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(54) **Apparatus for treatment of a product**

(57) Apparatus for treatment of products comprising a product carrying unit (4) extending along a longitudinal product conveying direction and being provided with a plurality of openings adapted to allow an upwardly directed flow of gas through said openings and past the products. The apparatus further comprising a gas treatment means (10-1) and a gas circulation means (20,22,24,26). The apparatus being characterized by a first compartment adapted to guide the flow of gas from the carrying unit down along a first side of the treatment means (10-1), the treatment means having an inlet at a first level and an outlet at a second level, the second level being higher than the first level, thereby providing an upwardly directed flow of gas through the treatment means. The apparatus is further characterized by the circulation means (20,22,24,26) being adapted to draw the gas from the outlet downwardly along a second outer side of the treatment means (10-1), transversely opposite to the first side, and to provide the upwardly directed flow of gas through the openings of the carrying unit (4).

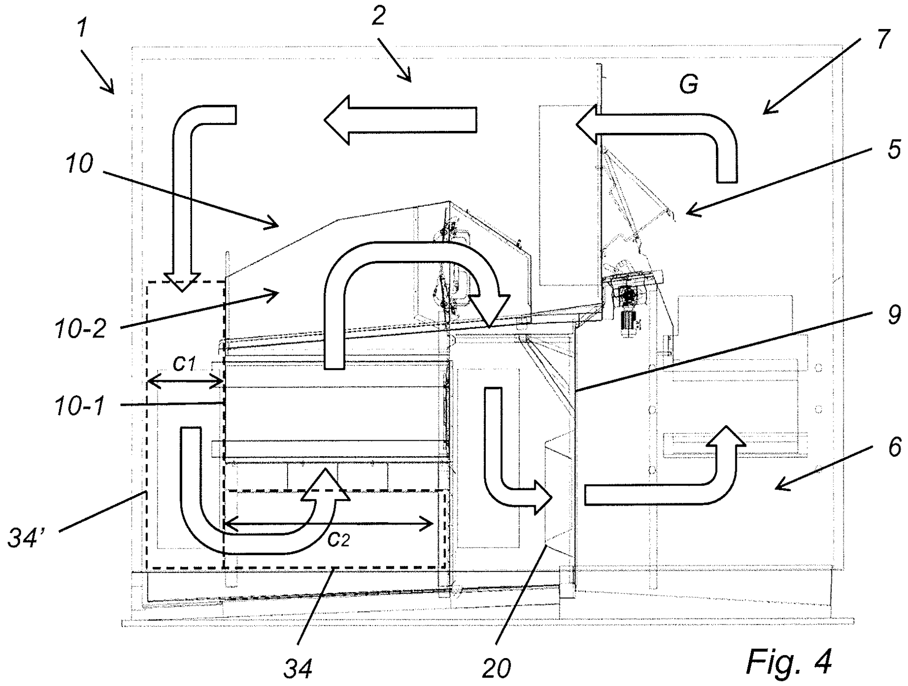

Fig. 4

Description

Field of the invention

[0001] The present inventive concept generally relates to treatment of products. More specifically, the present inventive concept relates to an apparatus for gas treatment of a product.

Background of the invention

[0002] In the food industry, flow freezers are commonly used for freezing food products such as vegetables, fruits, berries, etc. In this technique, the product may be put in a trough provided with a plurality of small holes. Cool air is blown upwardly through the holes, thereby providing a fluidized bed of products. In such a flow freezer, there is generally a problem with moist, snow and product particles getting caught in the flow of gas and being distributed along the gas circulation path in the flow freezer. This may lead to a build-up of ice and product debris on e.g. fans, cooling elements and the trough of the flow freezer. The build-up will degrade the performance of the flow freezer and affect the fluidization.

[0003] In the prior art, flow freezers hence need to be stopped relatively frequently for defrosting and/ or cleaning. These production stops limit the capacity of the flow freezers which in the extension leads to lost revenues for the producers. Frequent defrosting and/or cleaning also lead to increased maintenance costs.

[0004] This is may be a problem not only in flow freezer applications, but circulation of debris may be a problem in other gas treatment techniques such as drying applications, heating applications etc.

Summary of the invention

[0005] A general object of the inventive concept is to address the problems related to cleaning and/or defrosting. A more specific object of the inventive concept is to provide an apparatus requiring less frequent cleaning and defrosting than in the prior-art.

[0006] According to one aspect of the invention there is provided an apparatus for treatment of products. The apparatus comprises a product carrying unit extending along a longitudinal product conveying direction and being provided with a plurality of openings adapted to allow an upwardly directed flow of gas through the openings and past the products.

[0007] The apparatus further comprises a gas treatment means and a gas circulation means. The apparatus being characterized by a first compartment being adapted to guide the flow of gas from the product carrying unit down along a first outer side of the gas treatment means, the gas treatment means having an inlet at a first level and an outlet at a second level, the second level being higher than the first level, thereby providing an upwardly directed flow of gas through the gas treatment means. The apparatus is further characterized by the gas circulation means being adapted to draw the gas from the outlet of the gas treatment means downwardly along a second outer side of the gas treatment means, transversely opposite to the first outer side, and to provide the upwardly directed flow of gas through the openings of the product carrying unit.

[0008] The design of the inventive apparatus and its gas circulation path reduces the need for cleaning and maintenance compared to the prior-art designs. The advantages of the inventive apparatus become especially apparent when the inventive apparatus is used for circulating cool air, e.g. as in the case of flow freezers. However, many of the advantages may also apply for other applications, e.g. cooling, drying or heating of products. In the case the inventive apparatus is used for circulating cool air, the gas treatment means may be adapted to cool the upwardly directed flow of gas through the gas treatment means. Especially, the gas treatment means may be an evaporator.

[0009] The apparatus is especially suitable for treatment of particulate products, such as food products in form of a plurality of pieces that may be compared to particles. Examples of such products are vegetables, such as peas, fruits, berries, shell-fish, etc.

[0010] The upwardly directed flow of gas through the openings is adapted to treat the product. Especially, the upwardly directed flow of gas through the openings may be adapted to provide an at least partly fluidized bed of the products.

[0011] By guiding the flow of gas down along the first outer side of the gas treatment means and upwardly through the gas treatment means, any product particles, product debris and snow present in the downwardly directed flow of gas will, through the action of gravity, not be able to follow the airflow as it turns upwardly and the product particles and snow will be removed from the gas flow and deposited on the floor of the apparatus, where it can be conveniently removed. Since the product particles and snow will deposit on a location not critical for the function of the apparatus, one may accept relatively large amounts of product particles and snow being deposited before cleaning need to take place.

