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(72) Inventors:
• **Solin, Richard**
21200 Raisio (FI)
• **Heikkilä, Pertti**
21200 Raisio (FI)

(74) Representative: **Schmid, Wolfgang**
Lorenz & Kollegen
Patentanwälte Partnerschaftsgesellschaft mbB
Alte Ulmer Strasse 2
89522 Heidenheim (DE)

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(71) Applicant: **Valmet Technologies Oy**
02150 Espoo (FI)

(54) **PULP DRYER**

(57) The invention relates to a pulp dryer, which comprises a first end wall and a second end wall, arranged parallelly at a distance from each other, wherein an entrance opening for a pulp web is arranged in the first end wall and an exit opening for the pulp web is arranged in the second end wall. The pulp dryer further comprises a plurality of horizontal superposed drying decks arranged between the first and the second end wall, the drying decks comprising a plurality of elongated drying means for drying and supporting the pulp web. The drying means have a first end and a second end, a longitudinal axis extending from the first end to the second end, parallelly with the first and second end walls, and a blow surface with blow openings. The drying means are arranged side-by-side so that air removal gaps are formed between the adjacent drying means. At least one of the drying decks comprises an edge zone, where cover elements are arranged to cover at least part of at least some of the air removal gaps.

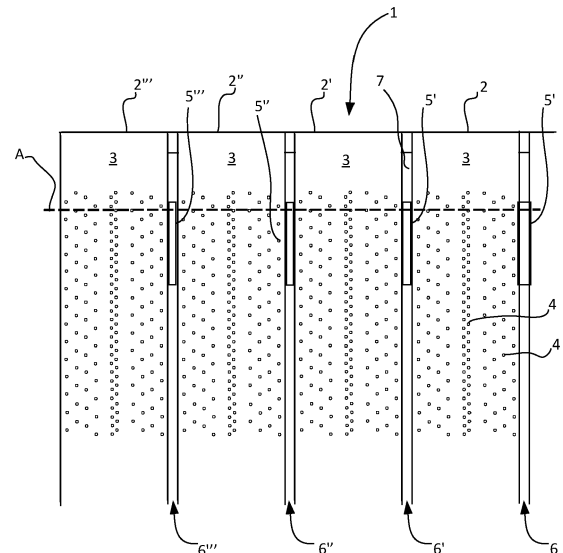


Figure 1

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Description

[0001] The present invention relates to a pulp dryer according to the preamble of the enclosed independent claim.

[0002] Pulp is dried in a pulp dryer, where a pulp web is conveyed along a multi-layered path by floating the pulp web in a contactless manner on an air cushion. The air cushion both dries and carries the pulp web through the pulp dryer. Air cushion is formed by drying means, which comprise blow openings arranged to blow hot air towards the pulp web. Typically the blown air has a temperature of 120 -170 °C. The drying means are arranged in several superposed horizontal drying decks. The pulp web is brought into the pulp dryer through its first end, the so-called wet end, and conveyed on a drying deck of the pulp dryer to the second end of the dryer. The ends of the pulp dryer comprise turn rolls, which turn the pulp web to the following drying deck. After the final drying deck, the pulp web is brought to a cooling deck, usually below the drying decks, and the pulp web is removed from the pulp dryer, usually from the second end of the pulp dryer. The pulp dryer typically has 10- 30 drying decks. When entering the pulp dryer, the pulp web typically has a dry solids content of 48 - 54 %. The dry solids content of the pulp web leaving the pulp dryer is approximately 85 - 95 %, most commonly approximately 90 %.

[0003] Especially in the beginning of the drying action, when the pulp web is still relatively moist, the edges of the pulp web may sag and the drying means are not able to maintain an air cushion that would guarantee that the pulp web is transferred completely contactless manner through the drying deck. The edges of the pulp web may thus contact the drying deck structures, and this may lead to loosening of particulate material from the web. This easily produces dust formation, which may cause process disruptions as the dust is deposited on the process surfaces, such as heat exchangers, steam radiators, blow openings, filter nets and the like. Excessive dusting and lint formation may also form an occupational hazard for the dryer operators.

