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(54) **APPARATUS AND METHOD FOR REDUCING TEMPERATURE OF ITEMS**

(57) In order to overcome the limitations and problems that earlier apparatus and methods have experienced, an apparatus (10; 50) for reducing a temperature of at least one item (12), in particular of at least one food item, is proposed, said apparatus (10; 50) comprising:
- a housing (14; 54) comprising a ceiling (16; 56), a floor (18, 58) and side walls (20; 60) defining a chamber (22; 62) within the housing (14; 54);
- at least one conveyor (24) extending into the chamber (22; 62) between the ceiling (16; 56) and the floor (18, 58);

- at least one gas circulation device (26; 66) disposed in the chamber (22; 62); and
- at least one turbulence-generating device (32) disposed in the chamber (22; 62) and between the at least one conveyor (24) and the at least one gas circulation device (26; 66).

A related method of reducing a temperature of at least one item (12), in particular of at least one food item, is also proposed.

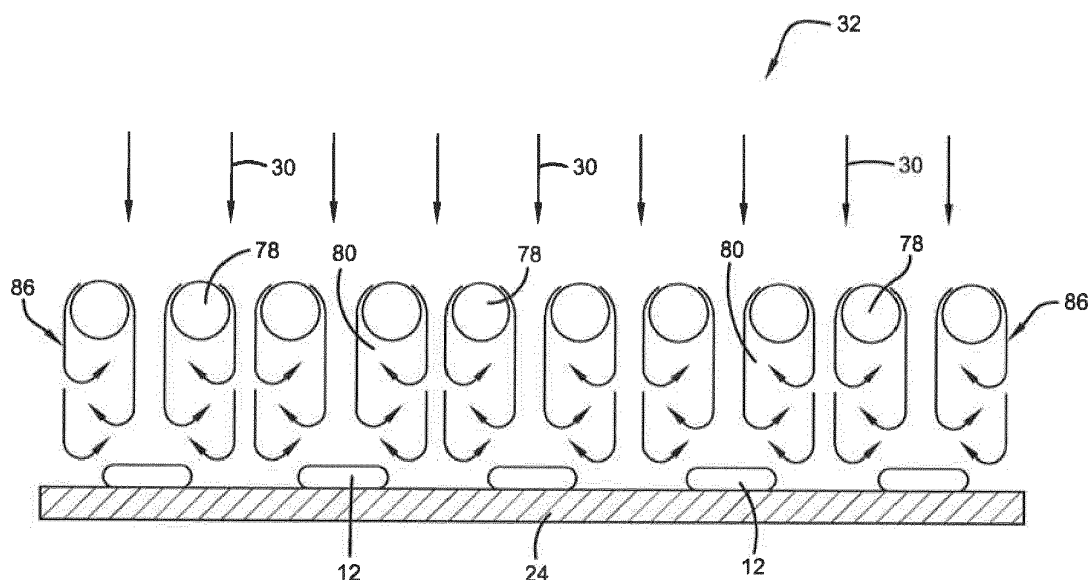


FIG. 3

Description

Technical field of the present invention

[0001] The present invention relates to an apparatus for reducing a temperature of at least one item, in particular of at least one food item; more specifically, the present invention relates to a high turbulence cooling apparatus.

[0002] The present invention further relates to a method of reducing a temperature of at least one item, in particular of at least one food item.

Technological background of the present invention

[0003] Cryogenic food cooling/freezing apparatus, such as freezing tunnels, have limited capacity based on the heat transfer coefficient of the apparatus. For example, a majority of conventional food freezing tunnels increase heat transfer by increasing air flow velocities. There are, however, practical and economical limitations to this method of increasing heat transfer.

[0004] What is needed is apparatus and/or methods which allow for increases in overall heat transfer of a cooling/freezing apparatus. Overall heat transfer increases may allow for fabrication of smaller systems to achieve a desired throughput, or greater throughput in conventionally-sized systems. An area of interest for increasing overall convective heat transfer is through generation of turbulence within the cooling zone of a cooling/freezing apparatus.

Disclosure of the present invention: object, solution, advantages

[0005] Starting from the disadvantages and shortcomings as described above as well as taking the prior art as discussed into account, an object of the present invention is to overcome the limitations and problems that earlier apparatus and methods have experienced.

