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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,*

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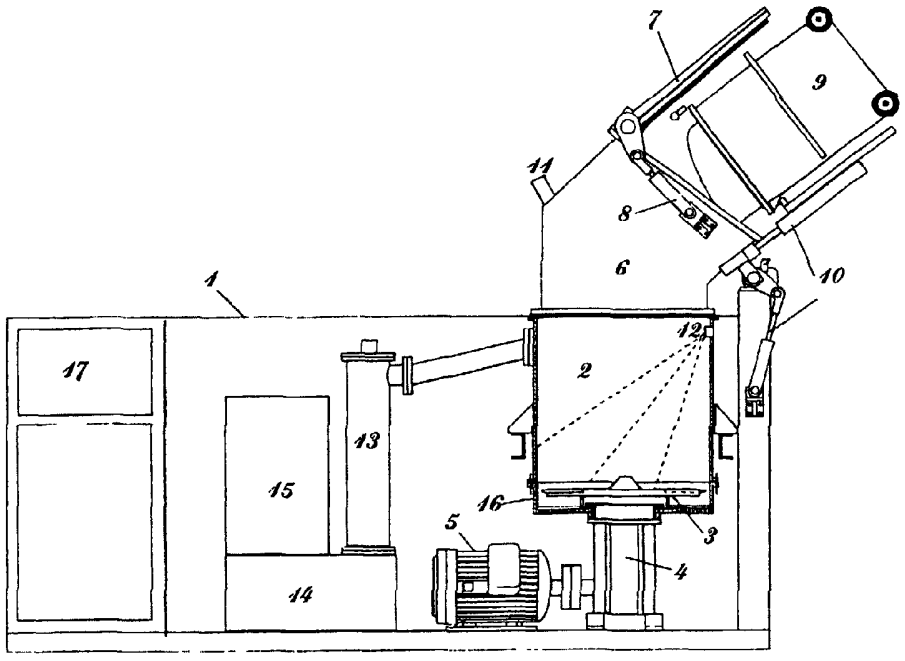
(54) Title: PROCESS AND APPARATUS FOR COOKING AND STABILISATION OF BIO-ORGANIC MATERIALS



(57) Abstract: A process for stabilisation of bio-organic materials such as biomass, residues and refuse, consisting in a treatment which cause dehydration and superheating of the material by the effect of mechanical compressions, then generation of steam from within the interior of the material itself by absorption of controlled quantities of water, with the result of devitalising seeds, eggs and other living organisms, obtaining a stable product. Apparatus for performance of the process is described.

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MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— *of inventorship (Rule 4.17(iv)) for US only*

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Process and apparatus for cooking and stabilisation of bio-organic materials

The present invention relates to a process and to apparatus for a special cooking, by means of heat and locally generated steam, of material of biological nature, such as biomass, the rejects and refuse from food workings and, in general, materials which contain or can contain substances of biological nature, including living organisms, achieving stabilisation of the materials in the form of a dehydrated product, which is stable for long periods of time.

Non-limitative examples of materials of organic nature treatable with the process described here are grass cuttings, pruning residues, marine algae and seaweeds, slaughterhouse waste, vegetable peel and waste from food production, refuse from the food industry, agricultural activity or fishing, the organic fraction of solid urban waste, medical waste containing biological materials, and sludge from biological purifiers.

As is known, biomass materials and, in general, materials containing substances of organic and biological nature, are not stable. This is due to the presence of water and the other compounds in liquid phase which constitute, together with the organic substance, a substrate suitable for the development of fungi, seeds, insects and, in general, living organisms which are both contained in the material itself and which come from the environment in the form of pollen, spores, micro organisms etc. Their storage pending subsequent use or disposal often represents a problem, particularly in the case of materials of low economic value.

The process forming the subject of the present invention is intended for the transformation of such materials in such a way as to obtain a stable product completely free from liquids, which can be preserved for a long time without problems pending use, for example as agricultural fertilisers or manures, for animal feed, or whilst awaiting disposal.

The process forming the subject of the invention is characterised in that the material is first reduced to small particles, then subjected to repeated action of compression and deformation until reaching a high temperature losing all moisture, then heating and finally cooking by generation of steam from within the material itself by absorption of metered quantities of water. Peculiarities of the procedure are the operating conditions by which, by metering a controlled quantity of water onto the material heated to a temperature between 130 and 180°C, preferably about 160°C, this progressively penetrates in the form of a liquid into the depth of the granules of the material and is then transformed into steam at the expense of the heat which is generated in the material by the mechanical effect.

