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(54) **Method and Apparatus for Processing Animal Waste**

(57) Waste materials passing through openings in a floor (16) in an animal confinement building (10) drop onto a ramp (30) substantially covering a pit (14). The materials are flushed down the ramp (30) through a narrow opening at the bottom of the ramp (30) into the pit (14). The level of the waste materials in the pit (14) is

maintained above the lower edge of the ramp (30) so that material under the ramp (30) is sealed from the atmosphere. Bio-degradable material is then digested in the anaerobic conditions by bacteria to produce bio-gas and a sludge. The waste materials in the pit (14) are heated to promote bacterial activity.

The bio-gas produced is withdrawn from under the ramp (30) and the remaining sludge is removed from the pit (14).

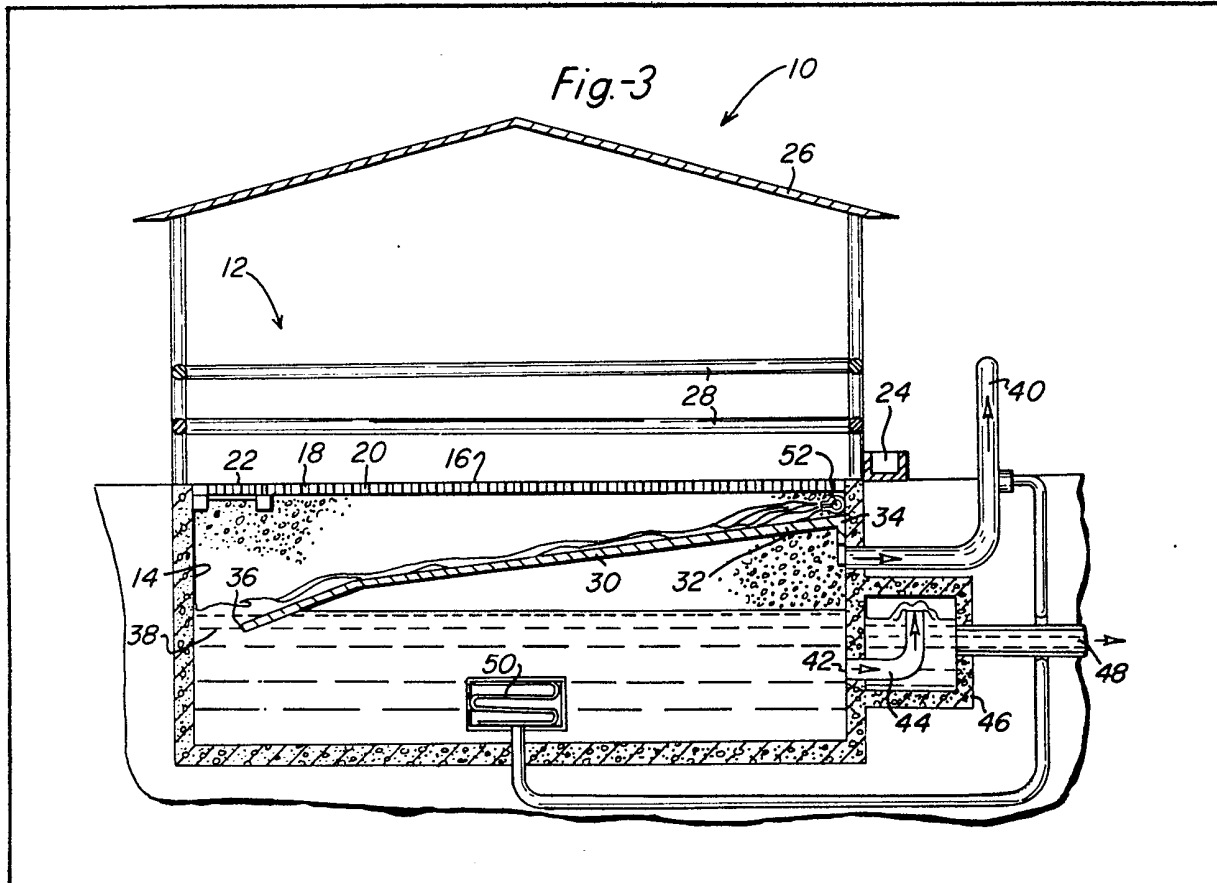
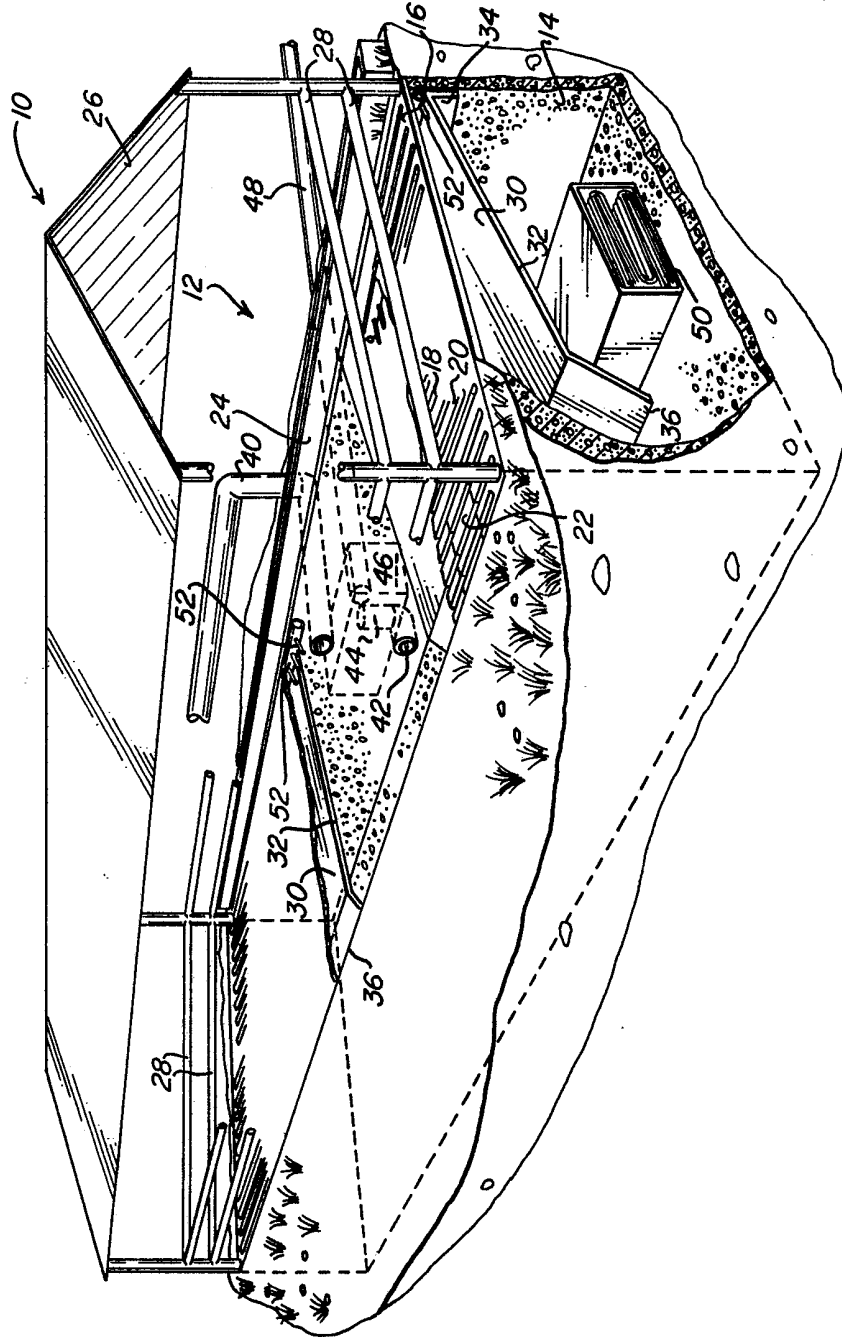
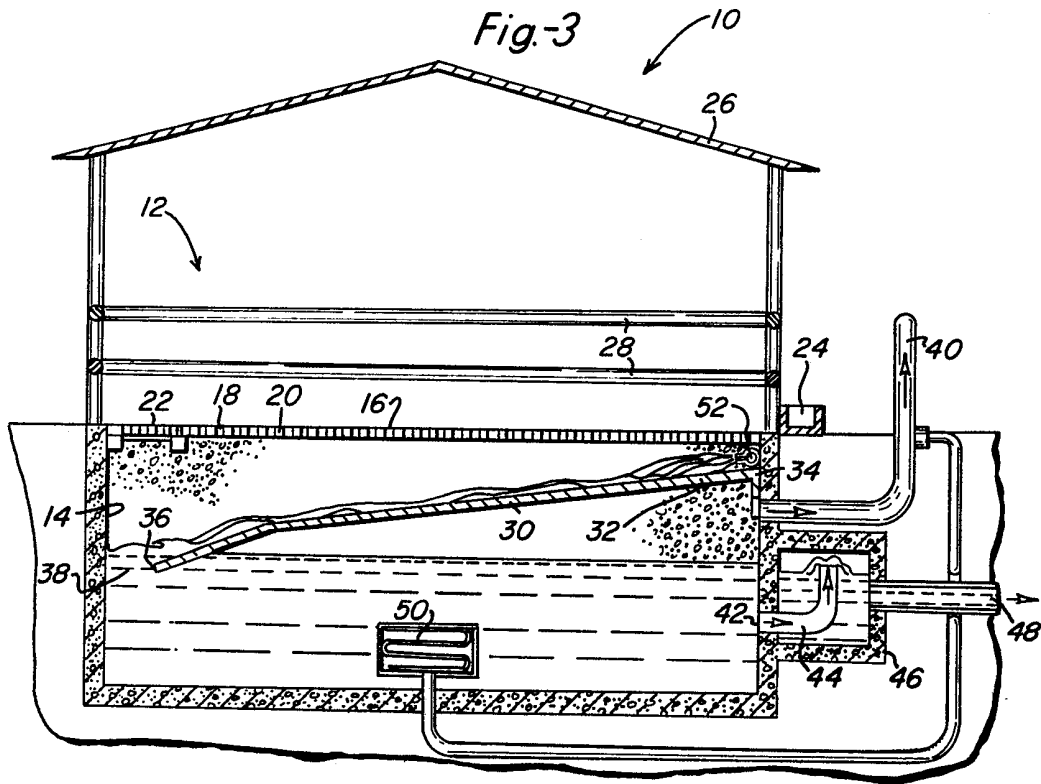
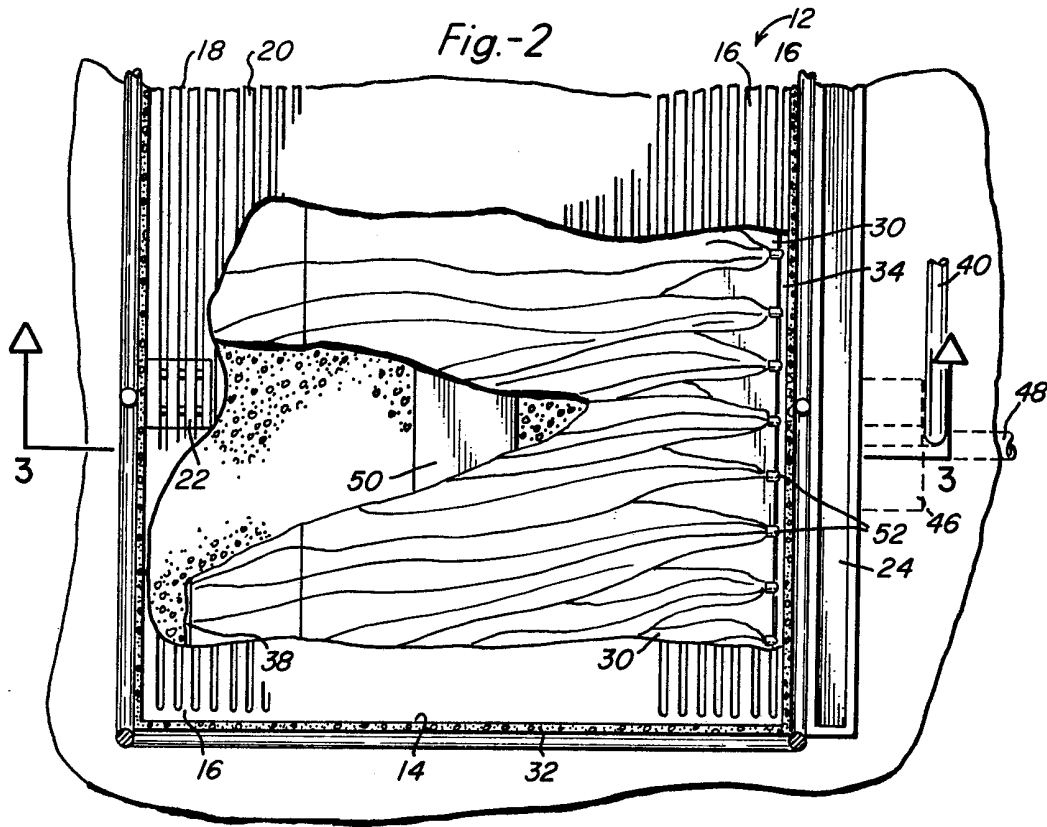