[0006] This object is accomplished by an apparatus comprising the features of claim 1 as well as by a method comprising the features of claim 13. Advantageous embodiments, expedient improvements and other optional features of the present invention are set forth herein and disclosed in the respective dependent claims.

[0007] The present invention basically provides for an apparatus, such as a freezing apparatus or a freezing tunnel, for reducing a temperature (such as cooling or freezing) of items, such as food items, comprising: a housing comprising a ceiling, a floor and side walls defining a chamber within the housing; at least one conveyor extending into the chamber between the ceiling and the floor; at least one gas circulation device disposed in the chamber; and at least one turbulence-generating device disposed in the chamber and between the at least one conveyor and the at least one gas circulation device.

[0008] Also provided is a method of reducing a tem-

perature of at least one item (such as at least one food item) using a cooling apparatus (such as a freezing apparatus or a freezing tunnel), including (for example comprising) at least one gas circulation device for generating a flow of circulating gas in a flow path toward at least one conveyor, comprising: providing at least one turbulence-generating device disposed in the flow path between the at least one conveyor and the at least one gas circulation device for disrupting the flow of the circulating gas at the flow path.

[0009] In certain embodiments, the method may further comprise moving the at least one turbulence-generating device relative to movement of the at least one conveyor.

[0010] In certain embodiments, the circulating gas may comprise a cryogenic substance.

[0011] The at least one turbulence-generating device creates a turbulent heat transfer zone through which the items are transported via the conveyor. Items entering a cooling apparatus have a boundary layer of air surrounding them, which insulates the item from a surrounding environment. Generation of turbulent flow around the items reduces the boundary layer, allowing for increased heat transfer from the items to the surrounding environment.

[0012] In certain embodiments, heat transfer may be increased by up to about thirty percent as compared with conventional cooling/freezing apparatus.

[0013] In certain embodiments, the at least one turbulence-generating device may comprise at least one elongated member disposed to disrupt gas circulation within the chamber.

[0014] In certain embodiments, the at least one turbulence-generating device may comprise at least one cylindrical member, such as a cylindrical member capable of generating vortex shedding.

[0015] For example, an array of cylindrical members, such as tubes or stainless steel tubes, may be situated between a gas circulation device and a conveyor, within the flow path generated by the gas circulation device. As gas passes around the cylindrical members and/or through the array, vortices are created along the trailing edges of the cylindrical members.

[0016] The vortices between the cylindrical members interact and shed as they impinge onto the surface of the items to be cooled/frozen.

[0017] The diameter of the tubes, spacing between the tubes, and distance from the bottom of the cylindrical member surface to the items to be cooled/frozen may be optimized to provide a desired flow turbulence via routine experimentation in a particular application.

[0018] In certain embodiments, a long axis of each member of the array of cylindrical members may be perpendicular to a long axis or path of travel of the conveyor.

[0019] In certain embodiments, depending on the particular application, the at least one turbulence-generating device may be co-extensive with the entire flow path between the at least one gas circulation device and the at

least one conveyor, or may occupy only a portion of such flow path.

[0020] In certain embodiments, depending on the particular application, the at least one turbulence-generating device may be co-extensive with the width of the conveyor.

[0021] In certain embodiments, a plurality of turbulence generating devices may be positioned, such as in an offset manner, above/below one another in the direction of flow within the apparatus, such as in order to generate further increases in turbulence.

[0022] In certain embodiments, the at least one turbulence-generating device may be adapted for oscillation within the flow path, in order to further increase turbulence generated by the turbulence-generating device. For example, an array of cylindrical members may be oscillated in a direction perpendicular to a long axis of each member of the array of cylindrical members, such as in directions parallel and counter to the axis of travel of the conveyor, in order to allow for further interaction of the vortices created by the cylindrical members.

[0023] In certain embodiments, such as those in which the at least one turbulence-generating device comprises at least one tube, one or more of the at least one tube may be adapted for injection or spraying of a coolant and/or cryogen, such as liquid nitrogen and/or solid/liquid/gaseous carbon dioxide, into the chamber of the cooling/freezing apparatus, toward the items. This may allow for even higher heat transfer coefficients.