The combined mechanical and thermal effects of the absorption of liquid water into the material undergoing treatment, followed by the transformation of the water into steam with a large change of volume, causes a slight lysis of the proteic materials and a mechanical action on the cell membrane. A perfectly dry and lifeless granular product free from spores, eggs, insects, seeds and living organisms in general is obtained from the treatment. The speed of the treatment makes it possible to obtain only a slight proteic lysis and therefore a good maintenance of the organaleptic properties of the material.

In comparison with other high temperature cooking treatments the process described here has the advantage of not requiring the use of pressure. Thus, it has advantages not only of simplicity of construction and management of the installations, but also in energy terms since pressure apparatus has the disadvantage of involving large masses of metal to heat and then cool at each treatment cycle. Finally, known pressure-cooking processes provide a treated material which is impregnated with water, which is not itself stable due to the water content. These treatments therefore involve the necessity of further treatments, such as the addition of preservatives or the use of ionising radiation, vacuum packaging etc.

By contrast, at the end of the treatment cycle the process forming the subject of the present invention provides a material which, as well as not containing live organisms, is stable due to its total desiccation.

The compression actions which result in the formation of heat are exerted by means of a member which moves at high speed close to fixed members. One non-limitative example is that described in Figure 1 where the fixed members are represented by a band or strip in the form of a fixed circular crown provided with alternating projections and recesses or cavities, with a sawtooth transverse section, whilst the movable member is constituted by a rotating part having a cuneiform section passing a short distance from the toothed plane. In the arrangement described, the part with the fixed projections is formed on the wall which constitutes the bottom of a container. Alternatively, the fixed projections can be arranged on a side wall.

The material is forced by the movement of the movable cuneiform member into successive and repeated deformations which cause rapid heating of the material itself. As well as producing heat the movable member also produces a continuous mixing of the material.

In Figure 1 the letters (a) and (b) indicate, respectively, the fixed plane with its saw tooth projections and the movable member in the form of a wedge. The relative movement leads to formation of two compression forces in opposition which compress the particles of the material indicated with the letter (c), with deformations involving the formation of heat within the material itself. The high speed and repetition of the compression and deformation actions lead to the formation of a significant quantity of heat such as to heat the mass of the material, cause complete evaporation of liquids contained in it, further heating the material to a temperature greater than 100^{0}C and to give off steam by the absorption of water in the superheated material.

Figure 2 shows a different arrangement for obtaining the compression effect where (a) indicates cuneiform projections fixed to the wall.

Figure 3 shows how the process develops. The graph plots the temperature of the material in degrees centigrade as a function of time in minutes. A heating and super heating phase indicated with the letter (d) having a duration of about 12 minutes is followed by a cooking phase indicated with (e) having a duration of about 3 minutes.

The material is initially heated from ambient temperature to a temperature of about 100^{0}C. Subsequently, between 100 and

110°C the heat provided causes evaporation of all of the water and all the liquids present in the material. Then further heat provided causes superheating of the material.

Although the superheating temperature of the material could be taken beyond 180°C, limiting the superheating to 160°C avoids the commencement of thermal degradation of the organic substances.

It can be seen that the deformations due to the compressions generate heat throughout the mass of individual particles, directly within their interior, and therefore in a completely different manner from the typical heating by conduction effected by administration of heat from the outside. In this latter case the part of the particle at higher temperature will be the outer part, whilst in the process forming the subject of the present invention, on the contrary, it is the inner part which is at the higher temperature in that the heat which forms within it by effect of the deformation remains confined within the interior because of the thermal insulating nature of the material, until the intervention of the cooking phase consisting of absorption of water and formation of steam.

Once the superheating phase has been completed, the subsequent cooking phase is effected by causing the absorption of a controlled quantity of hot water by the material, still maintained in movement and being heated by the mechanical action of the movable member.

The added water is absorbed at the surface and then ever more into the interior of the particles from which heat is extracted by the generation of steam. Figure 4 schematically

shows a particle of hot material during the commencement of the cooking phase. The letter (w) indicates the additional water and (v) represents the steam, which is emitted. Progressively, the surface layer of the particle in which the temperature has fallen sufficiently to permit the existence of liquid water gradually becomes deeper and deeper and this thus progressively penetrates and reaches by absorption the interior of the particle, developing steam ever further internally.

