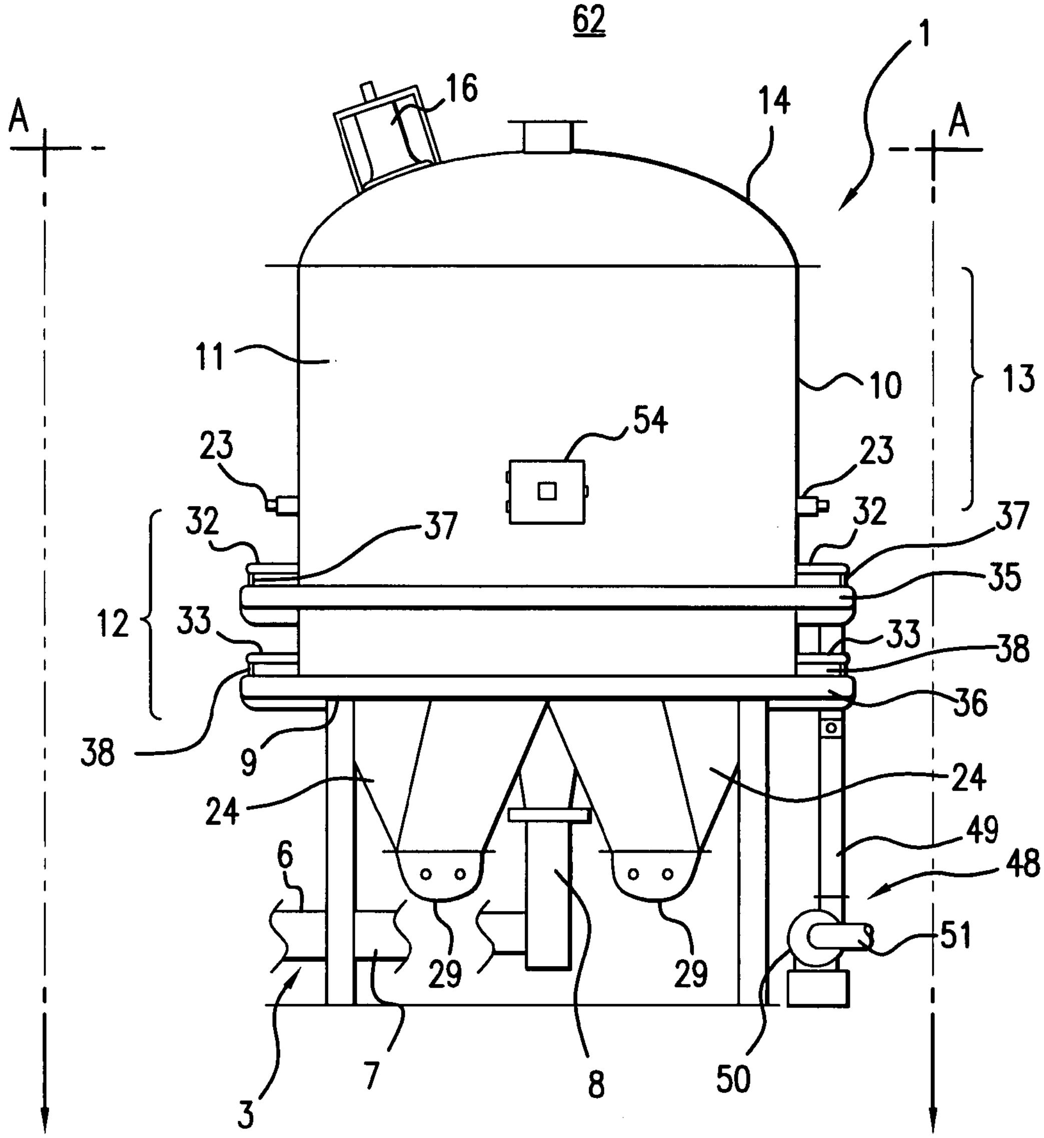
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FIG.2

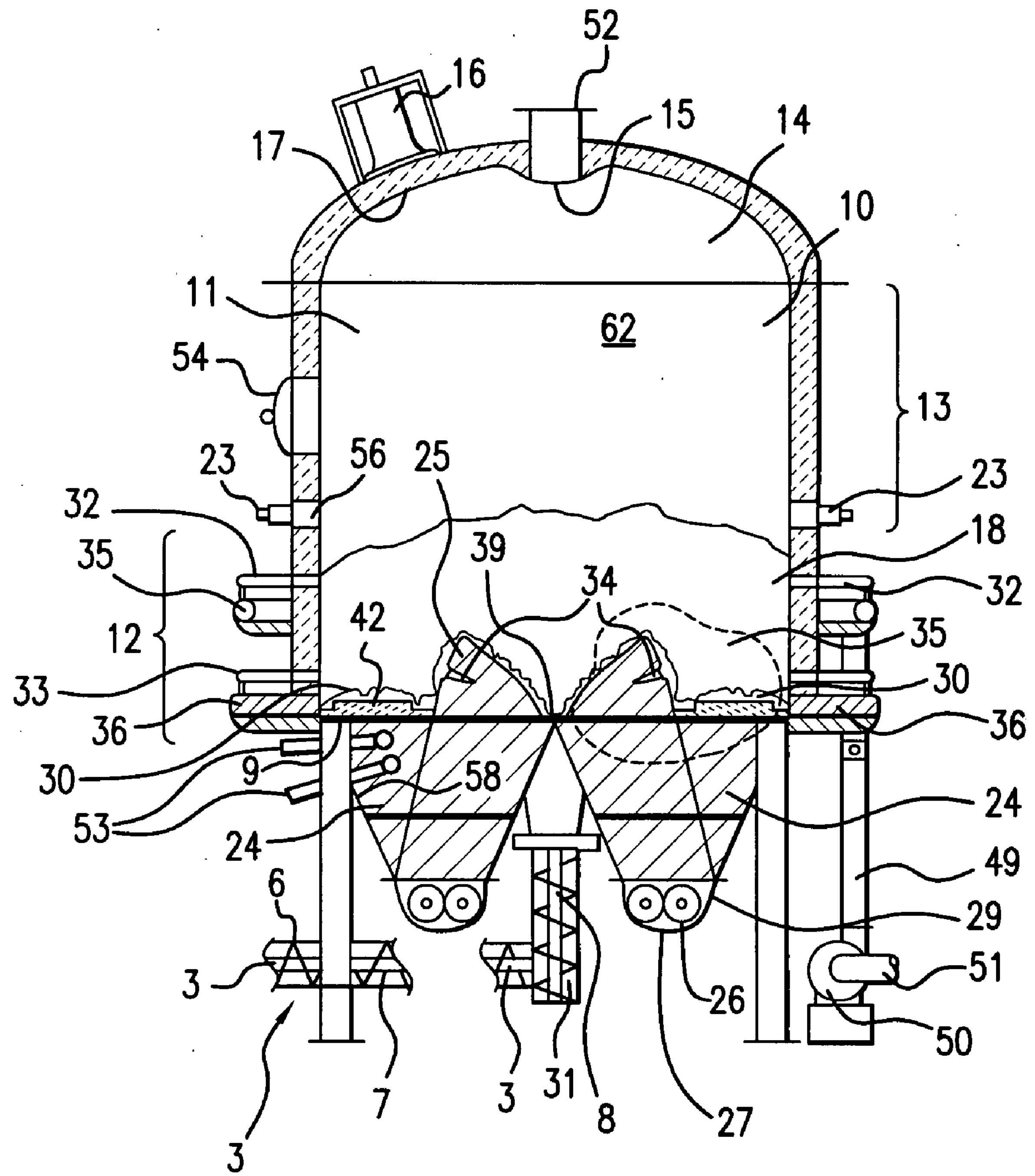
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FIG.3

