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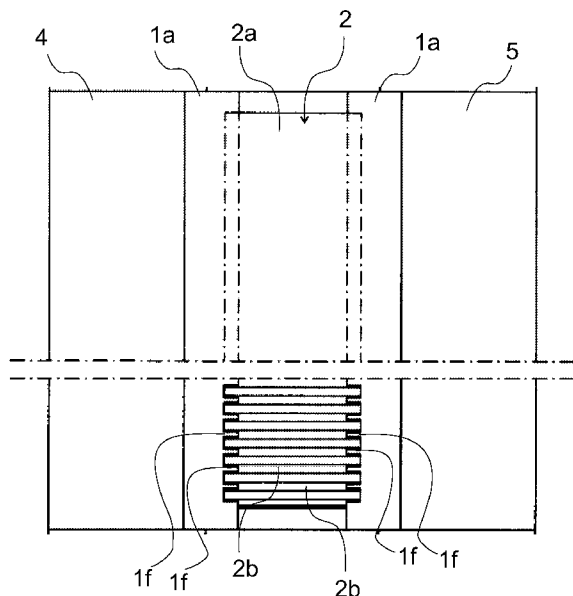


Fig. 12

(57) Abstract: An apparatus for removing liquid from a running wire or a web placed on a wire, the apparatus comprising at least: a roll (2) against which the wire is supported; a chamber (1), inside which said roll (2) is placed; a first gap (7a) which is placed between the roll (2) and a first beam (4); and a second gap (7b) which is placed between the roll (2) and a second beam (5); wherein said first and second gaps are configured to convey liquid removed from the wire (3) or the web into the chamber (1). The outer jacket (2a) of the roll (2) is equipped with a patterning with several grooves (2b) next to each other, and furthermore, the first or the second beam (4, 5) or both of them are equipped with a patterning with several ridges (1f) next to each other, each ridge being fitted in a groove in the outer jacket (2a). In an example, the first gap (7a) of the apparatus is configured larger than the second gap (7b). According to some examples, at least the width (7a) of the first gap (7a) is controllable in such a way that the roll (2) or the first beam (4) is transferable.

AN APPARATUS FOR REMOVING LIQUID FROM A MOVING WIRE OR WEB, AND A METHOD

Field of the invention

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The invention relates to an apparatus for removing liquid from a running wire or a web placed on a wire. The invention relates to a method for removing liquid from a running wire or a web placed on a wire.

10 Background of the invention

Conventionally, the operation of the wet end of a paper machine is based on the principle that paper pulp, which consists of liquid and the cellulose fibres required for paper manufacture and which is called a web, is fed onto an
15 endless rotating wire or between two wires. Water is removed from the web in several different steps by means of devices placed under the wire and including various suction boxes and suction rolls.

One suction box is presented in EP 0 639 667 A1. Said suction box comprises a roll rotating with the wire and having a jacket that is, for example, meshed. The roll is placed in the box under a negative pressure. Air flows through the wire and the jacket of the roll. A device for producing suction in the suction box is presented in WO 99/64667 A1. WO 95/07387 A1 discloses an apparatus used for controlling a felt and a web on it, applying a rotating
20 roll whose perforated jacket is permeable to air. Other rolls are also known which are provided with a perforated jacket and equipped with suction by means of a separate apparatus. One apparatus is disclosed in US 5,347,728.

A suction device according to WO 2006/090012 A1 is also known, which is
30 shown in Fig. 1 and which can be used to support a running wire in such a way that the frictions are low. More precisely, it is a suction roll. A rotating roll which is permeable to air and liquid is placed in an opening on top of the device. It is placed against the wire, and a negative pressure or suction is effective on the wire through the roll. The device is used to provide a sufficient suction effect and high-capacity dewatering, wherein it can also be
35 applied on wires with a high speed. The apparatus can be used particularly to

replace suction boxes of the state of art, and it is suitable for the removal of liquid as well as solids, for example dust, from a wire, a felt or various other fabrics which are used, for example, in a paper machine.

- 5 The device of Fig. 1 is also applicable for the removal of dust developed during the manufacturing process of various fabrics or the like, or for the removal of liquid, dust and solids accumulated during their cleaning. Consequently, the device can be used as a cleaning device or a dewatering device for removing liquid or solids from a running web or a fabric, for example from
10 a wire and a felt, which are sufficiently permeable to air or liquid.

- The operation of suction devices is critical, for efficient removal of liquid from the web. The capacity to achieve a high dry content is important, among other things, for keeping the amount of energy used for drying the web as low
15 as possible. Controlling the removal of liquid is critical in view of controlling the suction device. Furthermore, supporting the web and controlling it, avoiding friction forces, is critical for its durability.

