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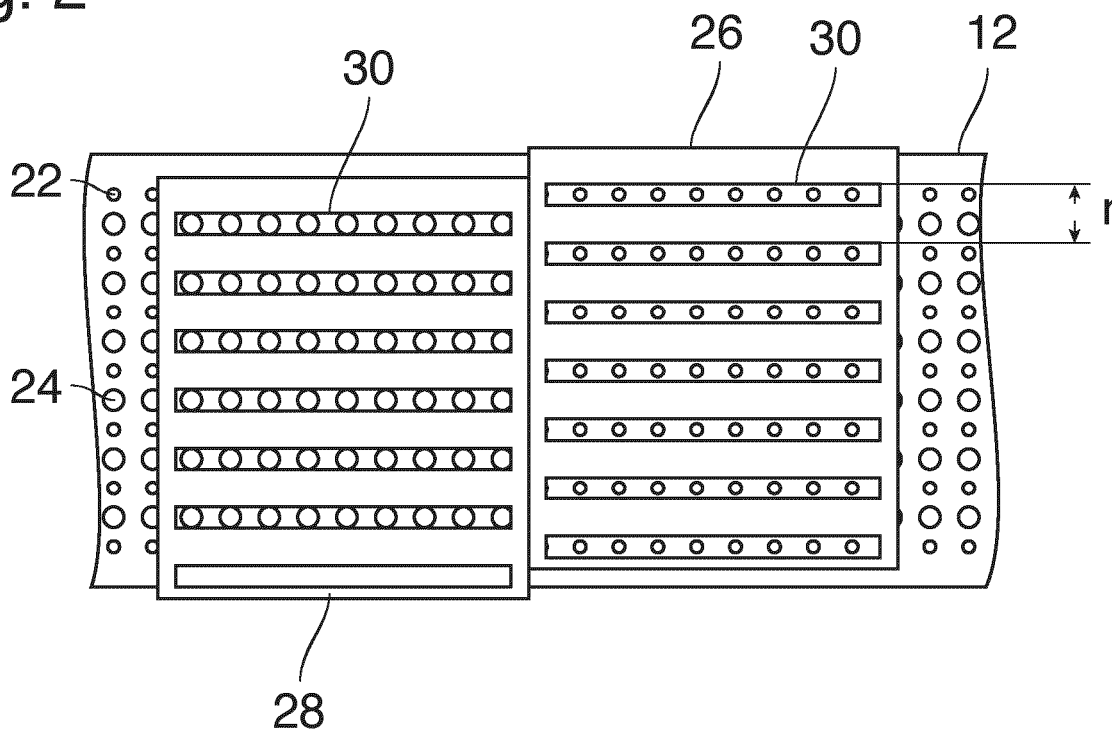
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(54) TRANSPORT SYSTEM

(57) A sheet transport system comprising at least one perforated belt (12) that defines a sheet transport path and runs over at least one suction box, the suction box having a belt support structure (26, 28) that has suction openings (30) distributed in a regular raster (r) in a transverse direction of the belt, characterized in that

perforations (22, 24) in the at least one perforated belt (12) are arranged in the same regular raster (r) as the suction openings (30), and the amount of overlap between the suction openings (30) and the perforations (22, 24) varies along the sheet transport path.

Fig. 2

Description

[0001] The invention relates to a sheet transport system comprising at least one perforated belt that defines a sheet transport path and runs over at least one suction box, the suction box having a belt support structure that has suction openings distributed in a regular raster in a transverse direction of the belt.

[0002] An example of a sheet transport system of this type has been described in US 2017/136787 A1.

[0003] Sheet transport systems are used for example in printers in order to convey the media sheets through various processing stages of the apparatus. Frequently, it is desired to attract media sheets to the perforated conveyor belt with a suction pressure so that the sheets are safely held in position and are prevented from bending or cockling. The suction pressure results in local airflows across the conveyor belt. In some processing stages, however, it may be necessary to adjust the suction pressure to reduce or control the airflows. For example, if the processing stage includes an ink jet printhead, then a too high suction pressure may create relatively strong air currents that flow in parallel with the plane of the sheets and may change the trajectories of the ink droplets and thereby compromise the print quality.