[0004] This far there has been few effective measures to prevent or decrease the contact between the edges of the pulp web and the drying deck structures and to counteract the dust formation. There have been proposals to increase the number or size of blow holes at the edges of the blow means in hope to provide more effective blowing action and air cushion at the edge region of the pulp web. However, there have been no proposals that could be easily retrofitted to the existing dryers. Consequently, there is an obvious need for solutions that can limit the contact between the pulp web edges and the drying deck and minimize the dust formation.

[0005] One object of the present invention is to reduce or even completely eliminate the problems appearing in the prior art.

[0006] An object of the present invention is to provide a pulp dryer, where the loosening of the particulate ma-

terial from the pulp web is reduced or minimized.

[0007] Another object of the present invention is to provide a pulp dryer where the lateral edges of the pulp web are effectively supported throughout the drying in the pulp dryer.

[0008] In order to realize the above-mentioned objects, the invention is characterized by what is presented in the characterizing part of the enclosed independent claim. Some preferable embodiments are described in the dependent claims.

[0009] The embodiments mentioned in this text are freely combinable with each other even if not explicitly stated so.

[0010] A typical pulp dryer according to the present invention comprises

- a first end wall and a second end wall, arranged parallelly at a distance from each other, wherein an entrance opening for a pulp web is arranged in the first end wall and an exit opening for the pulp web is arranged in the second end wall,
- a plurality of horizontal superposed drying decks arranged between the first and the second end wall, the drying decks comprising a plurality of elongated drying means for drying and supporting the pulp web, the drying means having

- a first end and a second end,
- a longitudinal axis extending from the first end to the second end, parallelly with the first and second end walls, and
- a blow surface with blow openings,

wherein the drying means are arranged side-by-side so that air removal gaps are formed between the adjacent drying means, wherein at least one of the drying decks comprises a lateral edge zone, where cover elements are arranged to cover at least a part of at least some of the air removal gaps.

[0011] Now it has been surprisingly found out that when the drying deck is provided with a lateral edge zone, where cover elements are arranged to cover at least a part of at least some of the air removal gaps, the web supporting air cushion at the lateral edge zone is strengthened. The cover elements locally prevent the removal of the air blown from the drying means, which creates an enhanced positive air pressure between the drying deck and the pulp web to be dried. This reduces bending and/or sagging of the moist pulp web towards the drying deck and minimizes or even eliminates the dust formation through web contact. The cover elements are easy to install to the air removal gaps between the horizontally adjacent drying means, and they can be even retrofitted to existing pulp dryers, if desired. Furthermore, the total blow air volume and/or the air flow is unaffected, which means that there is no need to redesign blowing

means or recalculate inlet/outlet flows as the air balance remains the very same. It is also easy to tailor the invention to suit each pulp dryer, as the number of air removal gaps to be covered by the cover elements can be selected according to the individual production needs of the dryer.

[0012] The lateral edge zone, where the cover elements are arranged, may extend at maximum of 550 mm, preferably at maximum of 400 mm, from the first end of the drying means towards the second end of the drying means and/or from the second end of the drying means towards the first end of the drying means. The width of the lateral edge zone may be, for example, 100 - 500 mm, preferably 150 - 400 mm, sometimes 200 - 350 mm, measured from the first/second end of the drying means. It has been observed that this width provides lateral edge zone, which is able to provide appropriate support for the pulp web edges. The lateral edge zone with the cover elements may be arranged at the first end of the drying means or at the second end of the drying means. In that case only one of the pulp web edges is supported by the enhanced air cushion provided by the cover elements. Alternatively, lateral edge zones with the cover elements can be arranged on both the first end and the second end of the drying means. In this case both edges of the pulp web are supported by the enhanced air cushion provided by the cover elements. The part of the lateral edge zone, where the air removal gaps are covered by the cover elements, may be called a cover zone.