Brief summary of the invention

- 20 The aim is to present a solution for eliminating the above-presented drawbacks in the state of art. By means of the presented solution, the removal of liquid from the wire and the web becomes more effective. By means of the presented solution, the construction of the suction device, particularly the
25 suction roll, is optimized in such a way that the quantity of liquid being removed is controlled at different points in the structure of the suction roll. By means of the presented solution, the wire can be supported particularly at gaps in the suction roll, and the running wire remains straighter than in the state of art. By means of the presented solution, it is possible to actively control the size of those gaps in the suction roll, through which liquid is removed
30 from the wire and transferred to the suction roll.

- The apparatus according to the invention is presented in claim 1. The method according to the invention is presented in claim 11.

The apparatus according to the solution comprises at least a roll which is configured to rotate around its rotating axis and which comprises an outer jacket and a chamber, inside which said roll is placed and which comprises an opening that exposes at least part of the outer jacket of the roll in such a way that the wire can be supported to the outer jacket. Furthermore, the apparatus comprises a first beam placed at the front edge of the opening, and a first gap placed between the roll and the first beam, wherein liquid is conveyed through the first gap into the chamber. Furthermore, the apparatus comprises a second beam placed at the rear edge of the opening, and a second gap placed between the roll and the second beam, wherein liquid is conveyed through the second gap into the chamber.

A feature in a particular example of the solution is that the outer jacket of the roll is equipped with a patterning of several grooves next to each other, each groove being placed in a plane transverse to the rotating axis of the roll. Furthermore, the first or the second beam or both of them are equipped with a patterning of several ridges next to each other, each ridge being fitted in a groove in the outer jacket. The grooves are used for controlling the path of liquid, and the ridges prevent the wire from sinking between the roll and the beam.

In an example, the apparatus further comprises at least one insert which is placed on the roll and in a groove in the outer jacket, as well as between the first and second beams. Said insert is configured to close one or more grooves in the outer jacket.

A feature in a particular example of the solution is that the gaps on opposite sides of the opening of the suction roll, through which gaps liquid is conveyed into the suction device, are configured different in size. Thus, liquid can be removed more effectively at that point where the wire and the web first enter the roll and where, for example, the web contains a lot of liquid.

A principle of a particular example of the solution is that the gap which is larger in size, for example wider, is provided on that side of the opening of the suction roll where the running wire enters first; that is, on the incoming side of the wire. On the second, opposite side of the opening of the suction

roll, the gap is smaller. The reason for making each gap larger or smaller is, for example, the fact that there is more liquid to be removed on the incoming side of the wire, wherein the gap is made larger, or the quantity of air sucked with liquid is to be limited on the exit side of the wire, wherein the gap is made smaller. Optimized sizes and deviating dimensions of the gaps are used for controlling the process of removing liquid from the web. The size of the gaps is also used for controlling the way in which the suction is effective in different points of the suction roll and the wire.

According to an example of the solution, one gap is configured larger in such a way that the roll of the apparatus is placed eccentrically in relation to the opening of the apparatus comprising the roll. According to another example of the solution, the roll is placed centrally in relation to the opening, but one gap is configured such in shape and dimensions that it is more permeable to liquid than the other gap. If a substantially identical pressure difference is effective over both of the gaps, the highest liquid flow is achieved, for example, through the gap having the largest so-called cross-sectional area. According to an example, the determining factor is the width of the gap; in other words, the distance between the roll and the structure of the chamber at said gap. In an example, it is the distance between the beam at the edge of the opening of the apparatus, and the roll.

According to some examples of the solution, the roll may be impermeable to liquid. In an example, the roll which is impermeable to liquid is provided with e.g. grooves which enhance the flow of liquid and the effect of suction.

In an example, the opening of the apparatus is bordered by a beam which is in an angular position in relation to the running wire. In addition, the beam comprises a planar upper surface, to which the wire is supported. Thanks to the inclined position, the beam can be provided with a short upper surface, whereby the friction is lower, and at the same time, the structure of the top part of the apparatus can be made compact and simple.

In a particular example, the beam has a shape that faces the roll and whose design is used to influence the size and the shape of the gap.

According to a particular example, the width of at least the first gap can be controlled in such a way that the roll or the first beam can be transferred in the direction of the wire. According to another particular example, the width of at least the first gap can be controlled in such a way that the roll or the first beam can be transferred in a direction substantially transverse or crosswise in relation to the wire.

With the presented solution, it is possible to control the moisture profile of the web, *i.e.* the distribution of moisture in different parts of the web, in a way better than before.

The control of the moisture profile is improved particularly when several suction devices are placed one after the other in the direction of movement of the wire, and they operate by slightly different principles. In an example, at least three devices are used for removing liquid.

