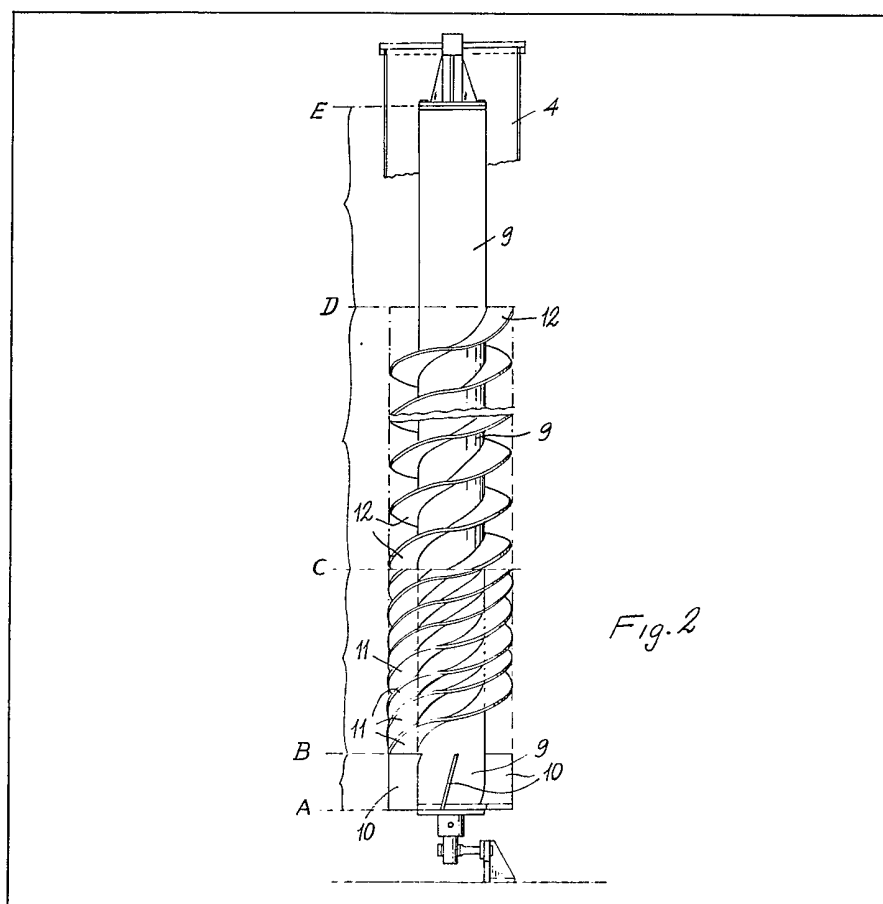
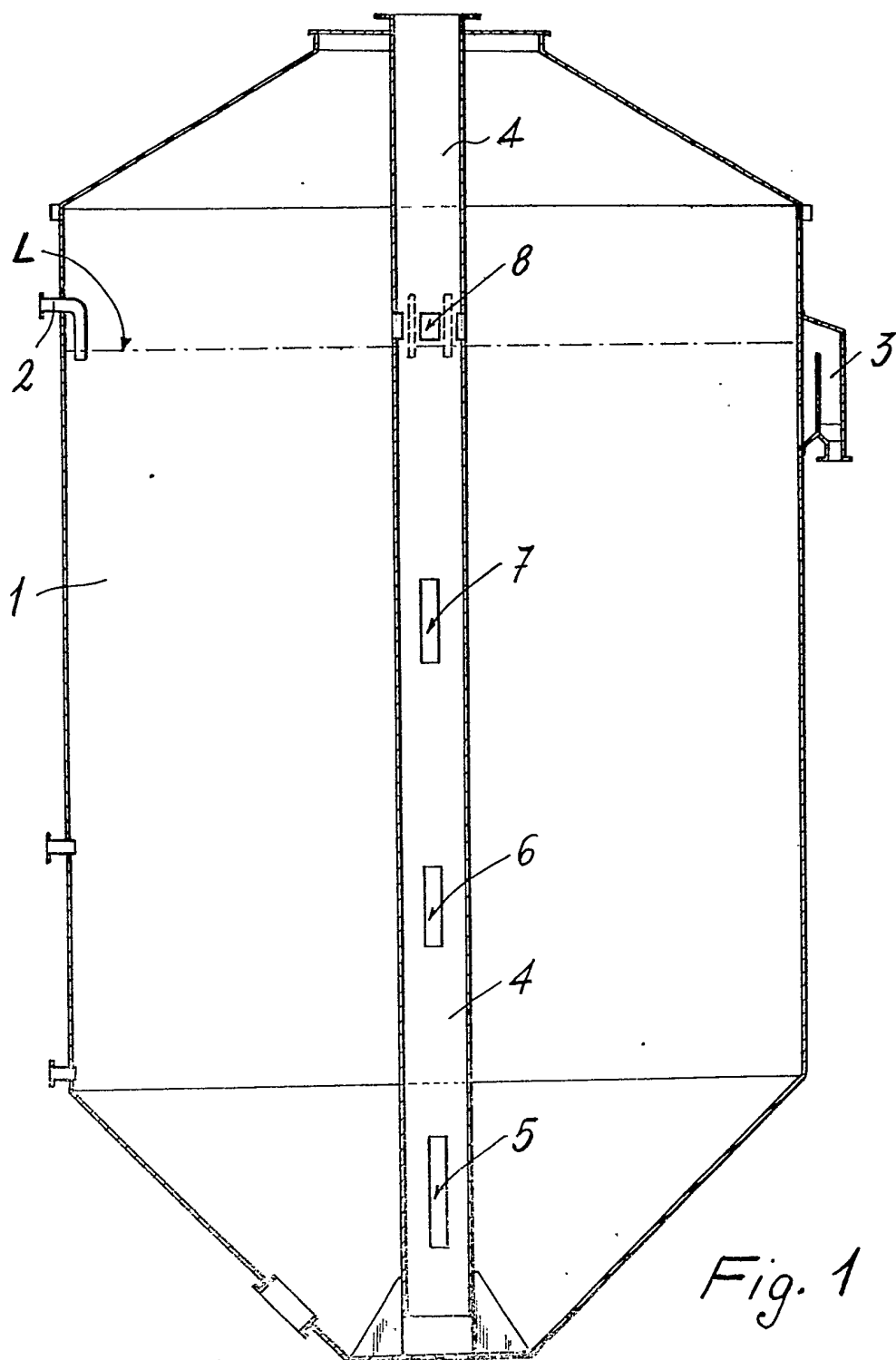


