



- (51) International Patent Classification:
C07F 17/02 (2006.01)
- (21) International Application Number:
PCT/US2012/022627
- (22) International Filing Date:
26 January 2012 (26.01.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
13/016,428 28 January 2011 (28.01.2011) US
- (71) Applicant (for all designated States except US): **FOR SOLUTIONS, LLC** [US/US]; 903 Rock Lane, Newton, NJ 07860-4575 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **SMITH-SEBASTO, Nicholas** [US/US]; 903 Rock Lane, Newton, NJ 07860-4575 (US).
- (74) Agent: **GENOVESI, Lina**; Gilman Pergament LLP, 1480 Route 9 North, Suite 204, Woodbridge, NJ 07095 (US).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report (Art. 21(3))

(54) Title: COMPOSTING MACHINE

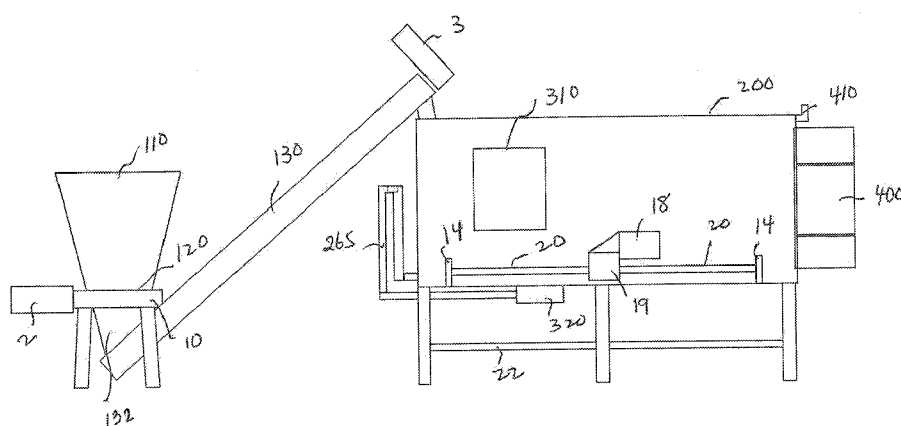


Fig. 1

(57) Abstract: An apparatus for the in-vessel composting of feedstock into nutrient-rich compost comprising means for shredding said input material, said means configured and powered for shredding said feedstock into a particle size no larger than one cubic inch, a vessel having an input port on top of such vessel and a discharge port, said vessel comprising one chamber, said vessel configured and powered composting said shredded feedstock, and said vessel tilted from the input port to the discharge port, means for passing said feedstock from said means for shredding into said vessel, means for rotating said vessel, means for introducing air into said vessel and a process controller, said process controller communicating with said means for shredding, said vessel, said means for rotating said vessel and said means for introducing air into said vessel.

WO 2012/103269 A1

COMPOSTING MACHINE

FIELD OF THE INVENTION

5 This invention relates to the contained digestion of feedstock consisting of food waste and associated organic materials into nutrient-rich compost.

BACKGROUND ON THE INVENTION

10 According to the United States Environmental Protection Agency, the United States generated approximately 34 million tons of food scraps in 2009. That's 22 tons or roughly 3 times the amount that was generated in 1960. That number continues to grow every year as the population continues to increase. In fact, while the average American generated only 120 lbs. of food scraps in 1960, that figure
15 increased to 221 lbs. in 2009. At the rate of increase between 1960 and 2008, the amount of food scraps generated by Americans will grow to over 39 million tons by 2018.

 Public and private sectors are facing increasing transportation and disposal costs for all discards, including food scraps. There is also increasing concern about
20 the sustainability of current disposal practices, which are instigating investigations into more environmentally benign disposal options. Previous methods such as landfilling and incineration are being recognized as unsustainable.

 Transporting food scraps to landfills contributes enormously to anthropogenic sources of greenhouse gases such as carbon dioxide and nitrogen and sulfur oxides

as well as other general air pollutants such as particulate matter, volatile organic compounds, and carbon monoxide. Once land-filled, organic discards such as food scraps contribute to methane production, a greenhouse gas believed to be 20-70 times more effective at trapping heat in Earth's atmosphere than carbon dioxide.

5 While some landfills are collecting the methane gas, most do not; it is simply vented to the atmosphere. In the U.S., this situation is further complicated by the rapidly approaching closure of many landfills.

Transporting food scraps to incinerators, or waste-to-energy facilities, contribute in the same manner to greenhouse gas emissions. The difference is that

10 while no methane is emitted, other gases are. Additionally, food scraps have one of the lowest BTU values per pound. Compared to plastics, which range between 11,000 and 20,000 BTUs/lb.; rubber, which produces approximately 11,000 BTUs/lb.; newspaper, which produces 8,000 BTUs/lb.; cardboard, which produces 7,000 BTUs/lb.; food scraps produce only 2,600 BTUs/lb. Consequently, incinerator

15 operators may be forced to supplement their fuel source with fossil fuels to maintain high burning temperatures if too much of their fuel is food scraps.