[0024] The term "cryogen" as used herein is similar to the term "coolant", and is not intended to necessarily be limited to materials which have a purely cryogenic effect, although that meaning is intended to be included in the use of "cryogen".

[0025] The term "coolant" as used herein means any material which provides a cooling effect to or reduces a temperature of an item.

[0026] In certain embodiments, the cooling/freezing apparatus may comprise a shroud or baffle being arranged for coaction with the at least one gas circulation device.

[0027] In certain embodiments, the at least one shroud or baffle may direct the flow of the circulating gas to be forced through the at least one turbulence-generating device toward the at least one item on the at least one conveyor.

[0028] In certain embodiments, the at least one shroud or baffle may enclose the at least one gas circulation device so that the circulating gas may be forced through the at least one turbulence-generating device.

[0029] In certain embodiments, the at least one shroud or baffle may be constructed as at least one longitudinal member extending within the chamber from the at least one turbulence-generating device to close proximity of an inlet of the at least one gas circulation device for directing the flow of the circulating gas to said inlet.

[0030] During operation of a cooling/freezing apparatus as described herein, snow and/or ice may build up

on the surface(s) of the at least one turbulence-generating device. A manual or automatic cleaning system may be incorporated into the cooling/freezing apparatus in order to periodically remove snow and/or ice from the at least one turbulence-generating device.

[0031] For example, in embodiments in which the at least one turbulence-generating device comprises an array of cylindrical members, a scraping device may be installed which scrapes the cylindrical members using a plate with half-round shapes. The plate may be permanently or temporarily engaged with an extending member to permit travel along the length of the array of cylindrical members.

[0032] In these embodiments, snow and/or ice may preferentially accumulate on the surface of the cylindrical members which faces opposite the direction of gas flow, and therefore the half-round shapes may be sufficient to remove most, if not all, of snow and/or ice accumulated on the cylindrical members.

Brief description of the drawings

[0033] For a more complete understanding of the present embodiment disclosures and as already discussed above, there are several options to embody as well as to improve the teaching of the present invention in an advantageous manner. To this aim, reference may be made to the claims dependent on claim 1 as well as on claim 13; further improvements, features and advantages of the present invention are explained below in more detail with reference to particular and preferred embodiments by way of non-limiting example and to the appended drawing figures taken in conjunction with the following description of exemplary embodiments, of which:

FIG. 1 is a cross-sectional view of a first embodiment of a cooling/freezing apparatus as described herein, said apparatus working according to the method of the present invention;

FIG. 2 is a cross-sectional view of a second embodiment of a cooling/freezing apparatus as described herein, said apparatus working according to the method of the present invention;

FIG. 3 is a cross-sectional view of a first embodiment of a turbulence-generating device as described herein;

FIG. 4 is a cross-sectional view of a second embodiment of a turbulence-generating device as described herein; and

FIG. 5 is a cross-sectional view of a third embodiment of a turbulence-generating device as described herein.

[0034] The accompanying drawings are included to

provide a further understanding of the apparatus and method(s) provided herein and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the apparatus and method(s) provided herein and, together with the description, serve to explain the principles described herein but are not intended to limit the specification or any of the claims. In the accompanying drawings, like equipment is labelled with the same reference numerals throughout the description of FIG. 1 to FIG. 5.

Detailed description of the drawings;

best way of embodying the present invention

[0035] Before explaining the present inventive embodiment in detail, it is to be understood that the embodiment is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the present invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

[0036] In the following description, terms such a horizontal, upright, vertical, above, below, beneath and the like, are used solely for the purpose of clarity illustrating the present invention and should not be taken as words of limitation. The drawings are for the purpose of illustrating the present invention and are not intended to be to scale.

[0037] In particular and referring to FIG. 1, there is shown an illustrative apparatus 10, such as a freezing apparatus or tunnel, for cooling or freezing items 12, such as food items, having a housing 14 with a ceiling 16, a floor 18 and side walls 20, which define a chamber 22 within the housing 14.

[0038] A conveyor 24 extends into the chamber 22 between the ceiling 16 and the floor 18. A gas circulation device 26 (such as an axial flow fan, as depicted in FIG. 1) in mechanical communication with a motor 28, is disposed in the chamber 22, and generates the flow of the circulating gas 30.