[0004] In principle, it is possible to provide separate suction boxes for the different processing stages and to control the suction pressures individually for each suction box. In addition, each suction box can be provided with its specific vacuum source, such a pump. Generally, commonly applied suction sources have a pre-determined pressure - flow rate ratio over a limited range. All in all, this, however, leads to a complicated vacuum system and vacuum control system.

[0005] It is an object of the invention to provide a sheet transport system in which the suction pressure and/or flow rate can easily be adjusted, specifically varied across different regions.

[0006] It is the insight of the inventor that a high flow rate per unit area through the conveyor belt is beneficial for attracting a sheet onto the conveyor belt, while a smaller flow rate is preferred where droplets are jetted to minimize their displacement due to air flows. It is the further insight of the inventor that different flow rate - negative pressure ratios and/or combinations can be achieved by varying the combined open area of the conveyor belt and its underlying support structure. In addition, the inventor devised that by varying the combined open area these different flow rate - negative pressure ratios can be achieved using only a single suction box and/or suction source.

[0007] According to the invention, in order to achieve this object, perforations in the at least one perforated belt are arranged in the same regular raster as the suction openings, and an amount of overlap between the suction openings and the perforations varies along the sheet transport path.

[0008] Thus, all suction boxes can be connected to a

common vacuum source or a common suction box may be provided for several processing stages, and the suction pressure is adapted to the local demand simply by changing the amount of overlap between the suction openings in the belt support structure and the perforations in the conveyor belt. This may be achieved very easily by slightly varying the relative transverse positions of the belt and the belt support structure. In processing stages, where a high flow rate per unit area and/or high suction pressure would be problematic, a reduction of the flow rate and/or suction pressure can be achieved for example by slightly shifting the belt support structure laterally into a position where the overlap between the suction openings and the belt perforations is smaller and the flow resistance for the air being sucked-in is increased accordingly. In one example, the pressure in the common suction box is substantially constant along the conveyor belt, and the different amounts of overlaps are applied to create different flow rates per unit area. For example, at the ink jet printhead(s), the overlap may be smaller to reduce the flow rate affecting the trajectories of ink droplets there as compared to upstream of the printhead where the sheet is to be drawn against the conveyor by greater flow rates.

[0009] More specific optional features of the invention are indicated in the dependent claims.

[0010] Preferably, the lateral position of the perforated belt is controlled to ensure reliable positioning of the sheet with respect to the printhead(s). This may for example be achieved by controllably tilting one or more rollers supporting the belt to adjust the lateral position of the belt. Alternatively, one could shift the belt support structure in the suction box or to shift the suction box as a whole. Preferably, movement of the belt with respect to the support structure is limited.

[0011] In an embodiment, the amount of overlap changes to define at least two separate areas on the support surface of the belt in its transport direction. Preferably that is achieved by two differently arranged belt support structures (which includes differently configured portions of one support structure assembly). Therein, one belt support structure is provided downstream of another belt support structure. Each belt support structure defines an array of suction openings, so that one array of suction openings is non-overlapping with the other array of openings when viewed along a transport direction of the sheet transport system;

- the perforations on the belt are dimensioned and/or arranged in at least two subsets, so that one subset of the perforations overlaps with the one array of suction openings but not with the other array, while the other subset of perforations overlaps with the other array of suction openings but not with the one array at the respective belt support structure. Each support structure is arranged to close off or seal one of the arrays of suction openings, but not the other. Each array has a different total open area per unit

area, so the flow rate resistance per unit area is different over each of the support structures. In consequence, areas with different flow rates are defined can be defined over a single suction box.

