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- (21) Application No 18727/78
- (22) Filed 10 May 1978
- (31) Convention Application No 797568
- (32) Filed 16 May 1977 in (19)
- (33) United States of America (US)
- (44) Complete Specification Published 30 Jul 1980
- (51) INT. CL.³ COSF 9/04
- (52) Index at Acceptance C1B 1 2 3E2



(54) "WASTE MATERIAL DIGESTERS"

(71) We, THE FAIRFIELD ENGINEERING COMPANY, a corporation organised and existing under the laws of the state of Ohio, United States of America, of 324 Barnhart Street, Township Marion, Marion County, State of Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This application relates to improvement in digesters for waste material.

The use of digesters to dispose of garbage, sewage sludge and other organic material is becoming of increasing importance. Digesters in various forms have previously been used but have had somewhat limited commercial acceptability because of problems in operation and lack of uniformly satisfactory results. A digester of a type which has been used on a limited basis is shown in Hardy United States Patent 3,114,622. The Hardy patent shows a circular receptacle to receive waste material which is advanced from one side of the receptacle (the outer perimeter) toward the opposite side of the receptacle (the center). A rotating bridge or carriage is provided with a series of inclined agitator screws intended to lift the waste material and intermix it with air for bacterial decomposition. While the concept of the Hardy digester is sound, difficulties have occurred with short circuiting of fresh material introduced into the digester. It has been found for example that a retention period in the digester of perhaps 4 to 6 days is desirable to permit suitable bacterial action and to produce a stable non-offensive organic material. In some instances, however, material freshly introduced has passed through the digester to

the outlet within a matter of hours before digestion has taken place. Accordingly, the output has been contaminated with new material.

Also, some material has become lodged within the digester and has been retained there for periods far in excess of the maximum desired time.

Various schemes have been tried to overcome these problems involving various arrangements of the aerator screws. It has been proposed, for example, to arrange the screws upon the carriage in two or more rows in the hope that this will prevent short circuiting of material from one screw directly to the next to the outlet of the digester within a more shortened period. The results have not been satisfactory, however.

The invention provides a digester having a receptacle for holding a bed of the waste material to be digested, said receptacle having an inlet side for adding fresh waste material and an exit side for discharging digested material, a carriage which moves over said bed of material during digestion, and an array of rotatably driven screws carried by the carriage, and extending into said material bed and being operative to lift said material generally from the bottom to the top of the bed as the carriage moves, each of said screws being disposed with its axis inclined away from the vertical both forwardly and laterally relative to the direction of carriage movement from its top to its bottom end so that the position of the bottom end of each such screw is ahead of and nearer the inlet receptacle side than the position of the top of such screw.

Each screw may be mounted on said carriage by means of an angularly adjustable connection

whereby the screw axis can be angularly adjusted relative to the carriage.

The angularly adjustable connection may comprise a ball and socket joint.

5 Drive means may be provided for the carriage and screws the speed of said drive means being separately adjustable.

10 The said carriage may be supported for pivotal movement through said bed about a pivot axis and the screws may be arranged on the carriage in at least two rows extending generally radially from said pivot axis.

15 The screws in the separate rows may be in staggered relationship relative to the direction of carriage travel.

The said exit side may comprise a wall extending at an angle to the vertical and substantially parallel to the angle of inclination of the adjacent screw.

20 The digester may further comprise probe means projecting into the material bed in a location in the path of said screws, means associated with said probe means for retracting the same from said location to a location out of said screw path, and carriage position sensing means for controlling said probe retracting means to retract said probe means in advance of the arrival of the screws.

25 The said receptacle may be generally annular with the interior opening forming the discharge side thereof and said carriage pivots continuously around the centre axis thereof.