Fig-1





SPECIFICATION

Method and Apparatus for Processing Animal Waste

5 This invention relates to apparatus and a method for the treatment of animal waste materials.

10 In some areas, much of the livestock, particularly cattle and hogs, are raised indoors rather than on the open range. This however, leads to the difficult and expensive task of removing disposing of the mixture of solid and liquid animal waste materials and contending with offensive odour associated therewith.

15 Bio-degradation of the manure to produce bio-gas for use as a fuel is a way of converting the waste materials from such an operation into a useful commodity. Unfortunately, however, it does not solve the odour problem or make cleaning the animal waste pits easier.

20 According to one aspect of the present invention, there is provided apparatus for the treatment of animal waste materials, the apparatus comprising a receptacle for animal waste materials, a floor covering said receptacle
25 for supporting animals, the floor having openings therein to permit waste products from the animals to pass therethrough, ramp means covering a substantial portion of the receptacle underneath the floor, a gap being provided between the lower
30 edge of the ramp means and an adjacent receptacle wall through which gap waste materials can enter the receptacle, the said lower edge of the ramp means being arranged such that it is immersible in waste materials contained in
35 the receptacle thereby isolating the portion of the waste materials located beneath said ramp means from the atmosphere, water supply means arranged in the region of the top of the ramp means, heating means within the receptacle for
40 heating the waste materials, contained therein to a temperature effective to produce a bio-gas from any bio-degradable constituents contained therein under anaerobic conditions when seeded with suitable bacteria, means for withdrawing gas
45 from underneath the ramp means, and means for withdrawing solids from the receptacle, said means being located at a point in the receptacle remote from the gap where the waste materials enter.

50 According to another aspect of the present invention there is provided apparatus for the treatment of animal waste materials the apparatus comprising a ramp arranged to receive animal waste material passing through openings
55 in a floor of an animal confinement building, a substantially sealed receptacle arranged to receive waste material from the ramp, heating means provided in the said receptacle, means for removing gas from the receptacle and means for withdrawing solid material from the receptacle.

60 According to another aspect of the present invention there is provided a method of treating animal waste materials passing through openings in the floor of an animal confinement building, the

65 method comprising catching a substantial portion of the animal waste on a ramp sloping down towards an entryway of a receptacle arranged such that a substantial portion thereof is located underneath the ramp, flushing the waste
70 materials deposited on the ramp down into the receptacle through said entryway, maintaining the level of waste materials within said receptacle above the lower end of said ramp to seal the portion of the waste materials located underneath
75 the ramp from the atmosphere, seeding the waste materials contained within the receptacle with bacteria capable of breaking bio-degradable constituents thereof down into bio-gas and solid residues, heating the waste materials within the
80 receptacle to the temperature conducive to promote anaerobic digestion of said bio-degradable constituents, withdrawing bio-gas produced from underneath the ramp, and removing the solid residues from the receptacle at
85 a point remote from the entryway.