[0013] Typically the drying decks have a width which is larger than the width of the pulp web to be dried. The drying deck can be, for example, 100 - 600 mm wider than the pulp web to be dried. This means that the drying deck extends over the edges of the pulp web, i.e. the length of the drying means is larger than the width of the pulp web to be dried. According to one preferable embodiment, the cover elements are arranged at the location of the web edges, which means that the cover elements cover at least some of the air removal gaps at the web edges. Thus the cover elements may be arranged at a distance of 0 - 250 mm, preferably 50 - 250 mm, more preferably 75 - 200 mm, sometimes 75 - 150 mm, from the first end and/or the second end of the drying means. This means that the lateral edge zone may comprise a cover free zone, where the air removal gaps are uncovered, at the immediate vicinity of the first end and/or second end of the drying means, and an adjacent cover zone, where the air removal gaps are covered by the cover elements, located next to the cover free zone. The cover free zone at the immediate vicinity of the end of the drying means facilitates controlled air removal of the lateral edge zone.

[0014] The cover elements may be made from any suitable material that can be used in the conditions prevailing in a pulp dryer. Especially, the cover elements may be made from materials tolerating the elevated temperatures of 70 - 275 °C and being able to withstand the heated air blown from the blow means. The cover elements

may be made of metal, such as aluminium or steel; polymer or silicone. Cover element made from metal may be alloy coated or painted metal. Preferably the individual cover element may be in form of an elongated profile, such as elongated metal profile or plate, or elongated polymer profile. Suitable elongated profiles, either of metal or polymer may preferably be obtained by extruding. According to one preferable embodiment, the cover elements are extruded aluminium profiles.

[0015] The cover elements are elongated elements, and the length of a cover element may be in a range of 75 - 300 mm, preferably 100 - 250 mm, sometimes 100 - 200 mm. It has been observed that the cover elements obstructing the air removal on this relatively short length of the air removal gap provide a desired supporting effect towards the pulp web edge and reduces the sagging risk. According to one embodiment, the cover element may have a telescopic structure, i.e. the length of the cover element is adjustable. In case the length of the cover element is adjustable, its length may be adjusted within the range as defined above.

[0016] The cover element has a cover surface, having a width which corresponds the width of the air removal gap. Typically the width of the cover surface is 10 -100 mm, more typically 20 - 60 mm. When the cover element is arranged to cover the air removal gap, the cover surface faces the pulp web to be dried. The cover element may preferably have side surfaces, which are integral with the cover surface. The cover surface and the side surfaces may preferably be arranged at an angle of at least $90^\circ \pm 2^\circ$. The cover surface of the cover element may have a perforated surface or a solid surface.

[0017] The cover elements are preferably tightly fitted in at least some of the air removal gaps between horizontally adjacent drying means. The cover elements may be arranged in various spacing patterns in a desired manner, depending how much more effective air cushion at the edge area is needed. According to one spacing pattern, a cover element may be arranged in each air removal gap between the horizontally adjacent drying means. According to another spacing patterns, a cover element may be arranged in every second, third or fourth air removal gap. According to yet another spacing pattern, it is possible to arrange cover elements of different length in the air removal gaps. For example, the length of the cover elements may gradually change (increase/decrease), seen in the machine direction, or a cover element with a different length (shorter/longer) may be arranged in the air removal gap at regular intervals, for example in every second, third or fourth air removal gap. The different spacing patterns can be freely combined with each other. It is also possible that the drying deck is divided in at least two or more sections, seen in the machine direction, where each of the sections comprise cover elements arranged in different spacing patterns, depending for example on the estimated moisture content of the web.

[0018] The cover elements may be firmly fastened to

the adjacent drying means, and/or they may comprise locking means for detachable attachment between the adjacent drying means. For example, the cover elements may comprise snap-fit connectors or other locking forms, preferably arranged on the side surfaces of the cover elements, and preferably providing a detachable attachment. Alternatively, or in addition, the cover elements may be firmly attached or fastened between the horizontally adjacent drying means by welding, bolting or by screwing.