The benefits of aerobic digestion of organic discards are well documented. In fact, it is the planetary default for the recycling of organic matter. When systems designed by humans replicate these biological processes, it is known as composting

20 and the end-product is known as compost. Commercial or industrial applications have often focused on outdoor windrowing technology. Problems associated with this option include odors, limitations on what may be composted (animal products are often excluded), time to produce the compost, and energy required. Recently, interest in aerobic in-vessel technology (known by various different names, including

rotary drum) has increased. This is because many of the concerns about windrowing are addressed. Because they are contained units, aerobic in-vessel systems dramatically reduce odor issues; remove limitations about what may be composted (animal products are acceptable), dramatically reduce the time to produce the compost, and require much less energy. It has also been suggested that "Harvesting food waste as a reusable resource is the next frontier in recycling."

Despite such encouraging comments, the recycling of food scraps via composting has remained at about 2.5% of the total amount generated since 2000. Part of explanation for this finding is that many of the existing aerobic in-vessel digestion systems available to the mass market have not been value-engineered, do not include required safety features, and are aesthetically unpleasing.

In light of these and further disadvantages of prior art composting system and methods, including their relative complexity and other design shortcomings, it is clear that there remains a need for an improved composting system and method that overcomes one or more of the disadvantages of the prior art. It is clearer still that a composting system and method that provides a solution to each of the above-described advantages while demonstrating enhanced effectiveness and utility would represent a market advance in the art.

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SUMMARY OF THE INVENTION

The invention provides an apparatus for the in-vessel composting of feedstock into nutrient-rich compost. The apparatus comprises means for shredding said input material, said means configured and powered for shredding said feedstock into a

particle size no larger than one cubic inch, a vessel having an input port on top of such vessel and a discharge port, said vessel comprising one chamber, said vessel configured and powered composting said shredded feedstock, and said vessel tilted from the input port to the discharge port, means for passing said feedstock from said means for shredding into said vessel, means for rotating said vessel, means for introducing air into said vessel, and a process controller, said process controller communicating with said means for shredding, said vessel, said means for rotating said vessel and said means for introducing air into said vessel.

The means for passing said feedstock from said means for shredding into said vessel comprises an input hopper connected to said means for shredding and an auger and a chute connecting said means for shredding to said input port of said input end of said vessel.

The vessel comprises means for tumbling to facilitate mixing of said shredded materials as the vessel rotates and the means for introducing air into said vessel comprises means for introducing air into an aeration port of said vessel. The means for aerating comprises perforations in the bottom part of said vessel and means for forcing said air into said perforations. Temperature in the vessel is maintained in the range of 100 to 135 °F.

The means for rotating said vessel comprises a base frame and a motorized direct-drive system comprising a motor and a gearbox attached to said base frame and coupled to said drum.

The apparatus further comprises means for collecting said digested feedstock and said means for collecting comprises a screener.

In one embodiment, the invention provides for an apparatus for the in-vessel composting of feedstock into nutrient-rich compost. The apparatus comprises a shredder for shredding said feedstock, a hopper connected to said shredder to facilitate feeding of said feedstock, a vessel having an input port on top of such vessel and a discharge port, said vessel comprising one chamber, said vessel configured and powered composting said shredded feedstock, and said vessel tilted from the input port to the discharge port, an auger and a chute connecting said shredder to said input port of said input end of said vessel, means for rotating said vessel, said means for rotating said vessel comprises a base frame and a motorized direct-drive system comprising a motor and a gearbox attached to said base frame and coupled to said drum, means for introducing air into said vessel, a process controller, said process controller communicating with said means for shredding, said vessel, said means for rotating said vessel and said means for introducing air into said vessel.

Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side elevation illustrating the shredder, the loading hopper, the conveying auger, a digester vessel, and a finishing screener.

Figure 2 is a block diagram illustrating the principal elements and the process flow of the present invention.

Figure 3 is a side elevation cross section of the vessel of the preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

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The invention is susceptible to many variations, including scaling for capacity, so long as process parameters and control logic are maintained. Accordingly, the drawings and following description of the preferred embodiment are to be regarded as illustrative in nature, and not as restrictive.

10

The invention provides for an aerobic in-vessel digestion system particularly suited to the accelerated digestion of food scraps. This invention provides several advantages over prior art. The composting system is capable of operating efficiently and with minimal preventative maintenance so that it may become more mainstream regarding solid waste management. The invention is designed to minimize potential malfunctions by reducing the number of moving parts. The aerobic in-vessel composting system also enables expedient repair or other remediation of the system should such action be necessary. Another advantage of the invention includes its compliance with all applicable OSHA regulations.

15

High quality compost made from food scraps does not happen by accident. It is produced by carefully blending the food scraps with a bulking agent/carbon source (often wood shavings), collectively known as the feedstock, to provide various microorganisms with an optimal diet. External factors, such a temperature, oxygen availability, and moisture content of the materials to be composted greatly influence the time it takes for the microorganisms to digest the feedstock. Under optimized

20

conditions, the microorganisms can convert food scraps based feedstock to compost in as few as 5 days. Varying species of bacteria present in the digester vessel will break down any organic materials into the output compost mixture, and as temperatures rise and fall in the compost, different bacterial species will become more or less active. Mesophilic and thermophilic bacteria each operate best within specific temperature ranges. Furthermore, with sufficient oxygen, microorganisms produce energy, grow quickly, consume more material and make nutrients available for plant growth. Without oxygen, aerobic bacteria die off and anaerobic bacteria take over. They will break down the material, but more slowly, and with an accompanying unpleasant odor. Offensive odors are produced only when the material in the system is allowed to become anaerobic, not a normal condition in the practice of this invention.