According to another aspect of the present invention there is provided a method of treating animal waste materials, the method comprising catching waste materials passing through
90 openings in a floor of an animal confinement building on a ramp, flushing the waste materials down the ramp into a substantially sealed receptacle, seeding the waste material with bacteria capable of bio-degrading the waste
95 materials to bio-gas and solid residue, tapping bio-gas produced in the receptacle and removing solid residues.

The ramp is arranged so that it defines an "in situ" anaerobic register.

100 Water is added to the waste as it enters the receptacle or pit so that it contains the proper proportion of solids for optimum digestion and also to wet it to the point where it will slide easily down the ramp. Heaters within the receptacle
105 maintain the temperature of the waste materials within the range which is ideally suited to maximize the bacterial action and promote the digestion process. These heaters also prevent the materials in the pit from freezing and becoming difficult to handle. Also, the source of heat to heat
110 the heaters is readily available in the form of the bio-gas generated by the process. Plenty of fuel is generated since as a rough estimate, each cow can be expected to produce enough manure to generate from a minimum of 20 up to around 40
115 cubic feet of bio-gas a day. Bio-gas is a combustible mixture of methane, carbon dioxide and hydrogen sulfide. Even without the removal of impurities having no fuel value from the bio-gas probably less than a third of the gas generated would be needed to operate the heaters even under extreme conditions.

120 An outlet at the base of the pit remote from the point at which the fresh manure enters is provided to deliver the digested sludge to an overflow box from whence it flows into a lagoon. The degasified sludge consists of only about half the solids that entered the system. At the same time, the sludge is far more dilute and will flow easily

out of the pit and into the lagoon.

Apparatus embodying the invention and a method according to the invention will now be particularly described by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a perspective view of an animal confinement building partly cut away to show apparatus for the treatment of waste materials;

Figure 2 is a plan view of a pen within an animal confinement building partly cut away to show waste treatment apparatus; and

Figure 3 is a section on line 3—3 of Figure 2.

The illustrated animal confinement building 10 is provided with a plurality of animal pens 12 (Fig. 1). Below the building 10 is a concrete-lined pit 14 covered by the slatted floor 16. Excrement deposited on the floor by the animals eventually works its way through slits 18 provided between slats 20 in the floor 16 and down into the pit 14. A door 22 (Fig. 3) is provided at one end of each pen 12 for cleaning purposes.

A feeding trough 24 extends along one side of the building 10 and is arranged to be filled from a truck driving alongside the building 10. A shed roof 26 covers the pens 12 and barriers 28 are arranged to confine the animals to their particular pen 12. Walls may or may not be provided around the building 10.

A ramp-like sloping lid 30 is located beneath the floor 16 and partially covers the pit 14. The side edges 32 as well as the upper end edge 34 of the lid 30 are attached to the adjacent walls of the pit 14 so as to maintain an essentially gas-tight seal therewith. The free edge 36 of the lid 30 opposite to the end edge 34 is arranged such that it is immersed in the contents of the pit 14 at a small distance from the adjacent pit wall so as to leave a gap 38 therebetween. As will be explained presently, the level of material contained in the pit 14 remains essentially constant so that the lid 30 together with three of the four pit walls prevent air from reaching all but a very small fraction of the pit contents, namely, that fraction which is exposed by the gap 38. The pit contents are seeded with bacteria which digest the bio-degradable portion of waste materials. In the anaerobic conditions below the lid 30, bacteria in the pit 14 break down the contents to produce a bio-gas consisting primarily of a mixture of methane, carbon dioxide and hydrogen sulfide and a wet sludge rich in protein and other nutrients. The bio-gas generated in the pit 14 is trapped underneath the lid 30 and constantly drawn off through a gas line 40 connected to the pit 14 above the level of the pit contents. As the digestion process proceeds, about half the pit contents is converted to bio-gas and the remainder is piped off as sludge through an outlet 42 near the bottom of the pit. This outlet 42 is connected to a standpipe 44 which opens into an overflow box 46. The height of the standpipe 44 determines the level of the contents in the pit 14 and it is arranged to ensure that the said level is above the free edge 36 of the lid 30.

