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(54) TREATMENT PLANT FOR PARTICULATE MATERIAL

BEHANDLUNGSANLAGE FÜR EIN TEILCHENMATERIAL

USINE DE TRAITEMENT POUR MATÉRIAU PARTICULAIRE

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Description

[0001] The present invention relates to a plant for treating (in particular drying or washing/drying) particulate material. Here "particulate material" is understood as meaning a mass of small particles (for example, particles with a size of the order of 1-50 mm). More particularly, the material may be of the substantially granular type, i.e. with a three-dimensional or two-dimensional form, namely with a thickness which is much smaller, for example by a factor of ten, compared to the other two dimensions.

[0002] For example, the plant may be advantageously used to dry granules or chads of plastic in a plastic recycling plant. These particles are usually produced by breaking up the plastic to be recycled into small pieces by means of grinding mills having grilles with a size of 1-50 mm, and are then subjected to a washing and drying cycle.

[0003] Usually, in recycling plants, washing is performed by means of immersion of the particles, and the subsequent drying operation is performed by means of special hot-air drying tunnels.

[0004] The washing performed in these plants therefore usually requires large quantities of water (which must be then disposed of by means of suitable anti-pollution treatment) and the subsequent drying operation involves relatively high energy costs (with rated power levels as high as 150 kW for an average-size plant).

[0005] All this reduces the efficiency and the advantage of recycling the plastic.

[0006] In the prior art, numerous drying systems which use large quantities of heat have been proposed.

[0007] For example, US4,490,927 and US4,734,996 describe a hot-air oven provided with a chamber which is passed through by conveyors transporting the material and into which a large quantity of hot air is introduced and extracted.

[0008] BE 468,229 describes a drier with a chamber through which material conveying belts pass. Hot air is introduced in a broad flow at the bottom of the chamber and is extracted at the top.

[0009] WO2009/081373 describes a drier in which a chamber is passed through by perforated conveyor belts between which the material to be dried is retained. In an attempt to reduce the quantity of hot air used, the hot air (produced outside of the chamber) is conveyed so as to be blown in the form of a plurality of local jets produced by a plurality of holes or nozzles, directly against both the sides of the material to be dried, and is then extracted from the chamber by means of a large suction duct.

[0010] DE 941,274 describes a drier with blowers which emit hot air along the path of material conveying belts. The blowers are arranged facing each other on both sides of the material. In order to try to reduce the power consumption of the drier, it is attempted to reduce the heat dispersion thereof using hot air ducts which are as short as possible, including heating the air directly inside the blowers.

[0011] WO2009/035406 discloses a system that uses steam to cook food.

[0012] The general object of the present invention is to avoid the problems of the prior art and to provide a plant for drying or washing/drying particulate materials, in particular granules or chads of plastic, which is rapid and efficient, with a low power consumption.

[0013] In view of this object the idea which has occurred is to provide, according to the invention, a plant for treating particulate material as claimed in claim 1.

[0014] Still according to the invention, the idea which has occurred is to provide a method for treating particulate material, as claimed in claim 13.

[0015] In order to illustrate more clearly the innovative principles of the present invention and its advantages compared to the prior art, a number of examples of embodiment applying these principles will be described below with the aid of the accompanying drawings. In the drawings:

- Figure 1 shows a schematic, partially sectioned, side elevation view of a plant designed in accordance with the invention;
- Figure 2 shows a cross-sectional, bottom perspective view of the plant according to Figure 1;
- Figure 3 shows a schematic cross-sectional view, on a larger scale, of a drying zone of the plant according to Figure 1;
- Figure 4 shows a partial cross-sectional view along the line IV-IV of Figure 1;
- Figure 5 shows a schematic cross-sectional view, on a larger scale, of a washing zone of the plant according to Figure 1;
- Figure 6 shows a schematic perspective view of a second embodiment of a plant designed in accordance with the invention;
- Figure 7 shows a cross-sectional view, on a larger scale, of a part of the plant according to Figure 6;
- Figure 8 shows a schematic perspective view of a third embodiment of a plant designed in accordance with the invention;
- Figure 9 shows a cross-sectional view, on a larger scale, of a part of the plant according to Figure 8;
- Figure 10 shows a partial schematic view, on a larger scale, of a further possible variation of the plant according to the invention;
- Figure 11 shows a schematic cross-sectional view of a plant as shown in Figure 1, to which the variation according to Figure 10 has been applied.

[0016] With reference to the Figures, Figure 1 shows a plant for treating particulate material according to the invention, denoted overall by 10.

[0017] The plant 10 comprises two facing surfaces 11 and 12 which define an interspace 13 between them inside which a layer of particulate material 14 is intended to be fed. Advantageously, but not exclusively, the par-

ticulate material may be formed by plastic which has been broken up into chads (for example from plastic containers) for recycling and which must undergo washing and subsequent drying operations.

[0018] The plant comprises a device 15 for emitting an air knife 16 which passes through at least one of the two surfaces and, preferably, both the surfaces (suitably perforated for allowing air, but not particulate material to pass through) so as to pass through the mass of material which is fed between the two surfaces by the movement means 17 which are intended to impart a relative movement to the layer of particulate material with respect to the air knife emission device. The air knife has, by nature, a cross-section transverse to the direction of the air which has a breadth in one direction (considered to be main direction) which is much greater than the thickness in the other direction perpendicular thereto. For example, an air knife may have a ratio of its thickness to length in the main direction of 1:1000.

[0019] The relative movement is directed transversely to the air knife, which occupies the entire width of the surfaces in the direction transverse to the movement, so that all the material passes through the barrier formed by the air knife (in Figure 1 the knife extends in the direction perpendicular to the plane of the drawing, while the movement of the material takes place from left to right).

[0020] In this way, the water which may be present in the material is extracted from the material owing to the air flow. In particular, the water is conveyed by the air flow and passes through the flow outlet surface, for example falling into a collection tank 18. Preferably, the air knife has a speed of the air which is greater than 100 m/s (advantageously more than 360 km/h).

[0021] The interspace at least in the zone of the air knife has a thickness which is preferably between 1 and 50 mm for the material ground with grilles having through-openings of 1-10 mm.

[0022] As can be clearly seen in Figure 1, the two surfaces are advantageously vertically arranged one above the other and at least the bottom surface 11 comprises at least one first conveyor belt 19 for transporting the material along the interspace. The belt is suitably perforated to allow the passage of the air knife and forms at least part of the said movement means 17. The holes in the belt have obviously a size smaller than the single particles of material, so as to prevent the material from being drawn by the flow through the belt. As can be clearly seen also in Figure 2, advantageously the belt is supported and travels, at least in the zone where the air knife passes through, over plates 25 which are arranged parallel to the direction of travel and which allow the air flow to pass through.

[0023] In the plant shown in Figure 1, the material arrives (via known means, not shown) to a loading hopper 26 which releases a layer of substantially uniform material onto the bottom belt 19 in an initial zone where there is no top surface 12. The belt 19 then performs unloading, at the end of treatment, into an output hopper 27 from which the material is then evacuated using known means (for example, a motor-driven screw feeder arranged on the bottom of the hopper).

[0024] Advantageously, the top surface 12 may comprise a second conveyor belt 20 which also helps form at least part of the movement means for transporting the material along the interspace. This belt is also suitably perforated so as to allow the air knife to pass through and may be moved in synchronism with or at a different speed from the bottom belt (so as to cause the movement of the material, thus favouring drying). The material to be treated thus travels together with the two superimposed belts which form the interspace 13.

[0025] As can be clearly seen in Figures 1 and 2, advantageously the two superimposed belts follow a zigzag path between the interspace inlet and outlet for the material. Moreover it has been found to be advantageous, in order to follow this zigzag path, for the two belts to be deviated by rollers 24 arranged alternately above and below the pair of belts. In this way, in the deviation zones around each roller, one of the two belts does not rest directly on a roller and is free to move away from the other belt, allowing zones of material of varying thickness to pass through. The belts are kept taut with a suitable tension by means of tensioning members 28 and 29.