Figure 5 schematically shows a particle of material at the end of the cooking phase. This phase is interrupted when the super heated temperature of the mass has fallen to a little above 100^0C; for example 105^0C. The temperature of the particles still being greater than 100^0C, these are perfectly dehydrated, dry and free running. The conditions of the operation result in a slight proteic lysis on the surfaces of the particles, rupture of the cellular membranes by internal pressure and coagulation of the cellular material invested by the steam, with devitalisation of seeds, eggs and micro organisms.

Further advantages and characteristics of the process and the apparatus according to the invention will become apparent from the following detailed description made with reference to the attached drawings, provided purely by way of non-limitative example, in which apparatus and some details for performance of the process are illustrated in a schematic manner.

Figure 6 shows the schematic arrangement of the apparatus. A frame (1) permits the assembly of components in such a way as to obtain a unitary apparatus. The main part of the machine

is constituted by a casing (2) forming a chamber of cylindrical form with a vertical axis. This part, provided with a rotating member (3), constitutes the system for production of heat by compression and deformation of the material under treatment.

The rotating member is held in position by the support (4) and driven by the motor (5) at a speed of rotation between 1500 and 2500 revolutions per minute, in such a way as to have a peripheral speed of a rotor between 30 and 70 metres per second. The speed of rotation of the rotating member is controlled by a system, which constantly and automatically compares the speed at which the material during the various phase of the process becomes superheated with respect to the calibrated values.

The upper part of the casing connects to the loading inlet (6) provided with a cover (7) actuated by devices (8) of hydrodynamic type or equivalent. The material to be treated is introduced into the cell (2) by opening the cover (7) and tipping the contents of a container (9) by actuation of hydrodynamic devices (10) or the equivalent.

On the loading inlet (6) is installed an infrared temperature measuring device (11) facing downwardly in such a way as to measure the exact temperature of the material in real time. On the upper part of the casing (2) is arranged a nozzle (12) for dosing the cooking water. The dosing is controlled by an automatic logic which comes into operation and stops at the programmed temperatures.

The steam which is released from the casing during the process is conveyed by means of a duct to a system (13) for

aspiration and extraction. This is constituted by a condenser operating by mixing steam with water. The condenser is connected with a tank (14) in which the separation of water from aspirated air is effected, which air is expelled after having been filtered in the filtration unit (15) comprising a droplet separator, a powder filter, an active carbon filter and an absolute filter.

The lower part of the casing (16) constituting the bottom is bolted on and replaceable in dependence on wear. An electrical control panel (17) completes the apparatus.

Figures 7, 8 and 9 respectively show a plan view and two sections (AA and BB) of the bottom (17) of the casing (2). Reference numeral (18) indicates the teeth of the bottom which can have a depth, indicated (19), of between 5 and 20mm.

Figures 10 to 11 show the section and plan of a construction arrangement where the compression-deformation system for the material is formed by movable wedges in co-operation with a toothed bottom. The movable member is constituted by the cuneiform elements (20) which are fixed to the blades (21) of the rotor (3). The rotor is provided with two or more blades.

Figure 12 shows the section of a constructional arrangement where the compression-deformation system for the material is obtained with movable wedges (20) in co-operation with cuneiform counter members (22) fixed to the side wall near the bottom (16) of the casing (2).

Figures 1, 2, 3, 4 and 5 show the principle of the process whilst Figures 5, 6, 7, 8, 9, 10, 11 and 12 show possible

constructional arrangements which can be naturally modified with respect to the essential characteristics of the invention.

CLAIMS

1. A process for the stabilisation of bio-organic materials, such as natural biomass and refuse, such as grass cuttings, pruning residue, marine algae and seaweed, slaughterhouse waste, peelings and vegetable waste from food production, food industry waste, waste from agricultural activity, fishing, the organic fraction of solid urban waste, medical waste containing biological material, and sludge from biological purifiers, characterised in that it comprises the operation of heating the particles of material by means of one or more cuneiform members caused to move at high speed within a cylindrical casing having a vertical axis, close to fixed counteracting members in such a way as to cause changes in volume constraining the material to compressions and deformations with the localised generation of a significant quantity of heat.

2. A process according to Claim 1, in which the fixed members are formed as radial teeth in the bottom of the cylindrical casing.

3. A process according to Claim 1, in which the fixed members are formed as lateral teeth on the lower part of the cylindrical wall of the casing.