- (21) Application No 8014579
(22) Date of filing 2 May 1980
(30) Priority data
(31) 22489
(32) 9 May 1979
(33) Italy (IT)
(43) Application published
31 Dec 1980
(51) INT CL³
B01F 7/24
C02F 3/28
(52) Domestic classification
B1C 18A1 18G5F 1
C1C 331 436 43Y 442 702
70Y E
(56) Documents cited
GB 1529777
GB 1435690,
GB 1112682,
GB 994354
(58) Field of search
B1C
(71) Applicants
Giza S.p.A.,
Via Provinciale Sud, 6,
42011 Bagnolo in Piano,
Reggio Emilia,
Italy.
(72) Inventors
Vladimiro Pozzi
(74) Agents
Serjeants

(54) Fermentation reactors

(57) A fermentation reactor for animal effluent comprises a vessel, a tube (4) upstanding within the vessel and an Archimedian screw (9) drivably housed in the tube. Slots are distributed along the length of the tube (4). The preferred arrangement of the slots is in groups of three identical slots equispaced around the tube (4) and also axially equispaced from one another, most preferably axially equispaced by about 1/4 of the length of the tube (4). The Archimedian screw (9) preferably has a lower section, (B - C) of greater lifting capacity than an upper section (C - D). This can be achieved by having more helix starts (11) in the lower section (B - C) than helix starts (12) in the upper section (C - D) or by having a smaller helix pitch in the lower section (B - C) than in the upper section (C - D).





