(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 781 865 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.09.2014 Bulletin 2014/39

(51) Int Cl.:
F26B 1/00 *(2006.01)* ***F26B 21/08*** *(2006.01)*
F26B 25/00 *(2006.01)*

(21) Application number: **13160434.0**

(22) Date of filing: **21.03.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(71) Applicant: **Siffert S.p.a.**
98076 S.Agata Militello (IT)

(72) Inventors:
- **Barone, Pietro**
  98076 S. Agata Militello (IT)
- **Barone, Basilio**
  98076 S. Agata Militello (IT)

(74) Representative: **Leone, Mario et al**
Cantaluppi & Partners S.r.l.
Viale della Tecnica, 205
00144 Roma (IT)

(54) Apparatus and method for the pelletisation of powdered or granular material

(57) Plant and method for pelletizing a granular and/or powder material and for drying of the extruded pellets. A closed system circulating drying air is used, thus making the use of a filter superfluous by eliminating the risk of dispersing powders, micro-powders, polluting substances and bad odours in the environment.

The plant comprises a closed circuit (10) for circulating a drying air flow, wherein a flow of pellets to be dried is inserted, said closed circuit comprising an air flow pumping device (12), an air cooling device (13), a device (14) for condensing the humidity transported by the air flow, and a device (16) for extracting the resulting water, so as to obtain an air flow with reduced water content, and a drying chamber (5), wherein the air flow with reduced water content intersects said flow of pellets to be dried.

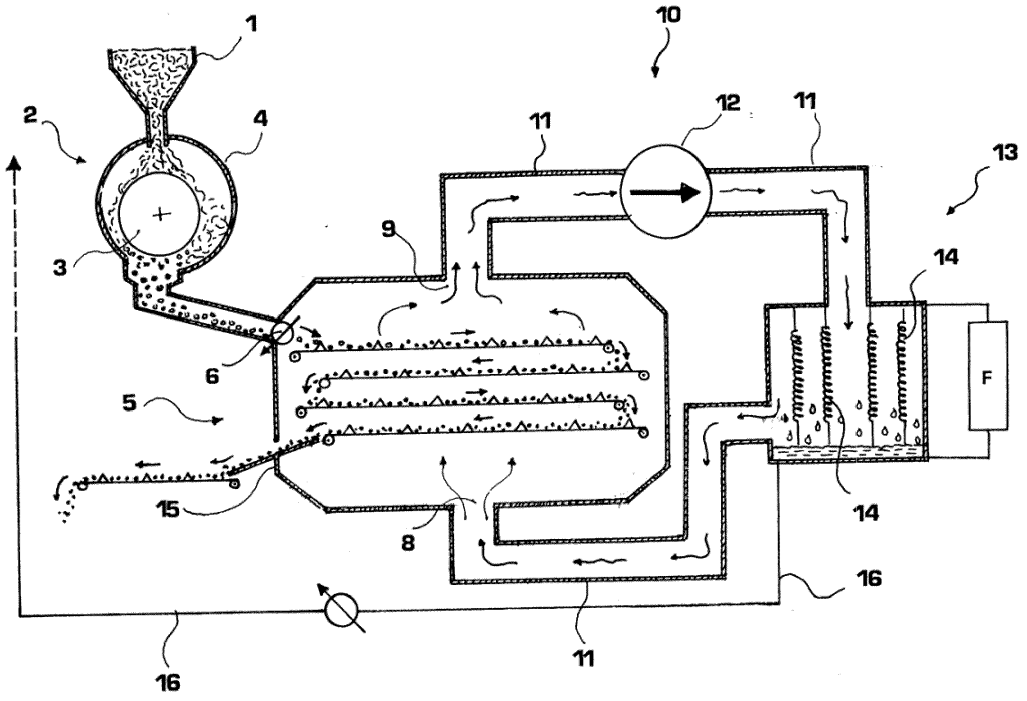

FIG.2

EP 2 781 865 A1

Description

[0001] The present invention has as object a plant and a method for pelletizing powder or granular material providing in particular a process for drying the pellets for eliminating a water excess existing in the starting material and/or added subsequently to allow the step of producing the pellets.