[0026] Advantageously, along the path there are at least two devices 15 for emitting the air knife such that the material treated and remixed by the first air knife is subject to a second final drying treatment underneath the second air knife.

[0027] Means may also be provided for cleaning the moving belts, so as to prevent the material to be treated from adhering to the belts. Preferably, the top belt has cleaning means 35 arranged immediately in front of the start of its travel path. The material removed may thus fall onto the bottom belt. The bottom belt has instead preferably cleaning means 36 arranged immediately following the end of its travel path. The removed material may thus fall into the hopper 27. The cleaning means 35 and 36 may advantageously be rotating brushes which are arranged transversely with respect to the belts and/or may consist of further air knife emission elements.

[0028] Figure 3 shows schematically a possible structure of the air knife emission device 15. It comprises a chamber 30 which extends transversely with respect to the direction of travel of the material and inside which a source 32 supplies air with a suitable pressure and speed (continuously or in a pulsed manner) so as to be emitted in the form of an air knife from an outlet mouth 31 formed by a slit of suitable width and extending in the direction transverse to the direction of relative travel of the particulate material. This mouth is advantageously at least as wide as the interspace in the direction transverse to the travel movement (as schematically shown in Figure 4) so as to encompass all the particulate material which passes underneath the device.

[0029] The thickness of the slit may be, for example,

between 0.1 and 1 mm. The air knife may have at the outlet a corresponding thickness. Preferably, the air knife has a very small thickness, namely in the region of a few tenths of a millimetre (e.g. between 0.1 and 1 mm at the slit). In view of the high speed of the air output from the slit, the thickness of the jet remains very small even at a distance from the slit.

[0030] As can be schematically seen again in the enlarged detail of Figure 3, the air knife is advantageously inclined with respect to the two surfaces which form the interspace at an angle α of between 15° and 90° and, in particular, in the region of 60°. Moreover, advantageously, the inclination is towards the direction of arrival of the material.

[0031] This results in a useful local remixing action of the material acted on by the air knife, said material being pushed back by the air knife, while it is moved forwards by the movement means and the following material. This action promotes perfect drying and helps the material to remain in the zone of the air knife until satisfactory drying is achieved.

[0032] In this connection it has been found to be advantageous if, at least in the zone acted on by the air knife, the thickness of the interspace between the two surfaces 11 and 12 is at least 1-5 times the average thickness of the particles, so as to facilitate remixing underneath the inclined air knife and at the same time the feeding movement. This particle thickness may for example be easily adjusted by means of the hopper or inlet device 26, as may be easily imagined by the person skilled in the art.

[0033] As shown schematically in Figure 4, the surfaces 11 and 12 have lateral edges for closing the interspace. In particular, in the case of belts, it has been found to be advantageous if they have raised lateral edges 22, 23 directed from one belt towards the other one, so as to form lateral closing elements for the interspace formed between the belts. Advantageously, as can be clearly seen in Figure 4, these lateral edges are laterally partially superimposed on each other so as to allow a relative movement of the two belts towards or away from each other, while keeping the interspace closed laterally. This also allows adaptation of the local thickness of the interspace depending on the local variations in the thickness or density of the layer of particulate material conveyed.

[0034] Before being acted on by the air knives, the particulate material may be washed using known methods (for example by means of immersion in a tank) and then introduced into the interspace 13 for drying.

[0035] However, advantageously the plant 10 also comprises one or more devices 21 for emitting water transversely between the two surfaces 11 and 12 for washing the material in the interspace. These devices 21 are therefore arranged upstream of the air knife emission device or devices 15 in relation to the movement imparted to the layer of particulate material by the movement means 17.

[0036] In this way, the material is subjected to the washing action directly between the two surfaces and, since the layer of material is relatively thin owing to the presence of the retaining interspace, the quantity of water needed is limited. In this way, the drying process acquires further efficiency.

[0037] Preferably, the device 21 for emitting water (to which suitable detergents may be added) may be a per se known device for emitting atomized hot or cold water or steam. This device is designed to create an atomized water barrier which is arranged transversely with respect to the interspace and through which the mass of material pushed by the action of the movement means 17 passes.

[0038] As can be clearly seen in Figures 1 and 2 and in the enlarged view of Figure 5, the devices for emitting atomized water or steam comprise advantageously a plurality of nozzles 33 which are supplied by a suitable pressurized steam or water source 34 and are arranged alongside each other in several rows in a direction transverse to the direction of the movement of the material inside the interspace.

[0039] The belts are advantageously supported by plates 25 also in the region of these devices so as to allow the water to be collected inside an underlying tank 18.

[0040] During operation of the plant as described, the particulate material is thus fed to the inlet 26 so as to fall onto the belt 19 and enter in a thin layer inside the interspace 13 which is formed between the two belts. The material then passes underneath the water emission devices so as to be washed and then underneath the air knife drying devices. After this, the material falls from the terminal end of the conveyor 19 into the outlet hopper 27. During its travel between the inlet and outlet the material advantageously follows a zigzag path being compressed and released between the belts so that the layer is remixed and made more uniform.

[0041] Figure 6 shows a second embodiment of a treatment plant designed in accordance with the invention. For the sake of simplicity, parts similar to those in the preceding embodiment will be indicated by the same numbering, but increased by 100.

[0042] In this second embodiment, denoted overall by 110, the relative movement of material to be treated and air knives is principally obtained by causing the air knives to travel along the facing surfaces for retaining the material. These facing surfaces 111 and 112 define an interspace 113 inside which a layer of particulate material is intended to be fed.

[0043] In the case of intermittent operation, the material may be for example spread between the surfaces (designed such that they may be suitably opened) and then the sliding movement of the air knives may be activated. In addition or as an alternative to continuous operation, the material may be fed to one end of the interspace (or also by providing a suitable opening on the top surface 112) and extracted from the other end. As can be clearly seen in Figure 6, in order to facilitate a feeding movement of the material, the two surfaces 111, 112 are

preferably inclined downwards in the desired direction of travel of the material and are caused to vibrate by means of a suitable vibrating unit 150, for example designed with an electric motor which rotates a suitable eccentric mass, as may be easily imagined by the person skilled in the art. Advantageously the two surfaces (formed with two superimposed perforated metal plates) are supported by leaf springs 151, 152 in order to facilitate correct vibration in the desired direction of feeding of the material and prevent the vibration from being transmitted to the base of the plant.

[0044] A tank 118 for collecting the water extracted from the material by means of the air knife is advantageously positioned underneath the plates 111, 112.

[0045] A device 115 (similar to the device 15 described above) for emitting the air knife transversely with respect to the surfaces 111, 112 is present on top of the plates, said device sliding along the perforated surface by means of motor-driven sliding means which form the said means 117 for relative feeding of the material and air knife. In particular, the movement may be performed (by means of a motor 154) with an alternating movement along a rail 153 which is in turn transverse to the air knife. Figure 7 shows an enlarged longitudinal section (transverse to the air knife) of the zone of the mouth 131 for emitting the air knife.

[0046] Owing to the movement of the device 115, all the material between the perforated surfaces is subject to the drying action and is then conveyed to the bottom outlet of the interspace by means of vibrations imparted by the unit 150.

[0047] Preferably the air knives may be inclined towards the direction of arrival of the material (at angles, relative to the perforated surfaces, similar to those described above for the other embodiments) so as to favour remixing and drying by means of multiple passing movements.

[0048] Figure 8 shows another embodiment of a treatment plant provided in accordance with the invention. For the sake of simplicity, parts similar to those in the first embodiment will be indicated by the same numbering, but increased by 200.