4. A process according to Claim 1, in which the fixed members are formed as cuneiform counterparts fixed to the lateral wall of the cylindrical casing.

5. A process according to Claim 1, in which the movable members of the heating system are carried by a rotor provided with blades driven to rotate at high speed.

6. A process according to any preceding claim, in which the stabilisation and cooking treatment for the bio-organic materials is effected first by rendering them dry and then superheating the material to a temperature of between 130 and 180°C and then dosing it with water in such a way that this is absorbed progressively towards the interior of the dehydrated material from where it is emitted in the form of steam, leading to the conditions for devitalisation of seeds, spores, eggs and micro-organisms.

7. A process according to Claim 6, in which upon attainment of the programmed cooking temperature, the dosing of water is automatically controlled by a regulation system in such a way that the temperature of the material gradually falls but without passing beyond the lower limit of 100°C.

8. Apparatus intended for cooking and stabilisation of bio-organic materials, characterised in that it comprises:

- a cylindrical casing for containing the material;
- a rotor within the casing, provided with blades carrying cuneiform members able to cause, in combination with fixed members on the bottom or walls of the casing, a restriction to the passage resulting in deformation and compression actions on the material, with a localised formation of heat able to bring the material rapidly to a temperature up to 180°C;
- infrared temperature measurement and control means positioned above the casing;
- means for emitting and dosing water, positioned in the upper part of the casing and controlled by the temperature measurement and control system;
- rotor means and systems for regulation of the speed operable to allow control of the quantity of heat produced;

9. Apparatus according to Claim 8, characterised in that it includes mechanised loading means for the material to be treated, means for condensation of the steam formed during the dehydration and water dosing phase into water, and filters for the treatment of the gases and vapours given off before discharge from the system.