30 An embodiment of the invention will now be described by way of example, reference being made to the accompanying drawings, of which:

Figure 1 is a side elevational view taken in section showing a digester embodying the invention;

35 Figure 2 is a plan view of the digester shown in Figure 1;

Figure 3 is a side elevational view of one of the agitator screws and the drive therefore;

40 Figure 4 is a plan view taken partly in section showing the mounting for one of the agitator screws;

Figure 5 is a sectional view taken on line V-V of Figure 4; and

45 Figure 6 is a partial elevational view showing the drive mechanism for the carriage.

50 Referring first to Figures 1 and 2, the digester comprises an upwardly open cylindrical structure having a circular outer wall 1 and a circular inner wall 2. The walls define feed and discharge sides of the receptacle across which organic material is moved during the course of digestion. Air conduits 3 are provided in the bottom of the receptacle to receive air supplied by a fan 4 through a manifold 5 leading to supply pipes 6 connected to air conduits 3. Manifold 5 and supply pipes 6 are located in a pit under the material receptacle as shown in Figure 1. A carriage 7 is provided spanning between outer wall 1 and inner wall 2. The inner end of carriage 7

is carried upon a central bearing structure 8 the outer end rides upon a rail 9 which is placed on top of outer wall 1 around the circumference of the digester. A receiving hopper 10 for waste material is placed above bearing structure 8.

70 An extension 7a of carriage 7 extends from bearing structure 8 to the outer side of the receptacle. A screw conveyor 11 located on carriage extension 7a extends from receiving hopper 10 to a discharge chute 12. Screw conveyor 11 is driven by an electric motor 13 through a belt drive 14 and gear reducer 15. A control panel 15 is mounted on extension 7a. A plurality of agitator screws 20 are mounted on carriage 7 between outer wall 1 and inner wall 2. The screws 20 are arranged in two rows 17 and 18 which extend generally radially (Figure 2). Carriage 7 rotates in the direction of arrow 19 with the result that row 17 is in front of row 18 as the carriage rotates upon bearing 8.

85 Each screw 20 is angled so that the bottom 21 of the screw is forward of and toward the outer wall from the top of the screw (see Figure 3). Each screw comprises a helical flight 22 which, when the screw is rotated, serves to elevate material from the bottom of the receptacle and to maintain continuous agitation of material in the receptacle. The normal level of material being digested is shown by line 23 (Figure 1). The upper end of each screw is journaled in a bushing 24 mounted in a sleeve 25. A gear reducer 26 is mounted on the upper end of sleeve 25 and is driven through a belt 27 from a variable speed motor 28. Sleeve 25 is fitted in a semi-spherical ball member 29 which is clamped between a bracket 30 and a clamping plate 31. By tightening down cap screws 32, the ball and socket mechanism may be clamped in any position, thereby allowing the angular position of each screw to be adjusted and maintained. Bracket 30 is rotatably mounted upon hinge pin 33 which is in turn mounted upon carriage 7. Hinge pin 33 is on the forward side of screw 20 as carriage 7 rotates. Sheer pins 34 connect bracket 30 to carriage 7 on the trailing side of each screw 20. A limit switch 35 is fitted between the rear edge of bracket 30 and carriage 7.

100 Carriage 7 is driven by an electric motor 36 through a speed reducer 37 which drives a wheel 38 riding on rail 9. (See Figure 6).

105 Inner wall 2 is conical in section (Figure 1) with the outwardly flaring base being at substantially the same angle to the vertical as the innermost screw 20. An outlet 39 for digested material is provided between inner wall 2 and bearing structure 8. Digested material which passes over the top of the inner wall 2 falls through the central cavity to a conveyor 40 in the pit below the receptacle. Conveyor 40 carries digested material from the pit to a discharge point 41.

115 A plurality of probes 42 are mounted in

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the pit beneath the receptacle on a structure
 43. The probes project upwardly through holes
 in the bottom of the receptacle into the mass
 being digested. An electric motor 44 is operable
 5 to drive the probes up and down through a
 conventional shaft and gear arrangement.
 Motor 44 is operated responsive to a limit
 switch 45 mounted upon outer wall 1.

