(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 455 541 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.05.2012 Bulletin 2012/21

(51) Int Cl.:
D21F 5/04 *(2006.01)*

(21) Application number: **10191653.4**

(22) Date of filing: **18.11.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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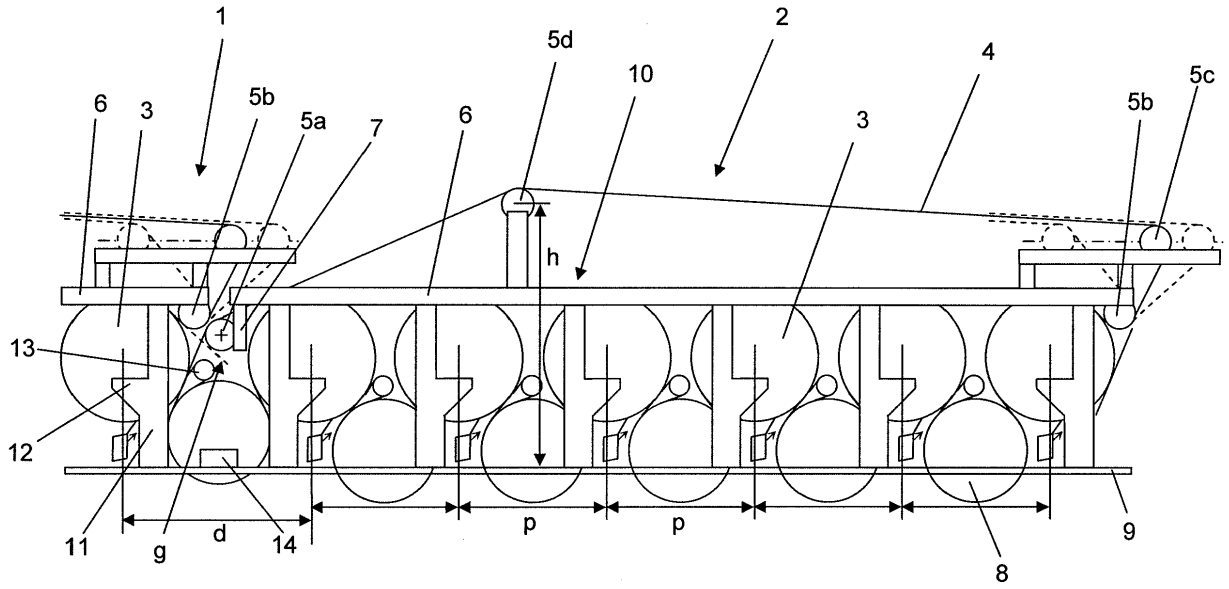
Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) Drying section of a web forming machine

(57) A drying section of a web forming machine comprises at least two dryer assemblies (1, 2) arranged in successive order and having plural cylinders in which a pitch (p) between adjacent drying cylinders (3) is substantially constant and a dryer wire (4) which passes a web through the plural cylinders in an alternating manner. The distance (d) from center to center of adjacent drying cylinders (3) of two successive dryer assemblies (1, 2) is larger than the pitch (p) between adjacent drying cylinders (3) within each dryer assembly (1, 2) so as to form a gap (g) between the successive dryer assemblies (1, 2) which is larger than the pitch (p) between the drying cylinders (3) within each dryer assembly (1, 2).

Fig. 1



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Description

[0001] The invention relates to a drying section of a web forming machine. More particularly, the invention relates to a single tier dryer section with dryer assemblies or dryer groups in which all drying cylinders are arranged in an upper row and turning rolls are arranged in a lower row.

[0002] In the prior art, web forming machines having single tier drying sections with drying cylinders in an upper row and turning rolls in a lower row are well known. The drying sections generally form a very large part of the web forming machine and are, therefore, usually designed and constructed in view of the total length of the whole machine wherein great efforts have been made to reduce the total length of the drying section as much as possible.

[0003] In order to achieve a reduced length, focus has particularly been put on a very compact structure. In order to realize a compact structure, it is attempted to arrange the different elements of the drying section as close to each other as possible. Especially when arranging the drying cylinders as close as possible to each other, a reduction in the length of the drying section can be achieved. Therefore, a uniform "drying cylinder to drying cylinder distance" is used in the prior art with the drying cylinders being arranged as close as possible to each other.