[0039] A turbulence-generating device 32 is disposed in the chamber 22 in the flow path between the gas circulation device 26 and the conveyor 24. An optional shroud 34 encloses the gas circulation device 26 so that the circulating gas 30 is forced through the turbulence-generating device 32 toward the items 12 on the conveyor 24.

[0040] In particular and referring to FIG. 2, there is shown an illustrative apparatus 50, such as a freezing apparatus or tunnel, for cooling or freezing items 12, such as food items, having a housing 54 with a ceiling 56, a floor 58 and side walls 60, which define a chamber 62 within the housing 54.

[0041] A conveyor 24 extends into the chamber 62 between the ceiling 56 and the floor 58. A gas circulation

device 66 (such as a centrifugal blower, as depicted in FIG. 2) in mechanical communication with a motor 68, is disposed in the chamber 62, and generates the flow of the circulating gas 30.

[0042] A turbulence-generating device 32 is disposed in the chamber 62 in the flow path between the gas circulation device 66 and the conveyor 24. An optional shroud or baffle 74 constructed and arranged for coaction with the gas circulation device 66 directs the flow of the circulating gas 30 to be forced through the turbulence-generating device 32 toward the items 12 on the conveyor 24.

[0043] The shroud 74 can be constructed as a longitudinal member extending within the chamber 62 from the turbulence-generating device 32 to close proximity of an inlet of the gas circulation device 66 for directing the flow of the circulating gas 30 to said inlet.

[0044] In particular and referring to FIG. 3 through FIG. 5, there is shown the illustrative turbulence-generating device(s) 32 comprising an array of cylindrical members 78 (such as tubes), constructed of a material which may be suitable for use in the apparatus of FIG. 1 and/or FIG. 2.

[0045] The cylindrical members 78 generate turbulent gas flow 80 when the circulating gas 30 passes between and around the cylindrical members 78. The cylindrical members 78 generate vortex shedding 86, and the vortices may interact with each other in order to further increase the turbulence of the turbulent gas flow 80.

[0046] The turbulent gas flow 80 reduces a boundary layer around each item 12 being transported on the conveyor 24, thereby allowing for increased heat transfer from the items 12 to the circulating gases 30, 80.

[0047] FIG. 4 depicts an alternative embodiment of the turbulence-generating device 32, in which the cylindrical members 78 may be oscillated, such as in parallel with and counter to the axis of travel of the conveyor 24, as represented by arrows 82.

[0048] FIG. 5 depicts an alternative embodiment of the turbulence-generating device 32, in which one or more of the cylindrical members 78 may be adapted with outlets and/or nozzles for injecting/spraying 84 cryogen into the turbulent gas flow 80 and toward the items 12 on the conveyor 24 for heat transfer.

[0049] In certain embodiments, the cryogen may be liquid nitrogen (LIN) and/or solid/liquid/gaseous carbon dioxide.

[0050] It will be understood that the embodiments described herein are merely exemplary, and that one skilled in the art may make variations and modifications without departing from the spirit and scope of the present invention. All such variations and modifications are intended to be included within the scope of the present invention as described and claimed herein. Further, all embodiments disclosed are not necessarily in the alternative, as various embodiments of the present invention may be combined to provide the desired result.

List of reference signs**[0051]**

10	apparatus, in particular cooling apparatus or freezing apparatus, in particular freezing tunnel	5
12	item, in particular food item	
14	housing	
16	ceiling	
18	floor	10
20	side wall	
22	chamber	
24	conveyor	
26	gas circulation device, in particular axial flow fan	
28	motor	15
30	circulating gas	
32	turbulence-generating device, in particular elongated member	
34	shroud	
50	apparatus, in particular cooling apparatus or freezing apparatus, in particular freezing tunnel	20
54	housing	
56	ceiling	
58	floor	
60	side wall	25
62	chamber	
66	gas circulation device, in particular centrifugal blower	
68	motor	
74	shroud or baffle, in particular longitudinal member	30
78	cylindrical member, in particular tube, for example stainless steel tube	
80	turbulent gas flow	
82	direction of axis of travel of conveyor 24	
84	cryogen injection or cryogen spray	35
86	vortex shedding	