[0019] According to embodiment of the invention, the cover elements are arranged movable along the air removal gap. This enables their exact arrangement at the edge of the pulp web to be dried. The cover element may comprise, for example, elongated perforation in its side surfaces, and the drying means may comprise a counterparts which can be fitted into the elongated perforations. This allows transfer of the cover element along the air removal gap to the desired location.

[0020] The cover elements of the present invention may be arranged or incorporated in any pulp dryer, especially to pulp dryers as described in the background part of this application. Typically, a pulp dryer comprises a hood with a first end wall and a second end wall, arranged parallelly at a distance from each other. An entrance opening for a pulp web is arranged in a first end wall of the dryer, usually at its upper end, and an exit opening for the pulp web is arranged in the second end wall of the dryer, usually at its lower end. The pulp dryer comprises a plurality of horizontal superposed drying decks, and usually at least one cooling deck arranged after the drying decks (seen in transfer direction of the web to be dried), wherein the drying decks and cooling deck(s) are arranged between the first and the second end wall. The entrance opening for the pulp web is arranged on the level of the first drying deck and the exit opening for the pulp web is arranged on the level of the cooling deck below the drying decks. Roll towers are arranged in the first and second ends of the dryer and they comprise several superposed parallel turn rolls for turning the pulp web to from a drying deck to a succeeding drying deck.

[0021] Each drying deck comprises a plurality of elongated drying means for drying and supporting the pulp web to be dried. The drying means are usually elongated blow boxes with drying nozzle structures, which extend across the pulp web width. The drying means are horizontally arranged side-by-side so that air removal gaps are formed between the horizontally adjacent drying means. The drying means have a first end and a second end, and a longitudinal axis which extends from the first end to the second end, parallelly with the first and second end walls of the pulp dryer. The blowing surface of the drying means comprises blow openings, such as nozzle openings, nozzle slots or the like, through which drying air is lead towards the pulp web to be dried. The drying air functions at the same time also as a supporting medium for the web. The first end of the drying means has

a supply air connection through which a fan supplies heated air into the drying means. The height of the drying means typically decreases from the first end towards the second end of the drying means, i.e. the drying means is thereby wedge-shaped in its longitudinal direction. The pulp dryer further comprises fan towers, each of which comprises a number of superposed axial fans, which are arranged to supply heated air to the drying groups. One fan may supply heated air to one or several drying groups.

[0022] The cover elements are preferably arranged on a level which is at maximum 20 mm, preferably at maximum 10 mm, lower than the blow surface level of the drying means, seen in horizontal direction. The blow surface level is here understood as the virtual, preferably horizontal, tangent level touching the highest points of the drying means of the drying deck. For example, the cover elements may be arranged 0-20 mm, preferably 5 - 15 mm, lower than the blow surface level.

[0023] The lateral edge zones with cover elements may be preferably arranged on at least on the two first drying decks, seen from the entrance opening of the pulp web. In this manner the proper support for the pulp web can be provided when the pulp web is still relatively moist and the risk for the web edge sagging is at the highest.

[0024] According to one embodiment of the present invention the cover elements may be retrofitted to an existing pulp dryer.

[0025] Some embodiments of the present invention are more closely described in the following schematical and non-limiting drawings.

Figure 1 shows an arrangement according to one embodiment of the invention, seen from above;

Figures 2A - 2D show the effect of the cover elements to the edge of the pulp web, seen in the direction of the movement of the web;

Figure 3 shows some exemplary ways of attaching cover elements between horizontally adjacent drying means, seen from the end of the drying means;

Figure 4A and 4B show details of one way of attaching the cover element between horizontally adjacent drying means.