[0004] With the above solution, it is possible to reduce the overall length of the web forming machine. This has the advantage that the building in which the web forming machine is to be placed can be built shorter and, therefore, the respective building costs are lower. However, with the above solution, reducing the size of the drying section is limited in that a minimum distance between adjacent drying cylinders and turning rolls has always to be maintained.

[0005] In view of the above, it is the object of the invention to provide a drying section of a web forming machine which is more compact regarding the accommodation space needed in a building.

[0006] The object is achieved with a drying section having the features summarized in claim 1.

[0007] Advantageous further formations are subject of the dependent claims.

[0008] According to the invention, the drying section of a web forming machine comprises at least two dryer assemblies or dryer groups which are arranged in successive order. Each of the dryer assemblies or dryer groups has plural cylinders, wherein a pitch between adjacent drying cylinders in each dryer assembly is substantially constant. A dryer wire passes a web through the plural cylinders in an alternating manner. The distance between adjacent drying cylinders from center to center of two successive dryer assemblies is larger than the pitch between adjacent drying cylinders within each dryer assembly. Therefore, a gap is formed between the successive dryer assemblies which is larger than the clearance between the drying cylinders within each dryer assembly.

[0009] The gap formed in the above manner provides a space in which other parts of the drying section can be accommodated in order to reduce the height of the drying section.

[0010] The drying section may comprise lead rolls for guiding the dryer wire and it is advantageous if at least a lead roll on the entry side of the dryer assembly, which serves for turning the dryer wire towards a web transfer point, is arranged in the gap. In this connection, "arranged in the gap" means that at least the center of the lead roll is arranged lower than the highest point of the cylinder. Furthermore, the web transfer point is the point at which the web is transferred from the drying cylinder of one dryer assembly to the dryer wire of the successive dryer assembly. Arranging the lead roll in such a manner reduces the distance between the lead roll and the web transfer point. Therefore, the amount of air transported to the transfer point by the wire is reduced. Consequently, the web transfer is made more stable.

[0011] It is particularly beneficial if at least the lead roll on the entry side of the dryer assembly is arranged below a level at which the highest points of the outer circumferences of the drying cylinders are located. With this arrangement, the lead roll on the entry side is brought to the web transfer point even more closely, so that the above described positive effect of arranging the lead roll in the gap is further enhanced.

[0012] In order to reduce the height of the drying section, a lead roll on the exit side of each dryer assembly may be arranged in the gap. Placing the lead roll on the exit side in the gap provides a basis for lowering further lead rolls which are arranged for guiding the dryer wire from the exit side of the assembly to the entry side of the assembly making the construction more compact. Therefore, the construction of the drying section is less cost intensive due to material savings, for example due to a reduction of the wire length.

[0013] The lead roll on the exit side of the assembly may be arranged as close to the drying cylinder as possible. In other words, a center of the lead roll on the exit side of the dryer assembly may be arranged below a level at which the highest points of the outer circumferences of the drying cylinders are located. Therefore, the wire runs downwards between the drying cylinder and the lead roll on the exit side. Advantageously, the exit side lead roll is arranged such that an imaginary line being tangent to the drying cylinder and the lead roll on the exit side passes the lead roll on the entry side below the center thereof. Said arrangement ensures that a tail of the web erroneously being adhered to the wire and being guided towards the lead roll on the exit side is taken to the right path by means of the wire running to the transfer point on the entry side of the successive dryer assembly. Also, the runnability of the wire is enhanced and the drying section can be manufactured at lower costs.

[0014] Advantageously, the lead roll on the exit side

of the dryer assembly is arranged at a higher level than the lead roll on the entry side of the dryer assembly. This arrangement makes it possible to bring the lead roll on the entry side as close as possible to the web transfer point so that the amount of air transported to the web transfer point by the wire is reduced as much as possible. Furthermore, it is beneficial when the lead roll on the exit side of a preceding dryer assembly is overlapped with the lead roll on the entry side of the successive dryer assembly, so that the distance between the lead roll on the entry side and the web transfer point is additionally reduced. Furthermore, a lowered lead roll on the exit side provides a longer wire wrap around the cylinder before the transfer point. Accordingly, the drying efficiency is enhanced.