[0049] As can be clearly seen also in the cross-section of Figure 9, a plant 210 denoted overall by 210 is therefore provided where the relative movement of material to be treated and air knives is principally obtained by means of falling of the material through an interspace 213 provided between two perforated surfaces 211 and 212 arranged so as to be substantially vertical. The means for moving the material are therefore obtained by means of the same interspace 213 arranged so as to be substantially vertical and, optionally, by means of the additional thrusting action of the air knives.

[0050] One or more devices 215 (similar to those described above) for emitting air knives, extending transversely with respect to the direction of falling movement of the material, are provided on one of the two surfaces. Figure 8 shows, for example, three devices 215 arranged one on top of the other. A tank or interspace 218 for collecting the water extracted from the material by means of the air knife is present on the opposite side of the interspace 213 to the units 215.

[0051] The two surfaces 211 or 212 may be perforated along their length or only in the region of the air knives.

[0052] Owing to the falling movement of the material, all the material between the perforated surfaces is subjected to the drying action. Preferably the outlet mouths 231 emit the air knives inclined upwards (at angles, relative to the perforated surfaces, similar to those described above for the other embodiments) so as to favour remixing and drying by means of multiple passing movements.

[0053] The material may be fed at the top to the interspace 213 and removed at the bottom using various known means. For example, it may be advantageous to use an incoming conveyor belt 226 which performs unloading above the interspace (with a suitably shaped wide mouth) and an evacuation conveyor belt 227 which receives the material which has passed through the interspace. Alternatively, hopper means as described for the first embodiment may also be used.

[0054] At this point it is clear how the objects of the invention have been achieved, by providing a plant which, owing to the use of air knives and not, for example, air jets with a substantially circular diffusion, is able to perform the (drying or washing/drying) treatment of particulate materials using a relatively small amount of electric power with at the same time a high degree of efficiency. From the text it is clear what is intended here by the term "air knife".

[0055] In particular, the method for treating particulate material according to the invention, which comprises the steps of feeding a layer of material into an interspace between two facing surfaces and subjecting the material between said surfaces to an air knife transverse to the interspace, advantageously with an air speed greater than 100 m/s in order to extract water from the material, enables a high efficiency and a low energy consumption to be achieved, while obtaining a material which is perfectly dry.

[0056] Since the air knife extracts the water from the material without the need for heating in order to cause evaporation thereof, the electric power consumption of the plant per unit of time may be for example in the region of 40 kW for the treatment of 1 mc/h of material, compared to the 150 kW required by a conventional hot air plant.

[0057] A plant for recycling plastic using the method and the plant according to the invention therefore becomes more advantageous from a cost point of view.

[0058] The concentrated flow of the air knives favours the removal of the moisture from the particulate material. The surface of the particulate material is in fact dried before the material is pushed away by the air owing to the difference in the thicknesses involved between the particle and the superficial covering; this would not be possible with a broader and slower flow - different from

a flow of the air knife type - since it would have the sole effect of moving the particle away together with its moisture.

[0059] With the particulate material moving inside an interspace, the air knife has been found to be of great efficiency since in the transverse direction the air output is continuous and speed components which induce lateral displacements of the moisture are not present. Moreover, with the air knives directed backwards, the particulate material moves forwards intermittently and passes several times (for example 2-3 times) below the air knife.

[0060] Obviously the description provided above of embodiments applying the innovative principles of the present invention is provided by way of example of these innovative principles and must therefore not be regarded as limiting the scope of the rights claimed herein.

[0061] For example, although the continuous movement of the material is preferable, the movement of air knife and mass of material is to be understood as being a relative movement. It may therefore be considered moving the air knife over the material while keeping the mass of material stationary or semi-stationary (as for example may occur with the plant according to Figure 6), or moving the material using belts or by means of gravity (as shown in Figure 1 or 8) while keeping the air knife fixed, or finally moving both the material and the air knife, the air knife being made to perform an intermittent movement (or continuous movement along a circular path) with a speed substantially greater than that of the material so as to intercept on several occasions the material during its feeding movement (as may be achieved with the plant according to Figure 6 or with the plant obtained by modifying the belt system according to Figure 1 with the introduction of suitable means for moving the knife emission device 15. Moreover, the relative movement may also be discontinuous or may be obtained with systems other than motor-driven moving belts or vibration systems.

[0062] Moreover, the facing surfaces which form the interspace may be formed directly by the belts alone or equivalent means or (if, for example, a greater rigidity is required) they may be formed by fixed rigid surfaces on which the movement means move. Mixed systems may also be used.

[0063] As described above, the method according to the invention comprises advantageously also the step of emitting water, which is preferably atomized, onto the material between the surfaces before exposing the material to the air knife, so as to provide a combined cycle involving washing and subsequent drying of the material. However, as mentioned above, washing may also be entirely or partly performed using different known methods. The washing systems, as for example described above for the first embodiment, may also be used in the other embodiments, as may be now easily imagined by the person skilled in the art.

[0064] The plant according to the invention may obviously be incorporated within recycling plants which comprise various other known treatment steps, which for the sake of simplicity are not described here, but may be easily imagined by the person skilled in the art.

[0065] It may also be considered providing a solution in which the surface furthest from the air knife emission device is impermeable to air, so that this air is deflected off it and emerges again on the same side as the air knife device. Clearly, when the surfaces are arranged on top of each other, in this situation it is preferable that the air knife emission device is arranged underneath the bottom surface which is provided with holes.

[0066] Figure 10 shows a variation of embodiment in which, on the side of the interspace opposite to the air knife emission device (for example the device 15 according to Figure 1), there is a suction system 37 which directly receives the air knife which has passed through the interspace containing the material.

[0067] In particular, in the embodiment shown, each air knife emission device has a corresponding suction device 37 which comprises a receiving housing 38 which extends parallel to the air knife and has an open side which is situated substantially against the surface (opposite to the emission device) delimiting the interspace along which the material to be dried moves. The housing is connected to an air and water flow evacuation duct 39 which downstream is connected to a suitable suction system (for example a known aspirator with known air/water separation means).

[0068] As can be clearly seen in Figure 11, in the case of a plant similar to that shown in Figure 1, the housing 38 may have incisions along the edges of the side walls (or front wall and rear wall, if appropriate for the direction of travel of the belts) which rest against the bottom belt (or make light contact with it). These incisions are provided so as to allow the plates 25 to pass through the housing.

[0069] Alternatively, the plates 25 may be interrupted so as not to penetrate into the housing and the belt supporting function may be provided locally by the edges of the housing. The use of the suction system allows more effective recovery of the water, preventing any ricocheting spray (in view also of the high speed of the flow) which could wet the belts and the material arranged between them.

[0070] In particular, the suction devices situated opposite the air knives allow any micro-droplets of water which tend to remain suspended in the air to be extracted.

[0071] This also prevents the formation of transient phenomena in the plant, which are due to a gradual increase in moisture of the belts owing to the ricocheting water and which could result in a lack of uniformity in drying over time. For example, in particular in the case of discontinuous drying cycles (for example, with material which may be fed in batches), the said belts, owing to the ricocheting water, could give rise to further moistening of the material after a few minutes operation. The same suction system may be used in the other embodiments.

Claims

1. Plant (10,110,210) for treating particulate material comprising two facing surfaces (11, 12, 111, 112, 211, 212) which define an interspace (13, 113, 213) between them inside which a layer of particulate material is intended to be fed; at least one device (15, 115, 215) for emitting air through at least one of the two surfaces; movement means (17, 117, 213) for performing a relative movement of the layer of particulate material with respect to the air emission device (15, 115, 215), **characterized in that** the air emission device (15, 115, 215) is a device (15, 115, 215) for emitting an air knife through at least one of the two surfaces and the relative movement is in a direction transverse to the extension of the air knife, so as to favour extraction with the air flow, through at least one of the two surfaces, of water which may be present in the material.