The sludge overflowing from the standpipe 44 drops into the bottom of box 46 where it is drained off to a storage area (not shown) through a drain 48.

A heater 50 which is preferably fired by the bio-gas produced, is located in the pit 14 buried in the contents thereof. Similar heaters can be provided under each pen 12. These heaters 50 maintain the temperature of the contents at a level which optimizes bacterial action.

In large scale operations, of for example a thousand cattle, the volume of bio-gas generated in the above described manner, can far exceed the normal needs of the average farm even if about a third of the bio-gas generated is recycled to the heaters. The remaining gas can be burned without further treatment and used for other applications around the farm. However, there will generally still be a lot left over and under these circumstances, scrubbing or other processing of the surplus gas may be justified.

Now, as previously noted, lid 30 slopes down toward its free edge 36 thus producing a ramp along which the excrement dropping through the slatted floor 16 slides before entering the pit 14 through the gap 38. To facilitate the sliding of the manure and other waste materials down the ramp and also to dilute these materials to an ideal consistency for digestion by bacteria, water is sprayed onto the top of the lid 30 through a series of, for example, spray nozzles 52 located just beneath the floor 16. The lid 30 is made from a smooth-surfaced metal that will not rust, for example it may be a galvanized plate. In the particular embodiment shown, a portion of the lid 30 in the region of the free edge 36 of the lid is bent at a steeper angle to the vertical forming a flange which is immersed in the pit contents.

The incoming waste entering the pit 14 through the gap 38 serves to push the digested sludge through the outlet 42.

The size of these pits 14 is such that the waste materials can stay in well over a month moving from the inlet to the outlet. This is ample time to insure almost 100% digestion, leaving only about half the solids that entered the system to be disposed of. Moreover, the remaining digested sludge has sufficient nutrient value to make it worth recycling. It is rich in protein values and is valuable as a feed supplement, after it has been properly processed to remove bacterial cells.

As a source of organic material for ploughing back into the soil, it is superior to the manure. Also, it is far less objectionable from an odour standpoint than the untreated material.

The highly dilute nature of the material in the pit (roughly 95% water) allows it to move easily toward the outlet as fresh material enters the system so the pits do not have to be pumped clean. The free flow of material is greatly enhanced by the fact that it remains warm and fluid even under very cold ambient conditions. By eliminating the pumping operation, the use of the pump along with the prime mover to drive it can be eliminated as well as the considerable saving

in labour. These cost savings go a long way toward offsetting the cost of the additional equipment necessary in the pits. In fact the pit cleaning operation can be eliminated altogether.

5 An important advantage of this system to the farmer is that his cattle are not stressed by having to breath the noxious gases given off by the excrement in the pit, the latter being essentially roofed-over except for the small gap left where
10 the material enters it. By lessening the odour problem, even the cattle benefit in that they are subject to less stress and, therefore, utilize their feed more efficiently, all of which brings the farmer more money in the marketplace.

15 Thus in summary the above described apparatus forms a subfloor anaerobic digester that is self-emptying and not only requires no input of energy to sustain its operation but produces an excess of energy. The above-
20 described method produces not one, but two, useful byproducts from manure and, at the same time, eliminates most of the problems associated with its disposal along with the stress produced in the animals due to the odour.

25 Therefore this improvement of facilities for fattening animals for market is simple, inexpensive in terms of converting existing facilities, versatile, productive, efficient and virtually labour-free insofar as emptying same is
30 concerned.