[0015] In order to support bearing housings of the lead rolls, the drying section may further comprise an upper main frame adapted to support the bearing housings. The bearing housings of the lead rolls may be attached at the upper main frame from below. The upper main frame may consist of a single horizontal beam for each dryer assembly, which directly or indirectly supports the lead rolls so that the bearing housings of the lead rolls are arranged below the upper main frame.

[0016] At least one of the lead rolls may be directly supported on the upper main frame. Advantageously, the lead roll on the exit side of each dryer assembly is directly supported on the upper main frame.

[0017] In order to arrange the lead roll on the entry side of the dryer assembly as close as possible, the bearing housing of the lead roll is supported on the upper main frame via a spacer. The spacer can be a beam which extends from the upper main frame in downward direction, for instance downward in a vertical direction. However, the spacer can be formed in any suitable way for bringing the lead roll on the entry side as close as possible to the web transfer point.

[0018] Each dryer assembly of the drying section may further comprise turning rolls which are supported by a base of the drying section, wherein a distance between the drying cylinders and the turning rolls is equal to or smaller than 50mm. Here, "supported by a base" means that bearing housings of the turning rolls are directly supported on the base by attaching the bearing housings at the base or that the bearing housings are indirectly supported by the base by supporting them at the base by means of spacers or the like.

[0019] Advantageously, the turning roll of the dryer assembly onto which the web is transferred from the adjacent dryer assembly is supported at a higher level than the other turning rolls in the same dryer assembly. Such an arrangement makes it possible to reduce the cylinder to cylinder distance between the turning roll arranged below the gap and the adjacent drying cylinders.

[0020] Preferably, the pitch between two adjacent drying cylinders in each dryer assembly is set to 2100mm $\pm$ 100mm.

[0021] Furthermore, the distance between adjacent drying cylinders of two successive dryer assemblies measured from a center of cylinder to the center of next cylinder may be set to 2700mm $\pm$ 100mm. Such a distance provides a sufficiently large gap for accommodating a lead roll and a turning roll in elevated position therein.

[0022] Other features and advantages of the invention will become obvious from the following description of a preferred embodiment of the invention which is described with reference to the appended drawings in which:

Fig. 1 is a side view of a dryer section of a web forming machine viewed from the tending side; and
Fig. 2 is an enlarged side view of a web transfer portion between two adjacent dryer assemblies.

[0023] A preferred embodiment of the invention is shown in Fig. 1. In this figure, a part of a drying section of a web forming machine is shown from the tending side. More precisely, Fig. 1 shows two dryer assemblies 1, 2 arranged in successive order. Although not shown for the left dryer assembly in Fig. 1, each of the dryer assemblies 1, 2 has plural drying cylinders 3. In the present embodiment, six drying cylinders 3 are provided in each dryer assembly 1, 2. Anyhow, it is advantageousto provide dryer assemblies with three to seven drying cylinders.

[0024] The drying cylinders 3 are supported by frames 10 provided on the driving side and the tending side, respectively. As is shown in Fig. 1, the frames 10 of each dryer assembly 1, 2 are constructed of vertical beams 11 and a horizontal beam 6 (upper main frame) supported by the vertical beams 11. In detail, bearing housings of the drying cylinders 3 are supported by shelfs or protrusions 12 formed on the vertical beams 11. As is shown in Fig. 1, all protrusions 12 of the vertical beams 11 on the tending side protrude in machine direction wherein five protrusions 12 protrude in downstream direction with respect to the web running direction and one protrusion 12 which is provided at the drying cylinder 3 on the exit side of the wire protrudes in an upstream direction with respect to the web running direction. This arrangement where at least one of protrusion is in reverse order, gives stability to the frame of the dryer assembly and is beneficial against frame vibrations. Here, the number of vertical beams 11 corresponds to the number of drying cylinders 3, so that each vertical beam 11 supports one bearing housing of one drying cylinder 3. However, other constructions are possible for supporting the drying cylinders 3, like one or two diagonal supports against vertical support per dryer assembly for stability reasons.

[0025] In the preferred embodiment, all drying cylinders 3 have the same diameter and the pitch p between adjacent drying cylinders 3 in each dryer assembly 1, 2 is substantially constant. Consequently, said pitch p between adjacent drying cylinders 3 in each dryer assembly 1, 2 is constant as well. Furthermore, all drying cylinders 3 in the dryer assembly 1, 2 are arranged on the same

level. In the embodiment, the cylinder to cylinder distance from center to center (pitch) of the drying cylinders 3 of each dryer assembly 1, 2 is 2100mm. However, this cylinder to cylinder distance of drying cylinders 3 in each dryer assembly 1, 2 may alternatively be in a range of 2100mm ± 100mm.