A system as presented above, comprising three devices, removes liquid particularly efficiently by the first device, and the third device finally takes care of achieving the desired dry content. The second device removes liquid, too, but is used as an intermediate stage, and by adjusting the properties of these three devices, the desired final result is obtained, for example in view of the web moisture profile. By means of the system it is also possible to influence other properties and the quality of the web.

Brief description of the drawings

In the following, the invention will be described by means of an example and with reference to the appended drawings, in which:

Fig. 1 illustrates the principle of a suction device according to prior art, the suction device comprising a rotating roll against a running fabric,

Fig. 2 shows the structure of the suction device of Fig. 1 in a cross section,

- Fig. 3 shows a suction device in which the invention is applied and whose structure is shown in a cross section, and
- Fig. 4 shows a detail of the suction device of Fig. 3 in a cross section,
- 5 Fig. 5 shows an example of the principle, according to which the invention is applied in the suction device of Fig. 3,
- Fig. 6 shows a second example of the principle, according to which the invention is applied in the suction device of Fig. 3,
- 10 Fig. 7 shows a third example of the principle, according to which the invention is applied in the suction device of Fig. 3,
- 15 Fig. 8 shows an example of the principle, according to which the invention is applied in the suction device of Fig. 2, and
- Fig. 9 shows an example of the principle relating to a system in which the invention is applied for removing liquid from a paper web,
- 20 Fig. 10 shows a suction device in which the invention is applied and whose structure is shown in a cross section, and
- Fig. 11 shows a detail of the suction device of Fig. 10 in a cross section,
- 25 Fig. 12 shows the suction device of Fig. 10 in a top view,
- Fig. 13 shows another example of the principle, according to which the invention is applied in the suction device of Fig. 10,
- 30 Fig. 14 shows an example of the principle, according to which the invention is applied in the suction device of Fig. 2.

More detailed description of the invention

We shall now look at a suction device in which the presented new solution can be applied. As shown in Figs. 1 and 2, the suction device for removing
5 liquid comprises a chamber 1 which comprises a box-like sealed structure used as a basin, inside which a rotating roll 2 is placed. The upper surface 1a of the chamber, on and against which surface a wire 3 is placed, is substantially flat and typically planar, and preferably horizontal. The two upper surfaces 1a are preferably parallel, but they may also form a very gently sloping
10 angle, the roll 2 being placed in its angular point. The chamber 1 is elongated and extends preferably underneath the wire 3, substantially across its entire length. The chamber 1 is placed crosswise, primarily perpendicularly to the travel direction of the wire 3, in the same way as the opening 1b between the upper surfaces 1a of the chamber 1. The opening 1b is uniform and continuous
15 and extends over the full width of the wire 3. The chamber 1 is closed, for example, with end parts 1c.

A roll 2 that is rotatable with the wire 3 is placed inside the chamber 1. An opening 1b exposes at least part of the outer jacket 2a of the roll 2 so that the
20 running wire that touches the chamber 1 can be supported to the outer jacket 2a. Preferably, the roll 2 extends slightly higher than the upper surface 1a and causes a gently sloping ridge in the wire 3, when the wire and the web are placed or aspirated against the outer jacket 2a. The roll 2 and the upper surfaces 1a form a surface, against which the wire 3 is pressed by the effect
25 of the suction. That part of the outer jacket 2a, which is exposed by the opening 1b, covers a sector-like part limited by beams 4 and 5 at the front and rear edges of the opening 1b, which beams are part of the structure of the chamber 1. The exposed sector-like part encompasses, for example, a sixth part or a smaller part of the outer jacket 2a shown in Fig. 1. In the pre-
30 sented embodiment, said beams 4 and 5 simultaneously constitute the upper surfaces 1a of the chamber 1 and are placed close to the roll 2.

The wire 3 travels along the upper surface 1a, and the negative pressure effective on the wire 3 draws liquid out of the wire 3 and into the chamber 1.
35 The roll 2 is perforated, and the suction prevailing inside it pulls the wire 3 against the outer jacket 2a of the roll and draws the liquid to the inside of the

roll 2 and into the chamber 1. The roll 2 is arranged to rotate around a rotation axis X, and the rotation axis X is parallel to the longitudinal axis of the roll 2 and also to the opening 1b. The width of the opening 1b is typically a fraction of the length of the roll 2 and the opening 1b. The longitudinal axis is parallel to the chamber 1 and transverse to the travel direction of the wire 3. The roll 2 rotates by means of friction or is rotated by a motor at a speed that corresponds to the speed of the wire 3.

The roll 2 comprises a shaft structure 6, for example a solid shaft, appropriately mounted with bearings at its ends. In the presented embodiment, the ends of the shaft protrude from both ends of the chamber 1, wherein the bearings can be easily arranged outside the chamber 1. The gap between the end of the chamber 1 and the shaft is sealed with appropriate gaskets. At least one end of the shaft may be connected to a separate rotating device, typically an electric motor, for rotating the roll 2 via the shaft.