[0012] In an embodiment, an average total open area per unit area of perforations overlapping with suction openings is different between the belt support structures. The cross-section and/or density of the suction openings in one array is different from the other. The flow rate resistance per unit area of one array is thus different from the other. Thereby, the flow rate as expressed in e.g. m/s is different over each support structure. Preferably, one of the belt support structures is positioned facing a print station, and wherein the average total open area per unit area of perforations overlapping with suction openings at that one belt support structure is smaller than at the other the belt support structure. The flow rate resistance through the combined belt and support structure at the print station is greater than upstream thereof. Air displacement is on average less below the print station, resulting in locally reduced air current velocities and reduced droplet displacement as a consequence thereof. Where the sheet is received in the belt, the flow rates are greater, as thereby a local negative static pressure due to the Bernoulli effect can be created to draw the sheet onto the belt.

[0013] The suction holes in the belt support structure may for example be shaped as slots or may arranged in rows that extend in sheet transport direction and are regularly interspaced in the transverse direction. The "regular raster" may then be considered to be the spacing between two adjacent rows of suction holes or any integer multiple of that spacing. Correspondingly, the perforations in the belt will be arranged in rows that extend in longitudinal direction of the belt and are regularly interspaced in the transverse direction, and the raster may be considered to be given by the spacing between two adjacent rows of perforations or any integer multiple of that spacing. The perforations may be provided in subsets with different open areas per unit area, for example by varying the perforation cross-section, shape, density, etc. Thus, the feature that the suction openings and the perforations are arranged in the same regular raster does not necessarily mean that the spacings between the rows of suction openings and the rows of perforations are equal. It is sufficient to require that one spacing is an integer multiple of the other.

[0014] According to another aspect, the invention discloses a sheet transport system comprising a perforated belt running over a suction box, the suction box having a belt support structure that has suction openings distributed in a regular raster in a transverse direction of the belt, wherein perforations in the perforated belt are arranged in the same regular raster as the suction openings, and an adjustment mechanism is provided for adjusting the relative position of the belt support structure and the belt in said transverse direction, thereby to vary the amount of

overlap between the suction openings and the perforations.

[0015] In this case, the sheet transport systems in the various processing stages may have an identical design, and in each processing stage the adjustment mechanism may be used for adapting the suction pressure to the local demand. This embodiment has the further advantage that the adjustment mechanism can also be used for optimizing the flow rate and/or suction pressure in view of, for example, the physical properties of the media sheets that are currently being processed.

[0016] According to yet another aspect, the invention discloses a method of adjusting a suction pressure in a sheet transport system that comprises a perforated belt running over a suction box, the suction box having a belt support structure that has suction openings distributed according to a regular raster in a transverse direction of the belt, perforations in the perforated belt being arranged in the same regular raster as the suction openings, characterized by a step of adjusting the relative position of the belt support structure and the belt in said transverse direction, thereby to vary the amount of overlap between the suction openings and the perforations.

[0017] Embodiment examples will now be described in conjunction with the drawing, wherein:

Fig. 1 is a schematic side view of a sheet transport system having a suction box;

Fig. 2 is a plan view of a belt support structure and a perforated belt as seen from the inside of the suction box;

Fig. 3 is a top plan view of the belt support structure and the suction box shown in Figs. 1 and 2; and

Fig. 4 is a side view of a sheet transport system according to a modified embodiment.

[0018] As is shown in Fig. 1, a sheet transport system comprises an endless perforated belt 12 trained around two deflection rollers 14 at least one of which is driven to rotate in anti-clockwise direction in Fig. 1 so as to move media sheets (not shown) past a print station 16 and a drying station 18. By way of example, it may be assumed that the print station 16 includes an ink jet printhead adapted to print images on the media sheets by jetting water-soluble ink onto the media sheets. The sheets leaving the print station 16 will then be dried in the drying station 18 by blowing hot air against the media sheets.