Claims

1. An apparatus (10; 50) for reducing a temperature of at least one item (12), in particular of at least one food item, comprising:
 - a housing (14; 54) comprising a ceiling (16; 56), a floor (18, 58) and side walls (20; 60) defining a chamber (22; 62) within the housing (14; 54);
 - at least one conveyor (24) extending into the chamber (22; 62) between the ceiling (16; 56) and the floor (18, 58);
 - at least one gas circulation device (26; 66) disposed in the chamber (22; 62); and
 - at least one turbulence-generating device (32) disposed in the chamber (22; 62) and between the at least one conveyor (24) and the at least one gas circulation device (26; 66).

2. The apparatus according to claim 1, wherein the at least one gas circulation device (26; 66) generates the flow of circulating gas (30).
3. The apparatus according to claim 2, wherein the at least one turbulence-generating device (32) comprises at least one elongated member disposed to disrupt the flow of the circulating gas (30) within the chamber (22; 62).
4. The apparatus according to claim 2 and to claim 1 or 3, wherein the at least one turbulence-generating device (32) comprises at least one cylindrical member (78), in particular an array of cylindrical members (78), for generating turbulent gas flow (80) when the circulating gas (30) passes between and/or around the at least one cylindrical member (78).
5. The apparatus according to claim 4, wherein the at least one cylindrical member (78) generates vortex shedding (86).
6. The apparatus according to claim 5, wherein the vortices interact with each other in order to further increase the turbulence of the turbulent gas flow (80), said turbulent gas flow (80) reducing a boundary layer around the at least one item (12) being transported on the at least one conveyor (24), thereby allowing for increased heat transfer from the at least one item (12) to the circulating gas (30) and/or to the turbulent gas flow (80).
7. The apparatus according to at least one of claims 4 to 6, wherein the at least one cylindrical member (78) is oscillated, in particular in parallel with and counter to the direction (82) of the axis of travel of the at least one conveyor (24).
8. The apparatus according to at least one of claims 4 to 7, wherein the at least one cylindrical member (78) is provided with at least one outlet and/or nozzle for injecting/spraying (84) a coolant or a cryogenic substance, in particular liquid nitrogen and/or solid/liquid/gaseous carbon dioxide, into the turbulent gas flow (80) and toward the at least one item (12) on the at least one conveyor (24) for heat transfer.
9. The apparatus according to at least one of claims 1 to 8, wherein at least one shroud or baffle (34; 74) is arranged for coaction with the at least one gas circulation device (26; 66).
10. The apparatus according to claim 2 and 9, wherein the at least one shroud or baffle (34; 74) directs the flow of the circulating gas (30) to be forced through the at least one turbulence-generating device (32) toward the at least one item (12) on the at least one conveyor (24).

11. The apparatus according to claim 9 or 10, wherein the at least one shroud or baffle (34) encloses the at least one gas circulation device (26).
12. The apparatus according to claim 2 and to at least one of claims 9 to 11, wherein the at least one shroud or baffle (74) is constructed as at least one longitudinal member extending within the chamber (62) from the at least one turbulence-generating device (32) to close proximity of an inlet of the at least one gas circulation device (66) for directing the flow of the circulating gas (30) to said inlet.
13. A method of reducing a temperature of at least one item (12), in particular of at least one food item, using a cooling apparatus (10; 50), including at least one gas circulation device (26; 66) for generating a flow of circulating gas (30) in a flow path toward at least one conveyor (24), comprising:
- providing at least one turbulence-generating device (32) disposed in the flow path between the at least one conveyor (24) and the at least one gas circulation device (26; 66) for disrupting the flow of the circulating gas (30) at the flow path.
14. The method according to claim 13, further comprising moving the at least one turbulence-generating device (32) relative to movement of the at least one conveyor (24).
15. The method according to claim 13 or 14, wherein the circulating gas (30) comprises a coolant or a cryogenic substance, in particular liquid nitrogen and/or solid/liquid/gaseous carbon dioxide.