10 In operation of the digester, raw material,
 such as municipal garbage is dumped into
 hopper 10 after screening, magnetic separation,
 pulping, etc. The material is then conveyed by
 screw 11 to discharge chute 12. As the digester
 comes into operation the material will fill the
 15 circular receptacle to level 23. In the normal
 course of operation material for digestion will
 be delivered during only a part of the day.
 While material is being received carriage 7 will
 be rotated, either continuously or incremen-
 20 tally, so that raw material is discharged
 uniformly around the outer edge just inside
 outer wall 1. The speed of motor 36 is con-
 trolled to provide a desirable speed of rotation
 fitted to the rate of feed. As carriage 7 rotates
 25 each of screws 20 will be driven by the associ-
 ated motor. The fact that the lower ends of the
 screws are angled forward will assist in
 advancing carriage 7. The fact that the lower
 end of the screws are angled outwardly will
 30 cause the material to be moved consistently
 inwardly as it is brought to the top. The
 effect of the screws as shown in Figure 1 is to
 thoroughly agitate and mix material in the
 digester across the entire width between the
 35 outer and inner walls as carriage 7 rotates. It
 is believed that the outward angle at the bottom
 of the screws causes a uniform steady movement
of material from the outer wall to the inner
wall. It is believed that as material is moved
 40 inwardly a zone is provided for receipt of the
 material next outwardly, thereby minimizing
 or eliminating short circuiting of material. It
 is further believed that the placement of the
 screws in at least two rows tends to prevent
 45 material at the top of one screw from being
 "handed off" to the top of the next screw and
 thereby short circuiting across the top of the
 digested material to discharge 39. The result is
 to provide a substantially uniform and predict-
 50 able flow of material from the outer wall to exit
 39. The use of a conical inner wall angled to the
 angle of inner most screw prevents accumulation
 of material in a dead space along the inner wall.

The speed of the individual screws may be
 55 adjusted to exactly fit the conditions required
 for suitable digestion. In the event that one of
 the screws should hit an unexpected obstruction
 the force will cause shear pins 34 to shear,
 permitting the screw to rotate about hinge pin
 60 33 without damage. In the event bracket 30
 rotates about hinge pin 33 the limit switch will
 open causing the entire digester to be shut down
 until the problem can be located and corrected.

65 Probes 42 normally sense the condition of
 the material (e.g. temperature, oxygen content)

and automatically open and close motor-
 operated gates located between the air manifold
 5 and air conduits 3 to supply the amount of
 oxygen needed for correct digestion. As
 carriage 7 approaches limit switch 45 and
 70 trips the switch, motor 44 is actuated to
 withdraw the probes while the screws pass
 over. As carriage 7 passes beyond limit
 switch 45 the limit switch will be released
 causing motor 44 to raise the probes back to
 75 operative position.

While we have illustrated and described a
 present preferred embodiment of our invention
 it is to be understood that our invention is not
 80 limited thereto and may be otherwise variously
 practiced within the scope of the following
 claims.

WHAT WE CLAIM IS:

- 85 1. A digester having a receptacle for holding
 a bed of waste material to be digested, said
 receptacle having an inlet side for adding fresh
 waste material and an exit side for discharging
 digested material, a carriage which moves over
 90 said bed of material during digestion, and an
 array of rotatably driven screws carried by the
 carriage, and extending into said material bed
 and being operative to lift said material
 95 generally from the bottom to the top of the
 bed as the carriage moves, each of said screws
 being disposed with its axis inclined away from
 the vertical both forwardly and laterally relative
 to the direction of carriage movement from its
 100 top to its bottom end so that the position of the
 bottom end of each such screw is ahead of and
 nearer the inlet receptacle side than the position
 of such screw.
- 105 2. The digester of claim 1 in which each
 screw is mounted on said carriage by means of
 an angularly adjustable connection whereby
 the screw axis can be angularly adjusted to
 the carriage.
- 110 3. The digester of claim 2 in which the
 angularly adjustable connection comprises a
 ball and socket joint.
- 115 4. The digester of claim 2 in which drive
 means are provided for the carriage and screws,
 the speed of said drive means being separately
 adjustable.
- 120 5. The digester of claim 1 in which said
 carriage is supported for pivotal movement
 through said bed about a pivot axis and the
 screws are arranged on the carriage in at least
 two rows extending generally radially from said
 pivot axis.
- 125 6. The digester of claim 5 in which the
 screws in the separate rows are in staggered
 relationship relative to the direction of carriage
 travel.
- 130 7. The digester of claim 1 in which said exit
 side comprises a wall extending at an angle to
 the vertical and substantially parallel to the
 angle of inclination of the adjacent screw.
8. The digester of claim 1 which further