To provide a simple, reliable, efficient, aerobic in-vessel composting system, it is most useful to optimize the apparatus to a selected, well-defined waste stream, thus reducing the processing variables and simplifying the apparatus and operation. This technique offers the user a composting process and apparatus that produces a more consistent, higher quality, nutrient rich, end product.

The invention, in its simplest form, is an integrated or unitized reduction and composting process and system for the recycling of food scraps and associated organic waste materials such as wood shavings, into an end product that is manageable, useful, and inoffensive. This waste stream provides an abundance of nitrogen and moisture, both important in the process. The amount of carbon-rich and moisture-absorbing bulking agent can be varied, based on process conditions, by adding supplemental organic materials such as wood shavings. The invention will

accept other bulking agents such as cardboard if desired, but it is specifically designed to incorporate wood shavings for the composting process of the invention.

The specified input materials for which the invention is intended must be combined in a recipe that produces a feedstock with an appropriate carbon to nitrogen ratio and moisture content. This is accomplished by blending an appropriate amount of the bulking agent/carbon source with the food scraps. The process is exothermic and requires only oxygen to be sustained to completion. The digestion vessel is well insulated, so the primary requirement of the system is to remove excess water vapor, control the temperature, and add sufficient air to supply the oxygen needed in order to sustain the process.

The system is tolerant of a limited amount of incompatible solid contaminants that may be present in particular applications or installations. The invention utilizes a continuous three-step process which has approximately a 5-day throughput cycle, consisting of shredding to the optimal particle size, then mixing and composting through an in-vessel process. The apparatus is self-contained to provide for continuous input of feedstock, generating an output of nutrient-rich, organic compost material of significantly less volume than the feedstock.

Process constraints include particle size, relatively significant retention quantities and dwell time in the digester vessel, sufficient aeration, and temperature control. Apparatus variables to be considered are the incremental amount and frequency of drum rotations required to control the heat, in combination with size and ratio of chamber length to drum diameter, and the port sizes.

The invention utilizes a continuous three-step process that has approximately a five-day throughput cycle, consisting of shredding the feedstock (the food scraps

and wood shavings) to the optimal size, conveying it to the vessel for the aerobic digestion, then off-loading and screening the compost. The high internal temperatures inside of the vessel vaporize water in the feedstock that is exhausted via a combination of enforced aeration and an exhaust vent. The apparatus is self-contained to provide for continuous input of feedstock, generating compost of substantially less volume than the feedstock.

One embodiment of the present invention is a shear shredder that size reduces the food scraps to approximately 1 cubic inch in volume. A 5-hp electric motor powers the cutting deck. The size reduced food scraps pass through a transition connection into a screw auger that conveys the material to the input port of the digester vessel. The conveyer is powered by a 2 hp electric motor. The screw auger is enclosed in a cylinder over its entire length.

A hopper mounted above the cutting surface includes a lid with a magnetic switch that prohibits movement of the cutting blades if the lid is raised. The hopper is also of a height that makes it virtually impossible for an average person to reach her/his arm into it to the depth of the cutting blades. An access port is available to permit maintenance of the cutting blades as would exist in the event of a jam. Again, a magnetic switch prevents actuation of the blades if the port door is open. A control panel located several feet away controls the shredder. To start the cutting blades, an operator presses a button labeled "Shredder On" (there is also a "Shredder Off" button). Two opposing axes with cutting blades operate such that one turns in a clockwise direction while the other turns in a counterclockwise direction. Upon starting, each axis reverses direction for approximately $\frac{1}{4}$ turn or 90 degrees, pauses momentarily, and then turns in the prescribed direction until the hopper is empty. A

5 hp motor powers the cutting deck. Shredded materials are discharged at the bottom of the cutting deck into a conveying auger.

The shredded food scraps as well as the wood shavings are conveyed to the input port of the digester vessel. The conveying auger consists of a 10-inch diameter tube with a screw auger completely enclosed inside of it. Flight edging assures full conveyance of all deposited materials and no residue buildup inside of the tube. A 2 hp motor powers the auger. The same control panel that controls the shredder controls this motor. A second column of buttons that includes an "Auger On" and "Auger Off" option appears to the right of the column for the shredder. The control protocol is designed so that the auger will not actuate if the loading door of the vessel is closed. This is made possible by a magnetic switch on the loading door.

Processing of the food scraps at this stage is accomplished by introducing them, along with the wood shavings, into the digester vessel. To conduct loading of materials into the vessel, assumed to be as often as daily, the operator opens the hopper lid, loads it with food scraps, and closes the lid. The lid to the input port of the digester vessel is then opened. The operating switches are then engaged to start the shredder and the auger. When the hopper is empty, the shredder is disengaged but the auger is allowed to continue to operate until the conveying tube is empty. The process is repeated until all of the feedstock has been conveyed to the digester vessel. At that point, the operating switch for the auger is disengaged. The input port for the digestion vessel is closed and the operating switch for the drum is engaged so that it makes one rotation.