The roll 2 is cylindrical and comprises an outer jacket 2a with a circular cross-section. The outer jacket 2a can be made of a sheet or, for example, a rigid wire-cloth that is permeable to liquid and air. In a way known as such, the outer jacket 2a may be perforated or equipped with holes or openings, through which the suction is effective on the running wire 3. Through the outer jacket 2a, the liquid or air flow can enter the inside of the roll 2. The air flow effected by the suction and passing through the wire 3 and the web carries liquid, dust and possibly other solids that can penetrate the wire 3 and the outer jacket 2a.

The chamber 1 is connected to a separate suction system to provide a suction which is effective inside the chamber 1 and, via the opening 1b, also on the wire 3. In this example, liquid is also removed through said connection 9, when the connection 9 is placed in the lower part of the chamber. The connection 9 may also be directed crosswise in relation to the rotation axis X, as in Fig. 2, or it may also be directed parallel to the rotation axis X and be placed at the end of the chamber 1. The pressure difference causes a flow of the liquid from the web through the outer jacket 2a and simultaneously through the wire 3 into the chamber 1.

Figure 3 shows a second example of a suction device removing liquid and comprising a roll 2 rotating in the chamber 1. In Fig. 3 and also in Figs. 4 to 8, the same reference numerals refer to those parts which functionally correspond to the parts of the apparatus of Fig. 2 and in which the principles of operation described above in connection with Fig. 2 can be applied.

In the example of Fig. 3, the opening 1b is bordered by beams 4 and 5 which are part of the structure of the chamber 1 but, deviating from the example of Fig. 2, each beam comprises an inclined lateral surface 1d (see Fig. 4) which forms a sharp angle A in relation to the planar running wire 3, and the upper surface 1a. According to Fig. 4, said angle is about 20 to 40°, preferably about 30°. The planar upper surface 1a, in turn, is parallel with the wire 3. The beams 4 and 5, as well as their upper surface 1a, extend over the whole length of the roll 2. The upper surface 1a is provided by working the beam, and the beam is placed in an inclined position and connected to the other structures of the chamber 1. The upper surface 1a is formed by removing one edge and a related triangular part of the beam material from the beam blank. Preferably, the beam blank has, for example, a rectangular shape and e.g. an even thickness before the working. A tip is formed in the beam, the tip comprising one edge of the beam blank. Said edge is placed next to the roll 2. The gap 7a, 7b between the beam and the roll 2 is adjusted to a suitable width, and the quantity of liquid passing through the gap can be controlled by the width of said gap. Preferably, the gap has an equal width at every point of the beam in the longitudinal direction of the roll or the beam, which is parallel to the rotation axis X. In the same way as Fig. 3, Figs. 4 to 8 also represent the cross section of the suction device transverse to the rotation axis X.

Thanks to the presented structure, the width of the upper surface 1a of the beam can be reduced, in order to reduce friction between the wire 3 and the upper surface 1a. At the same time, the inclined beam forms a cover that joins the chamber 1, so that a simple structure is obtained. In addition, a gap is formed between the lower surface 1e of the beam and the circular roll 2, through which gap the liquid can pass and which gap forms an elongated widening channel.

Figure 5 shows a solution in which the left gap 7a is configured larger than the right gap 7b (in other words, the right gap 7b is configured smaller than the left gap 7a). In this way, the left gap 7a is configured larger than the right gap 7b in view of the permeability to liquid. This is necessary, because the proportion of liquid in the web is higher on the incoming side of the wire (beam 4) than on the exit side of the wire (beam 5), due to the efficient function of the suction roll. The apparatus removes liquid from the web, when the wire 3 is at the opening 1b. Because the direction of rotation of the roll 2 is, at the opening 1b, towards the gap 7b, the natural flow of the liquid is also towards the gap 7b. Making the left gap 7a larger also enhances the guidance of the liquid into the left gap 7a, when suction is effective in the chamber 1 and, via the gaps 7a, 7b, also on the wire 3 and the web.

In the presented example, the outer jacket 2a of the roll can be closed, *i.e.* impermeable to air and liquid, for example smooth and without patterning, wherein liquid is only removed through the gaps 7a and 7b. Thus, more liquid is removed through the left gap 7a which is at that edge of the opening 1b where the wire 3 and the web come first. In an example, the outer jacket 2a of the roll is closed, but the outer jacket 2a is provided with a patterning, such as grooves, flutes or furrows. The patterning is configured in such a way that the suction prevailing in the chamber 1 is effective on the wire 3, via the patterning, also in the centre of the opening 1b, and liquid can be conveyed by the patterning to the gap and into the chamber 1.