[0026] In Figure 1 is shown a drying deck with a lateral edge zone according to one embodiment of the invention, seen from above. The drying deck 1 comprises a number of drying means 2, 2', 2'', 2''' having blow surfaces 3 with blow openings 4. the location of the edge of the pulp web to be dried is indicated with a dash line A. Elongated cover elements 5, 5', 5'', 5''' are arranged in the air removal gaps 6, 6', 6'', 6''' between the horizontally adjacent

drying means 2, 2', 2", 2'''. The cover elements 5, 5', 5", 5''' are arranged to locate at the edge of the pulp web to be dried. The cover elements 5, 5', 5", 5''' inhibit the removal of air blown from the blow openings 4 through the air removal gaps 6, 6', 6", 6''' at the edge of the pulp web to be dried. This provides an enhanced air cushion which effectively lifts the edge of the pulp web and counteracts sagging, bending, and may even prevent the sagging and/or bending of the edge of the pulp web. This is more closely shown in Figures 2A - 2D. A cover free zone 7 is created at the immediate vicinity of the ends of the drying means 2, 2', 2", 2'''. Air is removed in a normal manner through the cover free zone 7 and other uncovered parts of the air removal gaps 6, 6', 6", 6'''.

[0027] Figures 2A - 2D show the effect of the cover elements to the edge of the pulp web, seen in the direction of the movement of the web, i.e. in machine direction. In Figure 2A is seen pulp web 21 with a sagging edge 21'. No cover elements have been arranged in the air removal gaps, and the air cushion created by the drying means 22 is not enough to support the edge 21' of the pulp web 21. In Figure 2B is shown the same pulp web 21 as in Figure 2A, after a cover element 25 has been arranged to the air removal gap. The cover element 25 restrict the removal of air at the lateral edge zone 20, which provides an enhanced air cushion and elevates the edge 21' of the web 21 from the contact with the drying means 22. Figure 2C is seen a pulp web 21 with an edge area bent towards the drying means 22 and coming in contact with the drying means 22. This may depict a situation where the pulp web 21 of Figure 2A has been turned to a following drying deck. No cover elements have been arranged in the air removal gaps, and the air cushion created by the drying means 22 is not enough to support the bent edge area of the pulp web 21. Figure 2D show how cover elements 25 arranged at the edge area provide an enhanced air cushion and elevate the bent edge area of the web 21 from the contact with the drying means 22.

[0028] Figure 3 shows some exemplary ways of attaching cover elements between horizontally adjacent drying means, seen from the end of the drying means. According to one embodiment the cover element 35 is attached with fastening means 38, such as screws or bolts, to the bottom 321, 321' of the horizontally adjacent drying means 32, 32'. In this case the cover element 35 comprises side surfaces with protrusions 39 with enable the fastening of the cover element 35 to the drying means 32, 32'. In another embodiment the cover element 35' is attached with fastening means 40 through the side surfaces of the cover element 35' to the side surfaces of the horizontally adjacent drying means 32', 32''. According to yet another embodiment, the cover element 35" is attached to of the horizontally adjacent drying means 32", 32''' with a fastening means through the cover surface of the cover element 35".

[0029] Figures 4A and 4B show details of one exemplary way of attaching the cover element between horizontally adjacent drying means, seen from the end of the

drying means. The exemplified cover element 35" is arranged to be supported by forms 321", 321''' projecting from the sides of the drying means 32", 32'''. The cover element 35" is fastened on its place by using a flange plate 40, bolt 41 and screw 42. Figure 4B shows the same arrangement seen from above.

[0030] Even if the invention was described with reference to what at present seems to be the most practical and preferred embodiments, it is appreciated that the invention shall not be limited to the embodiments described above, but the invention is intended to cover also different modifications and equivalent technical solutions within the scope of the enclosed claims.

Claims

1. A pulp dryer, which comprises

- a first end wall and a second end wall, arranged parallelly at a distance from each other, wherein an entrance opening for a pulp web is arranged in the first end wall and an exit opening for the pulp web is arranged in the second end wall,
- a plurality of horizontal superposed drying decks arranged between the first and the second end wall, the drying decks comprising a plurality of elongated drying means for drying and supporting the pulp web, the drying means having

- a first end and a second end,
- a longitudinal axis extending from the first end to the second end, parallelly with the first and second end walls, and
- a blow surface with blow openings,

wherein the drying means are arranged side-by-side so that air removal gaps are formed between the adjacent drying means,

characterized in that

at least one of the drying decks comprises an edge zone, where cover elements are arranged to cover at least part of at least some of the air removal gaps.