[0002] The pellet production involves several technological fields: it is used to make usable the products which otherwise would be available in forms difficult to be used, such as powders, granules or even as muds, sewages, organic material, molasses and so on.

[0003] The pellets, small tablets of compressed material, represent a possible use form of a material characterized by great easiness in treatment, storage and use.

[0004] They are tablets with generally cylindrical shape, with sizes in the order of some millimetres, with high density and low humidity content, generally lower than 10%.

[0005] Thanks to the substantially granular shape, huge quantities of pellets can be kept in tanks, made to flow in ducts by gravity or thanks to pushing devices, for example screw devices, they can be easily stored in sacks, they can be dispersed inside restricted environments or in the outer environment.

[0006] Thanks to the their compactness, the pellets are self-supporting, they do not release powders and remain compact even during treatment steps such as transport, storing, supply and so on.

[0007] A common example of pellets is represented by the organic or organic-mineral fertilisers which are the result of compressing and drying biological and synthetic raw materials.

[0008] The fertiliser produced in this way is kept and distributed in bags and it can be easily supplied in the environment by mechanical spreading, without dispersion of organic powder which could hinder the spreading operation.

[0009] Another example of using the pellets is the one concerning the wood combustion, in particular for domestic heating. In this case, sawdust, for example the residues of the wood processing, is compacted in pellets to be able to be used in automatic systems for supplying fuel in ovens, boilers, stoves.

[0010] Another example of use is represented by animal feed or by the additives for feeding livestock, wherein various types of organic foods under the form of flours are compacted in pellets to be able to be distributed, even with automatic systems, in the feeders.

[0011] A last example is represented by the waste treatment, in particular with the purpose of recycling. In this case, a wide range of waste (for example wood, paper and cartons, biomasses, organic materials) can be at first minced and broken into small pieces and then collected in pellets for a greater easiness in storage, transport and use.

[0012] However it is meant that the above-mentioned list of uses is not exhaustive and it is provided by way of example only.

[0013] The pellets are manufactured by special extruding devices, wherein a mixture under the form of purée, pulp or of farinaceous type, with a certain humidity content, is compressed by a mould comprising a plurality of holes, therethrough the mixture is extruded.

[0014] In the extrusion, a high pressure is exerted which, locally, can reach values in the order of 1500 atmospheres and which involves even a high heating of the forming pellet.

[0015] With the purpose of making the extrusion possible, the starting material must have a humidity content in the order of $25 \div 30\%$. If the starting powder and/or granular material does not represent this humidity content, it must be enriched with water.

[0016] However, at the extruding press outlet the humidity quantity in the pellets is not compatible with the subsequent treatment and storage steps. In fact, the existing humidity could easily cause the pellet agglomeration which would vanish the above-described advantages.

[0017] However, at the extruding press outlet, the pellets must be subjected to a drying process, aimed at eliminating the water excess. This process requests that the pellet flow is struck by an air current drying the pellets.

[0018] However, this step is critical as such air current inevitably enriches with powders and/or micro - powders (fine dust with particles with sizes in the order of $1 \div 10$ μm) caused by a minimum surface disintegration of pellets, by the friction between and pellet and by the air current force.

[0019] These powders and micro - powders, if released in the environment, could cause pollution and cause possible bad odours. Furthermore they would represent a danger if inhaled directly, above all if the starting material was a potentially toxic material.

[0020] Furthermore, the quantity of powders and fine dust in the environment wherein a plant for manufacturing pellets is localized is subjected to strict rules limiting the presence thereof.

[0021] For this reason, the drying apparatus must include a complex system of filters to depurate the air current outgoing from drying. The filters, whichever type they are, represent an additional cost for the pelletizing process and request a huge energy consumption to implement the air circulation.