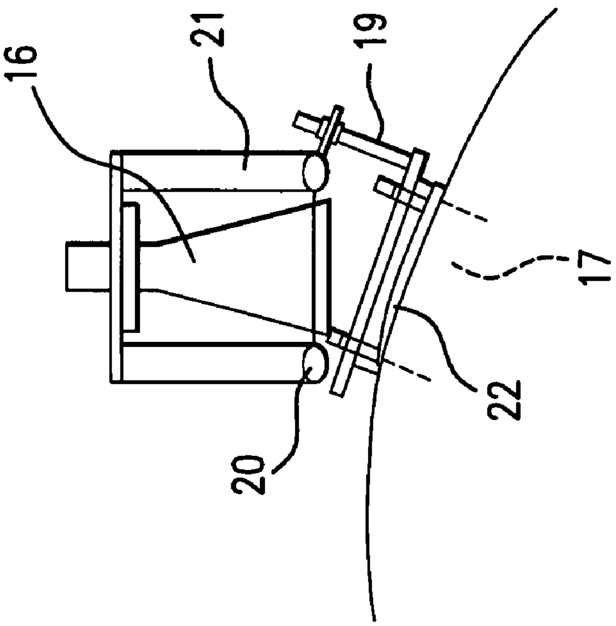

FIG. 4

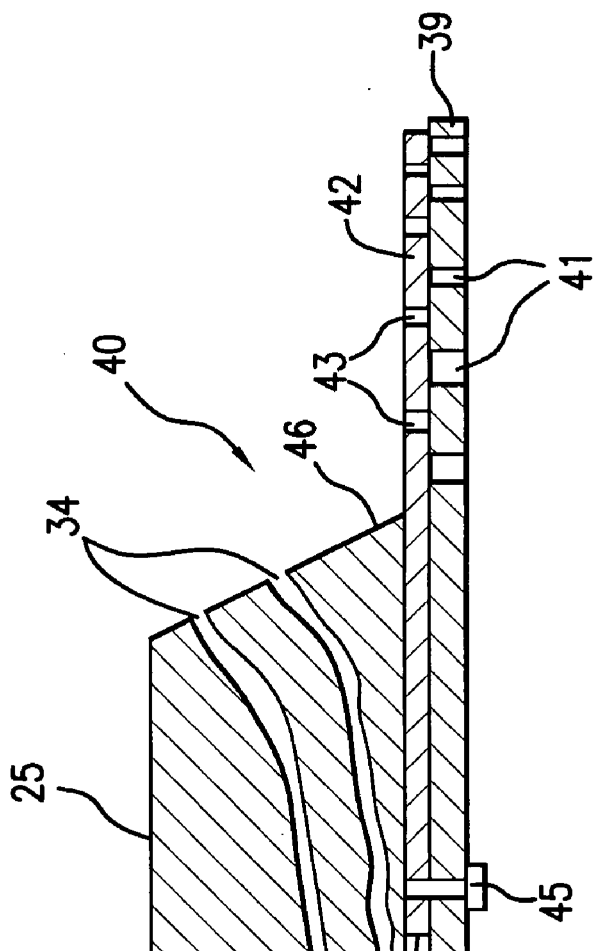

FIG. 7

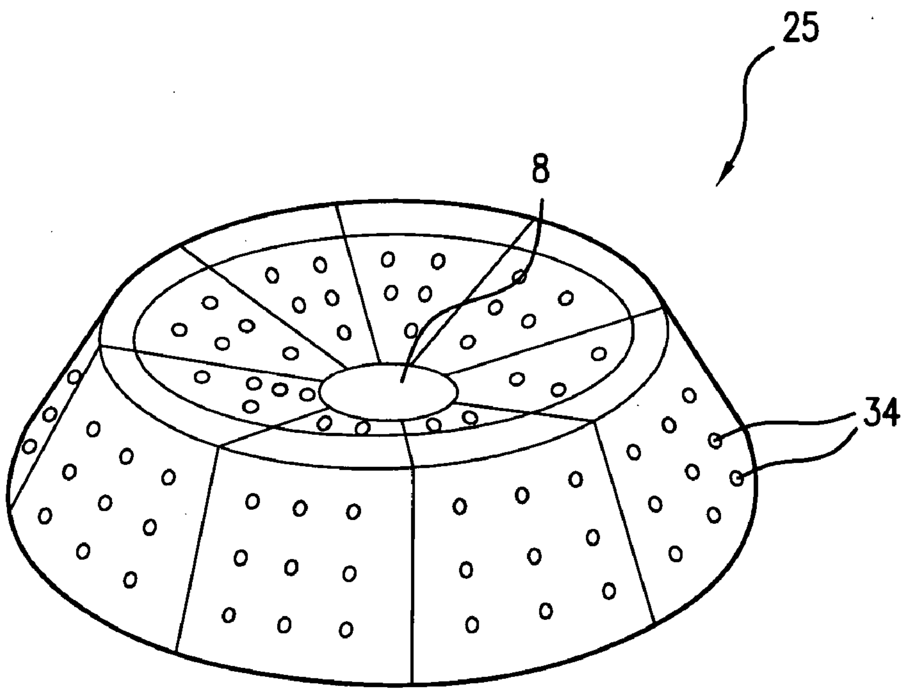

FIG.5

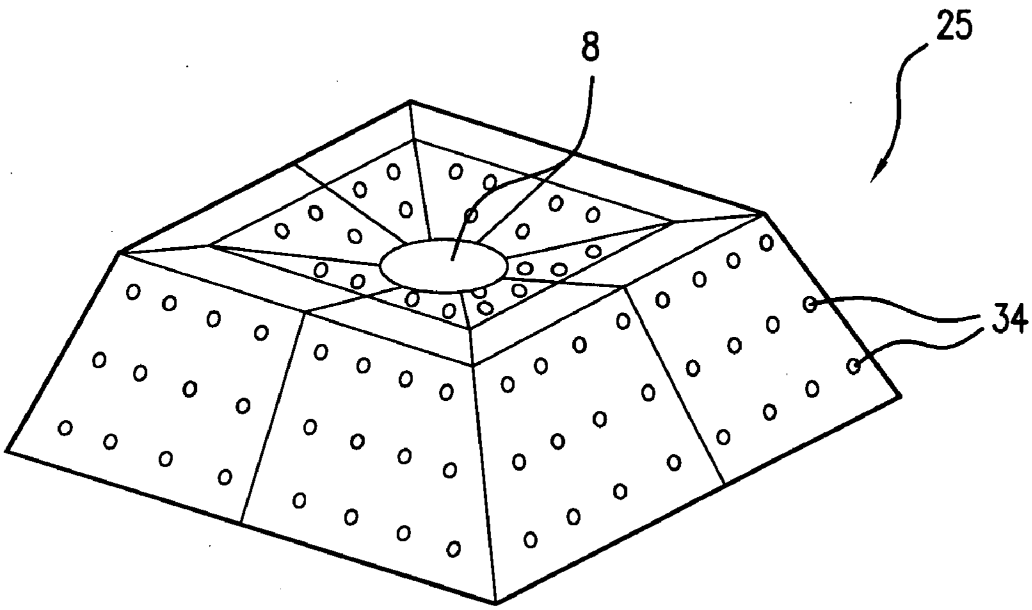

FIG.6

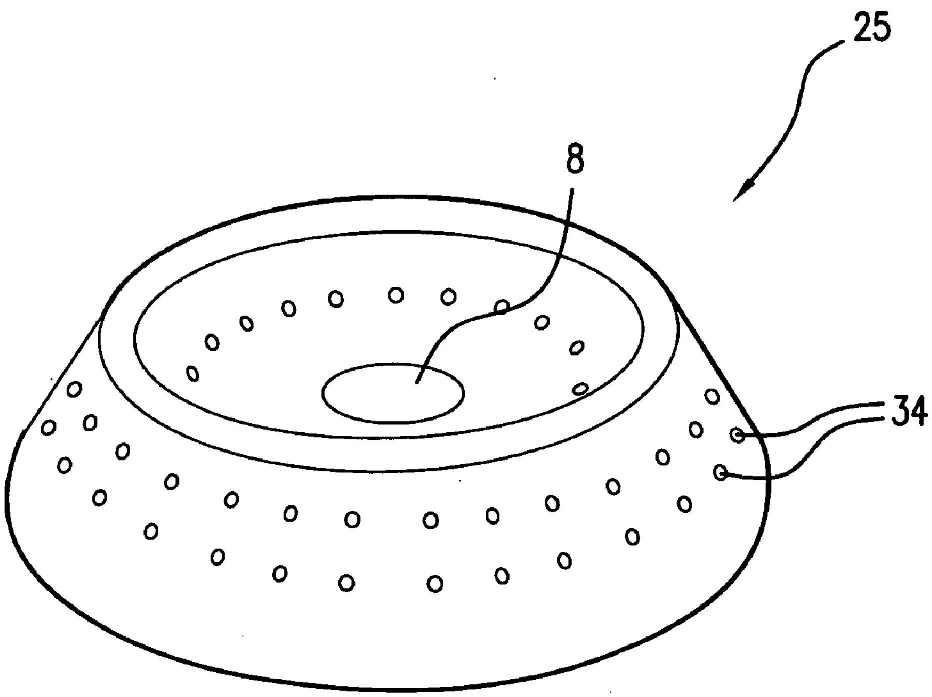

FIG.5A

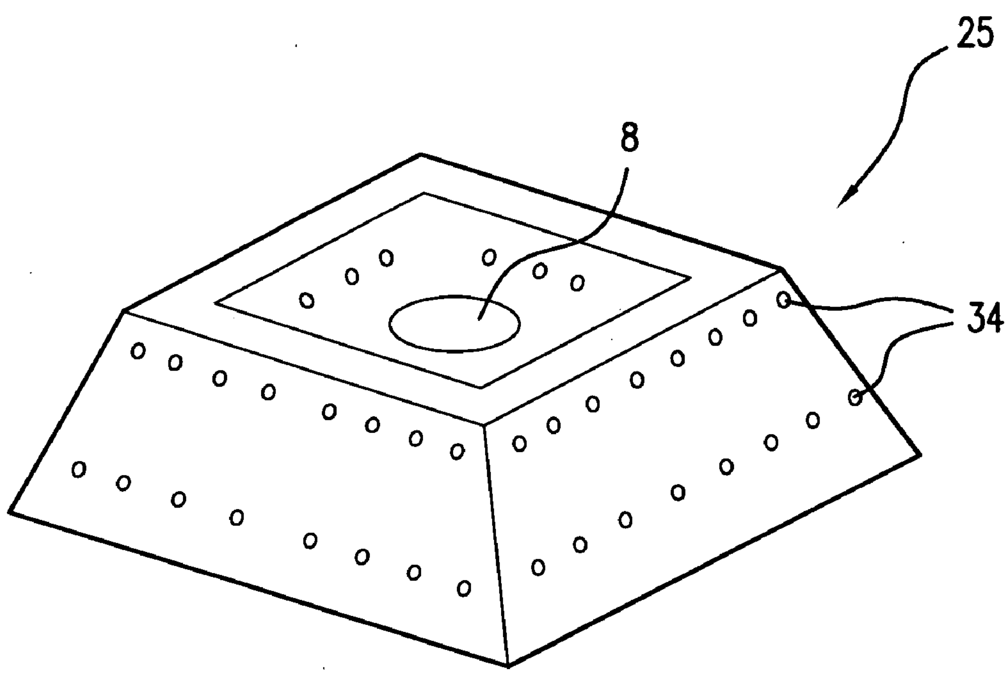

FIG.6A

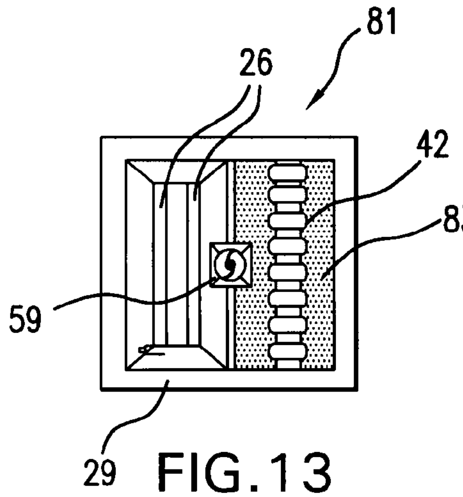

FIG.13

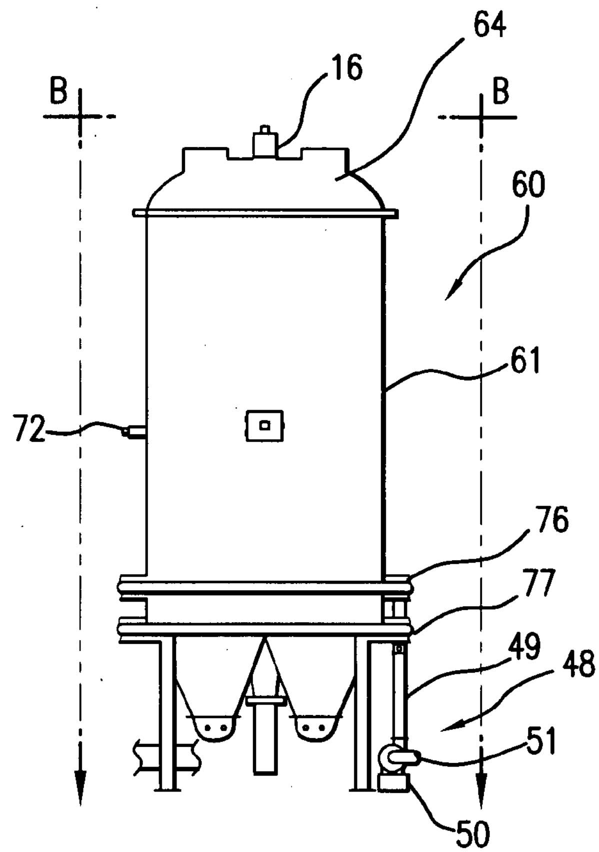

FIG.8

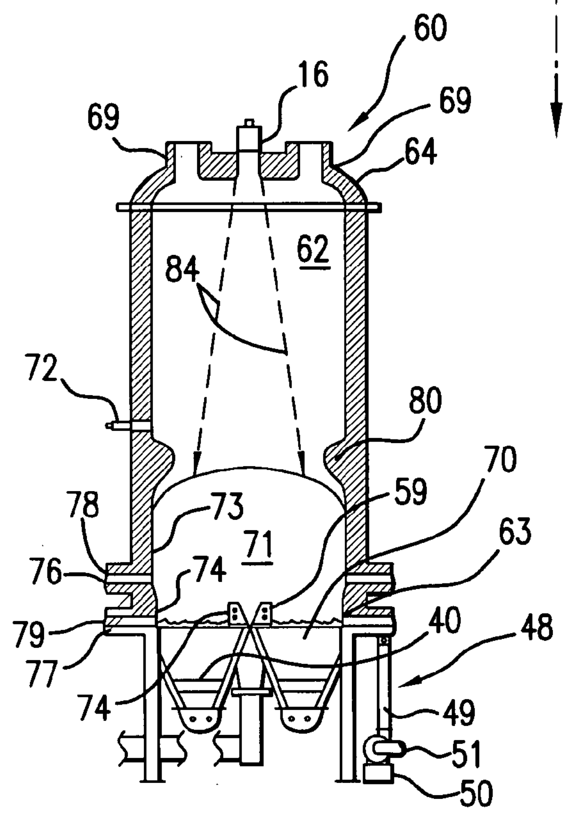

FIG.9

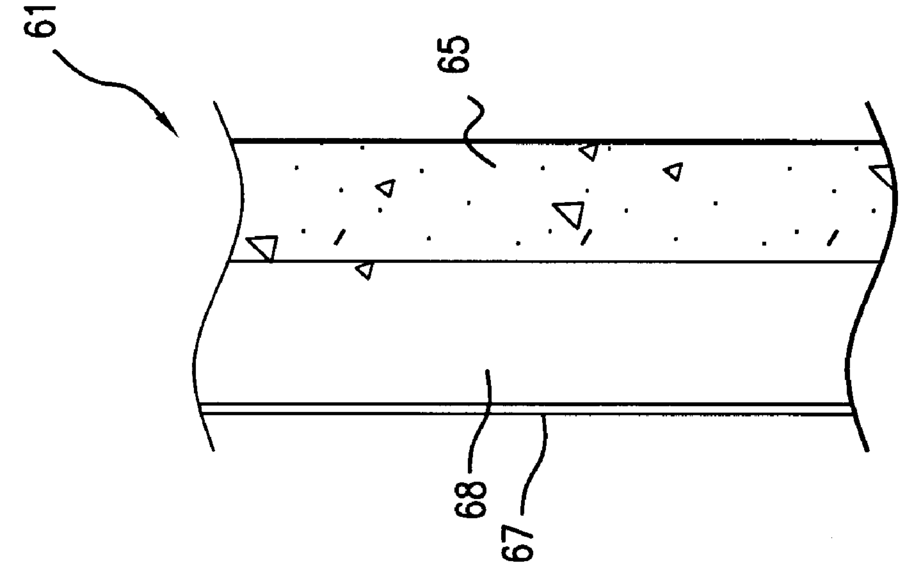

FIG.10B

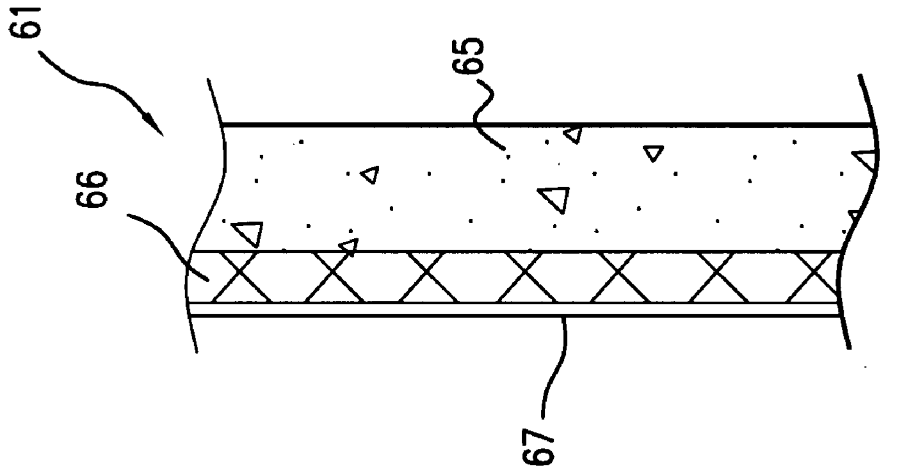

FIG.10A

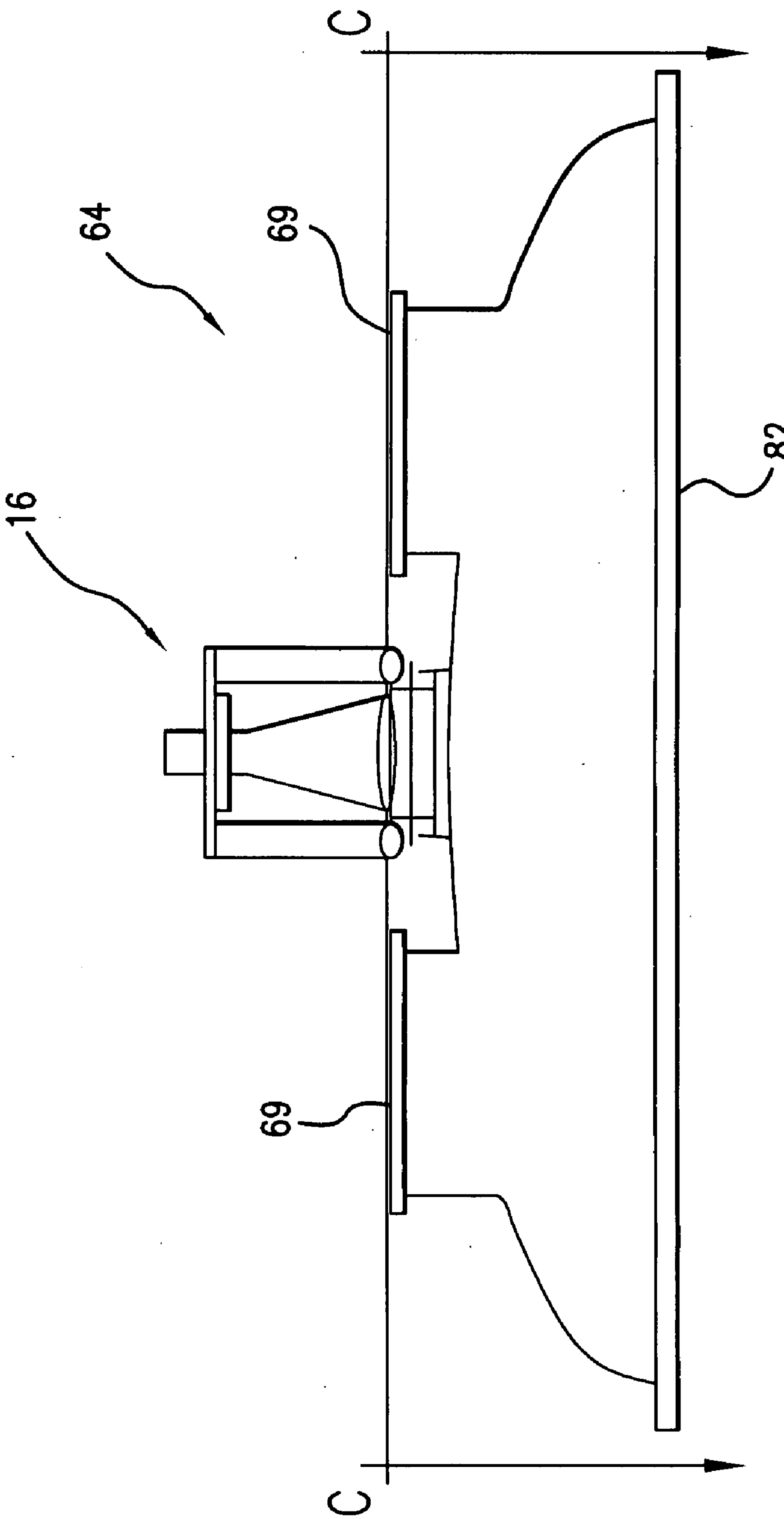

FIG. 11

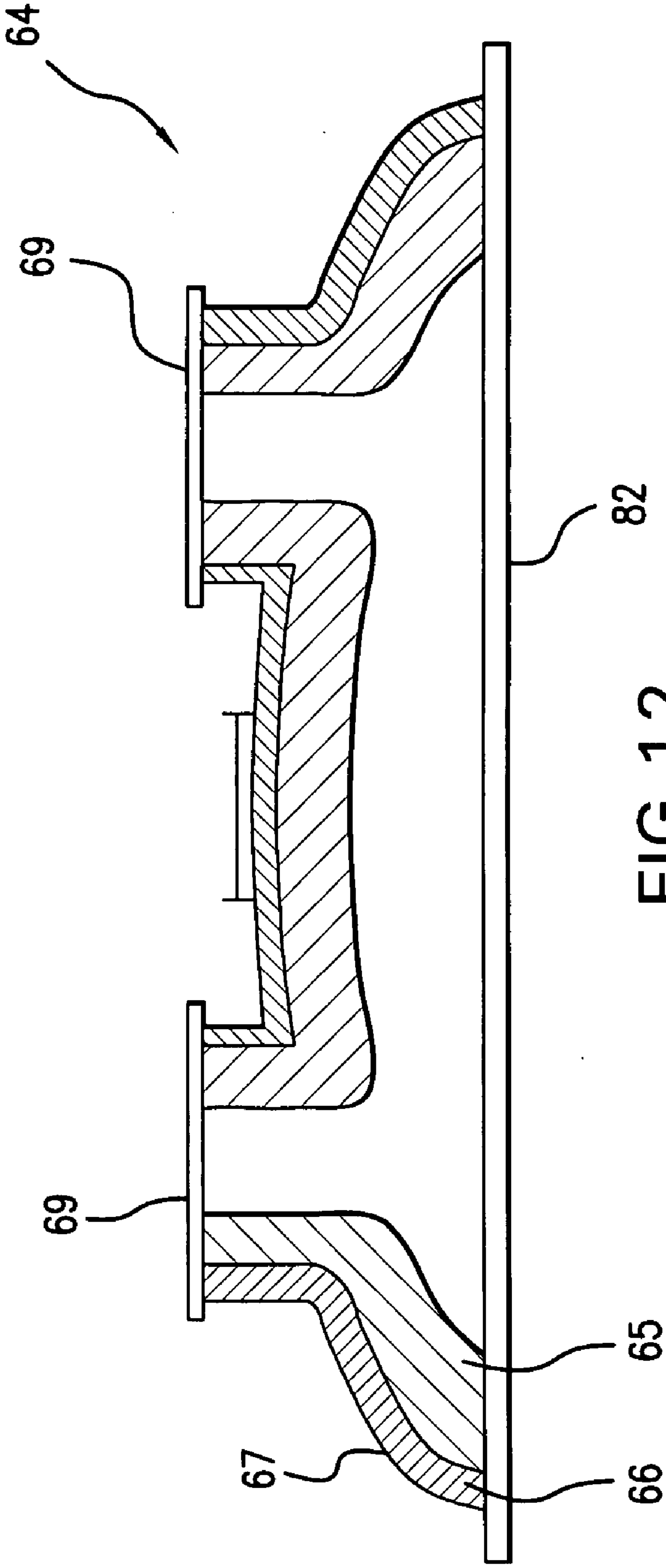

FIG.12

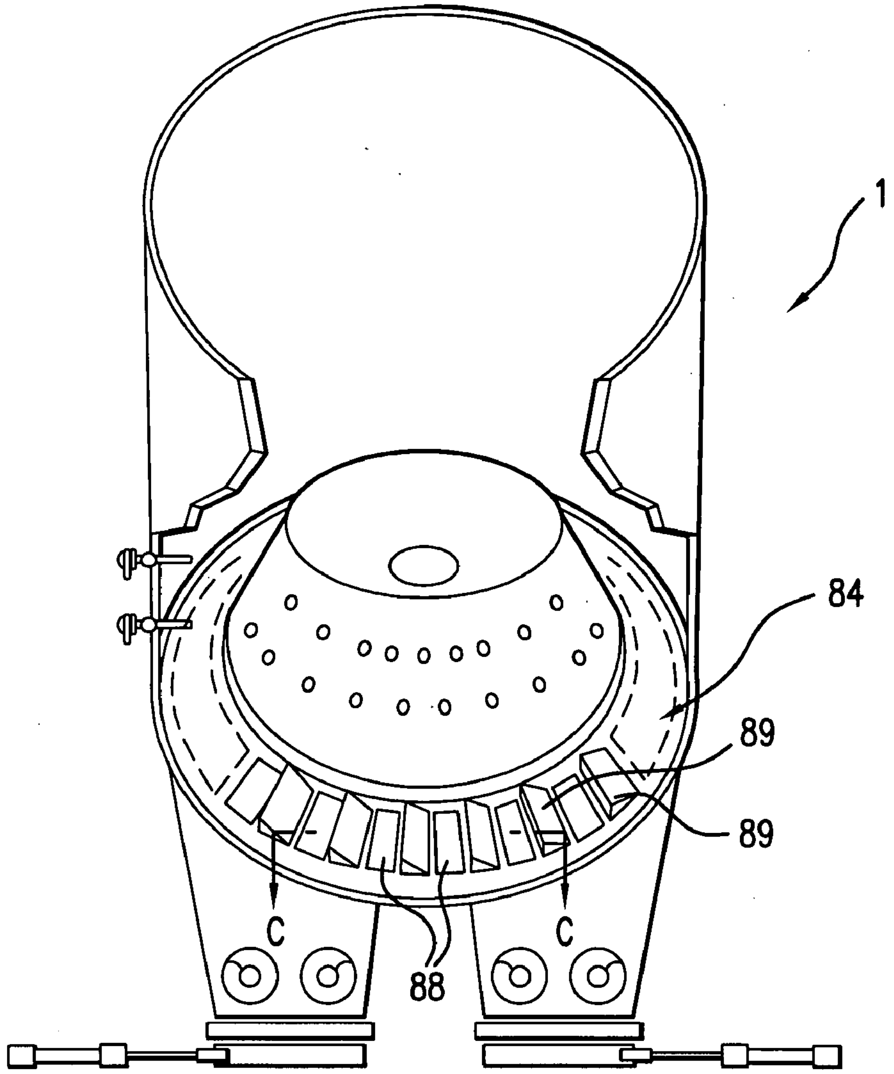

FIG.14

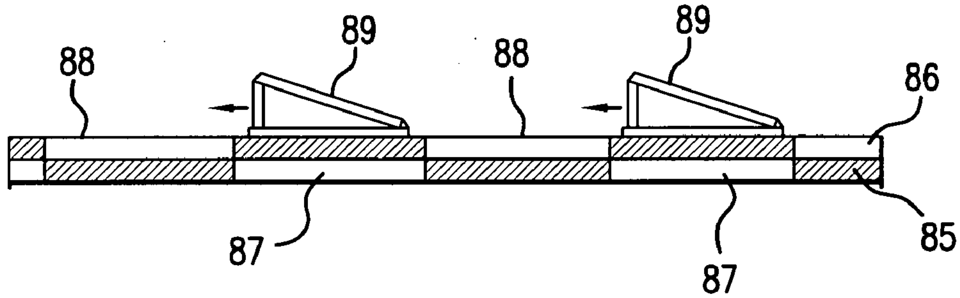

FIG.15

METHOD FOR GASIFYING SOLID ORGANIC MATERIALS AND APPARATUS THEREFOR

[0001] This application claims priority from U.S. Provisional Patent Application 60/801,574 filed May 18, 2006.

[0002] The invention disclosed and claimed herein deals with a method for gasifying solid organic materials, the novel apparatus for that purpose, and a system therefor. The instant invention is a unique method and apparatus that produces a high energy, low temperature, and low particulate-laden syngas by controlling the oxygen content in combustion air used for "starved air" combustion of biomass in a unique gasifier. Recirculated flue gas mixed with a predetermined amount of fresh air is utilized for providing the oxygen content therein and for controlling the method.

BACKGROUND OF THE INVENTION

[0003] More particularly, this invention deals with a method for gasifying biomass materials, such as forestry and agricultural residues, industrial waste materials such as saw mill pulp, paper products, fowl litter, such as chicken litter and turkey litter, and hydrocarbon based plastics and the like.

[0004] This invention also deals with the apparatus that is used to convert the chemical energy into thermal energy or gaseous products, and specifically, syngas, that is also called production gas. Syngas is a compressible synthetic combustible gas containing very little particulate material. Thus, this invention can also be viewed as a method of producing syngas.

[0005] It has long been recognized that many industrial and agricultural solid organic by-products, such as forestry and agricultural residue, and the like, are a potential source of large amounts of chemical energy. The substantial increases in the cost of traditional fuels, such as fuel, oil and natural gas, which occurred during the 1970's, have provided substantial economic incentive to try to develop effective and efficient techniques for recovering the energy in these organic by-products, energy that traditionally was not recovered to any substantial extent. Such organic materials, frequently referred to as "biomass" materials, are now successfully utilized to some extent as fuel in some very large industrial systems, for example, in firing the power boiler and the recovery boiler in a pulp or paper mill. However the high capital cost that has heretofore been associated with biomass energy recovery systems has precluded their successful use in small or even medium size energy recovery systems.