2. Pulp dryer according to claim 1, **characterized in that** the length of the cover element is 75 - 300 mm, preferably 100 - 250 mm.

3. Pulp dryer according to claim 1 or 2, **characterized in that** the edge zone extends at maximum of 550 mm, preferably at maximum of 400 mm, from the first end of the drying means towards the second end of the drying means and/or from the second end of the drying means towards the first end of the drying means.

4. Pulp dryer according to claim 1, 2 or 3, **character-**

ized in that the cover elements are arranged at a distance of 0 - 250 mm, preferably 50 - 250 mm, more preferably 75 - 200 mm, from the first end and/or the second end of the drying means.

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5. Pulp dryer according to any of claims 1 - 4, **characterized in that** the cover elements are arranged on a level which is at maximum 20 mm, preferably at maximum 10 mm, lower than the blow surface level of the drying means, seen in horizontal direction. 10
6. Pulp dryer according to any of claims 1 - 5, **characterized in that** the cover elements are made of metal, such as aluminium, steel; polymer or silicone. 15
7. Pulp dryer according to claim 6, **characterized in that** the cover elements made from metal are alloy coated or painted metal.
8. Pulp dryer according to any of claims 1 - 7, **characterized in that** the edge zones with cover elements are arranged on at least on the two first drying decks, seen from the entrance opening of the pulp web. 20
9. Pulp dryer according to any of claims 1 - 8, **characterized in that** the cover elements comprise locking means for detachable attachment between the adjacent drying means. 25
10. Pulp dryer according to any of claims 1 - 9, **characterized in that** the cover elements are attached between the adjacent drying means by welding, bolting or by screwing. 30
11. Pulp dryer according to claims 1 -10, **characterized in that** at least some of the cover elements have a telescopic structure so that their length is adjustable. 35
12. Pulp dryer according to claims 1 - 11, **characterized in that** the cover element has a cover surface which is a perforated surface or a solid surface. 40
13. Pulp dryer according to claims 1 - 12, **characterized in that** cover elements are arranged in a spacing pattern where each air removal gap between the adjacent drying means is covered with a cover element. 45
14. Pulp dryer according to claims 1 - 13, **characterized in that** the cover elements are arranged in a spacing pattern where every second, third or fourth air removal gap is covered with the cover elements. 50
15. Pulp dryer according to claims 1 - 14, **characterized in that** the drying deck is divided in at least two sections, seen in the machine direction, where each section comprises cover elements arranged in a different spacing pattern. 55