[0022] Furthermore, although depurated, the release in the environment of the air used for drying always represents a risk, both for a filtration which eliminates any impurity with difficulty and for the possibility of a malfunction of the filters.

[0023] On this matter systems are known for cleaning an air flow transporting a dry residue by means of so-called rain filters, wherein one tries to capture said dry residue by trapping it in water sprayed in the air flow.

[0024] However, in the known systems, this requires an additional water consumption and a subsequent dis-

posal of the polluted water, without solving radically the problem of disposing the air flow in the environment itself.

[0025] The technical problem underlying the present invention is to provide a pelletizing plant and a related method which allow obviating the drawback with reference to the known art.

[0026] Such problem is solved by a pelletizing plant as specified above characterized in that it comprises:

a closed circuit, for the circulation of a drying air flow, wherein a flow of pellets to be dried is inserted, said closed circuit being constructed so as to have:

- an air flow pumping device;
- an air cooling device;
- a device for condensing the humidity transported by the air flow and for extracting the resulting water, so as to obtain an air flow with reduced water content; and
- a drying tract, wherein the air flow with reduced water content, intersects said flow of pellets to be dried.

[0027] The above-mentioned problem is also solved by a pelletizing method as specified above, comprising the production of an air flow in a closed circuit and the steps of:

- pressurizing said air flow;
- refrigerating said air flow;
- condensing and extracting residual air from the humidity contained in said air flow; and
- drying a flow of pellets outgoing from an extruding press, by intersecting the flow of pellets with said air flow downwards said condensing and extracting step.

[0028] The main advantage of the plant and method according to the present invention lies in allowing the drying of pellets without the fact that the air used to this purposes is spread in the environment, by making then useless the use of any filter and by eliminating the risk dispersing in the environment powders, micro-powders, polluting substances and possible bad odours.

[0029] In fact, said powders or micro-powders remain trapped in the drying closed circuit: they dissolve or remain trapped in the condensed water. The volatile portion will reach a certain value of equilibrium in the plant and however will remain confined in the closed circuit.

[0030] According to a preferred version of the plant and of the related method, the water recovered by the condensation step is re-entered upwards of the extruding press to humidify the powder and/or granular material.

[0031] In this way, the residues removed during the drying step cannot in any case dispersed in the environment and they return to be involved in the pellet-forming step, thus by allowing a saving of water and starting material.

[0032] The present invention will be described hereinafter according to a preferred embodiment example thereof, provided by way of example and not with limitative purpose with reference to the enclosed drawings wherein:

- figure 1 shows a functional scheme of a pelletizing plant according to the invention; and
- figure 2 shows a schematic and partial view of the pelletizing plant of figure 1.

[0033] By referring to the figures, the plant and the method for pelletizing defined above will be described by referring to a plant for producing fertilizing pellets of organo-mineral, dehydrated, cooled and therefore ready-for-package type.

[0034] It is meant however that what described in the specific case could be adapted to any pelletizing plant, for producing different pellets, for example fuel pellets, feed, waste to be recycled and so on.

[0035] In this example, the starting material is constituted by a set of raw materials suitable for producing fertilizers, for example but not exclusively powder nitrogenous material.

[0036] Such raw materials are loaded on dosing hoppers and, by means of an extracting belt, they are introduced into homogenizing mills.

[0037] In these mills the raw material is mixed so as to reach the requested homogenization and a water quantity is added thereto so that the whole humidity, in the present example, reaches a percentage of $8 \div 10\%$.

[0038] This step of the plant and of the process is not represented in the figures and it is of substantially conventional type.

[0039] The so-treated compound is extracted and sent, through a hopper 1, to an extruding press 2, of conventional type too and composed of rotating cylinders compressing the compound and they extrude it through suitable holes. The mutual motion of the cylinders 3, 4 and the pressure implemented between the surfaces compressing the compound produces pellets with small cylinders with standard sizes, with diameter in the order of some millimetres.

[0040] The pellets produced in this step are hot, due to the effect of compression and extrusion, and they have high humidity content. They must be then dried in order to be subsequently packaged without forming lumps.