[0006] Medium size energy recovery systems are used in community centers, schools, nursing homes, and small industrial and commercial establishments and, to date, biomass fuels have not been satisfactorily utilized as fuels in heating systems for such facilities. Among the U.S. patents that have issued on inventions relating to the recovery of energy from wood chips or similar organic materials are for example, U.S. Pat. No. 5,138,957 that issued to Morey, et al. on Aug. 18, 1992; U.S. Pat. No. 4,184,436 that issued to Palm, et al. Jan. 22, 1980; U.S. Pat. No. 4,312,278 that issued to Smith, et al. on Jan. 26, 1982; U.S. Pat. No. 4,366,802 that issued to Goodine on Jan. 4, 1983; U.S. Pat. No. 4,321,877 that issued to Schmidt, et al on Mar. 30, 1982; U.S. Pat. No. 4,430,948 that issued to Schafer, et al. on Feb. 14, 1984; U.S. Pat. No. 4,593,629 that issued to Pedersen, et al. on Jun. 10, 1986; U.S. Pat. No. 4,691,846 that issued to Cordell, et al. on Sep. 8, 1987, and U.S. Pat. No. 4,971,599 that issued to Cordell on Nov. 20, 1990.

[0007] However, it is not known that any of the inventions described in these patents have been successfully adapted to recover biomass energy on a cost-effective basis in small and medium size energy recovery systems.

[0008] Thus, gasifiers are not new in the art and there are many publications dealing with such pieces of equipment and systems in which they are used, but by way of illustration, attention can be directed to U.S. Pat. No. 4,691,846 that issued on Sep. 8, 1987 to Cordell, et al, in which there is described a method and apparatus for gasifying solid organic materials in which the system is described in detail with emphasis on the hopper and its manner of operation. It should be noted that the gasifier is shown and described as a dome-like structure with a bottom feed mechanism for the solid organic materials, and an upper exhaust system to remove the gaseous effluent to a secondary chamber.

[0009] A second disclosure can be found in U.S. Pat. No. 6,120,567 that issued on Sep. 19, 2000 to Cordell, et al in which there is described a method of gasifying solid organic materials and in which a similar apparatus and system as is disclosed in the '846 patent is set forth. The '567 patent is related to the '846 patent. Again, it should be emphasized that the gasifier is shown and described as a dome-like structure having a bottom feed and an upper exhaust for the gaseous effluent.

[0010] A typical and general process in the prior art can be found in Canadian patent 2,058,103 that issued on Oct. 14, 1997 in the name of Morey, et al. in which a bottom feed, biomass materials, and gasification system is set forth. The system feeds fuel such as green and wet woodchips from below, up through a central opening in a stationary, perforate fire table that supports the mound-like fuel bed that is formed thereby. A plurality of ring-like manifolds below the fire table, and surrounding the fuel supply tube are separately provided with air in a controlled manner according to the demand for the combustible gas produced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1**A is a schematic of embodiments of this invention utilizing gasifiers and methods of this invention showing a portion of the embodiments.

[0012] FIG. **1**B is a schematic of embodiments of this invention utilizing gasifiers and methods of this invention showing additional portions of the embodiments.

[0013] FIG. **2** is a full front view of a circular gasifier of this invention.

[0014] FIG. **3** is a cross sectional front view of the gasifier of FIG. **2** through line A-A.

[0015] FIG. **4** is an enlarged detail of the radar device used in this invention.

[0016] FIG. **5** is a view in perspective of one configuration of a segmented, round cone feed of this invention.