In another example, the outer jacket 2a of the roll can be permeable to liquid and air. Thus, the roll 2 is, for example, perforated or equipped with slots or holes, through which the suction is effective on the running wire and the web also when they are in the centre of the opening 1b. Thus, liquid is removed through the outer jacket 2a of the roll into the chamber 1. Also in this example, the larger size of the left gap 7a can be used to enhance the removal of liquid on the incoming side of the wire 3, if necessary.

The size of the gap 7a depends on the permeability of the outer jacket 2a to liquid, on the efficiency of the suction, as well as on the speed of the wire 3. The suitable width of the left gap 7a, and the suitable width of the right gap 7b, can be determined, for example, by test arrangements and by trying dif-

ferent alternatives and by monitoring the web moisture profile or the quantity of water being removed.

5 Figures 5 to 8 show various alternative solutions for influencing the width and also the shape of the left gap 7a. At the same time, the quantity of the liquid being removed through said gap is influenced.

10 According to Fig. 5, the beams 4 and 5 are similar in structure and are symmetrically placed with respect to the opening 1b, but the beam 4 has been transferred away from the roll 2 in the direction of the wire 3 (or the beam 5 has been transferred closer to the roll 2 in the direction of the wire 3), to increase the width of the left gap 7a with respect to the right gap 7b. Consequently, the beam 4 is farther from the roll 2 than the beam 5. The centre of the opening 1b between the beams 4 and 5 is no longer placed on the line
15 transverse to the wire 3 and extending through the central line of the roll 2. Consequently, the roll 2 is placed eccentrically with respect to the opening 1b and its centre.

20 As shown in Fig. 6, the beams 4 and 5 are equidistant from the roll 2, but the tip of the beam 4 placed closer to the roll 2 has been shaped both by making the tip shorter and by increasing the gap 7a by removing material from at least part of the lower surface 1e of the beam. Consequently, the beam 4 is provided with a surface 8 facing the roll 2 and forming one side wall of the gap 7a. The shape of the surface 8 can be used to influence the flow of the
25 liquid. In this solution, too, the roll 2 is thus placed eccentrically with respect to the opening 1b and its centre.

According to Fig. 7, the beams 4 and 5 are equidistant from the roll 2 but the lower surface 1e of the beam 4 has been shaped in such a way that material
30 has been removed from at least part of the lower surface 1e of the beam, and simultaneously the gap 7a between the roll 2 and the beam 4 becomes larger. Consequently, the beam 4 is provided with a surface 9 facing the roll 2 and forming one side wall of the gap 7a. The shape of the surface 9 can be used to influence the flow of the liquid. In this solution, the roll 2 is thus
35 placed centrally with respect to the opening 1b and its centre, because the tip

of the beam 4 has not been made shorter, but it is thinner than the tip of the beam 5.

Figure 8 shows an example, in which the beams 4 and 5 are similar in structure but the beam 4 has been transferred away from the roll 2 in the direction of the wire (or the beam 5 has been transferred closer to the roll 2 in the direction of the wire), whereby the width of the left gap 7a is increased with respect to the right gap 7b. Consequently, the beam 4 is farther from the roll 2 than the beam 5. The centre of the opening 1b between the beams 4 and 5 is no longer placed on the line transverse to the wire 3 and extending through the central line of the roll 2. Consequently, the roll 2 is placed eccentrically with respect to the opening 1b and its centre. The shape of the beams 4 and 5 corresponds to the example shown in Fig. 2, in which the whole upper surface of the beam is substantially horizontal. With respect to the beam 4 of Fig. 2, it is also possible to apply the principles presented in Figs. 6 and 7. The dimensions of the gap between the beam 4 and the roll 2 are influenced by working the beam 4 and providing it with a suitably shaped surface which acts as a side wall of the gap.

Figure 10 shows a third example of a suction device removing liquid and comprising a roll 2 rotating in the chamber 1. In Fig. 10 and also in Figs. 11 to 14, the same reference numerals refer to those parts which functionally correspond to the parts of the apparatus of Fig. 2 or the apparatuses of Figs. 3 to 8, and in which the principles of operation described above in connection with said figures can be applied. For example, the apparatus of Fig. 10 applies the structure of the beams of Fig. 3.

In Figs. 10 to 14, the outer jacket 2a of the roll is closed, but the outer jacket 2a is provided with a patterning, such as grooves 2b or corresponding flutes or furrows. The suction prevailing in the chamber 1 is effective on the wire 3 by means of the patterning, and liquid can be conveyed by the patterning to the gap 7a, 7b and into the chamber 1.

The grooves 2b are next to each other, and they are provided in the outer jacket 2a, for example, at regular intervals. A ridge is formed between two grooves 2b, so that the outer jacket 2a is provided with ridges next to each

other. In an example, no grooves 2b are provided at the ends of the roll 2. In another example, the width of the grooves 2b and/or their spacing varies in the direction of the rotation axis X of the roll 2. Grooves 2b are provided over the whole length of the roll 2, or over almost its whole length.