[0041] According to the processes known in the state of art, the drying process usually is performed by inletting hot air which eliminates humidity in form of vapour, which is ejected outside the factory. However, it contains fine

dust the density thereof in the area surrounding the factory has to be kept under control and remain below levels well defined by the rules in force.

[0042] In the so-described plant, the pellets outgoing from the extruding press 2 are introduced into a drying chamber 5 through a non-return valve 6. Inside said chamber 5 the pellets are spread over a series of ring-like conveyor belts 7 or other equivalent transportation systems, arranged one onto the other one, with the aim of spreading the pellets on the widest possible surface.

[0043] The belts 7 are arranged one onto the other one, and the pellets pass from to the other one by fall at the end of each belt 7. In this way a flow of pellets descending inside the drying chamber 5 is implemented.

[0044] The latter is inserted inside a closed circuit, designated as a whole with 10. To this purpose, the chamber 5 is crossed by an ascending air flow entering form a lower door 8 and outgoing from an upper door 9.

[0045] In order to ease the air passage or the drying of pellets, the carpets can have a weft, of other type of passage, allowing them to be crossed by the air.

[0046] The closed circuit 10 is implemented by a duct 11 connected to said doors 8, 9. Upon observing the circuit clockwise, it comprises a device 12 for pumping the air flow which introduces it in an air cooling device, designated as a whole with 13.

[0047] The purpose of the cooling device 13 is to cool down the humid and hot air which has passed in countercurrent inside the drying chamber 5.

[0048] It also includes the device 14 condensing the humidity transported by the air flow and extracting the resulting air, so as to obtain an air flow with reduced water content and with low temperature (3°÷6°C) which, through the duct 11 of the closed circuit 10, is made to run in countercurrent into the hot and humid pellets inside the drying chamber 5.

[0049] It is meant that the two above-mentioned devices, the cooling and condensing devices, can physically coincide as in the present example.

[0050] The condensation takes place thanks to the presence of coils crossed by a coolant properly cooled by a cooling apparatus F. This determines the formation of rain-like condensate, wherein the impurity particles existing in the air constitute themselves the first condensation nucleus.

[0051] In this way, at the end of the route, the pellets outgoing from the drying chamber 5 have been cooled and dried, from an extracting door 15.

[0052] On the contrary, in the cooling device 13, the humidity contained in the air extracted by the chamber 5 gathers inside the condensing device 14. Condensate results therefrom, containing fine dust in suspension, which is wholly recovered through a recovery line 16 to be then re-introduced upwards of the extruding press 2, thus performing an integration of the water coming from outside.

[0053] In this way, a considerable saving in the starting material and an increase in the performance of the producing cycle is obtained, also avoiding to dispose such dried residue in the environment.

[0054] Said recovery line 16 constitutes a device for extracting condensate in the here described plant.

[0055] In this way, two virtuous circuits are activated, both closed and therefore without emissions outwards of fine dust, with the re-utilization of the components in a closed cycle A and a half-closed cycle B towards the production (figure 1).

[0056] The closed circuit A is the air circuit comprising hot and humid air with powders between the chamber 5 and the cooling device 13, and cold air between the cooling device 13 and the chamber 5.

[0057] The half-closed circuit B is the circuit of the water which is extracted from the condensing device 14, is re-introduced in the extruding press and ends up in the semi-processed humid and hot pellets, therefrom it is then extracted form the cold and dry air current which becomes hot and humid.

[0058] By way of example, the main technical features of said circuits are:

cooler yield	103 kW
room temperature	+18 °C
water temperature (in/out)	-7/+12 °C
water flow rate	15 m^3/h
flow rate of fans	21600 m^3/h
electric power of fans	2 x 4 kW
compressors	35 kW

[0059] It is to be noted that the cooling fluid used in the condensing device 14 is water, in case added with an antifreeze agent. The temperature of the cooling fluid will be chosen based upon the air temperature in the closed circuit and in particular based upon the content of air humidity subsequent to the drying step.