[0026] In each dryer assembly 1, 2, turning rolls 8 - six in this embodiment - are provided below the drying cylinders 3. The turning rolls 8 are supported on a base plate 9 wherein bearing housings of the turning rolls 8 are either directly or indirectly supported thereon. The arrangement of the turning rolls 8 will be described in detail later.

[0027] Furthermore, a dryer wire 4 which is arranged in a loop and which passes a web through the drying cylinders 3 and the turning rolls 8 in an alternating manner is arranged in each dryer assembly 1, 2. Besides the drying cylinders 3 and the turning rolls 4, lead rolls 5a, 5b, 5c and 5d are provided for guiding the dryer wire 4. In the embodiment, three lead rolls 5a, 5b and 5d are fixedly arranged and one lead roll 5c is horizontally movable arranged and serves for stretching the dryer wire 4. This allows a very simple support construction for said stretcher. All lead rolls 5a, 5b, 5c, 5d are arranged inside the loop of the wire 4 for the sake of cleanliness.

[0028] On the entry side of each dryer assembly 1, 2, one lead roll 5a turns the dryer wire 4 towards a web transfer point at which the web is passed from one dryer assembly 1 to the successive dryer assembly 2. More precisely, at the web transfer point, a suction box 13 or other underpressure device is arranged, which transfers the web from a drying cylinder 3 of the preceding dryer assembly 1 onto the wire 4 of the successive dryer assembly. Also, further suction boxes 13 are provided in a pocket space between the drying cylinders 3 and turning rolls of each dryer assembly 1, 2 so as to separate the web from the drying cylinders 3 with the help of said underpressure device. In addition there is a doctor and doctor beam with a ventilator below every cylinder.

[0029] As is shown in Figs. 1 and 2, the distance d from center to center of adjacent drying cylinders 3 of the two successive dryer assemblies 1, 2 is larger than the pitch p formed between adjacent drying cylinders 3 within each dryer assembly 2. In other words, the distance d between the drying cylinder 3 on the exit side of one dryer assembly 1 and the drying cylinder 3 on the entry side of a successive dryer assembly 2 is made larger compared to the other distances or pitch p between adjacent drying cylinders 3 within each drying section. In the embodiment, the distance d from center to center is 2700mm but may be in a range of 2700mm ± 100mm.

[0030] By making the distance d larger than the pitch p, a gap g is formed, which provides enough space for accommodating elements of the dryer assemblies 1, 2 therein. As is shown in Fig. 2, one suction box 13 and two lead rolls 5a, 5b are arranged in the gap g.

[0031] In the preferred embodiment, the lead roll 5b on the exit side of one dryer assembly 1 and the lead roll 5a on the entry side of the other, successive dryer assembly 2 are arranged in the gap. In other words, the centers of the lead rolls 5a, 5b are provided below a level at which the highest points of outer circumferences of the drying cylinders 3 are located. The suction box 13 as well as the lead roll 5a on the entry side are entirely located below this level while the highest point of the lead roll 5b on the exit side is about on the same level.

[0032] The bearing housings of the lead rolls 5a, 5b are supported at the horizontal beams 6 of the frames 10. In the preferred embodiment, the bearing housing of the lead rolls 5b provided on the exit sides of the dryer assemblies 1, 2 are directly attached at the horizontal beam 6. The lead rolls 5a on the entry sides of the dryer assemblies 1, 2 are indirectly attached at the horizontal beam 6 by means of a spacer 7 or the like in order to arrange the center of the lead roll 5a at a lower level than the center of the lead roll 5b.

[0033] The horizontal beam 6 is provided at a level at which the highest points of the outer circumferences of the drying cylinders 3 are located. Furthermore, the lead rolls 5a, 5b arranged in the gap g slightly overlap each other in machine direction so that the gap g can be kept as small as possible. Such an arrangement also reduces an air flow to the transfer point with the coming wire.

[0034] The lead roll 5d is the lead roll which is placed at the highest position. A height h at which a center of the highest placed lead roll 5d is placed mainly depends on the height at which the lead rolls 5a and 5c are arranged.