[0012] Due to the inventive vertical redirecting of the gas flow (down along outer side of gas treatment means and upwardly through the gas treatment means), the gas entering the gas treatment means will be relatively free from product particles and snow. Thereby, the gas treatment means of the inventive apparatus may hence require less frequent cleaning than gas treatment means of prior art apparatus.

[0013] Any particles and snow still remaining in the gas flow will commonly get stuck at the inlet to a larger degree than at the outlet. By the inventive upward direction of the gas flow through the gas treatment means any particles and snow will get stuck at a lowermost and downwardly facing region of the gas treatment means. This allows for convenient removal of any build-up of debris and ice on the gas treatment means, e.g. by rinsing water through the gas treatment means from the outlet to the inlet. Any removed particles and snow do not need to pass through the gas treatment means but will simply fall downwardly.

[0014] As the gas flows upwardly through the gas treatment means, the gas may successively become cooler. Water vapor may condense onto the gas treatment means and form ice. The gas leaving the gas treatment means will hence be drier than the gas entering the gas treatment means. Since the water content in the gas is highest at the inlet, build-up of ice will in general be largest in the vicinity of the inlet where it may be removed relatively easily.

[0015] By drawing gas from the outlet of the gas treatment means downwardly along the second outer side of the gas treatment means, and to provide the gas upwardly through the product carrying unit, a further inventive vertical redirecting of the gas flow is obtained which helps to remove product particles and snow from the gas flow.

[0016] As a result of the inventive design of the apparatus and its gas circulation path the product carrying unit will be relatively unexposed to debris and snow. Thereby, problems related to clogging of the openings of the product carrying unit are reduced, and the product will hence be treated by clean and dry gas also reducing the risk of the product pieces clumping together.

[0017] According to one embodiment, the first compartment is provided with a first cross sectional area at a first position and a second cross sectional area at a second position, the second position being located after the first position as viewed along a gas circulation path and the first cross sectional area being smaller than the second cross sectional area. By the provision of these different cross sections, the flow speed of the gas will be reduced quickly when passing the second position. This retardation will cause the flow to have a comparably lower impact and the gravity to have a comparably greater impact on the product particles and snow present in the gas flow. Thereby, this difference in cross-section and its resulting difference in flow speed will aid in letting product particles and snow to fall down to the floor of the apparatus and thereby be removed from the flow of gas.

[0018] According to one embodiment, the first position may be provided along the first side of the gas treatment means and the second position may be provided below the inlet, preferably even located vertically beneath, of the gas treatment means. Thereby a sudden gas flow retardation may be achieved simultaneously with the vertical redirection of the gas flow, whereby product particles and snow may be removed from the gas flow even more efficiently.

[0019] According to one embodiment, the first outer side of the gas treatment unit faces in a direction away from the product carrying unit. The gas will thereby flow over and past the gas treatment means, thereby providing a further redirection of the gas flow.

[0020] According to one embodiment, the first outer side of the gas treatment unit faces in a direction away from the gas circulation means.

[0021] According to one embodiment, the gas circulation means is provided after the gas treatment means as viewed along a gas circulation path. The gas circulation path is the path along which the gas will flow when circulating within the apparatus. The gas circulation means will thereby be exposed to the relatively dry air leaving the gas treatment means. This reduces problems with build-up of ice on the gas circulation means.

[0022] According to one embodiment, the gas circulation means is provided at a level below the product carrying unit.

[0023] According to one embodiment, the gas circulation means is provided before the product carrying unit as viewed along a gas circulation path.

[0024] According to one embodiment, the apparatus further comprises a closing means provided at the gas treatment means for at least partly closing the gas treatment means. When closed, the closing means prevents a flow of gas through the gas treatment means. The gas treatment means may thereby be isolated from the surrounding apparatus. This simplifies cleaning and defrosting of the gas treatment means since the risk of spreading product particles and snow within the apparatus is reduced.

[0025] According to one embodiment, the closing means is provided after the outlet as viewed along a gas circulation path. As discussed in the above, the gas leaving the outlet of the gas treatment means is relatively dry and clean. Problems with build-up of ice and product particles at the closing means are thereby reduced and the risk of failure of the closing means is thereby reduced.

[0026] According to one embodiment, the apparatus further comprises, on the second outer side of the gas treatment means, a second compartment adapted to guide the downwardly directed flow of gas along the second outer side of the gas treatment means.

[0027] According to one embodiment, the gas circulating means is provided in connection with the second compartment and the first compartment, wherein the second compartment is adapted to guide the flow of gas from the gas treatment means to the gas circulating means.

[0028] According to one embodiment, the apparatus further comprises a plurality of gas treatment means, wherein a closing means is provided at each gas treatment means for at least partly closing each gas treatment means. Especially, the closing means may be individually closeable.

[0029] By providing a plurality of gas treatment means in the apparatus, the gas may be cooled more efficiently as compared to using a single gas treatment means.

[0030] Moreover, the closing means allows for serial operation of the gas treatment means and the apparatus, whereby each gas treatment means may be cleaned and defrosted separately while the other gas treatment sections are in use. Production may hence be maintained even during cleaning and defrosting.

[0031] According to one embodiment, each gas treatment means of the apparatus has an inlet and an outlet, the outlet being provided at a level being higher than the level of the inlet, thereby providing an upwardly directed flow of gas through each gas treatment means.

[0032] Especially, the closing means of each gas treatment means may be provided after the outlet as viewed along a gas circulation path. These designs of each gas treatment means provide the advantages discussed in relation to the previous embodiments.

[0033] According to one embodiment, gas treatment means are disposed along the product carrying unit. This enables efficient cooling of the gas along the product carrying unit.

[0034] According to one embodiment, the apparatus comprises one or more gas circulating means disposed along the product carrying unit. This enables efficient provision of an upwardly directed flow of clean and dry gas through the openings of the product carrying unit along its entire length.

[0035] According to one embodiment, the first compartment extends longitudinally along the product carrying unit and past the plurality of gas treatment means, and wherein the first compartment is adapted to guide the flow of gas from the product carrying unit down along a first outer side of each gas treatment means.