[0017] FIG. **6** is a view in perspective of one configuration of a segmented, square cone feed of this invention.

[0018] FIG. 5A is a view in perspective of a unitary, round cone feed of this invention

[0019] FIG. 6A is a view in perspective of a unitary, square cone feed of this invention.

[0020] FIG. 7 is a cross sectional view of the area designated 28 of FIG. 3, showing the detail of the moveable cone feed and the bottom tuyeres.

[0021] FIG. 8 is a full front view of a square or rectangular, loaf gasifier of this invention.

[0022] FIG. 9 is a cross sectional end view of the loaf gasifier of FIG. 8, through line B-B.

[0023] FIG. 10A is a cross sectional view showing the detailed construction of the walls and roof of the gasifier of this invention having an insulation layer.

[0024] FIG. 10B is a cross sectional view showing another embodiment of this invention and the detailed construction of the walls and roof without insulation and using air as the insulation.

[0025] FIG. 11 is an enlarged view of a roof of a loaf gasifier of this invention showing two exit ports and how radar is placed thereon.

[0026] FIG. 12 is a cross sectional view of the roof of FIG. 11, showing the construction of the roof.

[0027] FIG. 13 is a top view of the ash collection system of the gasifier of FIG. 8.

[0028] FIG. 14 is a side view of a gasifier 1 of this invention with the sides open to show another embodiment of a grate system of this invention.

[0029] FIG. 15 is a side cross section view of the grates of FIG. 14 through line C-C of FIG. 14.

THE INVENTION

[0030] Thus this invention deals with a method for gasifying solid organic materials, the apparatus used in such a method, and a system therefor and with specificity, it deals with, in one embodiment, a gasifier for gasifying solid organic materials comprising in combination a housing, wherein the housing has a lower portion and an upper portion and a circular side wall supported by the lower portion and attached to the upper portion.

[0031] There is a roof for the housing, the roof being supported by and integral with the circular sidewall. There is at least one opening through the roof for exiting syngas effluent and at least one opening for a sensing device and located at, and connected to, the roof opening, is a device for removing the syngas from the gasifier.

[0032] Located at, and associated with the sensing device opening, there is at least one device for sensing the elevation of any mass of any solid organic material contained in the housing, the sensing device being a radar device that is mounted over any sensing device opening and surmounts a non-metallic plate that covers the opening.

[0033] Located in the lower housing there is at least one opening for supporting a device for determining the amount of non-combustible material remaining within the gasifier, and located at, and connected to, the lower portion of the housing, and within the opening for supporting a device for determining the amount of non-combustible material remaining within the gasifier there is at least one device for determining the amount of non-combustible material remaining within the gasifier.

[0034] Located in the circular wall, there is at least one opening for supporting at least one device for providing oxidative gas to the solid organic materials, the oxidative gas being recirculated flue gas containing a predetermined portion of fresh air. Located in, and connected to the oxidative gas opening is a device for providing an oxidative gas to the solid organic materials.