To conduct off-loading of compost, assumed to be as often as daily once the digester vessel reaches its operating volume, the operator opens the discharge door on the end of the digestion vessel and engages the operating switch for the drum. The vessel will rotate and compost will tumble from the discharge door into the screener. From there, it will fall through the screen into whatever collection system is desired by the owner of the system, including but not limited to a trailer, pick-up truck, wheel barrow, etc. When the desired amount of compost has been off-loaded, the operator disengages the drum switch and closes the discharge door.

The digester vessel is a single chamber of a volume calculated based on the projected daily input of feedstock. The input port is on the top of the vessel, which is cylindrical in shape, immediately at the terminus of the conveying auger. While the vessel may be constructed to various dimensions, the most common will be 6 feet in diameter by 12 feet in length. A cylinder of this size is capable of accepted 1,000 lbs. or one cubic yard of feed stock per day. The inside of the vessel includes a perforated floor through which a 3 hp blower on a programmed schedule enforces air, typically every 15 minutes. The vessel also includes an exhaust port at the top of the opposite end of the vessel. On the end of the vessel opposing the input port, a discharge door is provided for the off-loading of the compost. Two baffles are positioned at 90 and 270 degrees of the circumference of the vessel. These baffles assist in lifting the dropping the composting feedstock as the vessel rotates, typically once per hour. A 5 hp motor powers the direct-drive drum drive.

The food scraps are introduced by opening the loading door to the digester vessel; turning on the auger; opening the shredder lid and depositing a measured

amount of food scraps; closing the shredder lid; turning on the shredder to allow it to operate until the hopper is empty.

The actual process of aerobic digestion occurs in the digester vessel. The actual size of the digester vessel, which is cylindrical and measured by the diameter and length of it, is variable; however, typical diameters will be 3-10 feet, while typical
5 lengths will be 6-42 feet. The needed volume of the digester vessel determines the actual dimensions. The digester vessel of the invention does not include multiple chambers as do other prior art as they are not necessary. It is tilted on a 1-2 degree down angle from the point of input to the point of discharge. Along with a
10 programmed rotation once per hour, this tilt moves the composting feedstock toward the discharge end in a 5-day processing period. Baffles along the entire length inside of the digester vessel provide a lifting action and facilitate mixing of the material being composted as the digester vessel rotates. The base of the vessel includes a flat, perforated floor that permits a programmed aeration of the
15 composting feedstock. On 15-minute intervals, a blower introduces a calculated volume of air into the digester vessel. Because the microbes involved with the digestion are so efficient, they can deplete the oxygen inside of the vessel in 15 minutes. This condition, known as anaerobic, is problematic because odors are a characteristic of this type of digestion. Because food scraps tend to have an acidic
20 pH, the inside of the vessel is constructed of stainless steel. The vessel is also coated with 2-3 inches of closed-cell foam insulation. It is then wrapped with another layer of stainless steel, to provide a professional, scientific instrument-like appearance. A screener is attached to the digestion vessel which is located on the terminal end of

the vessel. The ½ inch by ½ inch mesh forms the sides of what represents another cylinder.

The temperature within the vessel is maintained by the continuous addition of
5 feedstock within the range of 100 to 135 ° Fahrenheit, preferably higher than 131
degrees Fahrenheit to ensure pathogen destruction. It is also necessary to maintain
this temperature range to kill any seeds present within the feedstock. In contrast,
from practice it was found that waste stream materials other than those containing
pathogens, such as fruits, vegetables, paper, etc. will degrade to compost at
10 temperatures as low as 95 degrees Fahrenheit due to the activity of mesophilic
bacteria. However, it should be noted that while there are no pathogenic materials to
contend with, seeds within the feestock will not be killed at such a low temperature.
Just as important, the temperature of the mixture material should not exceed 150
degrees Fahrenheit as the anaerobic bacteria will begin to die off as temperatures
15 rise above this level.

Unlike other commercially available aerobic in-vessel composting systems,
chains or belts do not rotate the vessel. Instead, it is rotated by wheels connected to
a direct drive shaft. Consequently, there are far fewer moving parts than other
systems. A 3 hp motor controls the drive shaft that turns the vessel.

20 Also unlike other commercially available aerobic in-vessel composting
systems, the material to be digested is not introduced into the digester vessel at a
center point of an end of the vessel. Instead, it is introduced via a circular port on
the top of the side of the digester vessel. This 'top-loading' permits a larger usable
volume of the digester vessel. A digester vessel with a diameter of 6 feet and a
25 length of 12 feet, for example, will have a geometric volume of 11.6 cubic yards and

a usable volume of 8.7 cubic yards. The usable volume assumes that the digester vessel may be filled to 75% of its geometric volume, which is only possible with a top-loading design.