[0060] The temperature at the cooling device conveniently will be below the dew-point temperature, which is function of the absolute humidity.

[0061] It is further meant that the air temperature inside the closed circuit will also depend upon the outer temperature.

[0062] With reference to the above-described plant, a method for pelletizing powder and/or granular material is implemented, providing the steps of homogenizing the starting material and a possible step of adding water to the mixture to get started with the real pelletizing step.

[0063] The quantity of water to be added obviously depends upon the operating parameters provided for the extruding press and upon the quantity of water already existing in the starting material. It is meant then that the added water fills-up the difference between already existing water and the requested water content for the extruding press good operation wherein, basically, the water acts as lubricant.

[0064] The extruding step involves a compression of

the starting material and a substantial drawing, with high pressures and localized frictions which determine a general increase in temperature thereto a limited humidity loss can correspond, however not sufficient to avoid agglomeration phenomena.

[0065] Therefore, the hot and humid pellets are getting started with a drying process comprising the production of a drying air flow in a closed circuit.

[0066] The production of such drying air flow comprises a step of pressurizing said air flow, in order to allow the forced circulation thereof.

[0067] Furthermore, a step of cooling said air flow is provided, wherein there are the condensation and extraction of water residual from the humidity contained in said air flow.

[0068] The cooled air flow, with reduced humidity content, is got started with the drying of a flow of pellets outgoing from the extruding press, by intersecting the flow of pellets with said air flow downwards said condensing and extracting step.

[0069] In the present method embodiment example, the intersection substantially takes place in countercurrent, inside a drying chamber.

[0070] The water extracted in the condensing step can be re-introduced in said homogenizing step, obviously if a water addition is requested in said step.

[0071] In this way, the volatile residue which remains trapped in the condensate is got started again inside the producing cycle.

[0072] It is meant that the extracted water is not sufficient for an adequate lubrication of the homogenized material and therefore the addition of further water must be then provided.

[0073] From the method description, it results evident that, apart from the pelletizing of the organic-mineral fertilizers, it can also be applied to other pelletizing processes, wherein the quantity of initial humidity of the starting material and the quantity of the humidity contained in the pellets to get started with packaging are adjusted during the process implementation.

[0074] In particular, the quantity of initial water depends upon the type of starting material and it can or cannot request an integration. Such integration, if requested, takes place with the water extracted from the above-mentioned extracting device, so as to re-introduce in the manufacturing process the residues trapped in the extracted water.

[0075] Such water is not sufficient, therefore additional water can then be added from any feeding.

[0076] Therefore, it is possible adapting the method to dry or humid starting materials.

[0077] To the above-described plant and method for pelletizing, a person skilled in the art, in order to satisfy additional and contingent needs, can introduce several additional modifications and variants, all however within the protective scope of the present invention, as defined by the enclosed claims.

Claims

1. A plant for pelletizing a granular and/or powder material, wherein said material is possibly homogenized and subsequently extruded in order to obtain pellets to be dried, **characterized in that** of comprising:

   a closed circuit (10), for circulating a drying air flow, wherein a flow of pellets to be dried is inserted, said closed circuit being created so as to have:

   - an air flow pumping device (12);
   - an air cooling device (13);
   - a device (14) for condensing the humidity transported by the air flow and for extracting (16) the resulting water, so as to obtain an air flow with reduced air content; and
   - a drying tract (5), wherein the air flow with reduced water content intersects said flow of pellets to be dried.

2. The plant according to claim 1, wherein said drying tract is constituted by a drying chamber (5) wherein the flow of pellets and the air flow are in countercurrent.

3. The plant according to claim 1 or 2, wherein the water extracted with said extracting device (16) is mixed with the starting material to get started with the extrusion.

4. The plant according to claim 3, wherein the extracted water is integrated with additional water coming from any feeding.