[0035] In detail, the turning angle by which the dryer wire is turned at the highest placed lead roll 5d is important for the running characteristics of the dryer wire 4. That is, amending the height h at which the highest lead roll 5d is placed is only possible in case the height of the adjacent lead rolls 5a or 5c is amended as well, so that the angle is kept substantially the same. Therefore, in the embodiment, in order to reduce the height h at which the highest lead roll 5d is placed as much as possible, the lead roll 5a on the entry side and the lead roll 5b on the exit side are placed inside the gap g.

[0036] Furthermore, the number of drying cylinders or length of the dryer assembly has also direct influence on the height at which the center of the highest placed lead roll 5d is arranged. In the present embodiment comprising six drying cylinders 3, the height of the highest placed lead roll 5d is in a range of 3900mm ± 200mm. In case the number of drying cylinders in the assemblies is lowered, the height h of the highest lead roll 5d can be lowered even more, for example about additional 300mm in case four drying cylinders are provided. As a comparative example, the height at which the center of the highest placed lead roll in the prior art is arranged is about 4700mm.

[0037] As is shown in Fig. 1, five of the six turning rolls 8 in each dryer assembly 1, 2 are successively arranged under the drying cylinders 3 at the same pitch p with which the drying cylinders 3 are arranged. Furthermore,

these five turning rolls are arranged on the same level. The turning axes of the five turning rolls are displaced with respect to the turning axes of the drying cylinders 3 by half of the pitch p. Also, the bearing housings of the five turning rolls described above are directly supported on the base plate 9 and the distance between each circumferential surface of the turning rolls 8 and adjacent drying cylinders 3 is constant. In the preferred embodiment, the distance is 15mm but anyhow less than 50mm.

[0038] One turning roll of the six turning rolls 8 of one dryer assembly 1, 2, which is the first turning roll of each dryer assembly 1, 2 in the machine direction, is indirectly supported on the base plate 9 at a higher level than the other five turning rolls described above by means of a spacer 14 in order to bring the turning roll 8 closer to the drying cylinders 3. The distance between the circumferential surface of this first turning roll and the circumferential surface of adjacent drying cylinders 3 may be the same distance as the distance between each circumferential surface of the turning rolls 8 and adjacent drying cylinders 3 of the five turning rolls described above or may be different thereto.

[0039] With the arrangement according to the invention, the height of the dryer assemblies 1, 2 is significantly reduced. This has the positive effect that less vibration occurs in the machine frames of the dryer section. Furthermore, the highest placed lead roll 5d can be supported closer to the horizontal frame 6 so that the lead roll 5d is arranged more stable. Moreover, the highest maintenance points of the drying section are easily reachable, for example by means of movable maintenance units.

[0040] The preceding description of the present invention is merely exemplary, and is not intended to limit its scope in any way. Various details of the present invention may vary within the scope of the invention as defined in the claims and may differ from the exemplary details described above in accordance with the knowledge of a person skilled in the art.

Claims

1. A drying section of a web forming machine comprising

at least two dryer assemblies (1, 2) arranged in successive order and having plural cylinders in which a pitch (p) between adjacent drying cylinders (3) is substantially constant and a dryer wire (4) which passes a web through the plural cylinders in an alternating manner,

wherein the distance (d) from center to center of adjacent drying cylinders (3) of two successive dryer assemblies (1, 2) is larger than the pitch (p) between adjacent drying cylinders (3) within each dryer assembly (1, 2) so as to form a gap (g) between the successive dryer assemblies (1, 2) which is larger than the pitch (p) between the drying cylinders (3) within each dryer assembly (1, 2).

2. A drying section according to claim 1, wherein each dryer assembly (1, 2) further comprises lead rolls (5a, 5b) for guiding said dryer wire (4) and wherein at least a lead roll (5a) on the entry side of the dryer assembly (1, 2), which serves for turning the dryer wire (4) towards a web transfer point (t), is arranged in the gap (g).

3. A drying section according to claim 2, wherein at least the lead roll (5a) on the entry side of the dryer assembly (1, 2) is arranged below a level at which the highest points of the outer circumferences of the drying cylinders (3) are located.

4. A drying section according to one of claims 2 or 3, wherein a lead roll (5b) on the exit side of each dryer assembly (1, 2) is arranged in the gap (g).