2. Plant according to Claim 1, **characterized in that** the air knife emission device comprises an air knife emission mouth (31) which is formed by a slit extending in the direction transverse to the direction of relative movement of the layer of material.

3. Plant according to Claim 1, **characterized in that** the two surfaces (11, 12) are arranged on top of each other and at least the bottom surface comprises a first conveyor belt (19) for conveying the material along the interspace (13), which is perforated so as to allow the air knife to pass through and form at least part of the said movement means (17).

4. Plant according to Claim 3, **characterized in that** the bottom surface comprises a second conveyor belt (20) for conveying the material along the interspace (13), which is perforated so as to allow the air knife to pass through and form at least part of the said movement means (17).

5. Plant according to Claim 4, **characterized in that** the first conveyor belt (19) and the second conveyor belt (20) each have lateral edges (22, 23) raised towards the other belt so as to form elements for laterally closing the interspace (13) formed between the surfaces.

6. Plant according to Claim 5, **characterized in that** the lateral edges of the two belts (19, 20) are laterally partially superimposed so as to allow a relative movement of the two belts towards and away from each other while keeping the interspace (13) laterally closed.

7. Plant according to Claim 1, **characterized in that** the air knife (16) is inclined with respect to the said two surfaces (11, 12, 112, 211, 212) at an angle of between 15° and 90° and, in particular, of about 60°, towards the direction of arrival of the material.

8. Plant according to Claims 3 and 4, **characterized in that** the two superimposed belts (19, 20) follow a zigzag path.

9. Plant according to Claim 8, **characterized in that**, in order to follow the zigzag path, the two belts (19, 20) are deviated by rollers (24) arranged alternately above and below the pair of belts.

10. Plant according to Claim 1, **characterized in that** the air knife output from the emission device (15, 115, 215) has a speed of the air which is greater than 100 m/s.

11. Plant according to Claim 1, **characterized in that** the surfaces (211, 212) are arranged so as to be substantially vertical in order to produce the movement of the material which falls along the interspace (213).

12. Plant according to Claim 1, **characterized in that** a suction system (37) is situated on one side of the interspace (13, 113, 213) opposite to the air knife emission device (15, 115, 215), said system receiving directly the air knife for evacuation of the air flow with the water which may be present in the material and is conveyed out of the interspace by means of the air knife.

13. Method for treating particulate material, comprising the step of feeding a layer of material into an interspace (13, 113, 213) between two facing surfaces (11, 12, 111, 112, 211, 212) and **characterized by** subjecting the material between said surfaces (11, 12, 111, 112, 211, 212) to an air knife transverse to the interspace (13, 113, 213) and having a speed of the air greater than 100 m/s so as to extract any water from the material.

14. Method according to Claim 13, wherein the material between the surfaces (11, 12, 111, 112, 211, 212) is made to move in a direction parallel to the surface and the air knife is inclined in a direction opposite to the direction of movement at an angle with respect to the surfaces of between 15° and 90°, and in particular of about 60°.

15. Method according to Claim 13, wherein at least one of the two surfaces (11, 12, 111, 112, 211, 212) is formed by a perforated conveyor belt, preferably arranged in zigzag fashion.

16. Method according to Claim 13, wherein the air knife is a continuous jet or pulsed jet, preferably with a frequency of 5 to 20 pulses per second.

Patentansprüche

1. Anlage (10, 110, 210) zur Behandlung eines teilchenförmigen Materials, welche umfasst, zwei gegenüberliegende Oberflächen (11, 12, 111, 112, 211, 212), die dazwischen einen Zwischenraum (13, 113, 213) definieren, in dem eine Schicht eines teilchenförmigen Materials eingebracht werden soll; mindestens eine Einrichtung (15, 115, 215) zur Ausgabe von Luft durch mindestens eine der beiden Oberflächen; Bewegungsmittel (17,117,213) zur Durchführung einer relativen Bewegung der Schicht des teilchenförmigen Materials in Bezug auf die Luft-Ausgabe-Einrichtung (15, 115, 215), **dadurch gekennzeichnet, dass** die Luft-Ausgabeeinrichtung (15, 115, 215) eine Einrichtung (15, 115, 215) ist, um eine Luftbürste durch mindestens eine der zwei Oberflächen auszugeben und dass die relative Bewegung in einer Richtung transversal zu der Ausdehnung der Luftbürste erfolgt, um so eine Extraktion von in dem Material gegebenenfalls vorhandenem Wasser mit dem Luftstrom durch mindestens eine der zwei Oberflächen, zu begünstigen.

2. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die Luftbürsten-Ausgabe-Einrichtung einen Luftbürsten-Ausgabe-Mund (31) umfasst, der durch einen Schlitz ausgebildet ist, welcher sich in der Richtung transversal zu der Richtung der relativen Bewegung der Schicht des Materials erstreckt.

3. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die zwei Oberflächen (11, 12) aufeinander angeordnet sind und mindestens die untere Oberfläche ein erstes Förderband (19) umfasst, um das Material entlang des Zwischenraums (13) zu transportieren, welches perforiert ist, so dass die Luftbürste durchgelangt und mindestens einen Teil der Bewegungsmittel (17) ausmacht.

4. Anlage nach Anspruch 3, **dadurch gekennzeichnet, dass** die untere Oberfläche ein zweites Förderband (20) umfasst, um das Material entlang des Zwischenraums (13) zu transportieren, welches perforiert ist, so dass die die Luftbürste durchgelangt und mindestens Teil des Bewegungsmittels (17) ausbildet.

5. Anlage nach Anspruch 4, **dadurch gekennzeichnet, dass** das erste Förderband (19) und das zweite Förderband (20) jeweils seitliche Kanten (22, 23) aufweisen, die auf das andere Band zu erhöht sind, um Elemente zu bilden, um den Zwischenraum (13), der zwischen den Oberflächen ausgebildet ist, seitlich zu schließen.

6. Anlage nach Anspruch 5, **dadurch gekennzeichnet, dass** die seitliche Kanten der zwei Bänder (19, 20) seitlich teilweise überlagert sind, um eine relative Bewegung der zwei Bänder aufeinander zu und voneinander weg zu ermöglichen, während der Zwischenraum (13) seitlich verschlossen bleibt.

7. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die Luftbürste (16) in Bezug auf die zwei Oberflächen (11, 12, 112, 211, 212) in einem Winkel von zwischen 15° und 90° und insbesondere von etwa 60° in Richtung auf die Ankunft des Materials geneigt ist.

8. Anlage nach Anspruchs 3 und 4, **dadurch gekennzeichnet, dass** die zwei überlagerten Bänder (19, 20) einem Zick-Zack Weg folgen.

9. Anlage nach Anspruch 8, **dadurch gekennzeichnet, dass**, die zwei Bänder (19, 20), um dem Zick-Zack-Weg zu folgen, durch Rollen (24) abgelenkt werden, die alternierend über und unter den Bändern angeordnet sind.

10. Anlage nach Anspruch 1 **dadurch gekennzeichnet, dass** die Luftbürsten-Ausgabe von der Ausgabeeinrichtung (15, 115, 215) eine Luftgeschwindigkeit von über 100 m/s aufweist.

11. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** die Oberflächen (211,212) angeordnet sind, um im Wesentlichen vertikal angeordnet zu sein, um die Bewegung des Materials zu erzeugen, welches entlang des Zwischenraums (213) fällt.

12. Anlage nach Anspruch 1, **dadurch gekennzeichnet, dass** an einer Seite des Zwischenraums (13, 113, 213) abgewandt von der Luftbürsten-Ausgabeeinrichtung (15, 115, 215) ein Absaugsystem (37) vorgesehen ist, worin das System die Luftbürste zur Entfernung des Luftstroms mit dem Wasser, welches in dem Material vorhanden sein kann, und welches mittels der Luftbürste aus dem Zwischenraum transportiert wird, direkt erhält.