5. The plant according to claim 2, wherein the drying chamber (5) is fed with pellets through a non-return valve (6).

6. The plant according to claim 2 or 5, wherein, inside said drying chamber (5), the pellets are spread on a series of ring-like conveyor belts (7) or on an equivalent transport system, arranged one onto the other one, the pellets passing from one to the other one by fall at the end of each belt (7) so as to implement a flow of pellets descending inside the drying chamber (5).

7. The plant according to claim 6, wherein the belts (7) or the equivalent transport system have a weft and/or passages allowing them to be crossed by the air.

8. A method for pelletizing an initial granular and/or powder material, comprising a step of extruding said starting material and for producing a flow of pellets to be dried, wherein the generation of an air flow in a closed circuit is provided and the steps of:

- pressurizing said air flow;
- refrigerating said air flow;
- condensing and extracting residual water from the humidity contained in said air flow; and
- drying said flow of pellets, intersecting the flow of pellets with said air flow downwards said condensing and extracting step.

9. The method according to claim 8, wherein the step of homogenizing the starting material and a step of adding water to the mixture to get started with the pelletizing step are provided.

10. The method according to claim 8 o 9, wherein, the intersection between flow of pellets and air flow takes place substantially in countercurrent, inside a drying chamber (5).

11. The method according to claim 9, wherein the water extracted in the condensation step is re-entered during said homogenization step.

12. The method according to claim 11, wherein in the homogenization step the addition of additional water is provided based upon the humidity contained in the starting material, upon the one requested in the extrusion step and the one requested in the pellets at the end of the method.

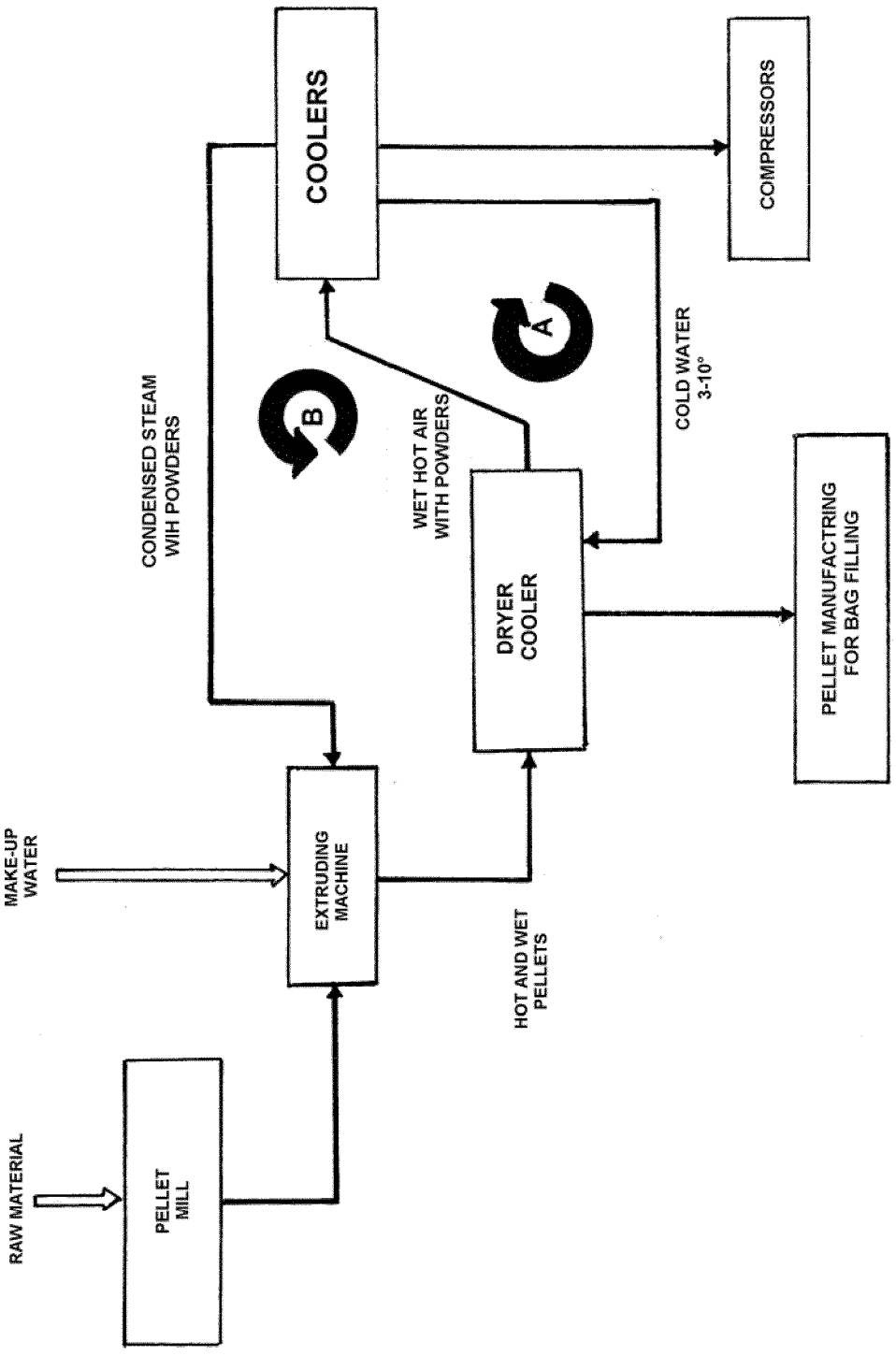
RAW MATERIAL
PELLET MILL
MAKE-UP WATER
EXTRUDING MACHINE
HOT AND WET PELLETS
DRYER COOLER
CONDENSED STEAM WIH POWDERS
WET HOT AIR WITH POWDERS
COLD WATER 3-10°
COOLERS
COMPRESSORS
PELLET MANUFACTRING FOR BAG FILLING
A
B