comprises probe means projecting into the material bed in a location in the path of said screws, means associated with said probe means for retracting the same from said location to a
5 location out of said screw path, and carriage position sensing means for controlling said probe retracting means to retract said probe means in advance of the arrival of the screws.
9. The digester of claim 1 wherein said
10 receptacle is generally annular with the interior opening forming the discharge side thereof and

said carriage pivots continuously around the centre axis thereof.

10. A digester substantially as herein described with reference to and as shown in the 15 accompanying drawings.

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Fig. 1.

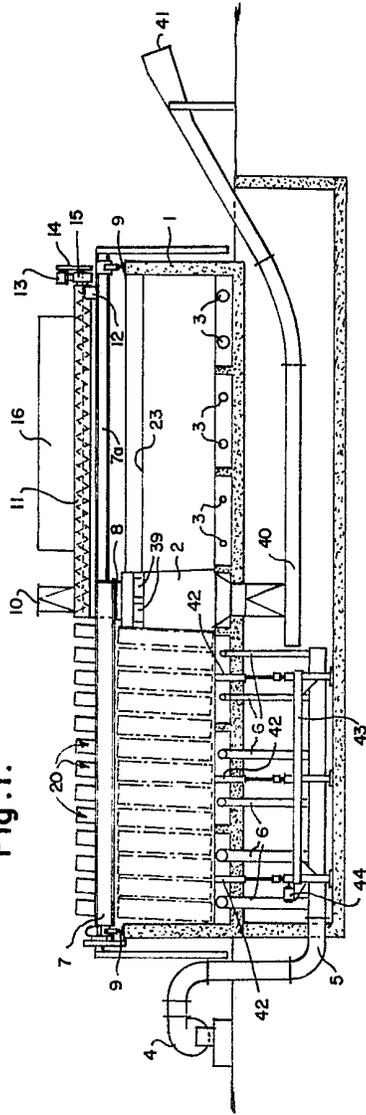
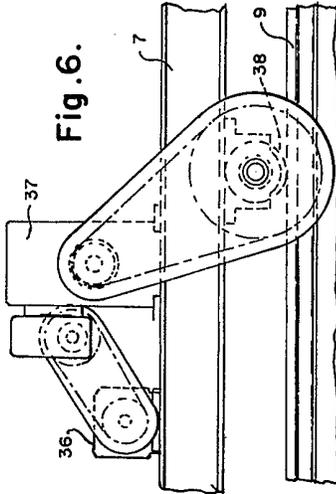


Fig. 6.



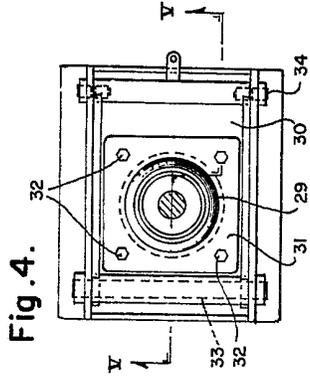


Fig. 4.

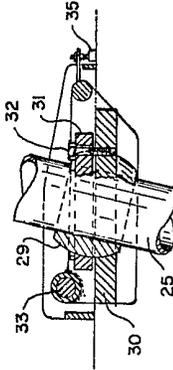


Fig. 5.

Fig. 3.