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Each groove 2b has a cross section of, for example, a U shape. Preferably, the groove 2b has a straight bottom lined by two parallel and vertical walls. The groove 2b is endless, because it extends around the roll 2. The groove 2b and simultaneously the ridge between two grooves are placed in a plane transverse to the rotation axis X of the roll 2, whereby the groove 2b remains in place during rotation of the roll 2.

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A tip, edge or side of the beam 4, 5, placed next to the roll 2, is also equipped with a patterning that corresponds to the patterning of the outer jacket 2a in such a way that the patternings of the outer jacket 2a and the beam are interlaced. The beam is provided with e.g. grooves or corresponding flutes or furrows, and ridges 1f formed between these. The ridges 1f of each beam are placed in the grooves 2b of the roll 2. Each ridge 1f has a cross section of e.g. a U shape, and in the case of several ridges 1f it is possible to refer to a so-called comb-like or tooth-like shape. The ridge 1f is dimensioned so that a gap 7a, 7b with a desired width is left between the groove 2b and the ridge 1f, and simultaneously between the roll 2 and the beam 4, 5.

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Preferably, the ridges are provided directly in the beam 4 and 5, as shown in Figs. 10 to 14. According to another example, corresponding ridges are formed in a separate part attached to the beam. Said part is placed between the roll and the beam.

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In the examples of Figs. 10 to 14, the formed gap 7a, 7b is twisty, or alternatively, the gap is discontinuous in the longitudinal direction of the roll 2, if the parts of the gap 7a, 7b outside the bottom of the grooves 2b are disregarded. In these parts placed elsewhere, the width of the gap is, in an example, configured so narrow that the quantity of liquid exiting through these parts is relatively lower than at the bottom of the groove 2b. Therefore, particularly the gap 7a, 7b between the bottom of the groove 2b and the ridge 1f is set suitable and is used for controlling the liquid exiting through the gap 7a, 7b.

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Preferably, the upper surface of the ridges 1f forms an extension to the upper surfaces 1a of the beams 4, 5. The ridges 1f support that part of the wire 3 which is between the roll 2 and the beams 4, 5. As an advantage, the bending of the wire 3 and its entry in the gap between the beam and the roll 2 is prevented.

The shape of the ridges 1f can be influenced by applying the principles presented above in connection with the Figs. 6 to 8. For example, in the example of Fig. 11, the shape and the patterning of the ridge 1f extend all the way to the lower surface 1e of the beam. The bottom of the grooves of the beam, between the ridges 1f, can have a straight, curved or zigzag shape. In the example of Fig. 14, the principles of Fig. 8 are applied in view of the structures of the beams. In the example of Fig. 14, the shape and the patterning of the ridge 1f extend at least to that suitably shaped surface of the beam which acts as a side wall of the gap and, if necessary, all the way to the lower surface of the beam.

In the examples of Figs. 10 to 13, it is also possible to apply the principles of Figs. 6 to 7 in view of the structures of the beams, and in these examples, the shape and the patterning of the ridge 1f extend at least to the surface 8 and 9 formed in the beam and, if necessary, all the way to the lower surface 1e of the beam. Following, for example, the example of Fig. 6, the size, e.g. the height, of the ridges 1f of the beam 4 may differ from that of the ridges 1f of the beam 5.

In an embodiment of the apparatus, only one of the beams 4, 5 comprises ridges 1f which are placed in the grooves 2b of the roll 2. Thus, said beam follows the principles of one of the Figs. 10 to 14. In a corresponding manner, the other beam follows the principles of one of the Figs. 2 to 8.

In an embodiment of the apparatus, it is also possible that one or more adjacent grooves 2b of the roll 2 can be closed with an insert 13. As shown in Fig. 13, the insert 13 is placed between the beams 4 and 5 on top of the roll 2, where the insert 13 remains in position and is placed in the groove 2b. Two inserts 13 can be placed at the ends of the roll 2, wherein the same roll

can be used with different wires 3 of different widths, or the insert is used for closing those grooves of the roll 2 which are placed outside the wire 3.

5 The thickness of the insert 13, or the patterning of that surface of the insert which is placed against the roll 2, is configured to match the patterning of the outer jacket 2a in such a way that the insert 13 and the patterning of the outer jacket 2a are interlaced. The insert 13 is provided with e.g. grooves or corresponding flutes or furrows, and at least one ridge 1f is formed between these. The ridge 13a is placed in the groove 2b of the roll 2. The ridge has, 10 for example, a U shape. The ridge is dimensioned so that a gap with a desired width is left between the groove 2b and the ridge.

In the example of Fig. 13, an insert is provided, whose thickness corresponds to the width of the groove 2b and which fills one groove 2b. The length of the 15 insert 13 substantially corresponds to the distance between the beams 4 and 5; that is, the width of the opening 1b. The insert 13 is made of, for example, low-friction plastic.