5. A drying section according to claim 4, wherein a center of the lead roll (5b) on the exit side of the dryer assembly (1, 2) is arranged below a level at which the highest points of the outer circumferences of the drying cylinders (3) are located.

6. A drying section according to one of claims 4 or 5, wherein the lead roll (5b) on the exit side of the dryer assembly (1, 2) is arranged at a higher level than the lead roll (5a) on the entry side of the dryer assembly (1, 2).

7. A drying section according to one of claims 2 to 6, further comprising an upper main frame (6) which is adapted to support bearing housings of the lead rolls (5a, 5b).

8. A drying section according to claim 7, wherein the bearing housing of at least one of the lead rolls (5a, 5b) is directly supported on the upper main frame (6).

9. A drying section according to claim 7 or 8, wherein the bearing housing of the lead roll (5a) on the entry side is supported on the upper main frame (6) via a spacer (7).

10. A drying section according to one of the preceding claims, wherein each dryer assembly (1, 2) further comprises turning rolls (8) which are supported by a base (9) of the drying section, wherein a distance between the drying cylinders (3) and the turning rolls (8) is equal to or smaller than 50mm.

11. A drying section according to claim 10, wherein the turning roll (8) of the dryer assembly (2) onto which the web is transferred from the adjacent dryer assembly (1) is supported at a higher level than the other turning rolls (8) in the same dryer assembly (2).

12. A drying section according to one of the preceding

claims, wherein the pitch (p) between two adjacent drying cylinders (3) in each dryer assembly (1, 2) is set to 2100mm ± 100mm.

13. A drying section according to one of the preceding claims, wherein the distance (d) from center to center of adjacent drying cylinders (3) of two successive dryer assemblies (1, 2) is set to 2700mm ± 100mm.

Amended claims in accordance with Rule 137(2) EPC.

1. A single tier drying section of a web forming machine comprising

at least two dryer assemblies (1, 2) arranged in successive order and having plural cylinders arranged in an upper row, in which a pitch (p) between adjacent drying cylinders (3) is constant and a dryer wire (4) which passes a web through the plural cylinders in an alternating manner,
characterized in that the distance (d) from center to center of adjacent drying cylinders (3) of two successive dryer assemblies (1, 2) is larger than the pitch (p) between adjacent drying cylinders (3) within each dryer assembly (1, 2) so as to form a gap (g) between the successive dryer assemblies (1, 2) which is larger than the pitch (p) between the drying cylinders (3) within each dryer assembly (1, 2).

2. A single tier drying section according to claim 1, wherein the single tier drying section further comprises lead rolls (5a, 5b) for guiding said dryer wire (4) and wherein at least a lead roll (5a) on the entry side of each dryer assembly (1, 2), which serves for turning the dryer wire (4) towards a web transfer point (t), is arranged in the gap (g).

3. A single tier drying section according to claim 2, wherein at least the lead roll (5a) on the entry side of each dryer assembly (1, 2) is arranged below a level at which the highest points of the outer circumferences of the drying cylinders (3) are located.

4. A single tier drying section according to one of claims 2 or 3, wherein a lead roll (5b) on the exit side of each dryer assembly (1, 2) is arranged in the gap (g).

5. A single tier drying section according to claim 4, wherein a center of the lead roll (5b) on the exit side of each dryer assembly (1, 2) is arranged below a level at which the highest points of the outer circumferences of the drying cylinders (3) are located.

6. A single tier drying section according to one of claims 4 or 5, wherein the lead roll (5b) on the exit side of each dryer assembly (1, 2) is arranged at a higher level than the lead roll (5a) on the entry side of each dryer assembly (1, 2).

7. A single tier drying section according to one of claims 2 to 6, further comprising an upper main frame (6) which is adapted to support bearing housings of the lead rolls (5a, 5b).

8. A single tier drying section according to claim 7, wherein the bearing housing of at least one of the lead rolls (5a, 5b) is directly supported on the upper main frame (6).

9. A single tier drying section according to claim 7 or 8, wherein the bearing housing of the lead roll (5a) on the entry side is supported on the upper main frame (6) via a spacer (7).

10. A single tier drying section according to one of the preceding claims, wherein each dryer assembly (1, 2) further comprises turning rolls (8) which are supported by a base (9) of the drying section, wherein a distance between the drying cylinders (3) and the turning rolls (8) is equal to or smaller than 50mm.