[0019] A suction box 20 is disposed below the upper run of the perforated belt 12. When a vacuum pressure is applied to the interior of the suction box 20, ambient air will be drawn in through uncovered perforations 22, 24 (Fig. 2) of the perforated belt 12. Media sheets conveyed on this belt are firmly attracted against the upper surface of the belt by a holding force which proportional to the

negative pressure and the open area of the belt 12 and its support structure 26, 28 that allows the negative pressure to act on the sheets. In order to prevent the belt 12 from sagging due to the vacuum pressure in the suction box, the belt is supported by two belt support structures 26, 28. Each support structure 26, 28 comprises a plurality of longitudinal support beams extending in the transport direction and spaced apart from one another in the transverse direction. In Fig. 2, the support beams are formed of a plate or within a tile, but individual or separate beams may be applied as well to form the belt support structure. The belt support structure 26 supports the belt in the region of the print station 16, and the belt support structure 28 supports the belt in the region of the drying station 18.

[0020] Fig. 2 shows the belt support structures 26, 28 and the perforated belt 12 as seen from the inside of the suction box 20, so that the belt support structures obscure certain parts of the belt 12. The two belt support structures 26, 28 have an identical design and each comprise or define slot-shaped suction openings 30 that extend in longitudinal direction of the belt 12 and are regularly interspaced in the transverse direction, thereby defining a regular raster *r* in the transverse direction.

[0021] The perforations 22, 24 of the belt 12 form alternating rows of small-diameter perforations 22 and large-diameter perforations 24 that fit into the raster *r* defined by the suction holes 30.

[0022] The belt support structures 26 and 28 are positioned at different positions along the transport direction. The belt support structures 26 and 28 differ slightly in their lateral positions. In case of the support structure 26, the suction holes 30 are aligned with the small-diameter perforations 22 whereas the large-diameter perforations 24 are blocked by the portions of the belt support structure that separate the suction holes 30. Consequently, the flow rate of the air being sucked-in in the region of the print station 16 is limited by the relatively small diameter of the perforations 22. Preferably, this support structure 26 is positioned facing the print station 16, so that the air flows at the print station are relatively small, thereby reducing their displacement of the jetted droplets.

[0023] In contrast, the belt support structure 28 is positioned such that the suction openings 30 are aligned with the large-diameter perforations 24 whereas the small-diameter perforations 22 are blocked. Consequently, the suction pressure is determined by the larger diameter of the perforations 24. This has the effect that, when passing underneath the blower of the drying station 18, the media sheets are firmly attracted with a high suction pressure so that they are firmly held in position in spite of the air current generated by the blower. Preferably, a similar support structure 28 is applied at the upstream side or end of the belt to create there an area, where the sheet is reliably drawn onto the belt, when it is received from an upstream conveyor. It will be appreciated that in this example, the suction pressure inside the suction box 20 is assumed to be substantially constant or the same at

both belt support structures 26, 28. Under that assumption, the different hole diameter result in different flow rates in the different areas. Note that the holding force per unit area is proportional to product of the suction pressure and the hole diameter, so the holding force can also be varied in this manner. It may be that the suction pressure is also locally affected by the different rates of air flows entering the different areas of the suction box, which could allow for local adjustment of the holding force and/or suction pressure.

[0024] Fig. 3 shows the suction box 20 and the sheet support structures 26, 28 - without the belt 12 - in a top plan view. Fig. 3 further shows an adjustment mechanism 32 that is provided for controlling the lateral positions of the two belt support structures 26, 28 and, therewith, the amount of overlap between the suction openings 30 and the perforations 22, 24 of the belt 12. The plate-like belt support structures 26, 28 are slidable in the transverse direction of the belt along guide rails 34 and are arranged and dimensioned to cover the entire top surface of the suction box 20. In particular, the belt support structures 26, 28 project beyond walls 36 of the suction box that extend in the sheet transport direction. The adjustment mechanism 32 has a frame 38 that is attached to the suction box 20 and accommodates and supports two linear drives 40, 42 for adjusting the lateral positions of the belt support structures 26, 28.