13. Verfahren zur Behandlung eines teilchenförmigen Materials, welches den Schritt umfasst, Beschicken einer Schicht des Materials in einen Zwischenraum (13, 113, 213) zwischen zwei gegenüberliegende Oberflächen (11, 12, 111, 112, 211, 212) und **gekennzeichnet durch** Unterziehen des Materials zwischen den Oberflächen (11, 12, 111, 112, 211, 212) einer Luftbürste transversal zu den Zwischenraum (13, 113, 213) und bei einer Luftgeschwindigkeit von über 100 m/s, um jegliches Wasser aus dem Material zu extrahieren.

14. Verfahren nach Anspruch 13, worin das Material zwischen den Oberflächen (11, 12, 111, 112, 211, 212) in einer Richtung parallel zu der Oberfläche bewegt

wird und worin die Luftbürste in eine Richtung abgewandt zu der Bewegungs-Richtung in einem Winkel in Bezug zu den Oberflächen von zwischen 15° und 90°, und insbesondere von etwa 60° geneigt ist.

15. Verfahren nach Anspruch 13, worin mindestens eine der zwei Oberflächen (11, 12, 111, 112, 211, 212) durch ein perforiertes, vorzugsweise in einer Zick-Zack-Art angeordnetes Förderband ausgebildet ist,

16. Verfahren nach Anspruch 13, worin die Luftbürste ein kontinuierlicher Strahl oder ein gepulster Strahl ist, vorzugsweise mit einer Frequenz von 5 bis 20 Pulsen pro Sekunde.

Revendications

1. Usine (10, 110, 210) pour traiter un matériau particulaire comprenant deux surfaces en vis-à-vis (11, 12, 111, 112, 211, 212) qui définissent un espace intermédiaire (13, 113, 213) entre elles, à l'intérieur duquel on prévoit d'amener une couche d'un matériau particulaire ; au moins un dispositif (15, 115, 215) pour émettre l'air par au moins l'une des deux surfaces ; des moyens de déplacement (17, 117, 213) pour réaliser un mouvement relatif de la couche de matériau particulaire par rapport au dispositif d'émission d'air (15, 115, 215), **caractérisée en ce que** le dispositif d'émission d'air (15, 115, 215) est un dispositif (15, 115, 215) pour émettre une lame d'air à travers au moins l'une des deux surfaces et le mouvement relatif est dans une direction transversale par rapport à l'extension de la lame d'air, afin de favoriser l'extraction avec l'écoulement d'air, à travers au moins l'une des deux surfaces, de l'eau qui peut être présente dans le matériau.

2. Usine selon la revendication 1, **caractérisée en ce que** le dispositif d'émission de lame d'air comprend une bouche d'émission de lame d'air (31) qui est formée par une fente s'étendant dans la direction transversale par rapport à la direction du mouvement relatif de la couche de matériau.

3. Usine selon la revendication 1, **caractérisée en ce que** les deux surfaces (11, 12) sont agencées l'une sur l'autre et au moins la surface inférieure comprend une première courroie transporteuse (19) pour transporter le matériau le long de l'espace intermédiaire (13), qui est perforée afin de permettre à la lame d'air de passer à travers et former au moins une partie desdits moyens de déplacement (17).

4. Usine selon la revendication 3, **caractérisée en ce que** la surface inférieure comprend une seconde courroie transporteuse (20) pour transporter le matériau le long de l'espace intermédiaire (13), qui est perforée afin de permettre à la lame d'air de passer à travers et former au moins une partie desdits moyens de déplacement (17).

5. Usine selon la revendication 4, **caractérisée en ce que** la première courroie transporteuse (19) et la seconde courroie transporteuse (20) ont chacune des bords latéraux (22, 23) relevés vers l'autre courroie afin de former des éléments pour fermer latéralement l'espace intermédiaire (13) formé entre les surfaces.

6. Usine selon la revendication 5, **caractérisée en ce que** les bords latéraux des deux courroies (19, 20) sont latéralement partiellement superposés afin de permettre un mouvement relatif des deux courroies vers et à distance l'une de l'autre, tout en maintenant l'espace intermédiaire (13) latéralement fermé.

7. Usine selon la revendication 1, **caractérisée en ce que** la lame d'air (16) est inclinée par rapport auxdites deux surfaces (11, 12, 112, 211, 212) à un angle compris entre 15° et 90° et, en particulier, d'environ 60°, vers la direction d'arrivée du matériau.

8. Usine selon les revendications 3 et 4, **caractérisée en ce que** les deux courroies (19, 20) superposées suivent une trajectoire en zigzag.

9. Usine selon la revendication 8, **caractérisée en ce que**, afin de suivre la trajectoire en zigzag, les deux courroies (19, 20) sont déviées par des rouleaux (24) agencés de manière alternée au-dessus et au-dessous de la paire de courroies.

10. Usine selon la revendication 1, **caractérisée en ce que** la lame d'air produite par le dispositif d'émission (15, 115, 215) a une vitesse d'air qui est supérieure à 100 m/s.

11. Usine selon la revendication 1, **caractérisée en ce que** les surfaces (211, 212) sont agencées afin d'être sensiblement verticales afin de produire le déplacement du matériau qui tombe le long de l'espace intermédiaire (213).

12. Usine selon la revendication 1, **caractérisée en ce qu'**un système d'aspiration (37) est situé d'un côté de l'espace intermédiaire (13, 113, 213) opposé au dispositif d'émission de lame d'air (15, 115, 215), ledit système recevant directement la lame d'air pour l'évacuation de l'écoulement d'air avec l'eau qui peut être présente dans le matériau et est transportée à l'extérieur de l'espace intermédiaire au moyen de la lame d'air.

13. Procédé pour traiter un matériau particulaire, comprenant l'étape consistant à amener une couche de

matériau dans un espace intermédiaire (13, 113, 213) entre deux surfaces en vis-à-vis (11, 12, 111, 112, 211, 212) et caractérisé en soumettant le matériau entre lesdites surfaces (11, 12, 111, 112, 211, 212) à une lame d'air transversale par rapport à l'espace intermédiaire (13, 113, 213) et ayant une vitesse de l'air supérieure à 100 m/s afin d'extraire l'eau du matériau.

14. Procédé selon la revendication 13, dans lequel le matériau entre les surfaces (11, 12, 111, 112, 211, 212) peut se déplacer dans une direction parallèle à la surface et la lame d'air est inclinée dans une direction opposée à la direction de mouvement à un angle par rapport aux surfaces compris entre 15° et 90°, et en particulier d'environ 60°.

15. Procédé selon la revendication 13, dans lequel au moins l'une des deux surfaces (11, 12, 111, 112, 211, 212) est formée par une courroie transporteuse perforée, de préférence agencée en zigzag.

16. Procédé selon la revendication 13, dans lequel la lame d'air est un jet continu ou un jet pulsé, de préférence avec une fréquence de 5 à 20 impulsions par seconde.