20 According to an example, the insert 13 has such a height that it does not rise above the upper surface 1a but is substantially flush with it. Such a dimensioning can be implemented in an insert 13 which is placed totally under the wire 3, or in at least that part of the insert 13 which is placed under the wire 3. That part of the insert 13 which is placed next to the wire may, if necessary, rise above the wire 3 and the upper surface 1a. Preferably, the shape of 25 the lower surface 13b of the insert corresponds to the shape of the roll 2, particularly the grooves 2b.

30 According to an example, the shape of the upper surface of the insert 13 corresponds partly to the shape of the outer jacket 2a. This is true particularly in the location where the roll 2 and the wire 3 are placed against each other and a gently sloping ridge is formed. In the example of Fig. 13, the insert 13 may have a curved central part and may rise higher than the ends of the insert 13 or the upper surface 1a.

In some embodiments of the apparatus, it is possible to control the width of the gaps so that said width can be actively changed e.g. during the use. Changing the width affects the quantity of liquid being removed.

5 With reference to Figs. 5 to 8, the eccentricity of the roll 2 or the width of the gaps 7a, 7b is controlled in such a way that the roll 2 is transferrable in the direction of the wire; in other words, both towards the beam 4 (and simultaneously away from the beam 5) and away from the beam 4 (and simultaneously towards the beam 5). The apparatus comprises the necessary transfer
10 members which, according to an alternative, transfer the shaft structure 6 and also its bearings, if necessary. The roll 2 moves with the shaft structure. These principles can also be applied in the examples of Figs. 10 to 14.

According to another example, at least one of the beams 4, 5 can be transferred in the direction of the wire, that is, both towards the roll 2 and away
15 from the roll 2. Preferably, at least the beam 4 at the front edge can be transferred. In the alternative, in which only the beam 4 is transferrable, the beam 4 is movable, on one hand, towards the roll 2 and the beam 5, and on the other hand, away from the roll 2 and the beam 5. In the alternative in
20 which both of the beams 4, 5 are transferrable together, the beam 5 moves away from the roll 2 when the beam 4 moves towards the roll 2, and the beam 5 moves towards the roll 2 when the beam 4 moves away from the roll 2. The apparatus comprises the necessary transfer members for moving at
25 least one of the beams 4, 5 in relation to the roll 2 and preferably also in relation to the chamber 1. The transfer members comprise, for example, various guides, glides, controllers, or actuators, which operate e.g. electrically, pneumatically or hydraulically.

With reference to the Figs. 10 to 14, the width of the gaps 7a, 7b is controlled, according to an alternative solution, in such a way that the roll 2 can
30 be transferred substantially transversely or crosswise in relation to the wire; in other words, both towards the wire 3 and away from the wire 3. Preferably, the movement is vertical, when the wire is horizontal, and the outer jacket 2a remains placed against the wire 3. According to another example, both of the
35 beams 4, 5 are transferrable substantially transversely or crosswise in relation to the wire 3. Thus, the width of the gaps 7a, 7b changes, when the

beams 4, 5 move in relation to the roll 2 and its outer jacket 2a. Preferably, the width of the opening 1b remains unchanged. These principles can also be applied in the examples of Figs. 5 to 8.

- 5 As mentioned above, the apparatus comprises the necessary transfer members which, according to an alternative, transfer the shaft structure 6 and also its bearings, if necessary. The roll 2 moves with the shaft structure. According to another example, the transfer members move at least the beams 4, 5 in relation to the roll 2 and preferably also in relation to the chamber 1.

10

The apparatus according to the presented solution can be used particularly to replace suction boxes of the state of art, and it is suitable for the removal of liquid as well as solids, for example dust, from a wire, a felt or various other fabrics which are used, for example, in a paper machine. Consequently, the

15 apparatus according to the presented solution can be used as a cleaning device or a dewatering device for removing liquid or solids from a running web or a fabric, for example a wire and a felt, which are sufficiently permeable to air or liquid.

- 20 Figure 9 shows a system in which the presented solution can be applied. The system comprises at least three apparatuses for removing liquid, wherein the first apparatus 10 is a conventional suction roll whose roll 2 is permeable to liquid and in which the holes can be of equal size. It is, for example, the apparatus shown in Fig. 2, but it is also possible to apply the apparatus
- 25 shown in Fig. 3, in which the holes have identical dimensions. Liquid is removed both through the roll 2 and through the gaps, which is illustrated by arrows drawn in the figure. The second apparatus 11 is in accordance with the above presented solution in such a way that the roll 2 is impermeable to liquid, but the roll surface is equipped with a patterning, such as a grooving,
- 30 which enhances the effect of the suction and the flow of the liquid, and furthermore, the gaps are different in size. Liquid is removed through the gaps, particularly through the gap on the incoming side of the wire, which is larger than the opposite gap. The third apparatus 12 is in accordance with the above presented solution in such a way that the roll 2 is impermeable to liquid. The roll 2 of the apparatus 12 is smooth, without patterning, and further-
- 35 more, the gaps are different in size. Liquid is removed through the gaps, par-

ticularly through the gap on the incoming side of the wire, which is larger than the opposite gap. The distances of the apparatuses from each other may vary.