[0035] There is a floor for the gasifier located in the lower portion of the gasifier, the floor having a top surface and a bottom surface, the floor having at least one opening through it to allow for the passage of solid organic material into the interior of the gasifier, wherein the top surface of the floor has a retaining wall on the outside of each of the floor openings to form a retention basin to retain the solid organic materials in the lower portion of the gasifier to form a floorless hearth.

[0036] There is a device for moving solid organic materials through the floor opening and into the gasifier in an upwardly motion and a device for providing and retaining a cone structure to the underside of the solid organic materials.

[0037] The gasifier has a device for containing the solid organic materials while above the retention basin and at least one opening in the lower portion of the gasifier to allow movement of non-combustibles out of the gasifier, along with a device in the retention basin for removing non-combustible materials out of the gasifier.

[0038] Finally, there is a control and monitor for the amount of mass of solid organic material within the gasifier and a control and monitor for the amount of non-combustibles in the gasifier that are inter-related. This type of gasifier is known in the art as a circular gasifier.

[0039] In another embodiment, the invention deals with a square or rectangular "loaf" gasifier. Thus, this embodiment deals with a gasifier for gasifying solid organic materials comprising a housing, wherein the housing has a lower portion and an upper portion and the housing has four side walls supported by the lower portion and attached to the upper portion, thus differing from the above-mentioned circular gasifier.

[0040] The loaf gasifier has a roof, the roof being supported by and integral with the four side walls and the gasifier has at least one opening through a side wall for exiting syngas effluent and at least one opening through the roof for a sensing device.

[0041] Located at, and connected to the side wall opening, is a device for removing the gaseous effluent from the gasifier and located at, and associated with the sensing device opening, there is at least one device for sensing the elevation of any mass of any solid organic material contained in the housing, said sensing device being a radar device that is mounted over any sensing device opening and that surmounts a non-metallic plate that covers the opening.

[0042] Located in the lower housing there is at least one opening for supporting a device for determining the amount of non-combustible material remaining within the gasifier and located at, and connected to the lower portion of the housing, and within the opening described just Supra, there is at least one device for determining the amount of non-combustible material remaining within the gasifier.

[0043] Located in the sidewalls there is at least one opening for supporting at least one device for providing oxidative gas to the solid organic materials, the oxidative gas being recirculated flue gas containing a predetermined portion of fresh air. Located in, and connected to the oxidative gas opening, is a device for providing an oxidative gas to the solid organic materials.

[0044] There is a floor for the gasifier located in the lower portion of the gasifier, the floor having a top surface and a bottom surface. The floor has at least one opening through it to allow for the passage of solid organic material into the interior of the gasifier, wherein the top surface of the floor has a retaining wall on the outside of each of the floor openings to form a retention basin to retain the solid organic materials in the lower portion of the gasifier to form a floorless hearth.

[0045] There is a device for moving solid organic materials through the floor opening and into the gasifier and a device for providing and retaining a cone structure to the underside of the solid organic materials.

[0046] In addition, there is a device for heating the solid organic materials while above the retention basin and at least one opening in the lower portion of the gasifier to allow movement of non-combustibles out of the gasifier, along with a device in the retention basin for removing non-combustible materials out of the gasifier.

[0047] Finally, there is a control and monitor for the amount of mass of solid organic material within the gasifier and a control and monitor for the amount of non-combustibles in the gasifier that are inter-related.

[0048] In another embodiment, the circular gasifier described Supra is modified to alter the flow of effluent by providing a constriction in the midsection of the gasifier. Thus, there is a gasifier for gasifying solid organic materials comprising a housing wherein the housing has a lower portion having a top part and an upper portion having a bottom part and the housing has a circular side wall supported by the lower portion and attached to the upper portion, wherein the circular side wall has a constricted section where the top part of the lower portion and the bottom part of the upper portion meet and join.

[0049] In yet another embodiment of this invention, the loaf gasifier described Supra is also modified. Thus, there is a gasifier for gasifying solid organic materials comprising a housing wherein the housing has a lower portion with a top part and an upper portion with a bottom part and the housing has four side walls supported by the lower portion and attached to the upper portion and the side walls have a constricted section where the top part of the lower portion and the bottom part of the upper portion meet and join.

[0050] There is still another embodiment of this invention, said embodiment being a method of gasifying solid organic materials to produce a gaseous effluent and a solid residue, the method comprising providing a supply of solid organic material and providing a circular gasifier as set forth in this disclosure.

[0051] Thereafter, the solid organic materials are introduced into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier. The solid organic materials are ignited and then heated in the gasifier while providing an oxidative gas to the gasifier, the oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a predetermined portion of fresh air.

[0052] There is provided an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and the syngas formed thereby is transferred outwardly from the gasifier and any non-combustible solids are transferred out of the gasifier.

[0053] A further embodiment of this invention is a method of gasifying solid organic material to produce a gaseous effluent and a solid residue, said method comprising providing a supply of solid organic material and providing a loaf gasifier as set forth in this disclosure and introducing the solid organic materials into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier.

[0054] The solid organic materials are ignited and then heated in the gasifier while providing an oxidative gas to the gasifier to provide a gaseous effluent, wherein the oxidative gas is recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a predetermined portion of fresh air.

[0055] There is provided an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and the syngas formed thereby is transferred outwardly from the gasifier and any non-combustible solids are transferred out of the gasifier.

[0056] It is contemplated within the scope of this invention to provide systems that utilize each of the various gasifiers disclosed and claimed in this invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0057] Turning now to FIG. **1**, there is shown therein a full front view of a circular gasifier **1** of this invention having a solid mass feeder **2** and an ash removal system **4**.

[0058] Thus, there is shown a gasifier **1** of this invention that is a circular gasifier that is equipped with a solid mass feeder **2** (shown in FIG. **1**), having a collection bin **5** that is connected by auger feed **3** to the bottom **9** (FIG. **2**) of the gasifier **1**. It should be noted that the solid mass feeder **2** runs essentially horizontally **7** beneath the gasifier **1** and then turns essentially ninety degrees vertically **8** and thus feeds the gasifier **1** from the center of the bottom **9** of the gasifier **1**. The solid mass feeder **2**, in the horizontal run **7** can be shrouded or it can be an open trough. It is shown as solid mass feed **2** that is covered by a shroud **6** enclosing the auger feed **3** (FIG. **3**).

[0059] The solid mass materials are first comminuted or chopped, if it is forestry product, so that it will flow and be ignited readily. Generally this chopped material is best handled if the pieces are at least **3** inches or less in any dimension. If the solid mass material is chicken litter or turkey litter, then chopping is not required.

[0060] FIG. **2** is an enlarged front view of a circular gasifier of this invention showing the gasifier **1**, the auger feed **3**, the shroud **6**, the horizontal run **7** and the vertical run **8**. The gasifier per se comprises in combination, a housing **10** that has a circular side wall **11** supported by the lower portion, generally shown as **12**, of the housing **10**. The circular sidewall **11** is attached to the upper portion indicated generally as **13**. The housing **10** is surmounted by a roof **14**, the roof **14** being supported by, and integral with the circular sidewall **11**.

[0061] Shown in FIG. **3** is an exit opening **15** through the roof **14** that is used for exiting syngas from the method of this invention. Also shown is a sensing device **16** that is positioned over an opening **17** (shown in FIG. **3**). The sensing device **16** is a radar that is used to monitor the top of the solid mass **18** shown in FIG. **3**. For purposes of illustration, only one such device **16** is shown, but it is within the scope of this invention to use more than one such device **16**, and it is preferred to use at least three such devices **16** and more preferred to use at least 5 such devices **16** on the gasifier as the height of the solid mass pile **18** is critical to providing particulate free, quality syngas. Details of the construction of the device **16** is shown in **4** and how it may be positioned on the gasifier **1** is shown in FIG. **3**

[0062] The control of pile height is of critical importance for combustion control and the release of gaseous combustibles, i.e., the "product gas". The location of feed cone(s) **25** and vertical auger(s) are designed to provide a pile having a generous depth, and which has a generally flat upper periphery. This flat, mesa-like upper surface extends over 60 to 70 percent of the floor area, generally filling the lower portion of gasifier **1**, and sharply tapers downward adjacent wall **11**. This downward taper, referred to as the angle of repose, is dependent upon the type of fuel used. A flat fuel pile is key to achieving uniform combustion without bridging. This flat configuration results in a uniform pile depth, which in turn results in uniform air pressure within the pile **18**, thus minimizing channeling of the pile. Maintaining pile depth is very important. About **6** inches or more of ash is maintained below the actively burning portion of the pile so as to prevent heat damage to feed cone **25** and ash removal system **4**.

[0063] As the feed material in the **18** in gasifier **1** moves to the feed cone **25** to the center and top of the mass, it gets hotter and hotter, and volatile components in such material and combustion products begin to dissipate from the surface of the pile, partly being assisted by the gases that are rising through such material. As the feed material in the pile **18** loses more and more of the volatile and pyrolytic ingredients it will begin to form high molecular weight carbonaceous derivatives and char until, eventually, it is exposed to the full operating temperature inside gasifier **1**. This material moves generally horizontally outward and then downward toward the outer wall and lower floor where it is exposed to further oxidation agents via tuyere arrays **32** and **34** for a more complete reaction, at which time all of the organic constituents of such feed material will gasify and will pass from gasifier **1** as an incompletely oxidized gaseous effluent of combustibles (syngas), the effluent leaving gasifier **1** through an insulated exit duct **52**. The velocity of the effluent above the fuel pile and out the exit duct is kept low, reducing particulate carryover.

[0064] It is contemplated within the scope of this invention to provide air-modified flue gas (oxidative gas), steam modified ambient air or steam modified pure oxygen to the burning piles **18** and **71** through the respective tuyeres fitted on the gasifiers **1** and **60**.

[0065] Feed rate into gasifier **1** is monitored and controlled by monitoring and controlling fuel pile height within gasifier **1**. Suitable instrumentation, not shown, is provided to control the rate of the delivery of the feed material into gasifier **1** by the feed assembly as a function of the elevation of the top of the feed material in the height of pile **18** to maintain such elevation at a substantially constant value, and thereby to contain the pile **18** of feed material at a substantially constant shape

[0066] Turning to FIG. **4**, there is shown the roof **14** of a circular gasifier **1** upon which is mounted a radar device **16**. The device **16** is housed in an open housing **21** and supported by adjustable fasteners **19** and has the capacity to be adjusted angularly on swiveled fasteners **20** so that the contour of the solid mass **18** in the interior of the gasifier **1** can be sensed. The device **16**, in its housing **21**, is mounted over a non-metallic plate **22**. The plates **22** have to be non-metallic so that the device **16** can beam into the interior of the gasifier **1** and sense the top of the solid mass pile **18**. It should be noted that the opening in the gasifier is only an opening in the metal cladding, and not an opening through the firebrick contained in the interior.

[0067] As the solid mass pile **18** burns, it creates a certain amount of ash that must be removed from the gasifier **1**. Therefore, there is at least one trench **24** provided in the gasifier floor featuring one or more devices for removal of ash and combustion residues and for control of the elevation of the "moving bed of ash" hearth. A most adaptable device is an auger **26** shown in FIG. **3** (end view only). In FIGS. **2** and **3**, there are two trenches **24**, one on either side of a centrally located feed cone **25** that will be described infra. The ash augers **26** in the trenches **24** move the ash towards points of discharge **27** suitably located at the end or bottom of the trenches **24**. The trenches **24** are connected to a bin or a conveyor of suitable design for further disposal of the ash (see FIG. **1**). The connections are standard connections and are not shown herein.