11. A single tier drying section according to claim 10, wherein the turning roll (8) of the dryer assembly (2) onto which the web is transferred from the adjacent dryer assembly (1) is supported at a higher level than the other turning rolls (8) in the same dryer assembly (2).

12. A single tier drying section according to one of the preceding claims, wherein the pitch (p) between two adjacent drying cylinders (3) in each dryer assembly (1, 2) is set to 2100mm ± 100mm.

13. A single tier drying section according to one of the preceding claims, wherein the distance (d) from center to center of adjacent drying cylinders (3) of two successive dryer assemblies (1, 2) is set to 2700mm ± 100mm.

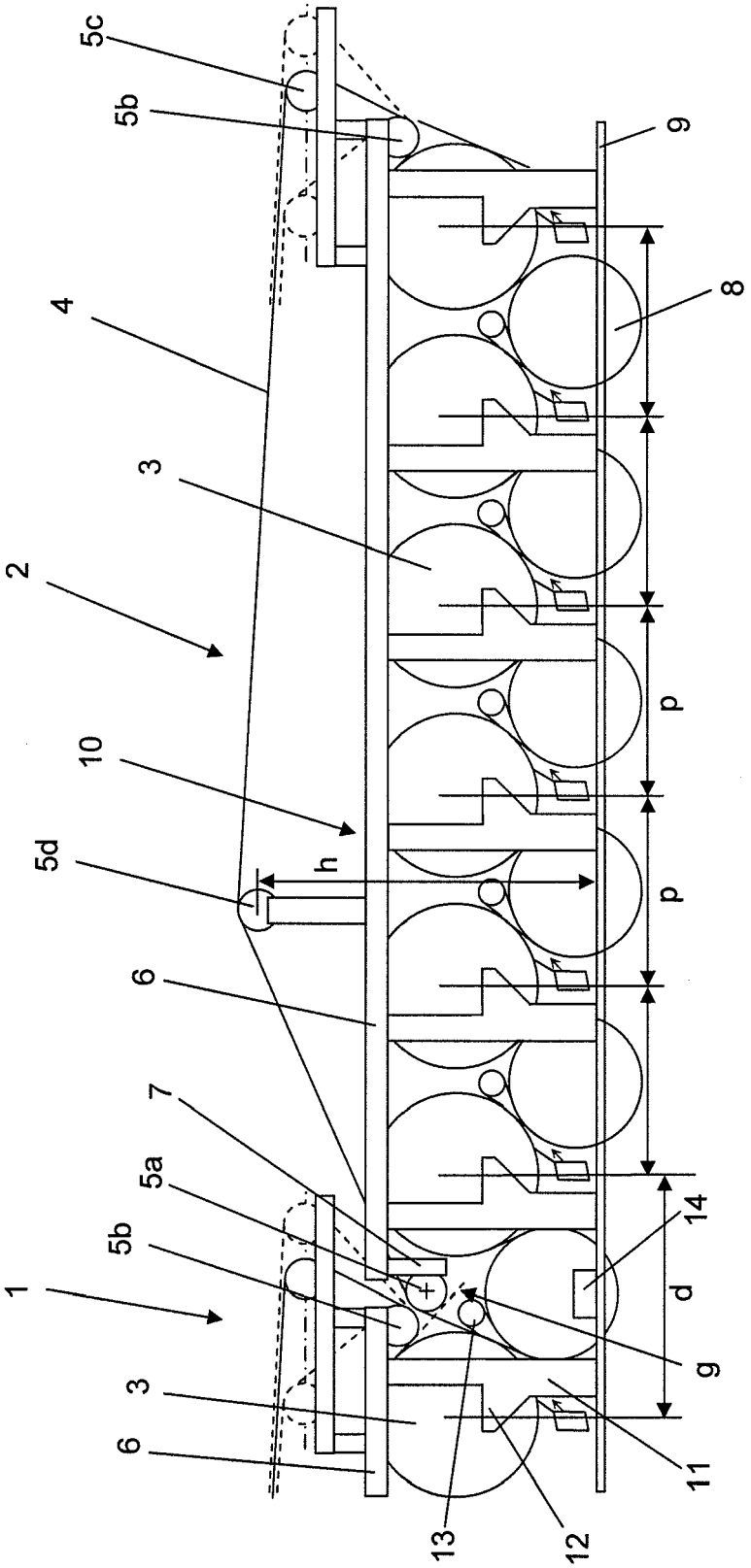

Fig. 1

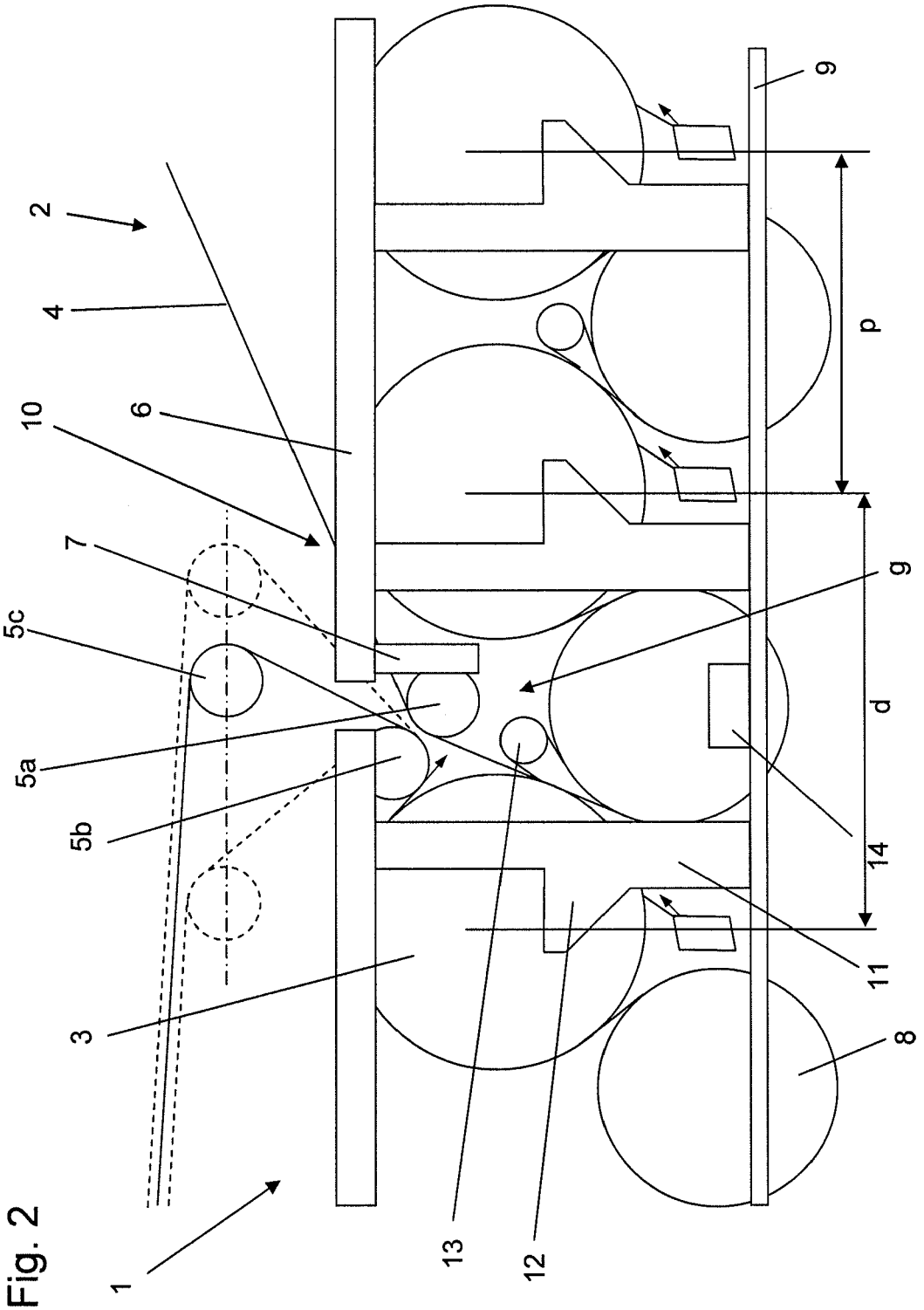

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 10 19 1653

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A	DE 196 01 812 A1 (VOITH SULZER PAPIERMASCH GMBH [DE]) 24 July 1997 (1997-07-24) * column 1, lines 37-46 * -----	1	TECHNICAL FIELDS SEARCHED (IPC) D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 January 2011	Maisonnier, Claire

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 10 19 1653

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