[0036] According to one embodiment, the second compartment extends longitudinally along the product carrying unit and past the plurality of gas treatment means. The second compartment may thereby provide a common space where the gas treatment means may let out the treated gas. This embodiment is advantageously combined with the embodiment including two or more gas circulating means, wherein, if one gas treatment compartment is closed for cleaning and defrosting, the gas circulating means may still draw air from the other compartment or compartments. The upwardly directed gas flow may thereby be maintained along the product carrying unit.

[0037] In case the gas treatment means is an evaporator, it may comprise a plurality of plates extending from the inlet to the outlet wherein the pair wise plate separation is smaller at the inlet than at the outlet. Alternatively, the pair wise plate separation may be smaller at the outlet than at the inlet. According to yet another alternative, the plurality of plates may be parallell to each other.

[0038] Additionally or alternatively, the plurality of plates may extend from the inlet to the outlet wherein the vertical levels of the lower plate edges of at least some of the plates are different at the inlet compared to the level of other plates. This provides a design where plates at the inlet is provided at one or more levels in a staggered design. This help in preventing clogging at the inlet and thus reduces the required frequency of cleaning and defrosting of the gas treatment means.

<u>Brief description of the drawings</u>

[0039] The inventive concept will now be described with reference to the accompanying drawings, illustrating non-limiting example embodiments of the invention.

Fig. 1 is a perspective view from a front side of an apparatus in accordance with a preferred embodiment of the invention.

Fig. 2 is a perspective view from a back side of an apparatus in accordance with a preferred embodiment of the invention.

Fig. 3 is a top view of an apparatus in accordance with a preferred embodiment of the invention.

Fig. 4 is a cross-sectional view of an apparatus in accordance with a preferred embodiment of the invention.

Fig. 5 illustrates a plate arrangement of an evaporator of an apparatus in accordance with a preferred embodiment of the invention.

<u>Detailed description</u>

[0040] With reference to Figs 1-5, an apparatus 1 for freezing of a food product using fluidization in accordance with a preferred embodiment of the invention is illustrated.

[0041] The product may be any particulate food product such as vegetables, fruits, berries, shellfish, etc. However, it is emphasized that the inventive concept is not limited to this specific application. The inventive concept is also applicable to e.g. cooling, drying and heat treatment of any particulate product. The treatment gas is preferably air however other gases may also be used. For example, nitrogen or carbon dioxide may be used for treatment of sensitive products requiring treatment in a protected atmosphere.

[0042] According to the preferred embodiment, the apparatus 1 comprises a product carrying unit 4. The product carrying unit 4 extends through a compartment 2 of the apparatus 1. The product carrying unit 4 extends along a longitudinal product conveying direction within the compartment 2. The product carrying unit 4 partitions the compartment 2 into a lower space 6 and an upper space 7. The lower space 6 and the upper space 7 are sub-spaces within the total space of the compartment 2.

[0043] The product enters the apparatus 1 through an opening 3-1 provided on a first short side of the apparatus 1. The product leaves the apparatus 1 through an opening 3-2 provided on a second short side of the apparatus 1, longitudinally opposite to the first short side.

[0044] The product carrying unit 4 is provided with a plurality of openings or apertures adapted to allow an upwardly directed flow of gas through the openings, the gas fluidizing the product and providing an at least partly fluidized product bed. By way of example, in freezer applications the temperature of the gas fluidizing the product may be in the range of -30°C to -35°C

[0045] The product carrying unit 4 may e.g. be an elongated plate, an elongated trough or a conveyor belt wherein the openings are provided as holes. Alternatively, the product carrying unit 4 may be a mesh, wherein the openings are provided as apertures in the mesh. The mesh may e.g. be formed by metal wire. Optionally, the product carrying unit 4 may comprise an elongated plate provided with a plurality of holes and a mesh as previously been described, wherein the mesh is arranged above the plate.

[0046] By way of example, the openings may have a diameter of 4 mm and the total open area may be 20 %.

[0047] In the case the product carrying unit 4 is an elongated trough, the products may be conveyed through the apparatus 1 by providing the trough at a slight inclination whereby the fluidized product flows through the apparatus 1. The fluidization may be improved by introducing vibration, e.g. by pulsating the air or by vibration of the trough. Moreover, the fluidized product may be conveyed through the apparatus 1 by introducing asymmetric vibrations of the trough in a manner which is well-known in the art. In the case the product carrying unit 4 is a conveyor belt, it may be driven by motors provided on the inside or on the outside of the apparatus 1.

[0048] Optionally, the apparatus 1 may further comprise pulsator means, indicated by reference numeral 30. A pulsator means may be an air-tight door, a damper, a vent or a valve. Each pulsator means may be opened and closed separately from the further pulsator means e.g. by means of a motor. In use, each pulsator means 30 may be opened to allow a a leakage of gas from the lower space 6 into the upper space 7. By quickly closing an opened pulsator means, the pressure in the lower space 6 may be increased, thereby creating a "pulse" of gas through the openings of the product carrying unit 4. The pulsators may be used to facilitate the start-up of the fluidization of the products. As indicated in the drawings, the majority of the pulsator means 30 are preferably provided at the beginning of the product carrying unit 4 where the products to be fluidized enter the apparatus 1.

[0049] Optionally, the apparatus 1 may further comprises by-pass means indicated by reference numeral 32. A by-pass means may be an openable hatch, a damper, a valve or similar. By opening a by-pass means, the pressure may be temporarily reduced in order to control the fluidization process. The by-pass means 32 may be opened manually using a handle provided on the by-pass means 32.

[0050] Optionally, the apparatus 1 may further comprise a a plurality of plates as indicated by reference numeral 5. The plates 5 are provided along a side of the product carrying unit 4. The plates 5 are provided at an incline in relation to the upper side of the product carrying unit 4. In Fig. 1, the apparatus 1 comprises a plurality of inclined plates. However, alternatively the apparatus 1 may comprise a single inclined plate extending along a side of the product carrying unit 4. As indicated in Fig. 1, the plates may be opened e.g. for inspection or service purposes. The plates 5 prevent the fluidized product from escaping from the product carrying unit 4. The plates 5 and the walls of the compartment 2 form a channel in the upper space 7 guiding the upwardly directed flow of gas rising from the product bed.