[0025] In the example shown, the linear drives 40, 42 may be configured to just switch between the two positions of the belt support structures 26, 28 that have been shown in Figs. 2 and 3. This has the advantage that the flow rate of the air being drawn-in is determined only by the vacuum pressure in the vacuum box 20 and by the diameters of the perforations 22, 24.

[0026] In a modified embodiment, the linear drives 40, 42 may be configured to move the support structures 26, 28 into any intermediate position between the two positions shown in Figs. 2 and 3, so that the amount of overlap between the suction openings 30 and the perforations 22, 24 may be varied continuously, which allows for a fine-adjustment of the combination or ratio of the flow rate and the vacuum pressure. In that case, it would not even be required that the perforations 22, 24 have different diameters.

[0027] Fig. 4 shows an embodiment of a sheet transport system that has two consecutive perforated belts 12', one for moving the sheets through the print station 16 and one for moving the sheets through the drying station 18. Each belt 12' has its own suction box 20' covered by a belt support structure 26' that, in this case, may be mounted rigidly in the suction box. In order to adjust the suction pressure, the suction boxes 20 and their belt support structures 26' may be moved as a unit. Since the suction pressures in the two processing stages can be controlled independently by the positions of the suction boxes 20', both suction boxes may be connected to a common vacuum source 44.

Claims

1. A sheet transport system comprising at least one perforated belt (12; 12') that defines a sheet transport path and runs over at least one suction box (20; 20'), the suction box having a belt support structure (26, 28; 26') that has suction openings (30) distributed in a regular raster (r) in a transverse direction of the belt, **characterized in that** perforations (22, 24) in the at least one perforated belt (12) are arranged in the same regular raster (r) as the suction openings (30), and an amount of overlap between the suction openings (30) and the perforations (22, 24) varies along the sheet transport path.
2. The sheet transport system according to claim 1, wherein the perforations (22, 24) of the belt (12) form a repetitive pattern consisting of a number of rows of perforations (22, 24) with different sizes, and the spacing between two neighboring suction openings (30) is equal to the product of the spacing between adjacent rows of perforations (22, 24) with different sizes and the number of rows in the repetitive pattern.
3. The sheet transport system according to claim 2, wherein the number of rows of the repetitive pattern is 2.
4. The sheet transport system according to claim 2 or 3, wherein the suction openings (30) have the shape of slots extending in longitudinal direction of the belt (12; 12').
5. The sheet transport system according to any of preceding claims, wherein:
 - one belt support structure (26, 28; 26') is provided downstream of another belt support structure (26, 28; 26');
 - each belt support structure (26, 28; 26') defines an array of suction openings (30), so that one array of suction openings (30) is non-overlapping with the other array of openings (30) when viewed along a transport direction of the sheet transport system;
 - the perforations (22, 24) on the belt (12) are dimensioned and arranged in at least two subsets, so that one subset of the perforations (22, 24) overlaps with the one array of suction openings (30) but not with the other array, while the other subset of perforations overlaps with the other array of suction openings (30) but not with the one array at the respective belt support structure (26, 28; 26').
6. The sheet transport system according to claim 5, wherein an average total open area per unit area of perforations (22, 24) overlapping with suction openings (30) is different between the belt support structures (26, 28; 26').
7. The sheet transport system according to claim 5, wherein one of the belt support structures (26, 28; 26') is positioned facing a print station (16), and wherein the average total open area per unit area of perforations (22, 24) overlapping with suction openings (30) at that one belt support structure (26, 28; 26') is smaller than at the other the belt support structure (26, 28; 26').
8. A sheet transport system comprising a perforated belt (12) running over a suction box (20), the suction box having a belt support structure (26, 28) that has suction openings (30) distributed in a regular raster (r) in a transverse direction of the belt, wherein perforations (22, 24) in the perforated belt (12) are arranged in the same regular raster (r) as the suction openings (30), wherein an adjustment mechanism (32) is provided for adjusting the relative position of the belt support structure (26, 28) and the belt (12) in said transverse direction, thereby to vary and an amount of overlap between the suction openings (30) and the perforations (22, 24).
9. The sheet transport system according to claim 8, wherein the belt support structure (26, 28) is movable relative to the suction box (20) and the adjustment mechanism (32) is arranged to adjust the lateral position of the belt support structure (26, 28) in the suction box (20).
10. The sheet transport system according to claim 9, wherein the suction box (20) has a plurality of independently movable belt support structures (26, 28).
11. A method of adjusting a suction pressure in a sheet transport system (10) that comprises a perforated belt (12) running over a suction box (20), the suction box having a belt support structure (26, 28) that has suction openings (30) distributed in a regular raster (r) in a transverse direction of the belt (12), perforations (22, 24) in the perforated belt (12) being arranged in the same regular raster (r) as the suction openings (30), **characterized by** a step of adjusting the relative position of the belt support structure (26, 28) and the belt (12) in said transverse direction, thereby to vary an amount of overlap between the suction openings (30) and the perforations (22, 24).