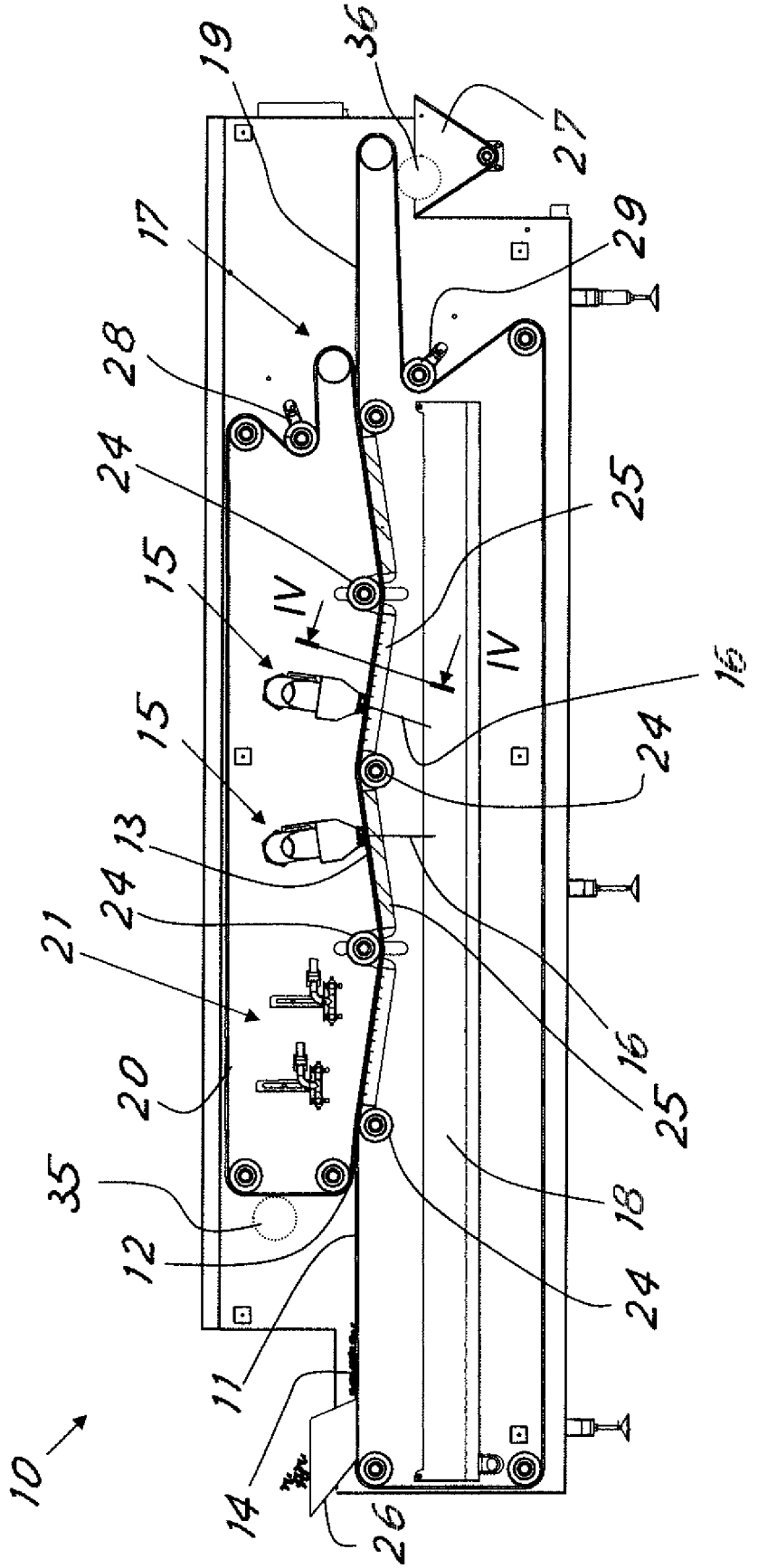

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Fig.1

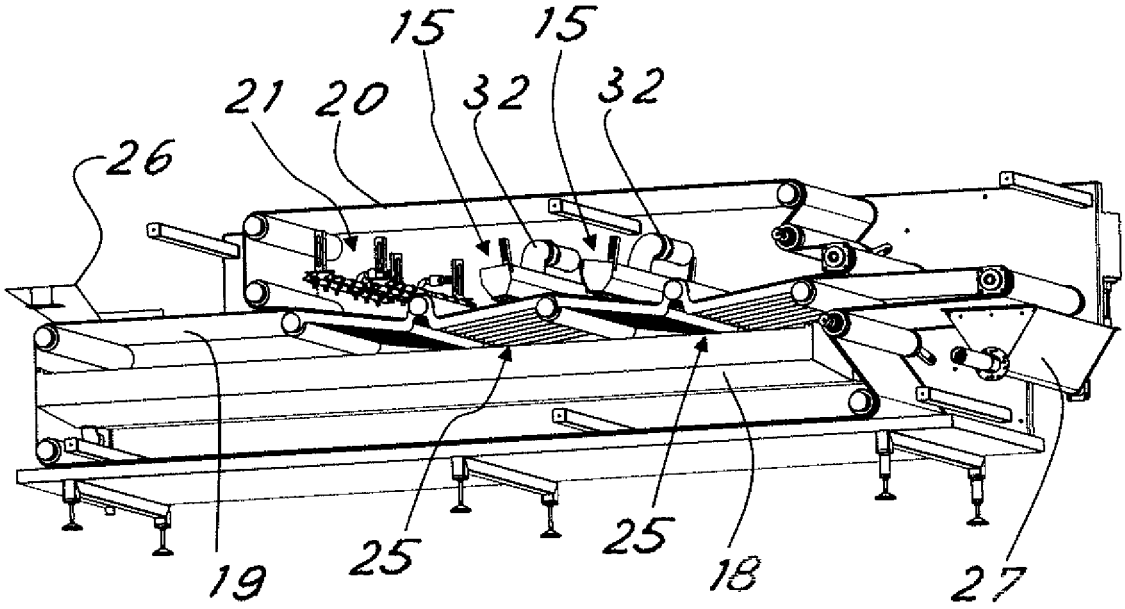


Fig.2

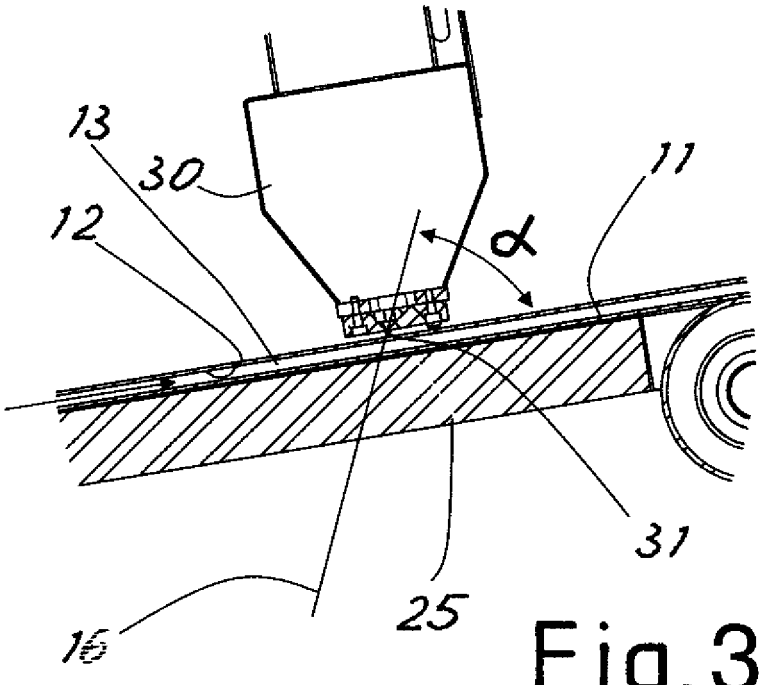


Fig.3

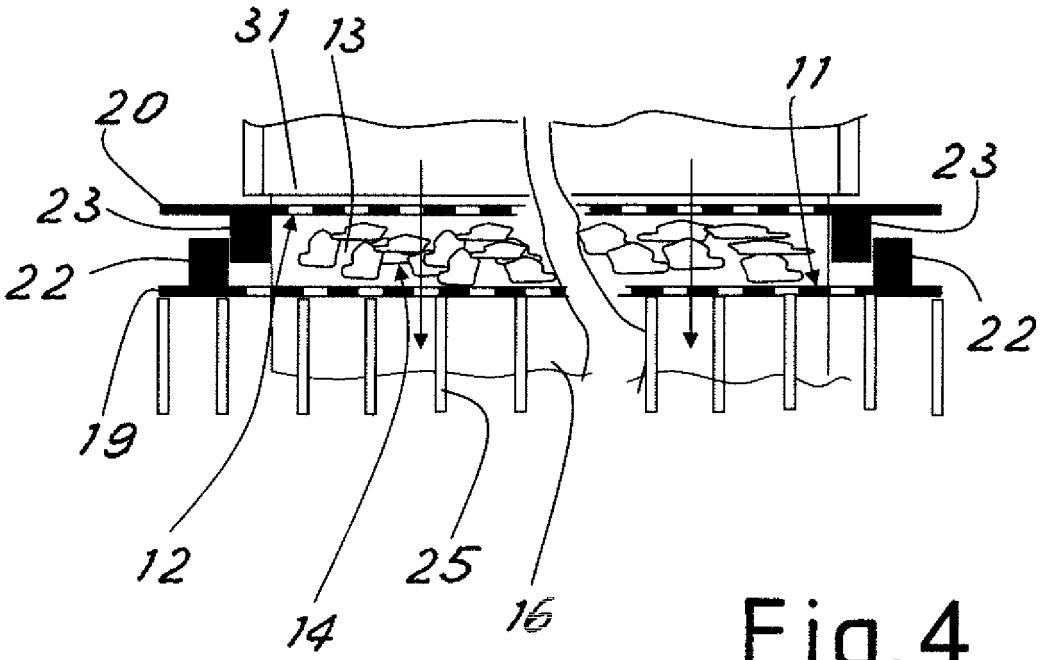


Fig.4

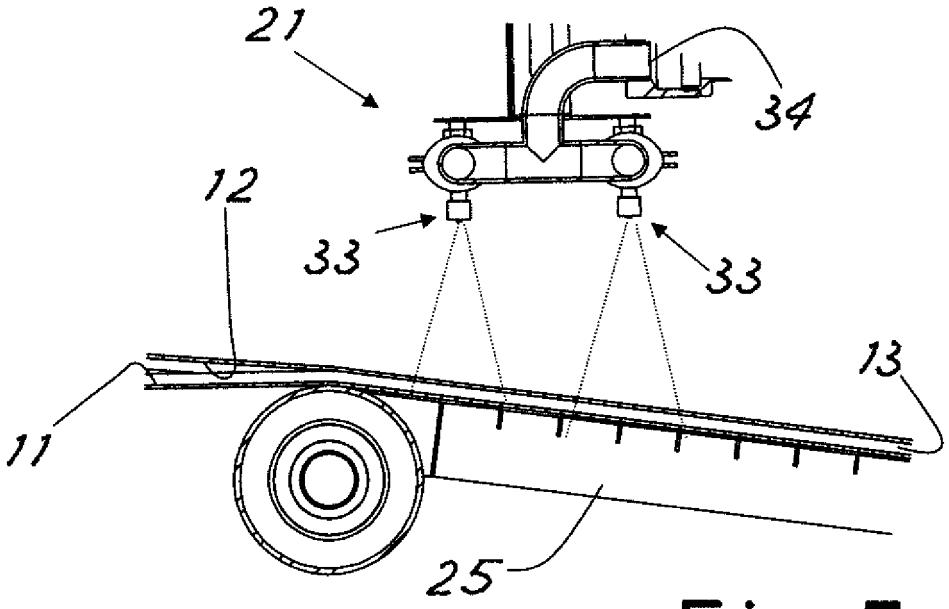


Fig.5