[0051] The apparatus 1 further comprises gas treatment compartments 10, 12, 14, 16, disposed in the compartment 2 along the product carrying unit 4. As may be seen in e.g. Fig. 4, there is provided a narrow space, or channel, along the sides of the gas treatment compartments 10, 12, 14, 16 followed by a wide space, or channel, below the inlets of the gas treatment compartments 10, 12, 14, 16. The narrow space has a first cross sectional area C_1 which is smaller than the second cross sectional area C_2. The narrow and the wide space is adapted to guide the flow of gas from the upper space 7 of the compartment 2 to the gas treatment compartments 10, 12, 14, 16 as will be described in greater detail herein. The flow speed of the gas will be higher in the narrow space than in the wide space due to the relative magnitudes of $_{C1}$ and C_2.

[0052] It is emphasized that although the apparatus of this example embodiment comprises four gas treatment compartments, the inventive concept is not limited to this specific number but is applicable to an apparatus comprising a single compartment or a plurality of gas treatment compartments being four or any other number.

[0053] For clarity, the gas treatment compartments will be described in detail with reference to the single gas treatment compartment 10. However, the following description of the gas treatment compartment 10 applies correspondingly to the further gas treatment compartments 12, 14, 16.

[0054] The gas treatment compartment 10 may comprise one or more gas treatment means. According to the preferred embodiment, the gas treatment compartment 10 comprises one gas treatment means 10-1. The gas treatment means 10-1 is provided for cooling the gas that is to be circulated in the apparatus 1. The gas treatment means 10-1 has an inlet 10-4 and an outlet 10-5. The inlet 10-4 is provided at a first level of the gas treatment means 10-1. The outlet 10-5 is provided at a second level of the gas treatment means 10-1. The gas treatment means 10-1 is thus adapted to provide an upwardly directed flow of gas.

[0055] As the gas flows through the gas treatment means 10-1, it will successively become cooler. As the temperature of the gas decreases, water vapor present in the gas will condense onto the gas treatment means 10-1. Hence, the gas leaving the outlet 10-5 will be drier than the gas entering the inlet 10-4. The condensed water may form ice on the gas treatment means 10-1.

[0056] During use, a combination of ice and product particles may form on the gas treatment means 10-1. Since the water content in the gas is highest at the inlet 10-4, the build-up will be largest there. If the build-up is not removed, the gas treatment means 10-1 may eventually become clogged.

[0057] Build-up of ice and product particles may be removed from the gas treatment means 10-1 e.g. by rinsing water from the outlet 10-5 to the inlet 10-4. Through the action of gravity, the ice and particles will fall to the ground where it can be conveniently removed from the apparatus 1. Other means may also be used to remove the ice and debris. Such other means include application of ultrasonic vibration, pulsating air bursts, etc. The latter may be used also during on-going use of the gas treatment means in full production.

[0058] The gas treatment means 10-1 may be an evaporator. The evaporator may comprise a plurality of cooling plates extending from the inlet 10-4 to the outlet 10-5. The plates form a plurality of upwardly extending gas channels.

[0059] The plate separation, in a direction transverse to the gas flow direction through the gas treatment means 10-1, may be smaller at the inlet 10-4 than at the outlet 10-5. The opposite configuration may also be used wherein the plate separation is smaller at the outlet 10-5 than at the inlet 10-4. Alternatively, the plate separation may be constant along the gas flow direction.

[0060] To prevent clogging at the inlet 10-4, the lower edges of the plates may be provided at different levels at the inlet 10-4. More specifically and with reference to Fig. 5, the plates 50, 52, 54 may extend from the inlet 10-4 to the outlet 10-5 wherein the vertical levels of the lower plate edges of at least some of the plates are different at the inlet 10-4 compared to the vertical level of the other plates.This provides a design where plates 50, 52, 54 at the inlet 10-4 are provided at one or more levels in a staggered design. The open flow area between each plate pair is thereby increased without increasing the total cross sectional area of the inlet 10-4. This helps in preventing clogging at the inlet 10-4 and thus reduces the required frequency of cleaning and defrosting of the gas treatment means 10-1.

[0061] The gas treatment compartment 10 further comprises closing means 10-3. A space 10-2 extends within the gas treatment compartment 10 from the outlet 10-5 to the closing means 10-3. The closing means 10-3 controls the flow of gas through the gas treatment means 10-1. The closing means 10-3 may be opened and closed by means of actuator means 11. The actuator means 11 may e.g. be hydraulic or electric actuators. The closing means of each gas treatment compartment 10, 12, 14, 16 may be opened and closed individually.

[0062] The closing means 10-3 may be an air-tight door, a damper, a vent or a valve which may be opened and closed.

[0063] When the closing means 10-3 is open, any gas entering the space 10-2 from the outlet 10-5 may flow through the open closing means 10-3 out from the gas treatment compartment 10.

[0064] When the closing means 10-3 is closed, no gas may flow through the closing means 10-3. The gas flow through the gas treatment compartment 10 and the gas treatment means 10-1 is hence stopped.

[0065] By stopping the gas flow through a gas treatment compartment, the gas treatment means of that gas treatment compartment may be cleaned and defrosted while the gas treatment means of the other gas treatment compartments 12, 14, 16 are in use and production (e.g. freezing of products) may thereby be maintained.

[0066] The gas treatment compartments 10, 12, 14, 16 are separate from each other. E.g. gas entering gas treatment compartment 10 at the inlet 10-4 may only leave through the outlet and the associated closing means 10-3. Preferably, there is no longitudinal flow of gas between the gas treatment compartments 10, 12, 14, 16.

[0067] Optionally, partitions may be provided between the gas treatment compartments 10, 12, 14, 16, as indicated by reference numeral 34 in Fig. 2 and Fig. 4.

[0068] The partitions 34 may extend from the inlets of the gas treatment compartments 10, 12, 14, 16 towards the floor of the apparatus 1. Alternatively, the partitions 34 may extend from the floor of the apparatus 1 towards the levels of the inlets of the gas treatment compartments 10, 12, 14, 16. The partitions 34 may extend all the way between the floor and the levels of the inlets. Alternatively, the partitions 34 may extend only a part of the way.

[0069] According to a further alternative, the partitions may extend both through the wide space below the gas treatment compartments 10, 12, 14, 16 and through the narrow space provided along the sides of the gas treatment compartments 10, 12, 14, 16, as illustrated by reference numerals 34 and 34' in Fig. 4.

[0070] The partitions 34 or 34 and 34' divide the space below and on the sides of the gas treatment compartments 10, 12, 14, 16 into four longitudinal sections.

[0071] The partitions help in preventing a flow of gas through a gas treatment compartment during defrosting and cleaning thereof.