[0068] The formation of the ash creates a floorless hearth in the gasifier **1** on which the burning solid mass pile **18** is situated. By intermittent or continuous ash removal, there is created a "moving bed of ash" which is essentially the floorless hearth **30** of this invention.

[0069] Alternatively, the control of the "moving bed of ash" level that creates the hearth **30**, and the removal of the ash, can be accomplished by a conveyor or conveyors moving across the entire floor, or section thereof, from side to side, or end to end of the gasifier as deemed most suitable for the dimensions and shape of the "moving bed of ash" hearth **30**, or alternatively, a set, or sets, of dump grates can be inserted under the "moving bed of ash" hearth **30** to facilitate and control removal of the ash.

[0070] Preferred for this invention when forestry products are used as the feed, is a peppermill grate **40** ash system (see

FIG. **7** which is a cutaway portion of FIG. **3**, section **80**). The peppermill grate **40** is known in the art and consists of a flat metal plate **39** that is perforated with a multiplicity of holes **41** for allowing the ash to fall through it. Over top of the flat plate **39** is a moveable grate **42**, that essentially covers part of the holes **41** part of the time and allows other of the holes **41** to be open. The grate **42** is also perforated with holes **43**. As the grate **42** is moved, generally in an oscillating motion, the ash is caused to fall through the holes **42** into the retention basins **29** below and the augers **26** then move the ash to one end **27** where it is moved out of the retention bins **29** into a conveyor system (see FIG. **1**) for transfer away from the gasifier **1**.

[0071] Another grate system **84** for the invention disclosed herein that is similar to a peppermill grate is shown in FIG. **14**. FIG. **14** is a side view of a gasifier **1** of this invention with the sides open to show the grate system **84**. The grate system **84** consists of two grate rings **85** and **86** (see FIG. **15**) at the bottom of the gasifier **1**. The bottom grate **85** is stationary and it has square openings **87** that are approximately **8** inches wide by **20** inches long. The top grate **86** is moveable, that is, activated by two (not shown) hydraulic cylinders that have a stroke maximum of about **8** inches. Because the grate is round, this stroke rotates the grate. The top grate **86** also has square openings **88**. The hydraulic cylinders stroke the top grate **86** such that it aligns the square openings **87** and **88** and on the back stroke misaligns the openings covering the bottom openings **87**.

[0072] The top grate **86** has wedge plates **89** mounted on top of it. These plates **89** are installed in such a way that when the top grate **86** is rotating towards the openings **88**, the wedge plates **89** push the ash in front of them towards the openings **87** in the bottom grate **85**. The movement and height of the wedge plates **89** ensure measurable and constant ash removal from the bottom of the pile, preventing the ash bridging above the ash grate openings. As the bottom layer of the ash is discharged, the mixture of ash and unburned carbon from the above drops down lower. As the carbon burns, the process temperature in the vicinity of the ash discharge thermocouples becomes higher indicating that the system has to wait for the next ash dump.

[0073] As the carbon is more and more combusted and disintegrates, the bottom of the gasifier becomes colder and colder indicating that the ash only is left at the bottom of the gasifier and it is time for a new ash dump.

[0074] The portion of a segment of a feed cone **25** is shown surmounting the grate **42**. The grate **42** is surmounting the flat plate **39**. At one edge **44** of the grate **42**, there is a pin **45** that attaches the grate **42** to the flat plate **39** and the grate **42** partially swings around the pin **45** such that the grate **42** moves in an oscillating motion. The swinging motion of the grate **42** moves the ashes that pile on the grate **42** and the flat table **39** and the ash falls through holes **41** and **43** into a bin below. Also shown are the bottom tuyeres **34**.

[0075] It is preferred within the scope of this invention to eliminate the peppermill grate system when the feed material into the gasifier **1** is soft, easily combustible materials, such as chicken litter, turkey litter, or plastics, and the like.

[0076] As indicated supra, the gasifier **1** has a centrally located feed cone **25** arranged along the centerline of the chamber and protruding above the general elevation of the "moving bed of ash" hearth **30**. The feed cone **25** is serviced by a single, or twin set, of fuel feed augers **31** entering vertically from below.

[0077] The feed cone **25** is circular (See FIGS. **5** and **5**A) for the circular gasifier **1** shown in FIGS. **2** and **3** and the feed cone **25** is square or rectangular (See FIG. **6** and **6**A) for the loaf type of gasifier described infra.

[0078] It is contemplated within the scope of this invention to have the feed cones **25** be utilized as one single piece, that is a unitary article, for example those shown in FIGS. **5**A and **6**A, respectively. However, it is preferred that the feed cones **25** be segmented as shown in FIGS. **5** and **6** so that they can more easily be moved into and out of the gasifier **1** for servicing, maintenance and repair. The segmented feed cones **25** can be simply set in place adjacent each other, or they can be mortared together, or glued together to hold them in place. Obviously, the segmented feed cones **25** shown in **5**A and **6**A are those used in the moveable feed cone described infra.

[0079] Also contemplated within the scope of this invention is the use of such feed cones **25** as non-moveable articles when in use in the gasifier. However, preferred for this invention are feed cones **25** that are moveable, that is are moveable in a partial circular motion within the gasifier **1**, such that they oscillate. (See FIGS. **5** and **6**). The purpose for the moveable feed cones **25** is for providing oxidative gases through the burning solid mass pile **18** evenly so that creation of gas channels can be voided. Periodic movement of the cone will prevent oxidative gas from burning holes between the gas sources and the surface of the pile.

[0080] In the gasifier, a partial primary method is one in which the combustion is carried out sub-stoichiometrically with the application of an oxidizing agent, which in this invention is flue gas mixed with a predetermined portion of fresh air, wherein the solid organic materials are transferred continuously or intermittently to the gasifier **1** at a predetermined rate to maintain a mass of solid organic materials in the gasifier, and further wherein the oxidant is continuously added to the gasifier **1** to continuously gasify the solid organic materials in the mass, and still further the solid residue (non-combustibles) are transferred out of the gasifier. The oxidizing agent is administered through a set or sets of suitable ducts connected to nozzles, preferably tuyeres and injection points located within, around and between the feed cones **25**, and to a row, or line of nozzles and/or tuyeres in the surrounding walls of the gasifier **1**.

[0081] Thus shown in FIG. **3** are the upper tuyeres **32**, and the lower tuyeres **33**, and the bottom tuyeres **34** in the cone **25**, all of which are used to facilitate the movement of the air modified flue gas to the gasifier **1** and into the burning solid mass **18**. The upper tuyeres **32** are fed through a common manifold **35** and the lower tuyeres **33** are also fed through a common manifold **36**. The tuyeres **32** are linked to the manifold **35** by feed tubes **37** and the tuyeres **33** are linked to the manifold **36** by feed tubes **38**.

[0082] As can be observed from FIGS. **2** and **3**, the manifolds **35** and **36** are fed from a flue gas return system, generally **48**, that consists of a duct **49** and an air motor **50**.The inlet **51** of the air motor is attached to the system **60** (FIG. **1**) for supplying fresh air-modified flue gas to the air motor **50**.

[0083] The gasifier **1** is equipped with an opening **15** for the movement of the syngas produced by the method. The opening **15** has surmounted on it, a fixture **52** for allowing the attachment of components that are used to handle the syngas, which will be described infra.

[0084] Located in the lower portion of the housing **10** of the gasifier **1** is a device for determining the amount of non-combustibles within the gasifier **1**. Thus probes **53** can be used to monitor the level of moving ash bed defined by the upper elevation of the accumulated ash. As an example of probes **53**, there are used thermo elements in pairs located one above the other, distanced sufficiently such that the level of the moving ash bed will be in between them, and capable of characterization by the difference in temperatures and the temperature of the material above the moving ash bed while in operation. Said temperature difference will then be the offset that will dictate the degree of auger **26** movement required to control the level of the moving ash bed between the probes. In this representation, it is assumed that gasifier **1** is equipped with several sets of probes **53**, inserted through openings **55**, around the perimeter of the chamber and an average of probe **53** input data will determine the auger **26** movements.

[0085] The floor **57** for the gasifier is located in the lower portion **12** of the gasifier **1**, the floor **57** having a top surface and a bottom surface. The floor **57** has at least one opening through it to allow for the passage of the solid organic material into the interior of the gasifier **1**.

[0086] To bring gasifier **1** to an operational condition on start up, the feed assembly **3** is activated to form the pile **18** of feed material in the gasifier **1** in preparation of development of a "moving ash bed" above bottom **9**. The pile **18** of feed material is ignited. To facilitate bringing the pile **18** of feed material up to its normal operating temperature, fuel oil or other readily combustible supplemental fuel may be added to it. As an example, this may be done manually through an opening **54** provided in the wall of the gasifier **1**.

[0087] As the oxidation proceeds and the temperatures elevate the solid mass **18** will pyrolyze and gasify. Gas produced in the starved combustion sifts through the burning pile and into the upper portion of the burning pile **18**, the upper pile **18** acting as a filter for particulate material. It is important to conduct the combustion of the solid mass below the pile **18**. The products of combustion rise through the pile **18** and cools because the latent heat of water absorbs the energy. As fuel comes, it gets pyrolyzed and the fuel moisture and volatile hydrocarbons get separated from the non-volatile components. These processes are driven by the hot gases that result from the combustion of the fixed carbon, which takes place below the pile **18**.

[0088] The moderately slow burning lower portion of the pile will serve to establish a quiet oxidation zone whereby entrainment of particulate matter and fly ash is minimized. Syngas with a maximum of combustible gaseous components and a minimum of particulate matter is one key objective of this invention.

[0089] Turning now to FIG. **8**, which is a full front view of a loaf type of gasifier **60**, and FIG. **9** that is a full cross sectional view of a gasifier **60** of FIG. **8** through line B-B, the gasifier **60** is defined by four vertical side walls **61**, giving the chamber a square or rectangular cross section and forming an enclosure **62** (FIG. **9**) which has an irregularly shaped bottom **63** and which has at its top a roof **64**, which in cross section may be vaulted, tapered or flat or any combination hereof.

[0090] Wall **61** is made up of a multiplicity of layers. In the preferred embodiment, FIG. **10**A, the innermost layer **65** is an insulating layer of a high-temperature resistant type refractory that is capable of withstanding the elevated temperatures that will develop within gasifier **60**, for example, temperatures in the range of approximately 2300° F. to approximately 2500° F., and that is capable of withstanding the operational temperature variations as well as the corrosive, erosive effects of the gaseous materials produced by the oxidation of the biomass feed material that is delivered into gasifier **60**. Wall **61** may also include an insulating layer **66** on the outside of the wall layer **65** to further prevent loss of heat through the wall **61** of gasifier **60**. As an example, the insulating layer **66** may be a single layer of insulating firebrick, block insulation, or blanket insulation. The outer casing of the wall **61** is a structural layer or shell **67** of sheet metal, for example, plate steel, which is airtight and provides the necessary strength and rigidity for the wall.

[0091] A second embodiment of wall **61** is shown in FIG. **10**B, wherein insulating layer **66** is not used, and a vacant layer or space **58** is provided between refractory innermost layer **65** and steel shell **67**. The air which fills vacant layer **68** acts as an insulator between refractory layer **65** and steel shell **67**. This warmed air can also be used as a source of preheated air for injection into gasifier **60** and recovery and regeneration equipment **96** and **98**.