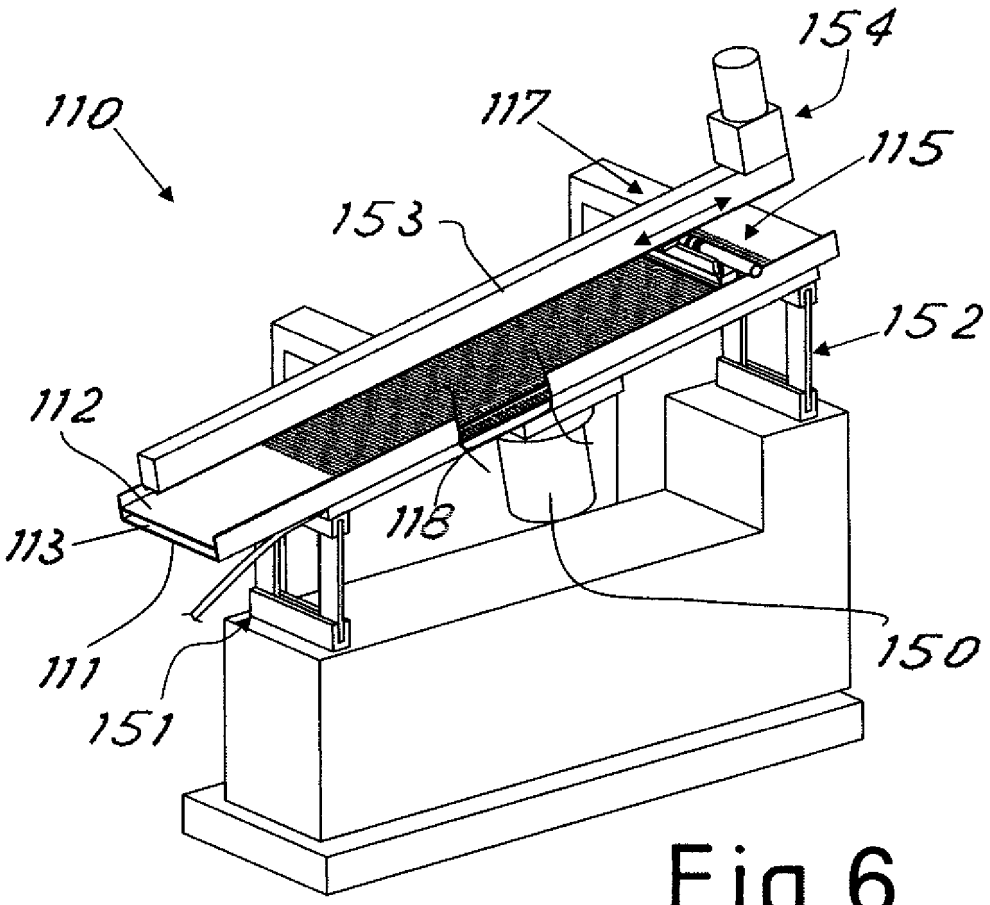

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Fig.6

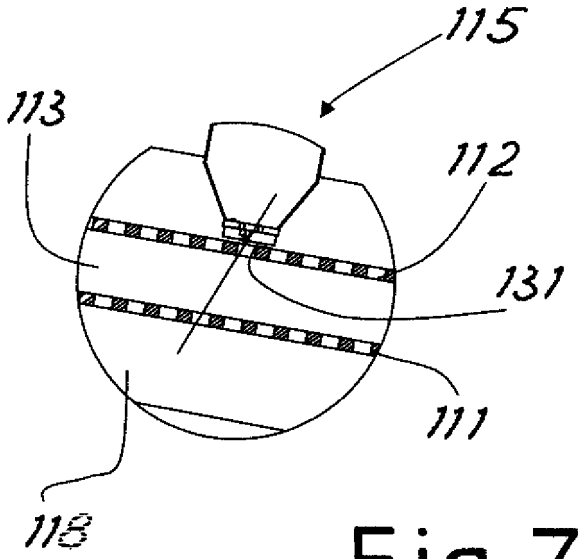

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Fig.7

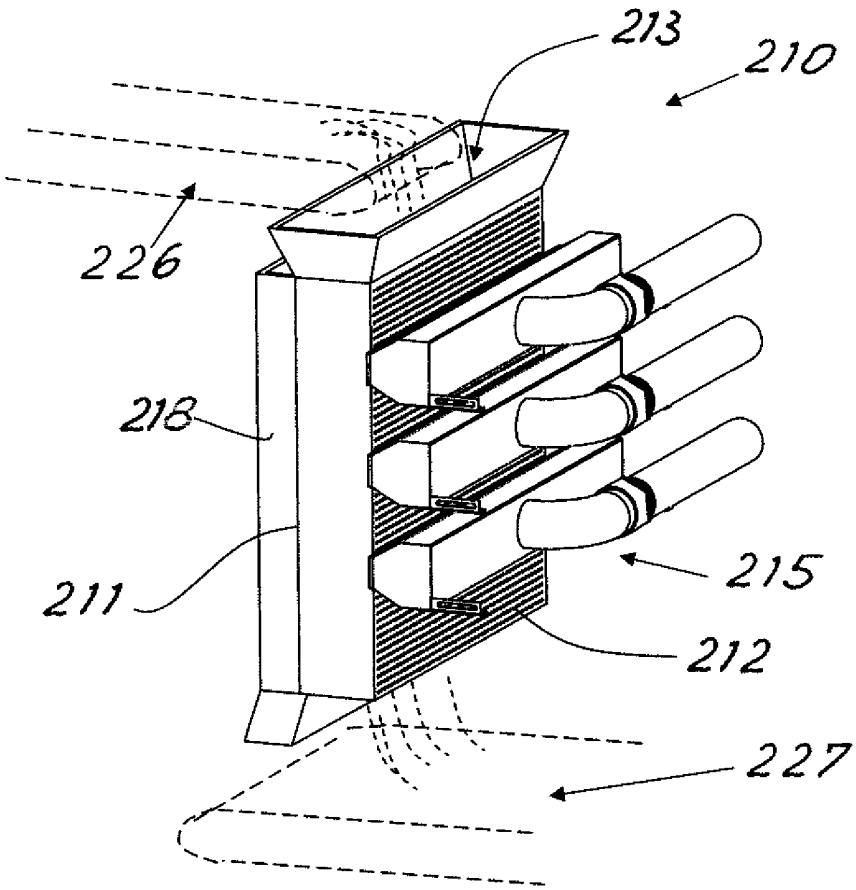


Fig.8

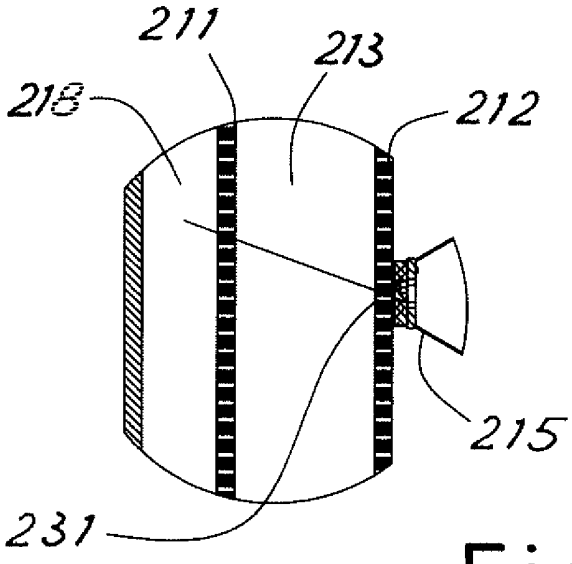