[0072] During cleaning and defrosting of a gas treatment compartment, the gas treatment means may be deactivated whereby the gas in the gas treatment compartment becomes warmer and more humid. The partitions help in preventing this warm and humid gas from leaving the gas treatment compartment and entering the gas flow through the other gas treatment compartments.

[0073] Optionally, an additional closing means may be provided at each section wherein a gas treatment compartment may be sealed off during defrosting and cleaning thereof.

[0074] The apparatus 1 further comprises a compartment 8. The compartment 8 extends along the product carrying unit 4 and past the gas treatment compartments 10, 12, 14, 16. The compartment 8 is separated from the compartment 2 by a partition 9. The compartment 8 communicates with the compartment 2 through openings in the partition 9. The compartment 8 forms a single continuous space which is common to all gas treatment compartments 10, 12, 14, 16. The space 10-2 communicates with the space of the compartment 8 through the closing means 10-3. This applies correspondingly to the corresponding spaces within the gas treatment compartments 12, 14, 16 and their respective closing means. Alternatively the compartment 8 may be divided into two or more sub-compartments located one after the other in the longitudinal direction. To allow production while a gas treatment compartment is closed, each sub-compartment is in this preferred embodiment associated with at least two gas treatment compartments, such that there is always at least one gas treatment compartment open and in connection with each sub-compartment.

[0075] The apparatus 1 further comprises gas circulating means 20, 22, 24, 26 provided along the product carrying unit 4. Each gas circulating means may e.g. be provided as one or more fans or compressors. The gas circulating means 20, 22, 24, 26 are provided at the openings of the partition 9. The openings and the gas circulating means 20, 22, 24, 26 are provided below the level of the product carrying unit 4. In the preferred embodiment they are located beside the product carrying unit 4 in a horizontal direction. By not providing the gas circulating means 20, 22, 24, 26 directly underneath the product carrying unit 4, the gas circulating means 20, 22, 24, 26 will not be directly exposed to any product particles falling from the product carrying unit 4.

[0076] According to an alternative embodiment, the compartment 8 may extend below the product carrying unit 4 along the transverse direction of the product carrying unit 4. The openings and the gas circulating means 20, 22, 24, 26 may then be provided underneath the product carrying unit 4. This may be used when aiming for a design being compact in the horizontal direction across the longitudinal direction.

[0077] It is emphasized that although the apparatus of this example embodiment comprises six gas circulating means, the inventive concept is not limited to this specific number but is applicable also for a larger or a smaller number of gas circulating means. The actual number may vary depending on the size and capacity of the apparatus, the type of product which is to be treated etc.

[0078] The gas circulating means 20, 22, 24, 26 are adapted to circulate the gas through the gas treatment means of each gas treatment compartment 10, 12, 14, 16, through the openings of the product carrying unit 4 and back to the gas treatment means, as indicated by the arrows G in Fig. 4.

[0079] Since the gas circulating means 20, 22, 24, 26 interact with the relatively dry air leaving the gas treatment compartments 10, 12, 14, 16, problems with ice and snow on the gas circulating means 20, 22, 24, 26 due to condensation are reduced.

[0080] In more detail, the gas circulating means 20, 22, 24, 26 are adapted to circulate gas from the spaces of each gas treatment compartment 10, 12, 14, 16, into the compartment 8, downwardly along an outer side of the gas treatment compartments 10, 12, 14, 16 facing the product carrying unit 4 , through the openings of partition 9 into the lower space 6 of the compartment 2, upwardly through the openings of the product carrying unit 4 into the upper space 7 of the compartment 2, through the upper space 7 over and past the gas treatment compartments 10, 12, 14, 16 in a direction away from the product carrying unit 4, downwardly along the outer side of the gas treatment compartments 10, 12, 14, 16 facing in a direction away from the product carrying unit 4, upwardly through the gas treatment means of the gas treatment compartments 10, 12, 14, 16, and finally back into the spaces of each gas treatment compartment 10, 12, 14, 16. The gas circulation path of the inventive apparatus 1 thus is forced to make turns back and forth summing up to eight 90 degree turns, i.e. 720 degrees in total.

[0081] In the lower space 6, after the gas circulating means 20, 22, 24, 26, the gas is pressurized. The gas passes through the openings of the product carrying unit 4 at a sufficient speed for fluidizing the bed of products.

[0082] The gas passes the fluidized bed of products and raises upwardly and to the side in the upper space 7.

[0083] As the gas reaches the narrow space of the compartment 2 having the first cross sectional area C_1 the flow speed of the gas increases. The gas then reaches the wide space of the compartment 2 having the second cross sectional area C_2 and the flow speed decreases. At this point the gas flow also changes from a downward direction to an upward direction. Product particles and snow or ice present in the gas flow will thereby be removed from the gas flow and deposited on the floor of the compartment 2.

[0084] As the gas enters the compartment 8, the flow changes from a horizontal flow direction into a downward direction.

[0085] As the gas is drawn closer to the floor of the compartment 8, the gas flow direction is gradually changed from a downward direction into a horizontal direction. Any product particles still present in the gas flow will thereby be removed from the gas flow and deposited on the floor of the compartment 8. The gas circulating means 20, 22, 24, 26 will hence be subjected to a very small amount of product particles whereby the wear will be kept low.Moreover, the gas flow through the openings of the product carrying unit 4 will be both clean and dry.

[0086] If the closing means of one or more gas treatment compartments is closed during defrosting and cleaning, more gas will flow through the remaining active gas treatment compartments. Hence, the flow speed through the gas treatment compartments and the compartment 8 may increase locally.

[0087] In general, each gas circulating means will mainly draw gas from the closest gas treatment compartment, but since the compartment 8 is common to the gas treatment compartments 10, 12, 14, 16 each gas circulating means may also draw gas from the other gas treatment compartments.

[0088] This is especially advantageous when one gas treatment compartment is closed for cleaning and defrosting, as described in the above. The gas circulating means provided closest to the closed gas treatment compartment may then draw air from the adjacent gas treatment compartment and thus the upwardly directed gas flow may be maintained all along the length of the product carrying unit 4. This is illustrated in Fig. 3 in which some components have been omitted to increase the clarity of the figure. In Fig. 3, the closing means 10-3 of gas treatment compartment 10 is closed. As schematically indicated by the gas flow arrows G, the gas circulating means 20 and 22 may still draw air from the compartment 8 and provide an upwardly directed flow through the product carrying unit 4. Production may hence be maintained even during defrosting, cleaning or other maintenance work on any of the gas treatment compartments 10, 12, 14, 16.