Fig. 1

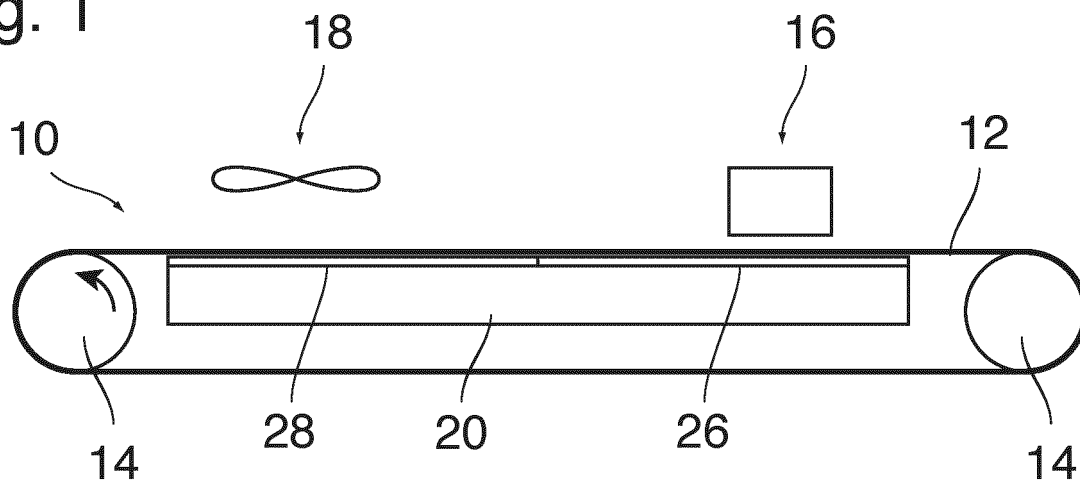


Fig. 2

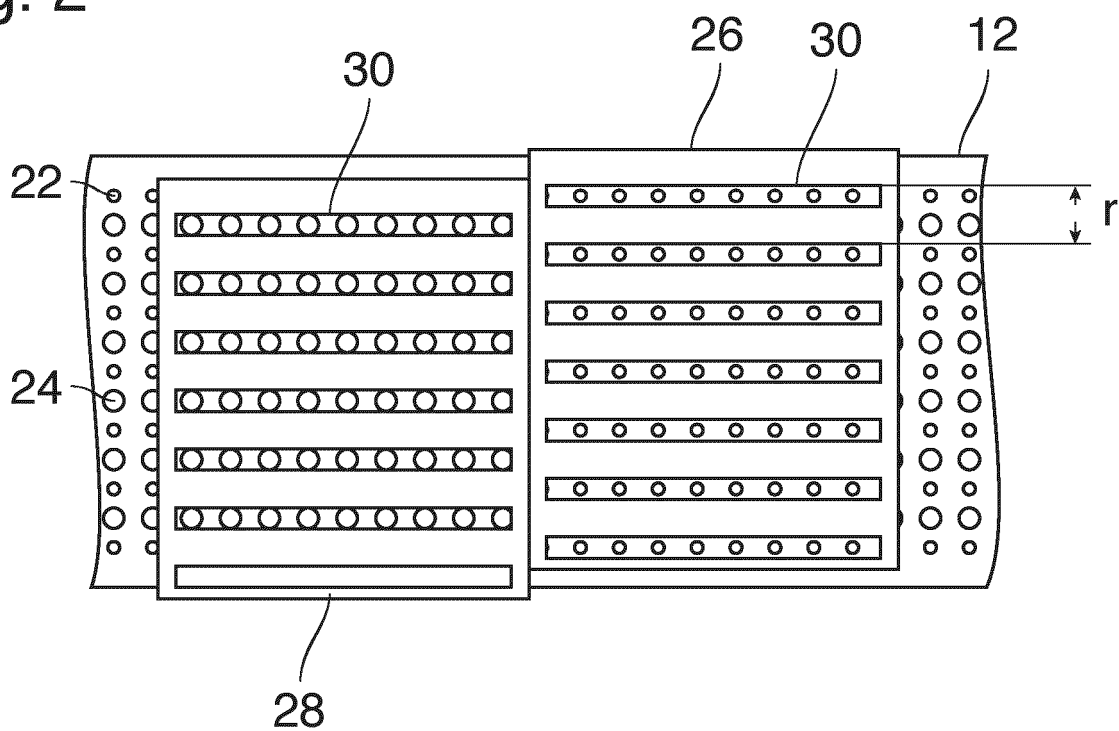


Fig. 3

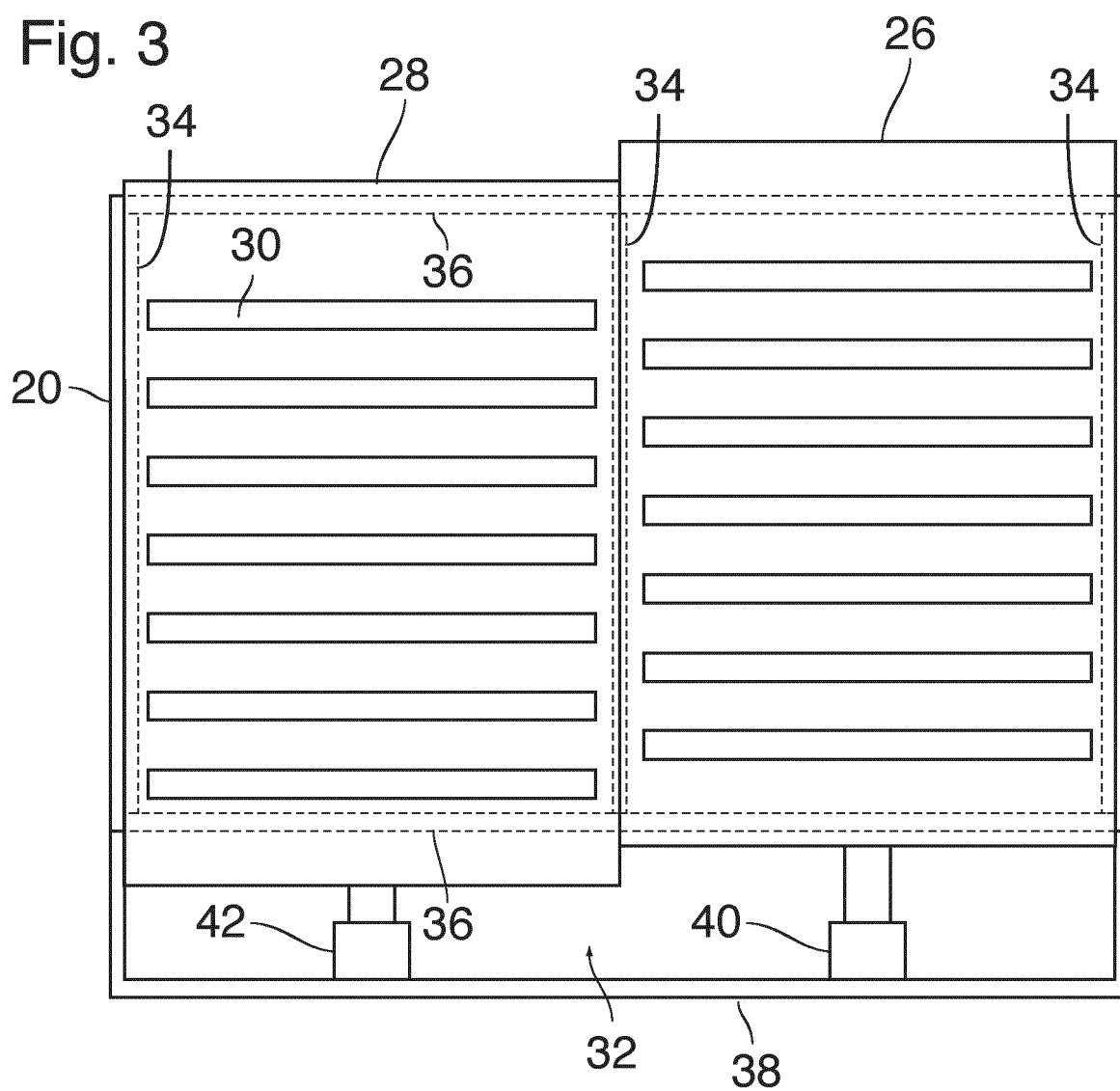
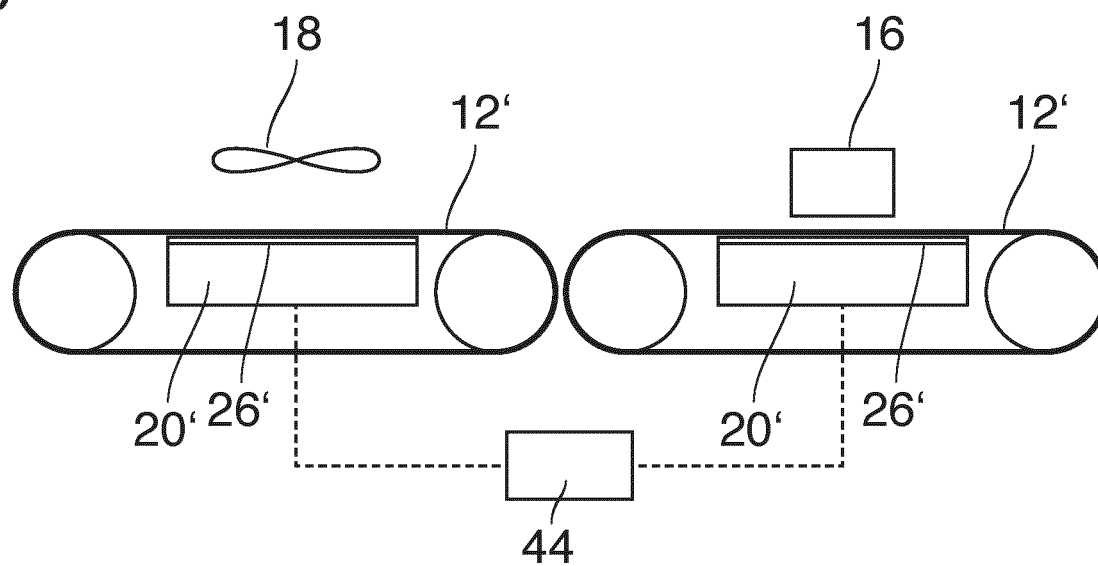


Fig. 4





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Application Number

EP 25 16 8012

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Place of search			Examiner
The Hague			Athanasiadis, A
Date of completion of the search			
11 September 2025			
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11-09-2025

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

REFERENCES CITED IN THE DESCRIPTION

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