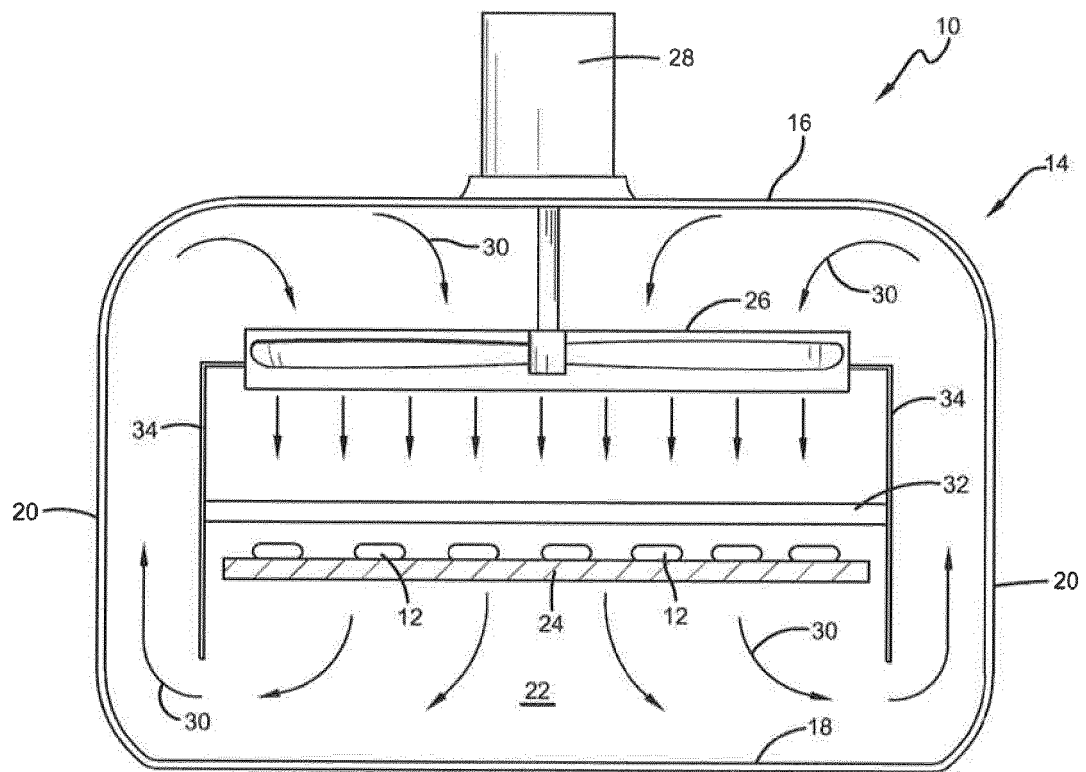


FIG. 1

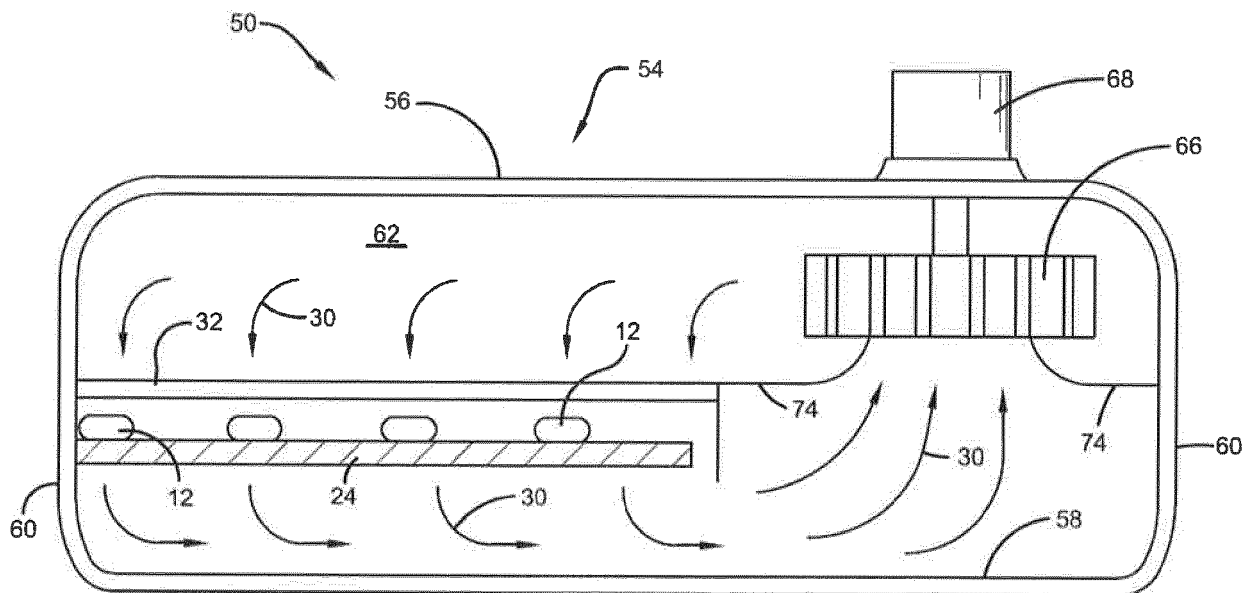


FIG. 2

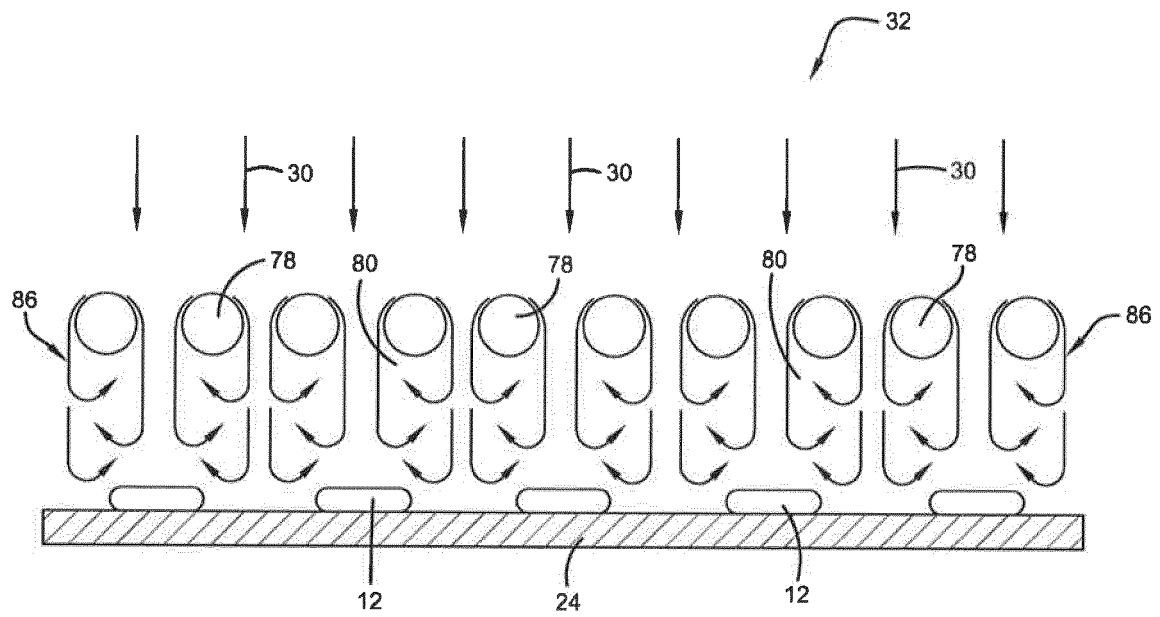


FIG. 3

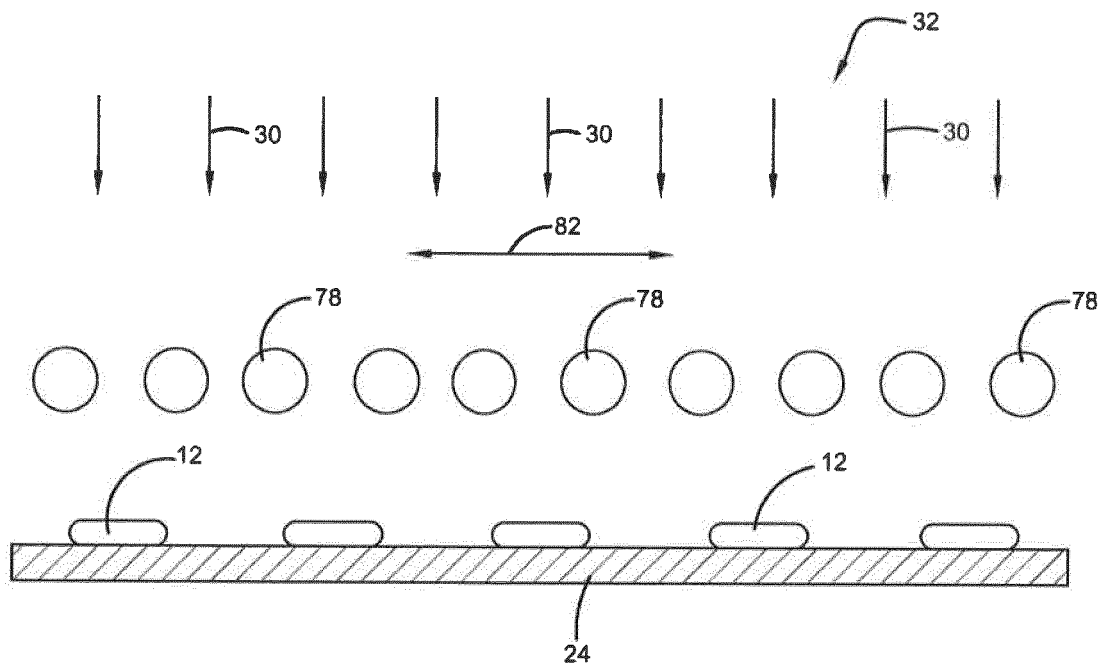