Claims

1. Apparatus for treatment of products, the apparatus comprising:

a product carrying unit extending along a longitudinal product conveying direction and being provided with a plurality of openings adapted to allow an upwardly directed flow of gas through said openings and past said products,
a gas treatment means, and
a gas circulation means,
characterized by
a first compartment being adapted to guide said flow of gas from said product carrying unit down along a first outer side of the gas treatment means,
the gas treatment means having an inlet at a first level and an outlet at a second level, the second level being higher than the first level, thereby providing an upwardly directed flow of gas through the gas treatment means, and
the gas circulation means being adapted to draw said gas from the outlet of the gas treatment means downwardly along a second outer side of the gas treatment means, transversely opposite to said first outer side, and to provide said upwardly directed flow of gas through said openings of the product carrying unit.

2. Apparatus as claimed in claim 1, wherein the first compartment is provided with a first cross sectional area at a first position and a second cross sectional area at a second position, the second position being located after the first position as viewed along a gas circulation path and the first cross sectional area being smaller than the second cross sectional area.

3. Apparatus as claimed in claim 2, wherein the first position is along said first side and the second position is below the inlet of the gas treatment means.

4. Apparatus as claimed in any of claims 1-3, wherein the first outer side of the gas treatment unit faces in a direction away from the product carrying unit.

5. Apparatus as claimed in any of claims 1-4, further comprising a closing means provided at the gas treatment means for at least partly closing the gas treatment means.

6. Apparatus as claimed in claim 5, wherein the closing means is provided after the outlet as viewed along a gas circulation path.

7. Apparatus as claimed in any of claims 1-6, further comprising, on the second outer side of the gas treatment means, a second compartment adapted to guide the downwardly directed flow of gas along the second outer side of the gas treatment means.

8. Apparatus as claimed in any of claims 1-7, the apparatus further comprising a plurality of gas treatment means, wherein a closing means is provided at each gas treatment means for at least partly closing each gas treatment means.

9. Apparatus as claimed in claim 8, wherein each gas treatment means has an inlet and an outlet, the outlet being provided at a level being higher than the level of the inlet, thereby providing an upwardly directed flow of gas through each gas treatment means.

10. Apparatus as claimed in claim 9, wherein the closing means of each gas treatment means is provided after the outlet as viewed along a gas circulation path.

11. Apparatus as claimed in any of claims 8-10, wherein said gas treatment means are disposed along the product carrying unit.

12. Apparatus as claimed in any of claims 8-11, wherein the first compartment extends longitudinally along the product carrying unit and past the plurality of gas treatment means, and wherein the first compartment is adapted to guide said flow of gas from said product carrying unit down along a first outer side of each gas treatment means.

13. Apparatus as claimed in any of claims 11-12, wherein the second compartment extends longitudinally along the product carrying unit and past the plurality of gas treatment means.

14. Apparatus as claimed in any of claims 1-13, wherein the gas treatment means is adapted to cool the upwardly directed flow of gas through the gas treatment means.