The system of the invention also includes a process controller that serves to
5 operate the shredder, the conveying auger, digester vessel, and blower. Safety features comprised of magnetic sensors, placed on the lid of the shredder and the input port of the vessel, prevent the unsafe operation of all aspects of the invention. The process control system serves to detect if (1) the hopper door is raised. If it is, the cutting deck of the shredder will not operate; (2) the cutting deck is operating. If
10 it is not, the conveying auger will not operate; (3) the input port is open. If it is not, the conveying auger will not operate; (4) the drum cycle is on. If it is not, the aerator will not operate. All of these features are designed to maximize the safety of the invention and to minimize the potential for operator error. For example, the conveying auger will not operate if the input port of the digestion vessel is closed.
15 This makes it impossible for the operator to move shredded feestock to the vessel if the door is not open.

Referring now to FIGS. 1 and 2, there is illustrated a hopper 110, a shredder 120, an auger 130, a vessel 200, a control panel 310, an aerator 320, a drum drive 330, and a compost finishing screener 400. The hopper 110 and shredder 120 are
20 located on a base frame 10. The finishing screener 400 is attached to the back end of the vessel 200. Natural outgassing occurs by design in the vent noted at coupling 410 when the exhaust fan is not running.

Referring to FIGS. 1 and 2, feed hopper 110 is about 36 inches high by 28 inches deep and 24 inches wide, that is closed between feedings. The hopper feeds

vertically downward into shredder 120. The shredder 120 is a material shredder/particle size reducer powered by a electric motor 2 that provides low speed, high torque counter-rotating cutters that intensively shear and shred. The tooth size, blade size, and spacing of shredder 120 are calculated to tear and shred the supplied materials into particles not larger than 1 cubic inch. The shredder 120 is capable of handling the all food scraps, including bones, as well as supplemental bulk materials such as wood chips.

Shredder 120 feeds vertically downward into auger 130, which is diagonally oriented and is likewise powered by an electric motor 3. The nine inch by 10 foot chute deposits the shredded material into vessel 200.

Referring to FIGS. 1 and 3, the digester vessel 200 consists of a 6-foot diameter, 12-foot long drum. The digester vessel 200 holds 8.7 cubic yards of working volume of materials in process, and has a throughput cycle of five days. The digester vessel 200 is preferably fabricated of stainless steel and it could be made of any suitable material. It is mounted horizontally on the base frame 22 so as to be rotatable by a motorized direct-drive system, consisting of drive shaft 20, drive wheels 14, motor 18 and gear box 19 (as shown in FIG. 1). As shown in FIG. 1, in addition to resting on drive wheels 14, vessel 200 rests on two roller wheels (not shown). The front end of vessel 200 has in input port 210 of about 12 inches diameter, through which auger 130 deposits the shredded materials. The back end of vessel 200 has a discharge door 280 of 16 inches x 16 inches for off-loading the output material into the finishing screener 400 as shown in FIGS. 1 and 2.

Referring to FIG. 3, the exterior of the digester vessel 200 includes the finishing screener 270. The interior of the digester vessel includes two baffles 230

that run the entire length of the of the interior, aeration pipe 260, aeration plenum 250, and aeration plenum ceiling 240. Air is forced through aeration pipe 260 via aerator 320 which connected to vessel 200 via air pipe 265 (as shown in FIGS. 1). Aeration plenum ceiling 240 includes 1,000 holes per square foot to enable the
5 diffusion of the air provided through the aeration pipe 260. Baffles 230 serve to lift the shredded material so the shredded material is allowed to tumble and undergo physical breakdown. Screener 270 is a cylindrical frame screener that serves to screen out particles larger than $\frac{1}{2}$ cubic inches from the compost that is being discharged through discharge door 280. Particles larger than $\frac{1}{2}$ cubic inches are
10 returned to the vessel if they are organic and to refuse container if they not organic.

Referring to FIGS. 1 and 2, the complete process path through the apparatus is into hopper 110, through shredder 120, through transition 132, through auger 130, through port 210, into vessel 200, as moved by drum rotation and the gradual down slope flow through discharge door 280 (as shown in FIG. 3), through finishing
15 screener 400 (as shown in FIG 1 and 3) into whatever collection receptacle is desired. Process controller 310 controls shredder 120, auger 130, drum drive 330, and aerator 320.

As will be realized, the invention is capable of other and different embodiments, and its several details are capable of modifications in various obvious
20 respects, all without departing from the essence of the invention. As an example, the invention can also include a bucket elevator in place of the auger, or the shredder could be connected directly to the digester vessel with no conveyance option. The invention can be scaled, so long as the critical parameters of the process are satisfied. A small version of the embodiment would be practical for a homeowner, an

intermediate version is practical for use by a restaurant or supermarket, and a large version would be practical for a municipal collection/drop-off facility.

WHAT IS CLAIMED IS:

1. An apparatus for the in-vessel composting of feedstock into nutrient-rich
compost comprising:
 - 5 means for shredding said input material, said means configured and powered
for shredding said feedstock into a particle size no larger than one cubic inch,
a vessel having an input port on top of such vessel and a discharge port, said
vessel comprising one chamber, said vessel configured and powered
composting said shredded feedstock, and said vessel tilted from the input port
10 to the discharge port,
means for passing said feedstock from said means for shredding into said
vessel,
means for rotating said vessel,
means for introducing air into said vessel.
 - 15 a process controller, said process controller communicating with said means
for shredding, said vessel, said means for rotating said vessel and said
means for introducing air into said vessel.
2. The apparatus according to claim 1, wherein said means for passing said
20 feedstock from said means for shredding into said vessel comprises an input
hopper connected to said means for shredding and an auger and a chute
connecting said means for shredding to said input port of said input end of
said vessel.