[0092] With further regard to FIGS. **8** and **9**, the biomass feed material from the storage hopper assembly (not shown) is introduced into gasifier **60** from below gasifier **60** through at least one feed cone **59** located along the centerline of bottom **63** of gasifier **60**. During normal operating conditions, the feed material rises over the top of the feed cone(s) **59** and rests on the hearth **70**. Hearth **70** is made up of ash and other solid combustion residues, until it forms a pile **71** of such material, which is the normal or equilibrium condition of gasifier **60**. This self-generated hearth **70** is the "moving ash bed" configuration, that is an essential part of this invention and which is described Supra with regard to gasifier **1**. As primary oxidation progresses, this bed continues to elevate and the ash must be removed at essentially the same rate it is formed to maintain the appropriate fuel pile height.

[0093] As in the gasifier **1** described Supra, the control of pile height is of importance for combustion control and the release of gaseous combustibles. The principles discussed Supra for the gasifier **1** apply equally well for the gasifier **60** and will not be repeated herein.

[0094] Returning to FIGS. **8** and **9**, there are shown exit ducts **69** and they are positioned so that it vents gasifier **60** through roof **64**. It should be noted that prior art loaf gasifiers required that the exit for the produced gases must be through the sidewall so as to minimize the flow of particulate materials along with the gas. Preferably, sidewalls **61** are provided in a height which allows any air-borne particulate to fall back to pile **71** rather that exit via duct **69**. The positioning of exit duct **69** within gasifier **60** can be as shown in FIGS. **8** or **9**, and may be sloped or vertical, and is selected to be practical and suitable for the specific application.

[0095] As in the gasifier **1**, Supra, the oxidizing agent is administered through a set or sets of suitable ducts connected to nozzles, preferably tuyeres and injection points located within, around and between the feed cones **59**, and to a row, or line of nozzles and/or tuyeres in the surrounding walls of the gasifier **1**.

[0096] Thus shown in FIGS. **8** and **9** are the upper tuyeres **73**, and the lower tuyeres **74**, and the bottom tuyeres **75** in the cone **59**, all of which are used to facilitate the movement of the air modified flue gas to the gasifier **60** and into the burning solid mass **71**. The upper tuyeres **73** are fed through a common manifold **76** and the lower tuyeres **74** are also fed through a common manifold **77**. The tuyeres **73** are linked to the manifold **76** by feed tubes **78** and the tuyeres **74** are linked to the manifold **77** by feed tubes **79**. Just as in the tuyeres of the gasifier **1**, the tuyeres of the instant invention are either on or off, and are not adjustable.

[0097] The modified flue gas return system useful in gasifier **60** shown in FIGS. **8** and **9** can also be observed in FIG. **2**, and this system is adaptable and useful in the gasifier **60**. The manifolds **76** and **77** of FIGS. **8** and **9** are fed from a flue gas return system as shown in FIG. **8**, generally **48**, that consists of a duct **49** and a fresh air motor **50**. The inlet **51** of the air motor is attached to the system **60** (FIG. **1**) for supplying fresh air-modified flue gas to the air motor **50**. The details of the movement of the fresh air modified flue gas from the flue stack to the gasifier is set forth in detail infra.

[0098] It should be noted that the upper part of the lower portion **12** and the lower part of the upper portion **13** of the gasifier (FIG. **3**) are modified from prior art devices in that, there is a constriction **80** of the interior of the gasifier **60**. This constriction **80** is built into the firewall brick **65**, or it can be formed from a plate that is set at an angle into the firebrick **65**. The purpose of this constriction **80** is to slow down the product gas in its flow upward which results in another method by which particulate material does not tend to reach the exits ports **69**.

[0099] Feed rate into gasifier **60** is monitored and controlled by monitoring and controlling fuel pile height within gasifier **60** using the same radar devices **16** as set forth Supra. Suitable instrumentation, not shown, is provided to control the rate of the delivery of the feed material into gasifier **60** by the feed assembly as a function of the elevation of the top of the feed material in the height of pile **71** to maintain such elevation at a substantially constant value, and thereby to contain the pile **71** of feed material at a substantially constant size.

[0100] Turning now to FIG. **11**, there is shown an enlarged view of roof **64** for the loaf gasifier **60**, that shows the two exit ports **69** for syngas located on the roof **64**. Also shown is a placement of a radar device **16** on the roof **64**, between the two exit ports **69**. The dotted lines **84** illustrate the beam of the radar **16** into the interior of the gasifier **1**. FIG. **12** shows the roof **64** and the construction of the walls of the roof **64**. There is thus shown the outside, or steel wall **67**, the insulating layer **66** and the interior firebrick wall **65**. The component **82** is a flange that is useful for fitting the roof to the sidewalls of the gasifier **60**.

[0101] FIG. **13** is a cross sectional view of the specifics of the ash handling system of the loaf gasifier as shown in FIG. **8**. There is shown the ash handling system **81** that includes the removable peppermill grates **42**, the increasing flight ash augers in the collection bin and retention bin **29**, and the castable tuyere panels **83**. Also shown is the exit of the centered feed cone **59**.

[0102] Turning now to FIGS. **1**A and **1**B and a description of a "system" of this invention, there is shown a schematic of a gasifier **1** of this invention and its interconnection to the various components that can make up the system wherein the numbers in pentagons are the flow paths and various components of the system as describe infra.

[0103] Thus, shown in FIGS. **1**A and **1**B is a gasifier **1** that is fed a solid mass material **2** using an auger feed **3**. Shown also is an ash removal system **4**. Syngas **90** that is produced by the pyrolysis and gasification of the solid mass material **2** exits the gasifier **1** through exit port **15** and into a syngas burner **91** and into a syngas blower **92**. The syngas **90** is controlled by draft controls **93**. The syngas burner **91** is aided in combustion using a combustion air blower **94** that provides air **95** to the syngas burner **91**.

[0104] The syngas **90** is provided to the syngas burner **91** at a temperature of about 500° F. to about 600° F. and is in a starved air condition. This part of the system is unique to this type of gasifier system in that the normal temperature of the air from prior art devices is in the range of 1200° F. to 1400° F., and in prior art systems, this air is not "starved air", and before the prior art air can be used, it has to be cooled and compressed, which means that additional and expensive equipment has to be added to the system in prior art processes. The syngas burner **91** heats and combusts the syngas **90** up to a temperature in the range of 1200° F. to 1400° F. before the heated air **97** is provided to a low NO_x oxidizer **96**.

[0105] In a further embodiment, the syngas **90** can be provided to a kiln **98** using a syngas blower **99** that moves the syngas **90** to a nozzle mix syngas burner **100**. Thereafter the syngas **90** is moved through the nozzle mix syngas burner **100** into the kiln **98**. The heated air (about 2200° F.) from the kiln **98** is moved to the low NO_x oxidizer **96** and combined with the starved air coming from the syngas burner **91**.

[0106] The heating and movement of the heated air in the kiln **98** is aided by passing heated air **101** from a heat exchanger **102** (see FIG. **1**B) and also mixing the heated air **103** with heated ambient air **105** being bleed into the nozzle mix syngas burner **100** using a preheated combustion air blower **104**, along with additional heated air **101** from the heat exchanger **102** that is bled **106** directly into the kiln **98**.

[0107] The heated air **107** from the kiln **98** is fed into the low NO_x oxidizer **96** and mixed therein with the air **97** being fed into the top portion of the low NO_x oxidizer **96**. The low NO_x oxidizer **96** is fed ambient air **108** using a combustion/tempering air fan **109**, through manifolds **110** and tuyeres (not shown) and the air **111** that exits the low NO_x oxidizer **96** does so at about 2000° F. and passes to the heat exchanger **102** shown in FIG. **1**B.

[0108] Turning now to FIG. **1**B, there is shown the heat exchanger **102** into which the heated air **111** has been passed and the exchanged air **112** is then passed to a metal heat exchanger **113** at about 1400° F., the metal heat exchanger **113** being useable because of the lower temperature of the air **112**. Air **114** is moved to the heat exchanger **102** and the heated air is that used in the heat exchanger **102** for the exchange. The movement of the air **114** is aided by the introduction of fresh air **124** using an air blower **125**.

[**0109**] Exchanged air having a temperature in the range of about 400° F. to 1200° F. is the air **101** that is passed back to the kiln **98**. The air **101** has to be occasionally vented in order to control the temperature and pressure of the air **101** and this is shown at **116**.

[**0110**] The heat-exchanged air **127** from the metal heat exchanger **113** is moved to an induction draft fan **115** before it enters the stack **117**. Prior to air exiting **122** the flue stack **117**, a portion of the flue gas **120** is withdrawn from the stack **117** and moved to a flue gas eductor **118**, which is aided by a an induced draft fan **119**. At this point, fresh air **128** is inducted and mixed with the flue gas **120** and it is this flue gas modified with fresh air **121** that is moved back to the gasifier **1** as the oxidative gas for use in the gasifier **1**. Also shown in FIG. **1**B is a sampling port **129**.

What is claimed is:

1. A gasifier for gasifying solid organic materials comprising in combination:

(I) a housing, said housing having a lower portion and an upper portion;

(II) said housing having a circular side wall supported by the lower portion and attached to the upper portion;

(III) a roof, said roof being supported by and integral with the circular side wall;

(IV) there being at least one opening through the roof for exiting syngas effluent and at least one opening for a sensing device;

(V) located at, and connected to, the roof opening, a device for removing the gaseous effluent from the gasifier;

(VI) located at, and associated with, the sensing device opening, at least one device for sensing the elevation of any mass of any solid organic material contained in the housing, said sensing device being a radar device that is mounted over any sensing device opening and surmounts a non-metallic plate that covers the opening;

(VII) located in the lower housing at least one opening for supporting a device for determining the amount of non-combustibles within the gasifier;

(VIII) located at, and connected to, the lower portion of the housing, and within the opening of (VII), at least one device for determining the amount of non-combustibles within the gasifier;

(IX) located in the circular wall, at least one opening for supporting at least one device for providing oxidative gas to the solid organic materials, said oxidative gas being recirculated flue gas containing a predetermined portion of fresh air;

(X) located in, and connected to the oxidative gas opening, a device for providing an oxidative gas to the solid organic materials;

(XI) a floor for the gasifier located in the lower portion of the gasifier, the floor having a top surface and a bottom surface, said floor having at least one opening therethrough to allow for the passage of solid organic material into the interior of the gasifier, wherein the top surface of the floor has a retaining wall on the outside of each of the floor openings to form a retention basin to retain the solid organic materials in the lower portion of the gasifier to form a floorless hearth;

(XII) a device for moving solid organic materials through the floor opening and into the gasifier;

(XIII) a device for providing and retaining a cone structure to the underside of the solid organic materials;

(XIV) at least one opening in the lower portion of the gasifier to allow movement of non-combustibles out of the gasifier;

(XV) a device in the retention basin for removing non-combustible materials out of the gasifier;

(XVI) a control and monitor for the amount of mass of solid organic material within the gasifier and a control and monitor for the amount of non-combustibles in the gasifier, the mass control and the non-combustible control being inter-related.