15. Apparatus as claimed in claim 1-14, wherein the gas treatment means is an evaporator.

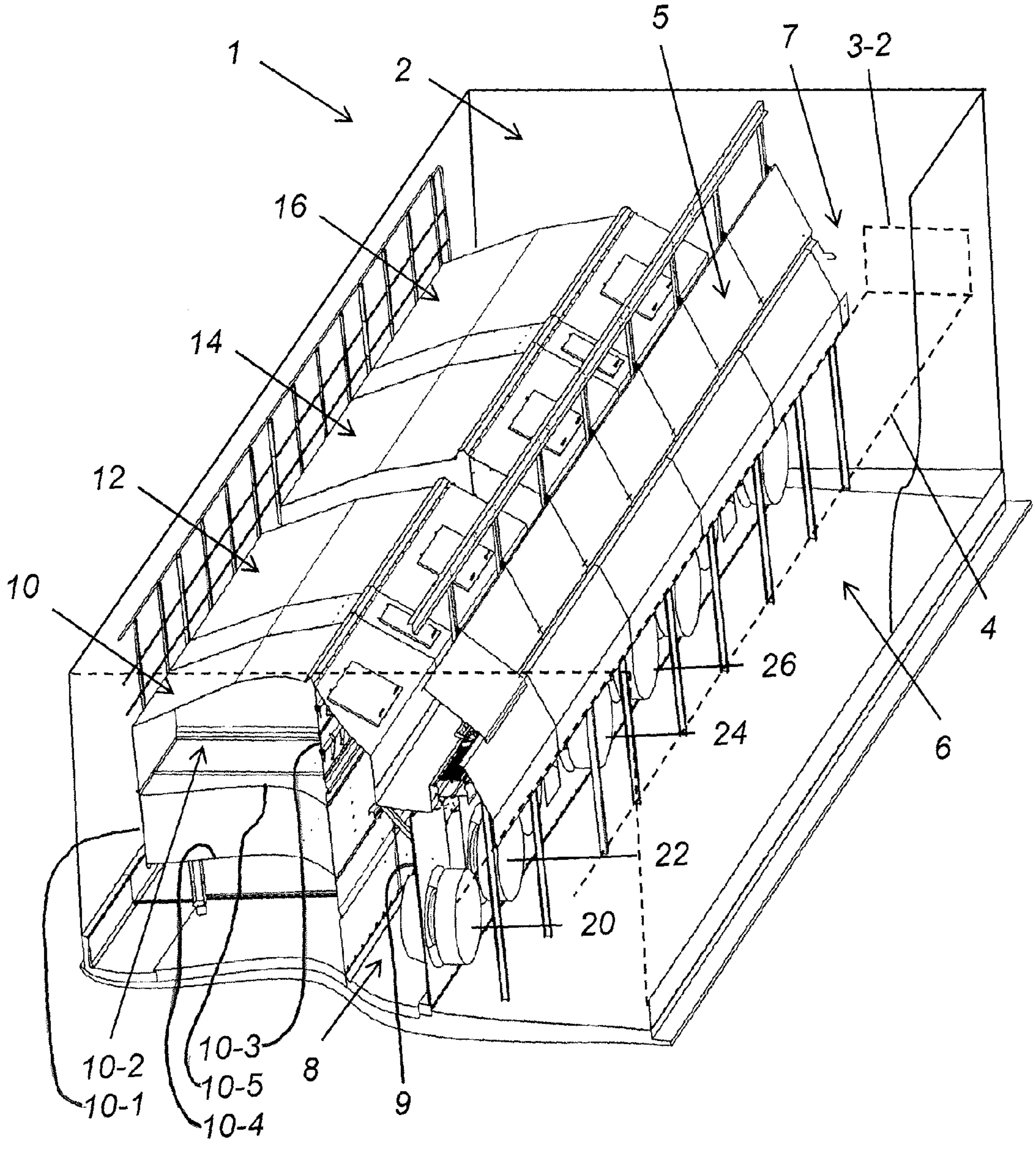

Fig. 1

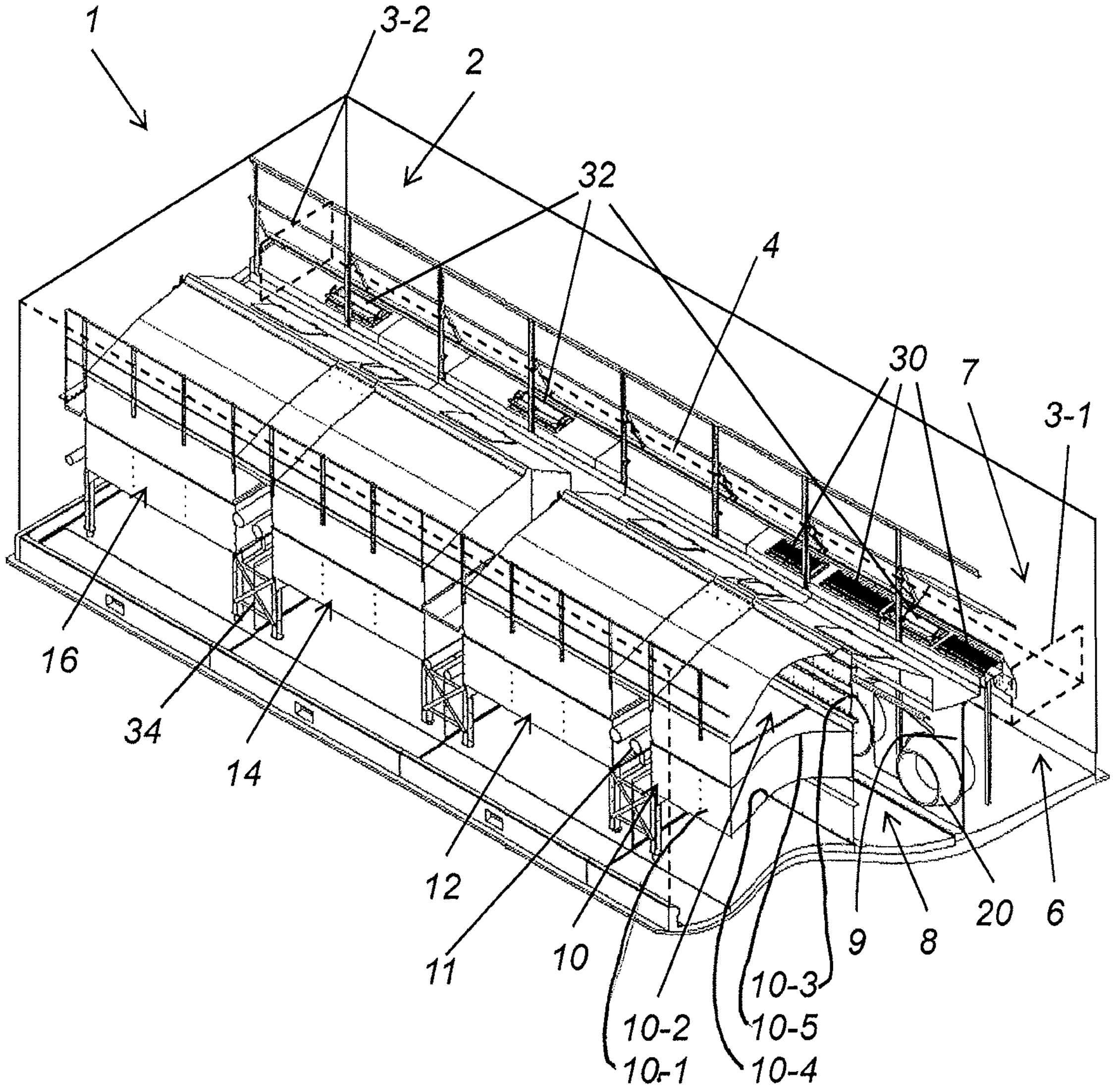

Fig. 2

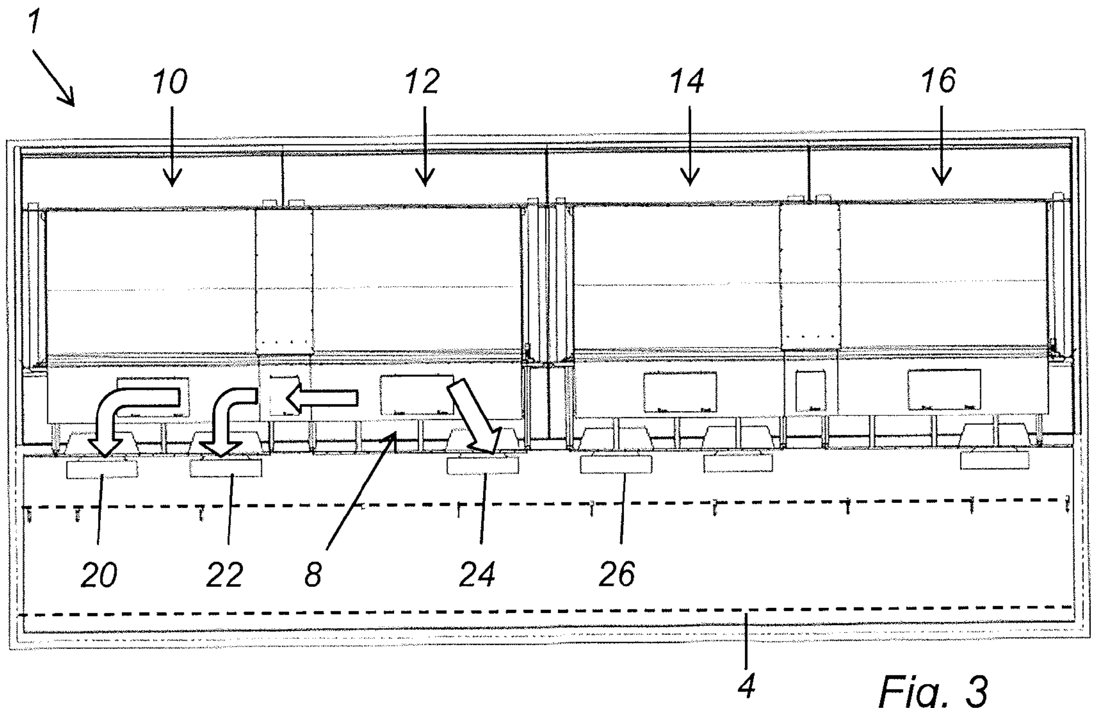

Fig. 3

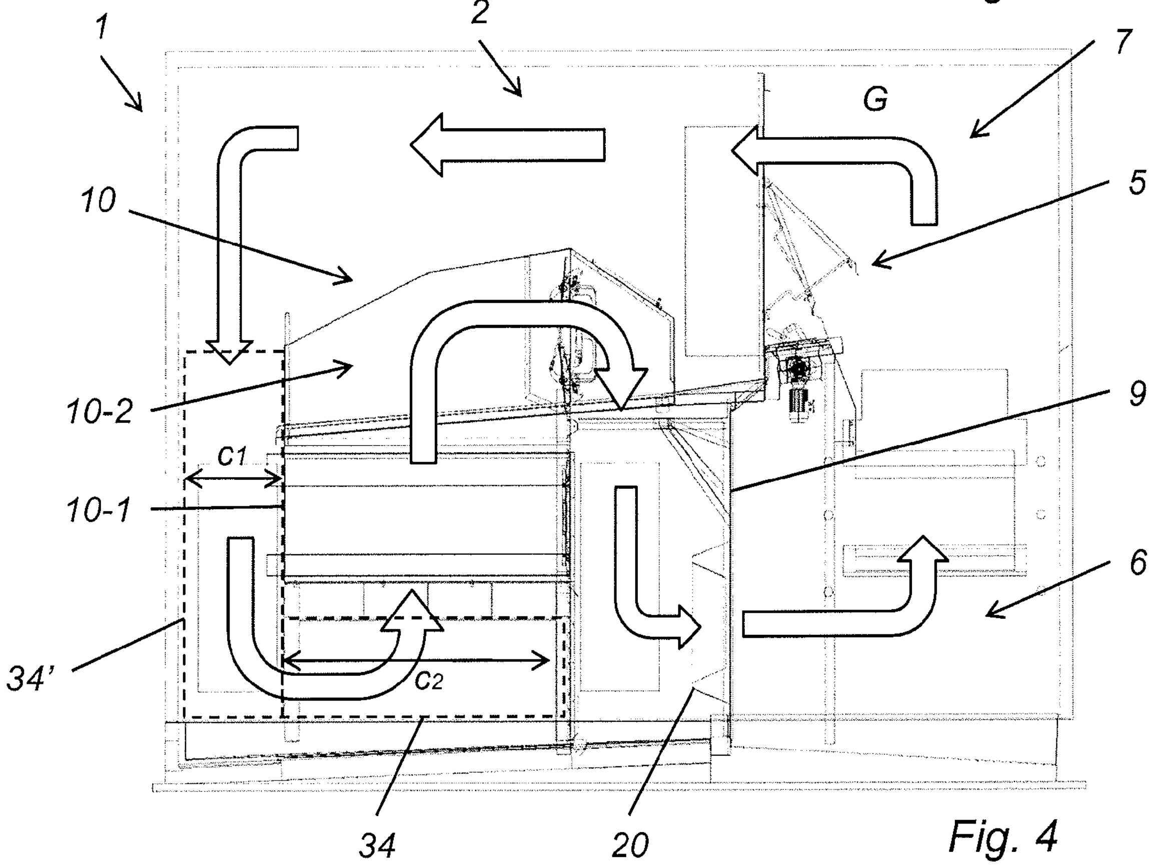

Fig. 4

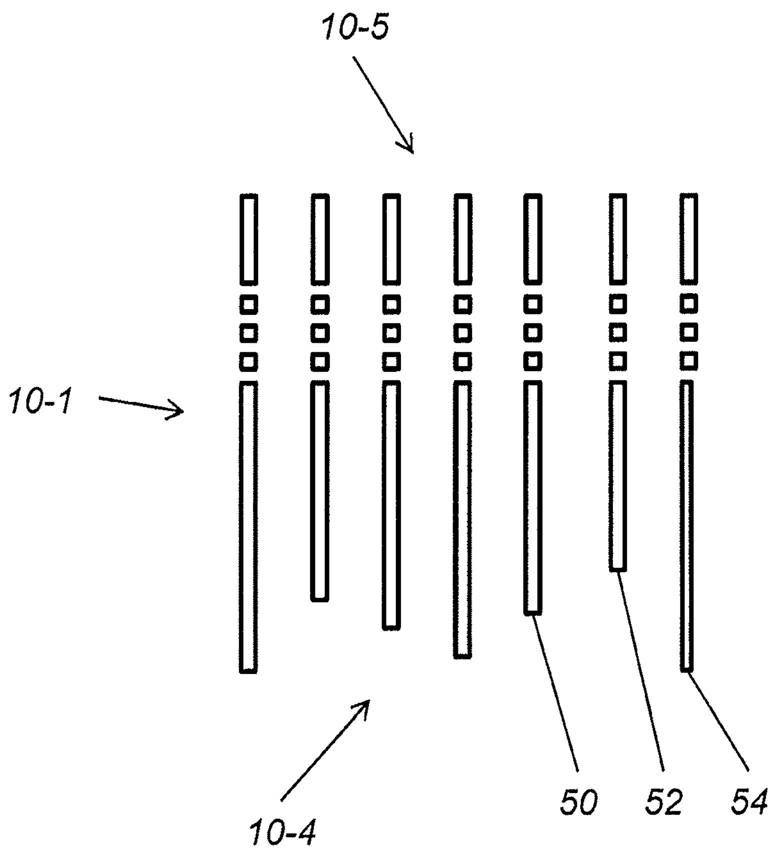

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 09 16 2189

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F25D
F25B
F26B

The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
The Hague	6 November 2009	Yousufi, Stefanie

CATEGORY OF CITED DOCUMENTS

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