Claims

1. Apparatus for the treatment of animal waste materials, the apparatus comprising a receptacle for animal waste materials, a floor covering said
35 receptacle for supporting animals, the floor having openings therein to permit waste products from the animals to pass therethrough, ramp means covering a substantial portion of the receptacle underneath the floor, a gap being provided
40 between the lower edge of the ramp means and an adjacent receptacle wall through which gap waste materials can enter the receptacle, the said lower edge of the ramp means being arranged such that it is immersible in waste materials
45 contained in the receptacle thereby isolating the portion of the waste materials located beneath said ramp means from the atmosphere, water supply means arranged in the region of the top of the ramp means, heating means within the
50 receptacle for heating the waste materials contained therein to a temperature effective to produce a bio-gas from any bio-degradable constituents contained therein under anaerobic conditions when seeded with suitable bacteria,
55 means for withdrawing gas from underneath the ramp means, and means for withdrawing solids from the receptacle, said means being located at a point in the receptacle remote from the gap where the waste materials enter.

60 2. Apparatus according to claim 1, wherein a downturned flange is provided at the lower edge of the ramp means adjacent the gap.

3. Apparatus according to claim 1 or claim 2, wherein the means for withdrawing the solids

65 from the receptacle comprises a discharge tube having an inlet end located at a level below the lower edge of the ramp means and an outlet end positioned at a level higher than the said lower edge, and a catch basin in which the discharge
70 tube is housed, said catch basin having a discharge opening located at a level below the level of the outlet end of the discharge tube whereby solids are withdrawn from the receptacle without effecting the level of waste materials
75 contained therein.

4. Apparatus according to any one of the preceding claims, wherein the heating means comprises gas-fired heaters connected to the means for drawing gas from underneath the ramp
80 means so as to use the gas as a source of fuel.

5. Apparatus for the treatment of animal waste materials the apparatus comprising a ramp arranged to receive animal waste material passing through openings in a floor of an animal
85 confinement building, a substantially sealed receptacle arranged to receive waste material from the ramp, heating means provided in the said receptacle, means for removing gas from the receptacle and means for withdrawing solid
90 material from the receptacle.

6. A method of treating animal waste materials passing through openings in a floor of an animal confinement building, the method comprising catching a substantial portion of the animal waste
95 on a ramp sloping down towards an entryway of a receptacle arranged such that a substantial portion thereof is located underneath the ramp, flushing the waste materials deposited on the ramp down into the receptacle through said
100 entryway, maintaining the level of waste materials within said receptacle above the lower end of said ramp to seal the portion of the waste materials located underneath the ramp from the atmosphere, seeding the waste materials
105 contained within the receptacle with bacteria capable of breaking bio-degradable constituents thereof down into bio-gas and solid residues, heating the waste materials within the receptacle to the temperature conducive to promote
110 anaerobic digestion of said bio-degradable constituents, withdrawing bio-gas produced from underneath the ramp, and removing the solid residues from the receptacle at a point remote from the entryway.

115 7. A method according to claim 6, wherein the bio-gas generated in the receptacle is utilized as a source of fuel to heat the waste materials in the receptacle.

8. A method according to claim 5 or claim 7, wherein the waste materials entering the
120 receptacle through the entryway forces the solid residues out of the receptacle following digestion thereof.

9. A method according to any one of claims 6 to 8, wherein the solid residues are removed from the receptacle at a point below the surface level thereof and discharged into an overflow basin at a
125 level above the lower edge of the ramp.

10. A method of treating animal waste

- materials, the method comprising catching waste materials passing through openings in a floor of an animal confinement building on a ramp, flushing the waste materials down the ramp into a*
- 5** substantially sealed receptacle, seeding the waste material with bacteria capable of bio-degrading the waste materials to bio-gas and solid residue, tapping bio-gas produced in the receptacle and
- removing solid residues.
- 10** 11. Apparatus for the treatment of animal waste materials substantially as hereinbefore described with reference to the accompanying drawings.
- 15** 12. A method of treating animal waste materials substantially as hereinbefore described.

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