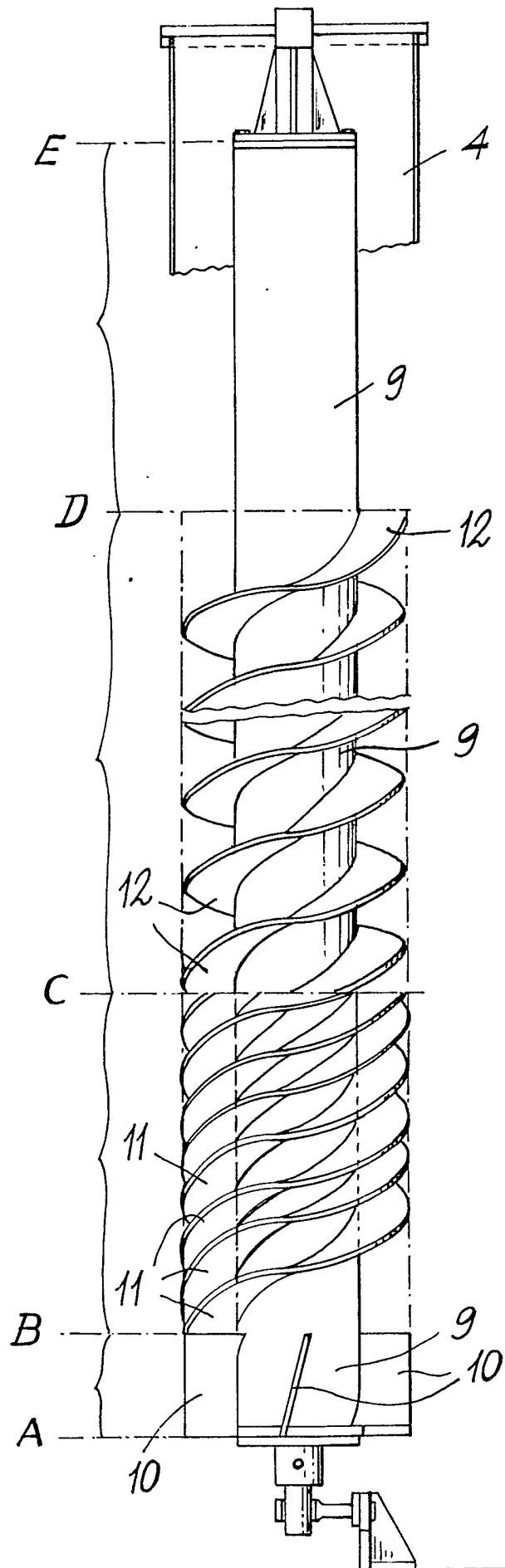


Fig. 2

SPECIFICATION

Fermentation reactors

5 The invention relates to fermentation reactors for zootechnic liquid material, particularly for bovine and swine liquid material. A method of recovering combustible gases and fertilizing muds from zootechnic liquid material is described in our co-

10 pending British Patent Application No. 8014578 filed herewith. This method involves subjecting the zootechnic liquid material to anaerobic fermentation, and the fermentation reactors disclosed herein have been developed for use in the said method.

15 Stirring of liquid material in fermentation reactors is carried out to move the whole mass of liquid material in order to bring each of the particles therein into contact with the microbic flora and permit degassing of the mass, that is to facilitate the

20 release of gases (mostly comprising methane gas) developed during fermentation. The stirring of the fermentation liquid material should therefore be thorough, but not violent or excessive as the fermentation cycle would then be disturbed and slowed or

25 even stopped.

As zootechnic liquid materials are very thick and a fertilizing mud tends to separate therefrom, layers of material having different specific gravity tend to form in the fermentation reactor. This should be

30 prevented as far as possible, while avoiding excessive mixing for the reasons given above.

Common blade stirrers have proved unsatisfactory for mixing zootechnic liquid material in fermentation reactors; thorough mixing was only possible

35 under stirring conditions sufficiently vigorous to impair the fermentation.

The invention provides a fermentation reactor for zootechnic liquid material, the fermentation reactor comprising a vessel, a substantially vertical tube

40 within the vessel, the tube being provided with slots distributed along its length, and an Archimedian screw housed in the tube and rotatable about its own axis by a drive mechanism.

The invention is illustrated by the drawings, of which:

45

Figure 1 is a diagrammatic axial sectional view of a fermentation reactor according to the invention; and

Figure 2 is a diagrammatic axial elevation of an Archimedian screw being a part of the fermentation

50 reactor of *Figure 1*.

With reference to *Figure 1*, a fermentation reactor for zootechnic liquid materials comprises a vessel 1, provided with a liquid material inlet 2, a fertilizing mud outlet 3 and circulation openings which have

55 not been numbered on the drawings for the sake of simplicity. The liquid material in the fermentation reactor reaches the level shown by the dash-dot line L.

A tube 4, mounted in the fermentation reactor, is provided with three identical slots 5, one of which is

60 shown in *Figure 1*, the three slots 5 being equispaced around the tube 4. The tube 4 is further similarly provided with three identical and equispaced slots 6, three identical and equispaced slots 7 and three

65 identical and equispaced slots 8. The slots 5 are both

longer and wider than any of the slots 6, 7 or 8. The slots 8 are positioned just above the liquid level 6. The vertical spacings between the slots 5 and 6, the slots 6 and 7 and the slots 7 and 8 are substantially equal and approximate to a quarter of the length of the tube 4.

Accommodated within the tube 4 is an Archimedian screw of an unusual form which is illustrated in *Figure 2*. At the lowest portion of the Archimedian screw (the section A-B shown by brace parenthesis) four blades 10 (one shown in the drawing) inclined at

75 about 10° to 15° to the vertical project radially from a cylindrical trunk 9. In the section B - C next above the section A - B, the Archimedian screw comprises a

80 four start helix 11 (that is four spirals enveloping the trunk 9). The next section, C - D, has the screw formed of a two start helix 12 (that is two side by side spirals enveloping the trunk 9), and in the uppermost section D - E no helices project from the trunk 9.