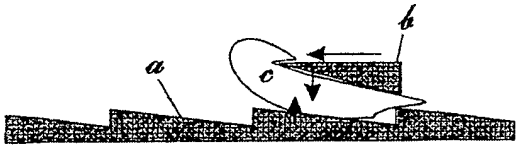

Fig. 1

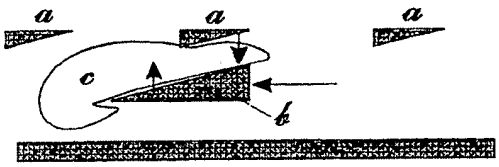

Fig. 2

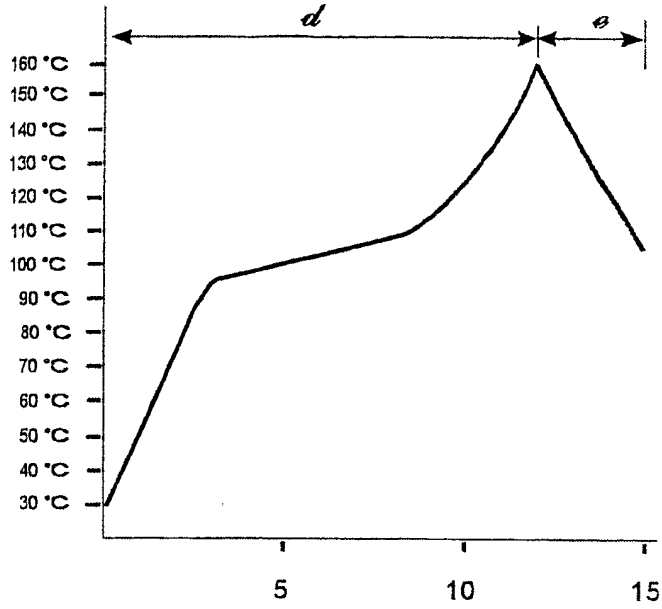

Fig. 3

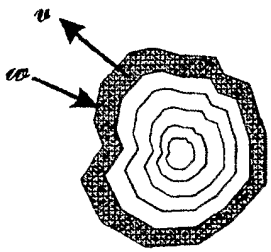

Fig. 4

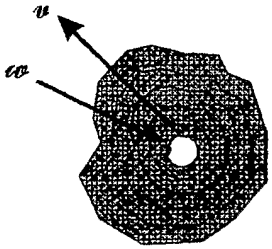

Fig. 5

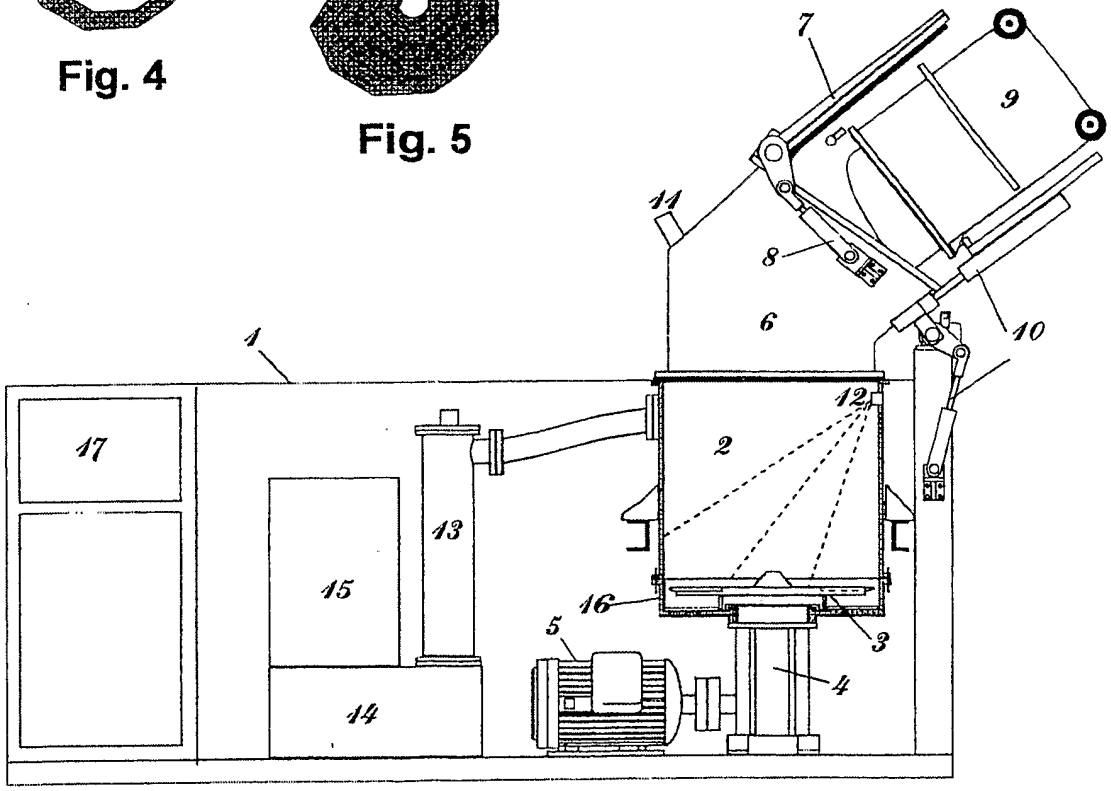

Fig. 6

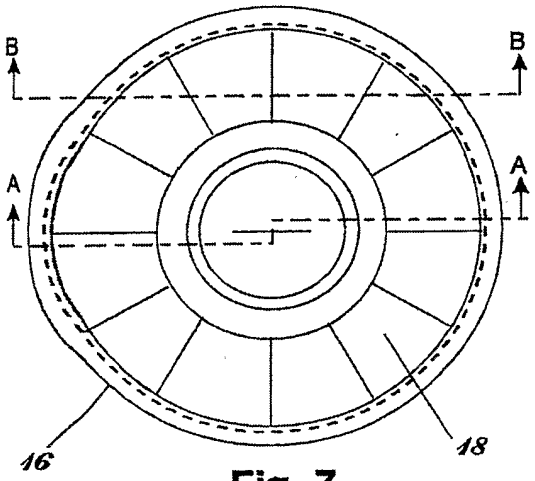

Fig. 7

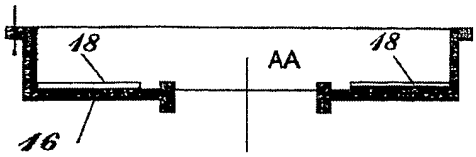

Fig. 8

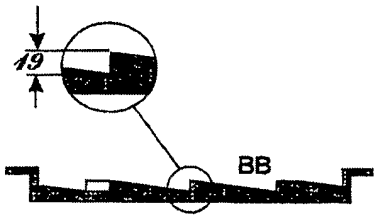

Fig. 9

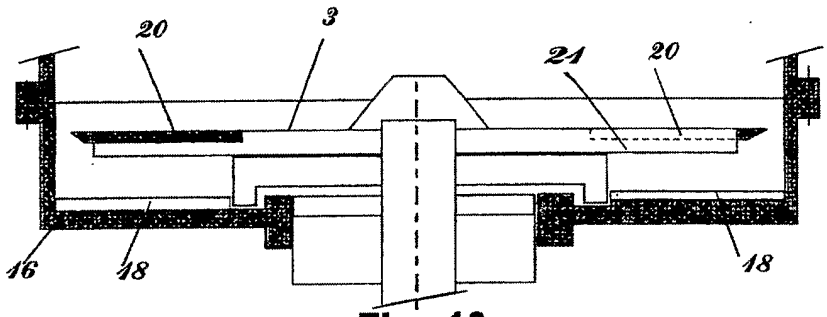

Fig. 10

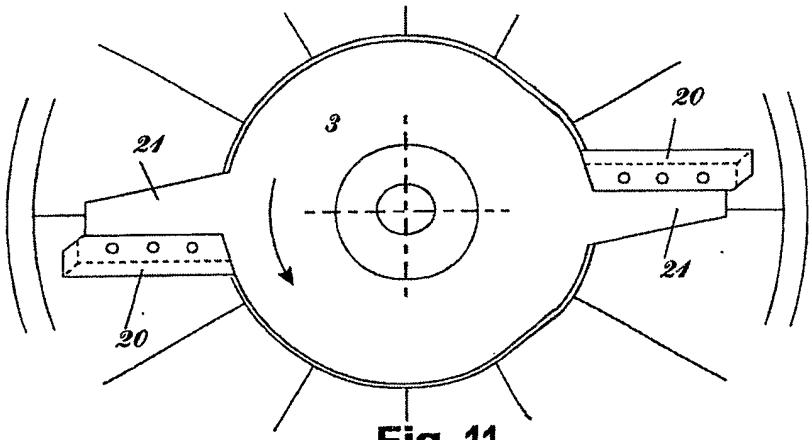

Fig. 11

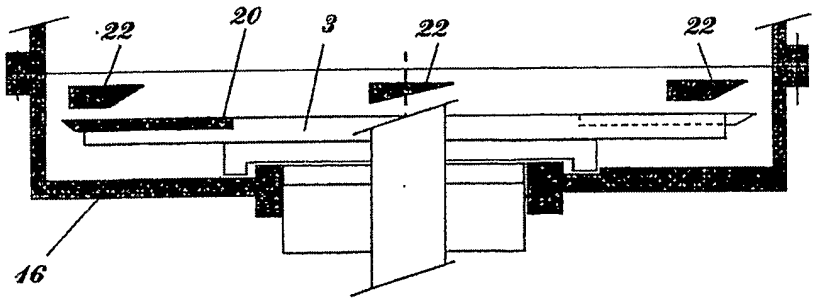

Fig. 12

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/08225

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F26B3/36 A61L11/00 B09B3/00

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)
IPC 7 F26B A61L B09B

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 32548 A (SO.T.I.) 30 July 1998 (1998-07-30) page 3, line 8 -page 12, line 14 figures	1,5-9
A	WO 95 03072 A (S.T.R.A.P.) 2 February 1995 (1995-02-02) page 2, line 1 -page 9, line 13 figures	1-3,5-9
A	WO 93 22059 A (PARTEK) 11 November 1993 (1993-11-11)	
A	WO 01 02027 A (LUNA TWO) 11 January 2001 (2001-01-11)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2003	15/12/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Laval, J

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/EP 03/08225

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 9832548	A	30-07-1998	IT	T0970048 A1	24-07-1998
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			WO	0102027 A1	11-01-2001

Box No. VIII (ii) DECLARATION: ENTITLEMENT TO APPLY FOR AND BE GRANTED A PATENT

The declaration must conform to the standardized wording provided for in Section 212; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (ii). If this Box is not used, this sheet should not be included in the request.

Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent (Rules 4.17(ii) and 51*bis*.1(a)(ii)), in a case where the declaration under Rule 4.17(iv) is not appropriate:

in relation to this international application,

SO.T.I. S.r.l. is entitled to apply for and be granted a patent by virtue of the following:

(iii) an agreement between Mr. MORGANTINI, Gianpiero; Mr. PELLEGRIN, Ruggero and SO.T.I. S.r.l. dated July 22, 2002

(ix) this declaration is made for the purposes of:
a) all designations (except the designation of the United States of America)

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (ii)".