FIG.1

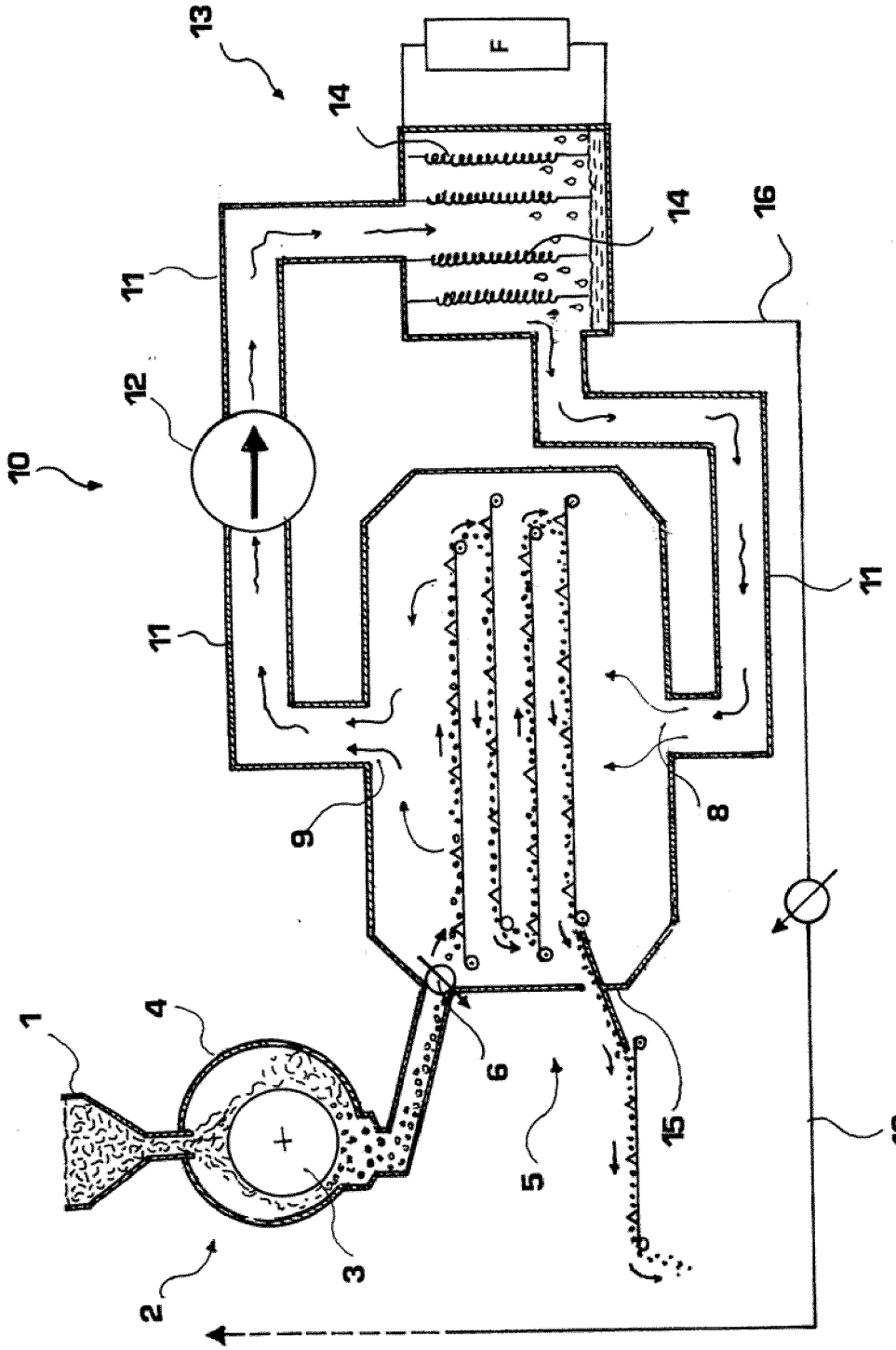

FIG.2

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 16 0434

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2006/101881 A1 (CARIN CHRISTIANNE [CA] ET AL) 18 May 2006 (2006-05-18) * paragraph [0002]; figure 1 * * paragraphs [0113], [0114] * * paragraphs [0130], [0131] *	1-4,6-11	INV. F26B1/00 F26B21/08 F26B25/00
Y	EP 0 356 388 A2 (BAER ROBERT) 28 February 1990 (1990-02-28) * column 1, line 3 - line 17; figures 1-3 * * column 1, line 56 - column 2, line 57 * * column 3, line 8 - column 5, line 21 * * column 5, line 51 - line 62 *	1-4,6-11	
A	WO 01/58815 A2 (NETZSCH ERICH HOLDING [DE]) 16 August 2001 (2001-08-16) * page 2, line 5 - line 8; figure 1 * * page 3, line 28 - page 4, line 25 *	2,6,7,10	
A	WO 2009/054033 A1 (WORLD ENVIRONMENTAL DESIGN CO [JP]; SHIBATA KATSUMI [JP]; SHIBATA KENT) 30 April 2009 (2009-04-30) * abstract; figure 5 *	1,6,8	TECHNICAL FIELDS SEARCHED (IPC) F26B
A	JP 2009 133512 A (KAJIMA CORP) 18 June 2009 (2009-06-18) * abstract; figures 1, 8-11 *	5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	30 August 2013	Hauck, Gunther

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 16 0434

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-08-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006101881 A1	18-05-2006	US 2006101881 A1	18-05-2006
		US 2011113841 A1	19-05-2011
EP 0356388 A2	28-02-1990	DE 58902754 D1	24-12-1992
		EP 0356388 A2	28-02-1990
WO 0158815 A2	16-08-2001	DE 10005165 A1	16-08-2001
		WO 0158815 A2	16-08-2001
WO 2009054033 A1	30-04-2009	TW 200918840 A	01-05-2009
		WO 2009054033 A1	30-04-2009
JP 2009133512 A	18-06-2009	JP 5071974 B2	14-11-2012
		JP 2009133512 A	18-06-2009

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82