85 While the blades 10 are restricted to the lower portion of the said Archimedian screw, it should be appreciated that the separation zone (Zone C) of helices 11 from helices 12 is positioned at the slots 5, while the helices 12 extend to above the slots 8. It

90 should also be pointed out that the Archimedian screw is connected to a driving motor (not shown) and that the diameter of the tube 4 is much less than that of the vessel 1.

The fermentation reactor for zootechnic liquid

95 material may suitably have the following dimensions: vessel 1 - diameter 6.5 m, a total height of 12 m; tube 4 - diameter 0.5 m, height about 12 m; slots 5 - length 1 m, width 0.2 m; slots 6 and 7 length 0.75 m, width 0.18 m; slot 8 - length and width 0.30 m; blades 10 axial extent 20 cm; section B - C of the Archimedian screw length 1.3 m; and length section

100 C - D of the Archimedian screw - length 7.8 m.

During the liquid material fermentation (which may last from 10 to 20 days, at a temperature of from

105 30° to 40°C, preferably 35°C), the Archimedian screw is rotated at a speed of from 30 to 120 r.p.m., preferably at about 70 r.p.m. The liquid material in the fermentation reactor is very thick and tends to be thickest at the bottom of the vessel 1. The blades 10

110 scrape the material at the bottom of tube 4, but more important is the different form of the helices 11 and 12 in the Archimedian screw sections B - C and C - D, respectively.

Thus, at the lower portion of the vessel 1, the

115 liquid material is very thick and the four start helices 11 are such as thoroughly to mix it. Should the Archimedian screw be of four starts also in the section C - D, at which the liquid material is less thick, it would cause a too vigorous and fast mixing of the liquid material, compromising the fermentation. This is a reason why the Archimedian screw has in section C - D helices 12 of only two starts. Thus, as the Archimedian screw rotates, the four start helices 11 vigorously and at a higher speed move the thicker

120 liquid material, while the two start helices 12 more smoothly move the overlying portion of the liquid material. The liquid material withdrawn by the blades 10 and accordingly by the helices 11 at the bottom of tube or pipe 4 is caused to move at a high

130 flow rate up the tube 4: since this amount of liquid

material is larger than that which can be transported by the helices 12 of only two starts, the excess liquid material is ejected through the slots 5 of the tube 4. As a matter of fact, at the bottom of the reactor, the 5 thickest portion of the liquid material is cycled by entering at the lower end of the tube 4, moving up along said tube and being mostly ejected at the bottom of the slots 5.

In turn, the Archimedian screw helices 12 cause a 10 suction of liquid material at the upper portions of slots 5, 6 and 7 and ejection of liquid material from tube 4 through the lower portions of slots 6, 7 and 8. Thus, the Archimedian screw creates in the liquid material in the reactor a turbulence which is sufficiently 15 vigorous to bring the liquid material particles in contact with the microbic flora, but sufficiently smooth not to disturb the fermentation, at the same time allowing the development of the combustible gases (mostly methane) being formed during fermentation. Experiments have shown that good 20 results in fermentation of zootechnic liquid material can be obtained in a fermentation reactor equipped with an Archimedian screw as described.

As will be apparent, an Achimedian screw instead 25 of comprising successive sections of helices having a different number of starts could comprise sections of helices having a constant number of starts, but of varying pitch, specifically a shorter pitch at the lower section of the Archimedian screw than at the higher 30 section.

CLAIMS

1. A fermentation reactor for zootechnic liquid 35 material, the fermentation reactor comprising a vessel, a substantially vertical tube within the vessel, the tube being provided with slots distributed along its length, and an Archimedian screw housed in the tube and rotatable about its own axis by a drive 40 mechanism.

2. A fermentation reactor according to claim 1 in which the Archimedian screw has lower and upper sections and the helix pitch in the lower section is smaller than the helix pitch in the upper section.

45 3. A fermentation reactor according to claim 1 in which the Archimedian screw has lower and upper sections and there are more helix starts in the lower section than in the upper section.

4. A fermentation reactor according to any preceding claim in which the Archimedian screw has a 50 lowermost section having radially projecting blades inclined at a few degrees to the axis of the Archimedian screw.

5. A fermentation reactor according to any preceding claim in which the slots in the tube are 55 distributed in groups spaced apart from one another along the axis of the tube.

6. A fermentation reactor according to claim 5 in which there are four groups of slots, each group 60 comprising three identical slots equispaced around the tube.

7. A fermentation reactor according to claim 5 or claim 6 in which the distance separating each group of slots from the next adjacent group of slots is 1/4 of 65 the length of the tube.

8. A fermentation reactor for zootechnic liquid materials the fermentation reactor being substantially as described herein with reference to the drawings.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon Surrey, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.