2. A gasifier for gasifying solid organic materials comprising in combination:

(I) a housing, said housing having a lower portion and an upper portion;

(II) said housing having four side walls supported by the lower portion and attached to the upper portion;

(III) a roof, said roof being supported by and integral with the four side walls;

(IV) there being at least one opening through the roof for exiting syngas effluent and at least one opening through the roof for a sensing device;

(V) located at, and connected to, roof opening, a device for removing the gaseous effluent from the gasifier;

(VI) located at, and associated with, the sensing device opening, at least one device for sensing the elevation of any mass of any solid organic material contained in the housing, said sensing device being a radar device that is mounted over any sensing device opening and surmounts a non-metallic plate that covers the opening;

(VII) located in the lower housing at least one opening for supporting a device for determining the amount of non-combustibles within the gasifier;

(VIII) located at, and connected to, the lower portion of the housing, and within the opening of (VII), at least one device for determining the amount of non-combustibles within the gasifier;

(IX) located in the side walls, at least one opening for supporting at least one device for providing oxidative gas to the solid organic materials, said oxidative gas being recirculated flue gas containing a predetermined portion of fresh air;

(X) located in, and connected to, the oxidative gas opening, a device for providing an oxidative gas to the solid organic materials;

(XI) a floor for the gasifier located in the lower portion of the gasifier, the floor having a top surface and a bottom surface, said floor having at least one opening therethrough to allow for the passage of solid organic material into the interior of the gasifier, wherein the top surface of the floor has a retaining wall on the outside of each of the floor openings to form a retention basin to retain the solid organic materials in the lower portion of the gasifier to form a floorless hearth;

(XII) a device for moving solid organic materials through the floor opening and into the gasifier;

(XIII) a device for providing and retaining a cone structure to the underside of the solid organic materials;

(XIV) a device for heating the solid organic materials while above the retention basin;

(XV) at least one opening in the lower portion of the gasifier to allow movement of non-combustibles out of the gasifier;

(XVI) a device in the retention basin for removing non-combustible materials out of the gasifier;

(XVII) a control and monitor for the amount of mass of solid organic material within the gasifier and a control and monitor for the amount of non-combustibles in the gasifier, the mass control and the non-combustible control being inter-related.

3. The gasifier as claimed in claim 1 in which the device in the retention basin is a pepper grate surmounted over at least one auger.

4. The gasifier as claimed in claim 2 in which the device in the retention basin is a pepper grate surmounted over at least one auger.

5. The gasifier as claimed in claim 1 in which the device for providing and retaining a cone structure to the underside of the solid organic materials is non-moveable during use of the gasifier.

6. The gasifier as claimed in claim 2 in which the device for providing and retaining a cone structure to the underside of the solid organic materials is non-moveable.

7. The gasifier as claimed in claim 1 in which the device for providing and retaining a cone structure to the underside of the solid organic materials is moveable during use of the gasifier.

8. The gasifier as claimed in claim 2 in which the device for providing and retaining a cone structure to the underside of the solid organic materials is moveable during use of the gasifier.

9. The gasifier as claimed in claim 1 in which each device for supplying oxidative gas to the solid organic materials is a tuyere.

10. The gasifier as claimed in claim 2 in which each device for supplying oxidative gas to the solid organic materials is a tuyere.

11. The gasifier as claimed in claim 11 in which each of tuyeres in a common line is provided the oxidative gas from a common manifold.

12. The gasifier as claimed in claim 12 in which each of the tuyeres in a common line is provided the oxidative gas from a common manifold.

13. The gasifier as claimed in claim 11 in which the common manifold is provided with oxidative gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air.

14. The gasifier as claimed in claim 12 in which the common manifold is provided with oxidative gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air.

15. The gasifier as claimed in claim 13 wherein the tuyeres in a common line are such that the tuyere line encircles the housing of the gasifier.

16. The gasifier as claimed in claim 15 wherein the tuyeres in a common line are such that the tuyere line defines the outside surface of the housing of the gasifier.

17. The gasifier as claimed in claim 15 wherein there is at least one common line of tuyeres above any burning activity in the gasifier and at least one common line of tuyeres below any burning activity in the gasifier.

18. The gasifier as claimed in claim 16 wherein there is at least one common line of tuyeres above any burning activity in the gasifier and at least one common line of tuyeres below any burning activity in the gasifier.

19. The gasifier as claimed in claim 1 wherein the cone structure is provided with at least one array of tuyeres formed in the inner surface and with at least one array of tuyeres formed in the outer surface.

20. The gasifier as claimed in claim 2 wherein the cone structure is provided with at least one array of tuyeres formed in the inner surface and with at least one array of tuyeres formed in the outer surface.

21. A method of gasifying solid organic material to produce a gaseous effluent and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 1;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide a gaseous effluent, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

22. A method of gasifying solid organic material to produce a gaseous effluent and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 2;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide a gaseous effluent, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

23. A gasifier for gasifying solid organic materials comprising in combination:

(I) a housing, said housing having a lower portion having a top part and an upper portion having a bottom part;

(II) said housing having a circular side wall supported by the lower portion and attached to the upper portion, said circular side wall having a constricted section where the top part of the lower portion and the bottom part of the upper portion meet and join;

(III) a roof, said roof being supported by and integral with the circular side wall;

(IV) there being at least one opening through the roof for exiting syngas effluent and at least one opening for a sensing device;

(V) located at, and connected to, the roof opening, a device for removing the gaseous effluent from the gasifier;

(VI) located at, and associated with, the sensing device opening, at least one device for sensing the elevation of any mass of any solid organic material contained in the housing, said sensing device being a radar device that is mounted over any sensing device opening and surmounts a non-metallic plate that covers the opening;

(VII) located in the lower housing at least one opening for supporting a device for determining the amount of non-combustibles within the gasifier;

(VIII) located at, and connected to, the lower portion of the housing, and within the opening of (VII), at least one device for determining the amount of non-combustibles within the gasifier;

(IX) located in the circular wall, at least one opening for supporting at least one device for providing oxidative gas to the solid organic materials, said oxidative gas being recirculated flue gas containing a predetermined portion of fresh air;

(X) located in, and connected to the oxidative gas opening, a device for providing an oxidative gas to the solid organic materials;

(XI) a floor for the gasifier located in the lower portion of the gasifier, the floor having a top surface and a bottom surface, said floor having at least one opening therethrough to allow for the passage of solid organic material into the interior of the gasifier, wherein the top surface of the floor has a retaining wall on the outside of each of the floor openings to form a retention basin to retain the solid organic materials in the lower portion of the gasifier to form a floorless hearth;

(XII) a device for moving solid organic materials through the floor opening and into the gasifier;

(XIII) a device for providing and retaining a cone structure to the underside of the solid organic materials;

(XIV) a device for heating the solid organic materials while above the retention basin;

(XV) at least one opening in the lower portion of the gasifier to allow movement of non-combustibles out of the gasifier;

(XVI) a device in the retention basin for removing non-combustible materials out of the gasifier;

(XVII) a control and monitor for the amount of mass of solid organic material within the gasifier and a control and monitor for the amount of non-combustibles in the gasifier, the mass control and the non-combustible control being inter-related.

24. A gasifier for gasifying solid organic materials comprising in combination:

(I) a housing, said housing having a lower portion with a top part and an upper portion with a bottom part;

(II) said housing having four side walls supported by the lower portion and attached to the upper portion; said side walls having a constricted section where the top part of the lower portion and the bottom part of the upper portion meet and join;

(III) a roof, said roof being supported by and integral with the four side walls;

(IV) there being at least one opening through the roof for exiting effluent and at least one opening through the roof for a sensing device;

(V) located at, and connected to, the roof opening for the exiting of effluent, a device for removing the gaseous effluent from the gasifier;

(VI) located at, and associated with, the sensing device opening, at least one device for sensing the elevation of any mass of any solid organic material contained in the housing, said sensing device being a radar device that is mounted over any sensing device opening and surmounts a non-metallic plate that covers the opening;

(VII) located in the lower housing at least one opening for supporting a device for determining amount of non-combustibles within the gasifier;

(VIII) located at, and connected to, the lower portion of the housing, and within the opening of (VII), at least one device for determining the amount of non-combustibles within the gasifier;

(IX) located in the side walls, at least one opening for supporting at least one device for providing oxidative gas to the solid organic materials, said oxidative gas being recirculated flue gas containing a predetermined portion of fresh air;

(X) located in, and connected to, the oxidative gas opening, a device for providing an oxidative gas to the solid organic materials;

(XI) a floor for the gasifier located in the lower portion of the gasifier, the floor having a top surface and a bottom surface, said floor having at least one opening therethrough to allow for the passage of solid organic material into the interior of the gasifier, wherein the top surface of the floor has a retaining wall on the outside of each of the floor openings to form a retention basin to retain the solid organic materials in the lower portion of the gasifier to form a floorless hearth;

(XII) a device for moving solid organic materials through the floor opening and into the gasifier;

(XIII) a device for providing and retaining a cone structure to the underside of the solid organic materials;

(XIV) a device for heating the solid organic materials while above the retention basin;

(XV) at least one opening in the lower portion of the gasifier to allow movement of non-combustibles out of the gasifier;

(XVI) a device in the retention basin for removing non-combustible materials out of the gasifier;

(XVII) a control and monitor for the amount of mass of solid organic material within the gasifier and a control and monitor for the amount of non-combustibles in the gasifier, the mass control and the non-combustible control being inter-related.

25. A system for gasification of solid waste materials, said system comprising in combination:

(A) a gasifier as claimed in claim 1;

(B) at least one oxidizer, and,

(C) at least one heat recovery device.

26. A system as claimed in claim 25 wherein, in addition, the system has a device for moving flue gas from a flue stack of the system, mixing the flue gas with inducted fresh air and moving the combination of flue gas and fresh air to the gasifier.

27. A system for gasification of solid waste materials, said system comprising in combination:

(A) a gasifier as claimed in claim 2;

(B) at least one oxidizer, and,

(C) at least one heat recovery device.

28. A system as claimed in claim 27 wherein, in addition, the system has a device for moving flue gas from a flue stack of the system, mixing the flue gas with inducted fresh air and moving the combination of flue gas and fresh air to the gasifier.

29. A system for gasification of solid waste materials, said system comprising in combination:

(A) a gasifier as claimed in claim 23;

(B) at least one oxidizer, and,

(C) at least one heat recovery device.

30. A system as claimed in claim 29 wherein, in addition, the system has a device for moving flue gas from a flue stack of the system, mixing the flue gas with inducted fresh air and moving the combination of flue gas and fresh air to the gasifier.

31. A system for gasification of solid waste materials, said system comprising in combination:

(A) a gasifier as claimed in claim 2;

(B) at least one oxidizer, and,

(C) at least one heat recovery device.

32. A system as claimed in claim 31 wherein, in addition, the system has a device for moving flue gas from a flue stack of the system, mixing the flue gas with inducted fresh air and moving the combination of flue gas and fresh air to the gasifier.

33. A method of gasifying solid organic material to produce a gaseous effluent and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 24;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide a gaseous effluent, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

34. A method of gasifying solid organic material to produce a gaseous effluent and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 24;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide a gaseous effluent, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

35. A method of producing syngas, the method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 1;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide syngas, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

36. A method of gasifying solid organic material to produce syngas and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 2;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide syngas, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

37. A method of gasifying solid organic material to produce syngas and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 24;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide syngas, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

38. A method of gasifying solid organic material to produce syngas and a solid residue, said method comprising:

(I) providing a supply of solid organic material;

(II) providing a gasifier as claimed in claim 24;

(III) introducing the solid organic materials from (I) into the gasifier upwardly from a lower portion of the gasifier to provide a mass of solid organic materials in the gasifier;

(IV) heating the solid organic materials in the gasifier while providing an oxidative gas to the gasifier to provide syngas, said oxidative gas being recirculated flue gas from a flue stack located in a system in which the gasifier is operating and, the oxidative gas is flue gas containing a portion of predetermined fresh air;

(V) providing an effluent path of flow within the gasifier for a portion of the gaseous effluent to migrate, mix, and react through the heated solid organic materials and wherein syngas formed thereby is transferred outwardly from the gasifier;

(VI) transferring any non-combustible solids out of the gasifier.

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