Fig.9

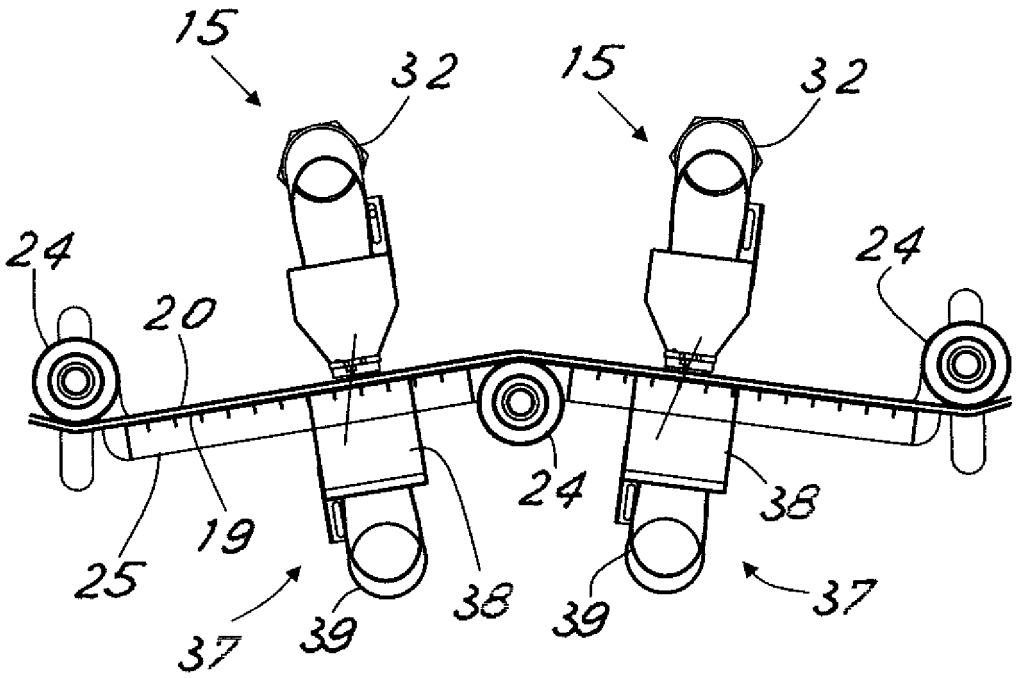

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Fig.10

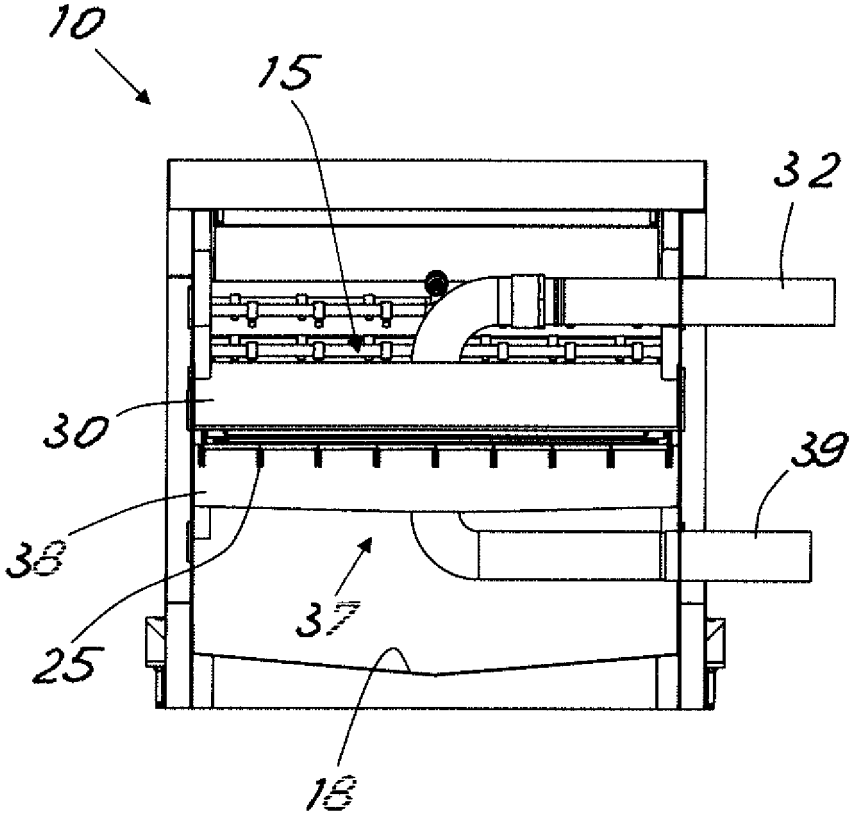

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Fig.11

REFERENCES CITED IN THE DESCRIPTION

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