3. The apparatus according to claim 1, wherein said vessel comprises means for tumbling to facilitate mixing of said shredded materials as the vessel rotates.
4. The apparatus of claim 1, wherein said means for introducing air into said
5 vessel comprises means for introducing air into an aeration port of said vessel.
5. The apparatus of claim 4, wherein said means for aerating comprises perforations in the bottom part of said vessel and means for forcing said air
10 into said perforations.
6. The apparatus of claim 1, wherein said vessel further comprises means for maintaining the temperature of said vessel in the range of 100 to 135 °F.
7. The apparatus according to claim 1, wherein said means for rotating said
15 vessel comprises a base frame and a motorized direct-drive system comprising a motor and a gearbox attached to said base frame and coupled to said drum.
8. The apparatus according to claim 1, further comprising means for collecting
20 said digested feedstock.
9. The apparatus of claim 7, wherein said means for collecting comprises a screener.

10. An apparatus for the in-vessel composting of feedstock into nutrient-rich
compost comprising:
a shredder for shredding said feedstock,
5 a hopper connected to said shredder to facilitate feeding of said feedstock,
a vessel having an input port on top of such vessel and a discharge port, said
vessel comprising one chamber, said vessel configured and powered
composting said shredded feedstock, and said vessel tilted from the input port
to the discharge port,
10 an auger and a chute connecting said shredder to said input port of said input
end of said vessel,
means for rotating said vessel, said means for rotating said vessel comprises
a base frame and a motorized direct-drive system comprising a motor and a
gearbox attached to said base frame and coupled to said drum,
15 means for introducing air into said vessel,
a process controller, said process controller communicating with said means
for shredding, said vessel, said means for rotating said vessel and said
means for introducing air into said vessel.
- 20 11. The apparatus according to claim 10, wherein said vessel comprises means
for tumbling to facilitate mixing of said shredded materials as the vessel
rotates.

12. The apparatus of claim 10, wherein said means for introducing air into said vessel comprises perforations in the bottom part of said vessel, means for introducing air into an aeration port in said vessel and means for forcing said air into said perforations.

5

13. The apparatus of claim 10, wherein said vessel further comprises means for maintaining the temperature of said vessel in the range of 100 to 135 °F.

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14. The apparatus according to claim 10, further comprising means for collecting said digested feedstock.