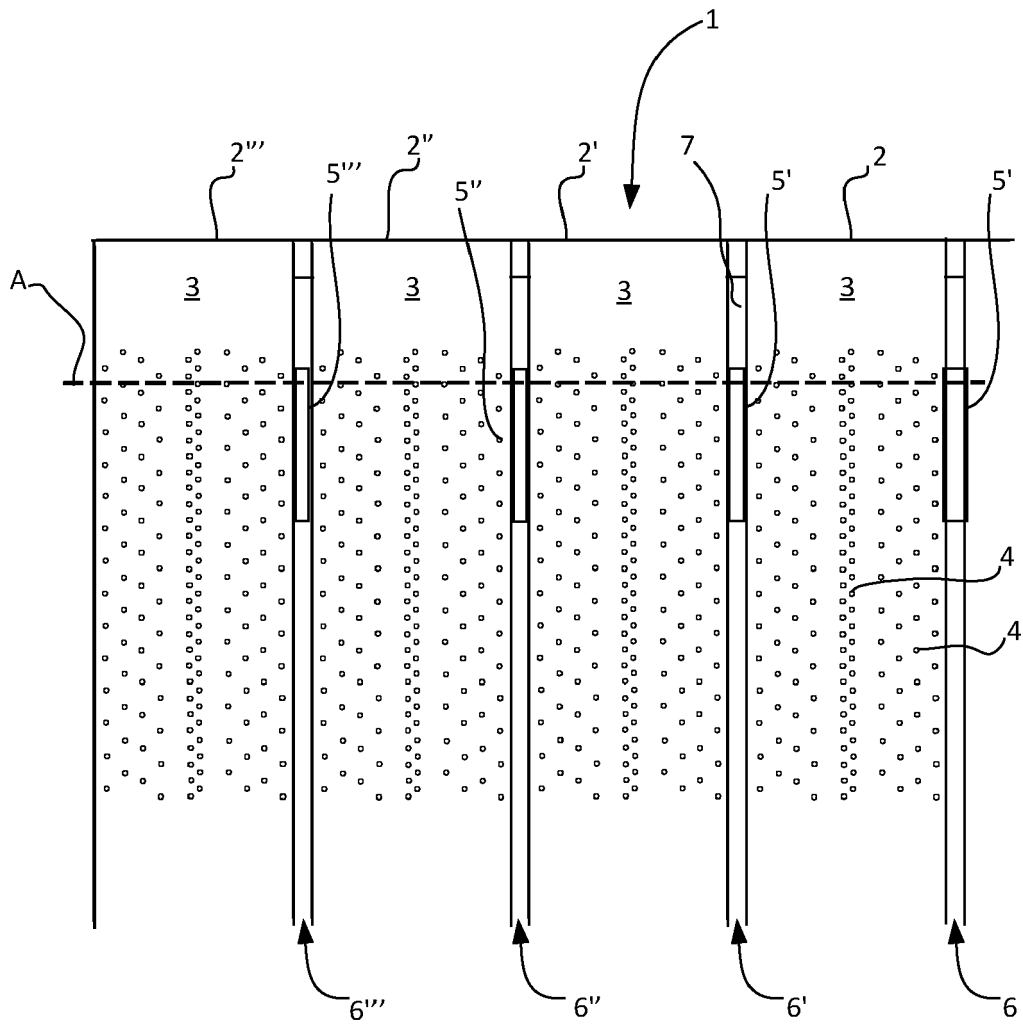


Figure 1

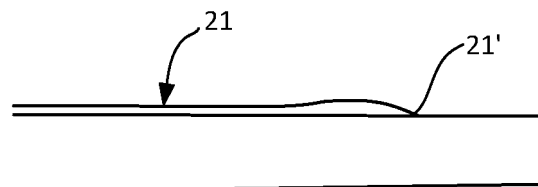


Fig. 2A

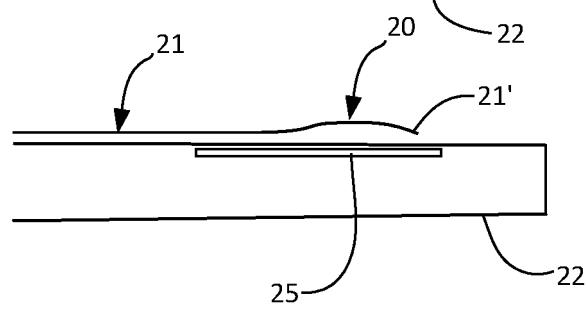


Fig. 2B

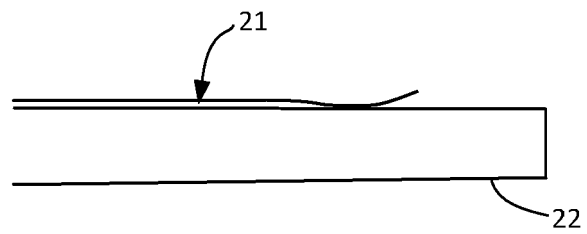


Fig. 2C

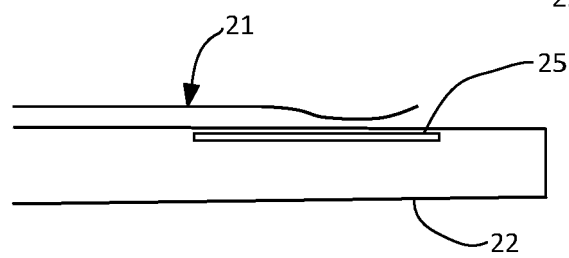


Fig. 2D

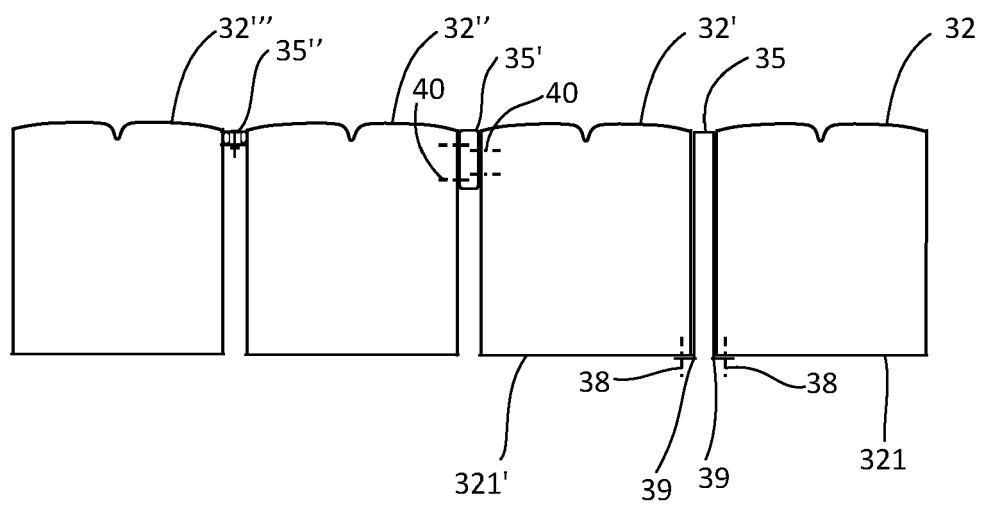


Figure 3

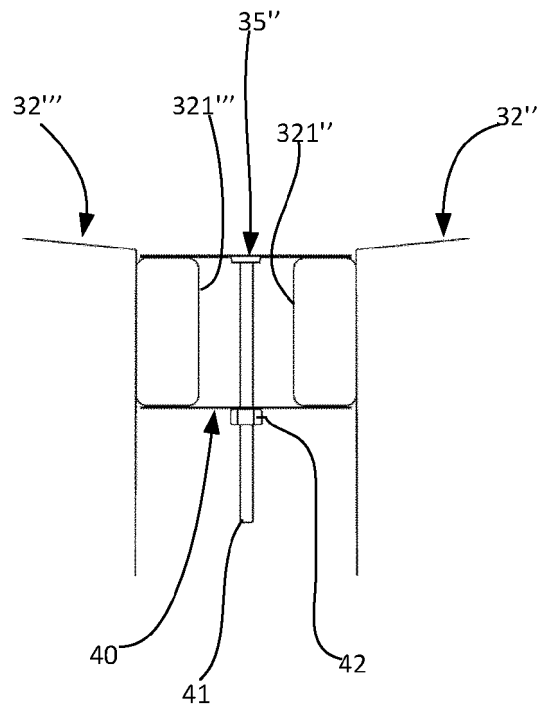


Figure 4A

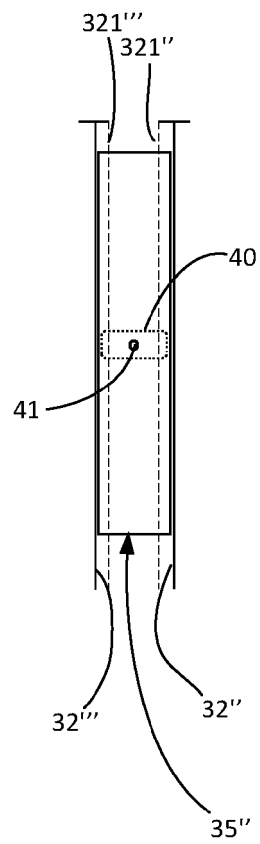


Figure 4B



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Application Number

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Place of search Munich		Date of completion of the search 8 September 2023	Examiner Kopacz, Ireneusz
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