FIG. 4

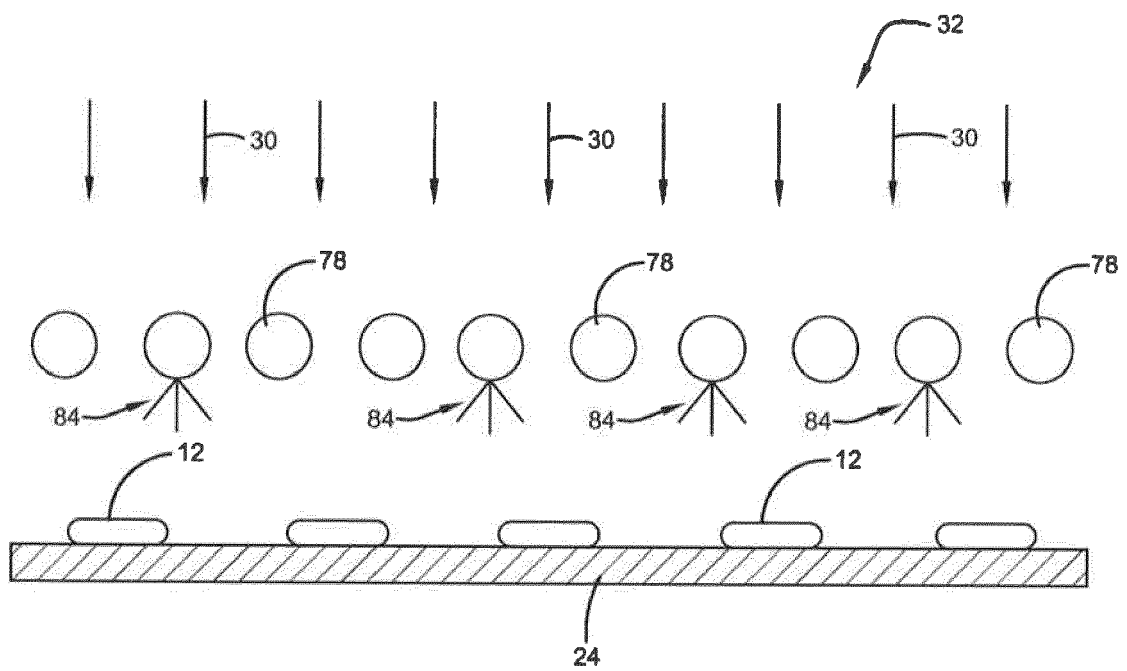


FIG. 5



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Application Number
EP 17 17 2271

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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	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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