15. The apparatus of claim 14, wherein said means for collecting comprises a screener.

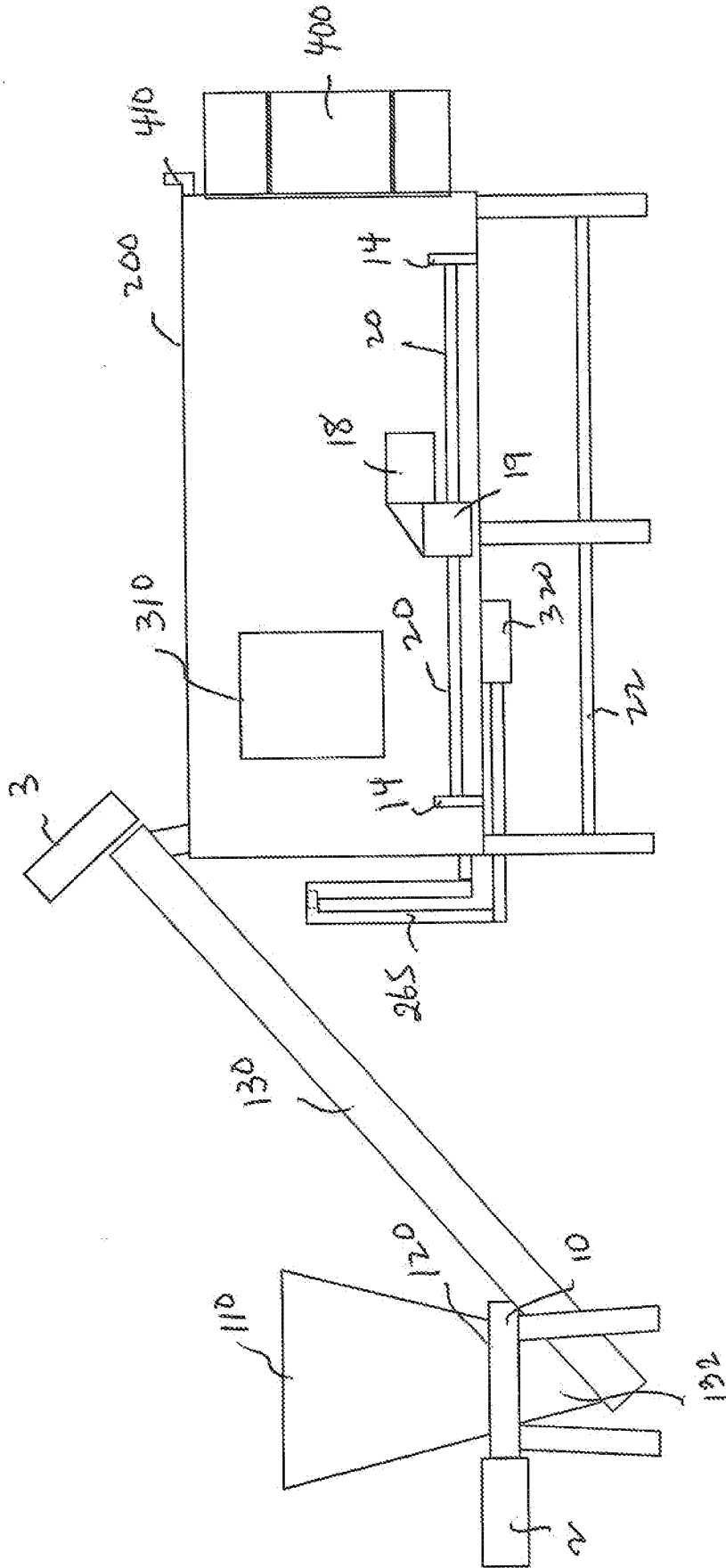


Fig. 1

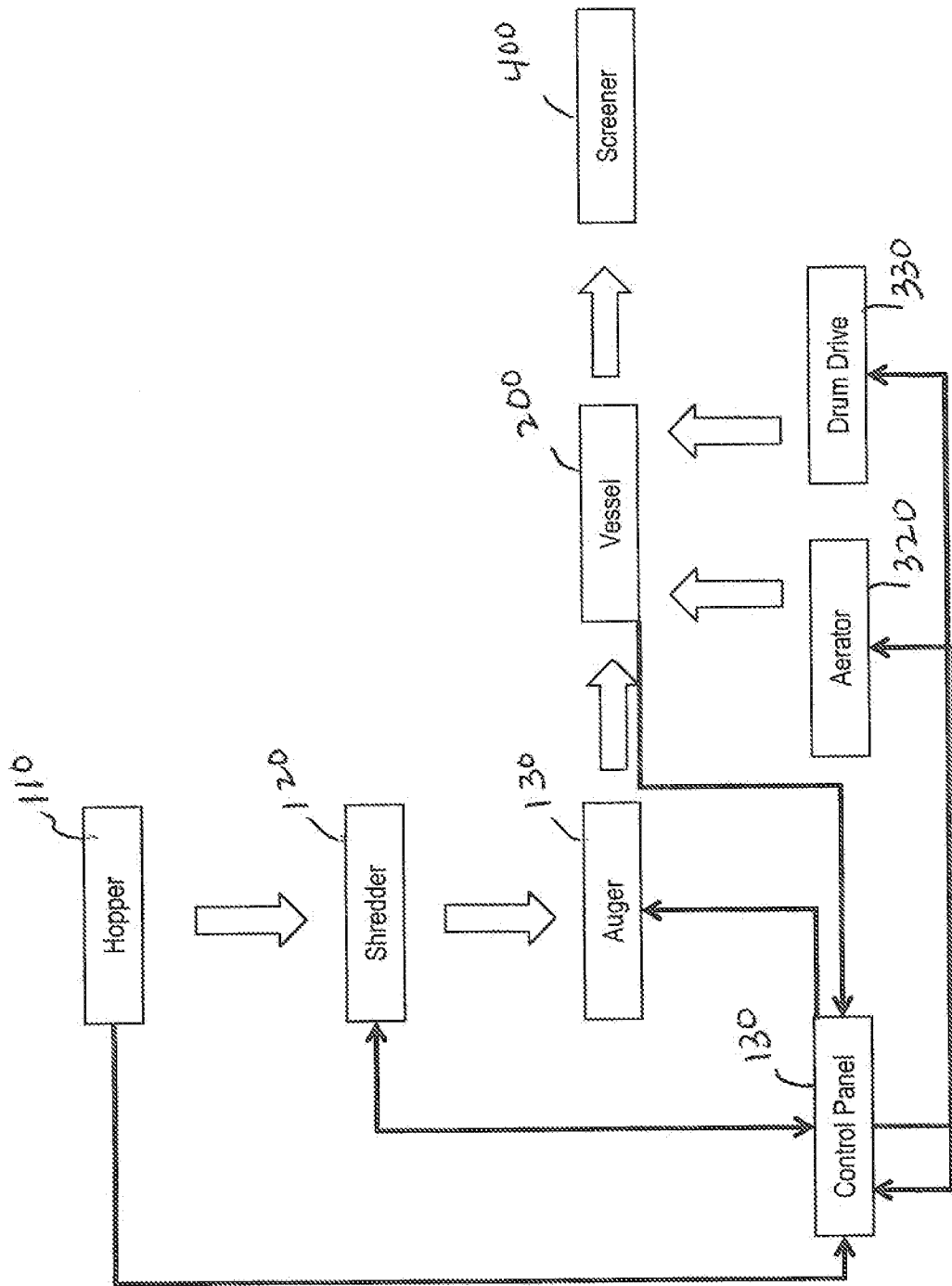


Fig. 2

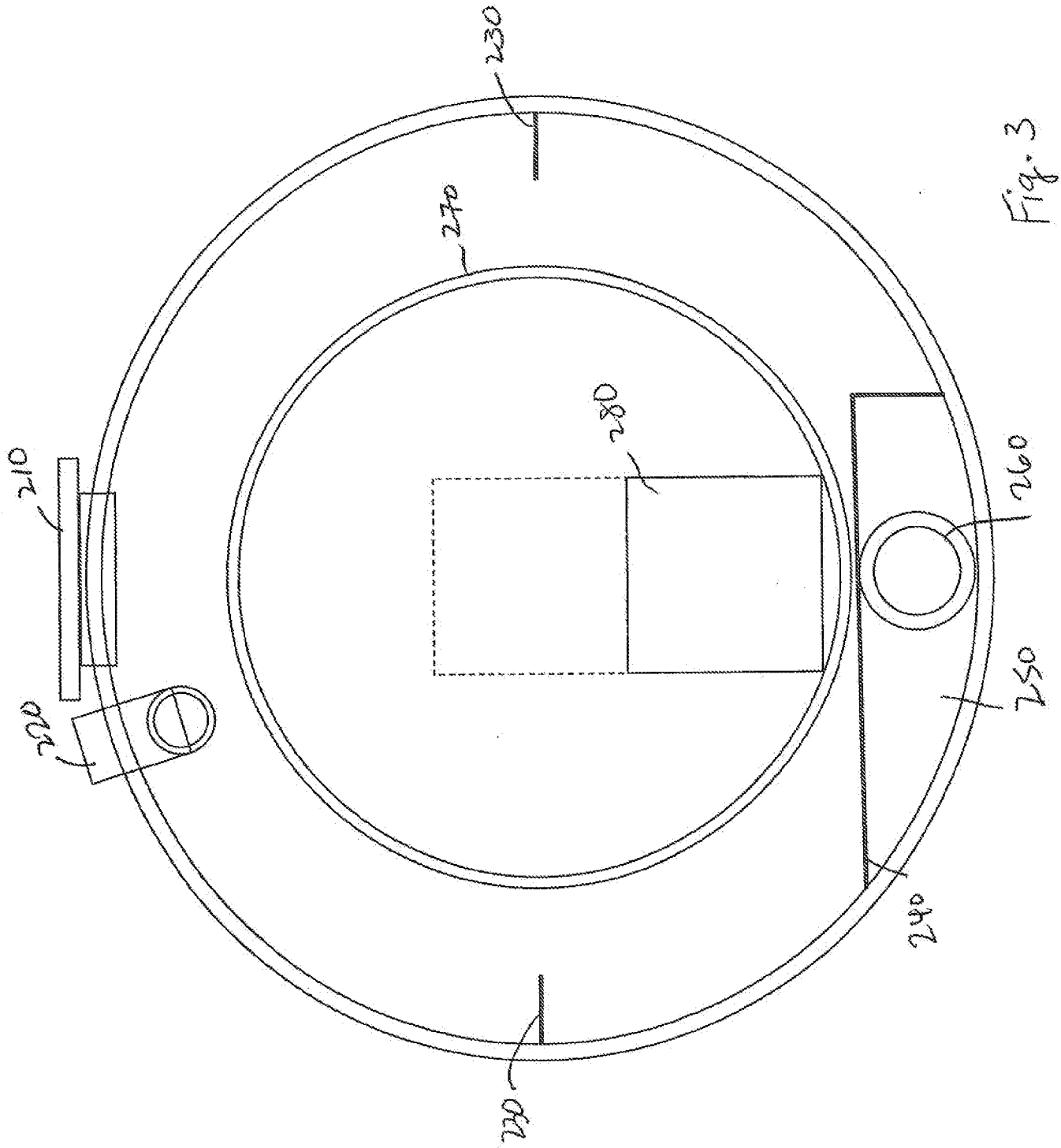


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/022627

A. CLASSIFICATION OF SUBJECT MATTER
INV. C05F17/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C05F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 354 443 A2 (LESCHA MASCHF GMBH [DE]) 14 February 1990 (1990-02-14) column 3, line 28 - column 5, line 49 -----	1-15
X	US 4 204 959 A (DEDERICHS KNUT [DE] ET AL) 27 May 1980 (1980-05-27) column 1, line 23 - line 49 column 3, line 8 - line 12 column 4, line 26 - line 65 -----	1-15
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X	GB 931 365 A (HEAD WRIGHTSON & CO LTD) 17 July 1963 (1963-07-17) page 1, line 15 - line 54 page 3, line 28 - line 92 -----	1-15
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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- "E" earlier document but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
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Date of the actual completion of the international search

3 April 2012

Date of mailing of the international search report

17/04/2012

Name and mailing address of the ISA/
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Cardin, Aurélie

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/022627

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0 309 872 A2 (SALZGITTER MASCHINENBAU [DE] NOELL SERV & MASCHTECHN GMBH [DE]) 5 April 1989 (1989-04-05) figure 1 -----	1-15

INTERNATIONAL SEARCH REPORT

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