- 5 With reference to Fig. 9, with respect to the apparatuses 11 and 12, it is possible to apply the apparatus of Fig. 2, in which the gaps are configured different in size and the roll is configured closed. With respect to the apparatus 10, it is possible to apply the apparatus of Fig. 3, in which the roll is configured permeable to air and liquid. The gaps of the apparatus 10 may be equal in
- 10 size, but it is also allowable to configure them different in size, if this is necessary for controlling the web and the removal of liquid. The system according to Fig. 9 is applied particularly in a paper machine having a web carried on a wire 3, particularly a paper web from which liquid is removed.
- 15 The invention is not limited solely to the above examples, but the above presented structures and principles can be applied in various combinations depending on the way in which the formed gaps are to be controlled, what shape they are to have, and how the beams are to be manufactured.

Claims

1. An apparatus for removing liquid from a running wire or a web placed on a wire, the apparatus comprising at least:

- 5 - a roll (2) which can be placed crosswise with respect to the running wire (3), is configured to rotate around a rotating axis (X), and comprises an outer jacket (2a);
- 10 - a chamber (1), inside which said roll (2) is placed and which comprises an opening (1b) in the direction of said rotating axis (X), the opening exposing a part of the outer jacket (2a) of the roll in such a way that the running wire (3), tangential to the chamber (1), can be supported against the outer jacket (2a);
- 15 - a first beam (4) placed at the front edge of the opening (1b) and comprising an upper surface (1a) which is configured to be substantially flat and to support the running wire (3);
- 20 - a first gap (7a) placed between the roll (2) and the first beam (4), wherein said first gap is configured to convey the liquid removed from the wire (3) or the web into the chamber (1);
- a second beam (5) placed at the rear edge of the opening (1b) and comprising an upper surface (1a) which is configured to be substantially flat and to support the running wire (3); and
- a second gap (7b) placed between the roll (2) and the second beam (5), wherein said second gap is also configured to convey the liquid removed from the wire (3) or the web into the chamber (1);
- 25 **characterized** in that:
- the outer jacket (2a) of the roll (2) is equipped with a patterning with several grooves (2b) next to each other, each groove being placed in a plane transverse to said rotating axis (X); and
- 30 - the first or the second beam (4, 5) or both of them are equipped with a patterning of several ridges (1f) next to each other, each ridge being fitted in a groove in the outer jacket (2a).

2. The apparatus according to claim 1, **characterized** in that the apparatus further comprises at least one insert (13) placed in a groove (2b) on the roll (2) and between the first and second beams (4, 5), wherein said insert (13) is configured to close one or more grooves (2b).

35

3. The apparatus according to claim 1 or 2, **characterized** in that the first gap (7a) is configured to be larger than the second gap (7b), so that the quantity of liquid passed through the first gap (7a) would be greater than the quantity of liquid passed through the second gap (7b), when a suction is effective in the chamber (1), the suction removing liquid from the wire and the web.

4. The apparatus according to any of the claims 1 to 3, **characterized** in that the roll (2) is placed eccentrically in the opening (1b).

5. The apparatus according to claim 4, **characterized** in that the first beam (4) comprises a shaped surface (8, 9) which is placed at the first gap (7a) and faces the roll (2).

6. The apparatus according to claim 4 or 5, **characterized** in that the upper surface (1a) of the first beam (4) forms a sharp angle (A) to the running wire (3), and said upper surface (1a) is placed between the opening (1b) and the inclined upper surface (1d), and furthermore, the first beam (4) comprises a tapering tip, on whose opposite sides the upper surface (1a) and the first gap (7a) are placed.

7. The apparatus according to claim 6, **characterized** in that the second beam (5) further comprises an inclined upper surface that forms a sharp angle to the running wire (3), and said upper surface (1a) is placed between the opening (1b) and the inclined upper surface, and furthermore, the second beam (5) comprises a tapering tip, on whose opposite sides the upper surface (1a) and the second gap (7b) are placed.

8. The apparatus according to any of the claims 1 to 7, **characterized** in that the roll (2) is impermeable to liquid.

9. The apparatus according to any of the claims 1 to 8, **characterized** in that at least the width of the first gap (7a) is controllable in such a way that the roll (2) or the first beam (4) is transferrable in the direction of the wire (3).

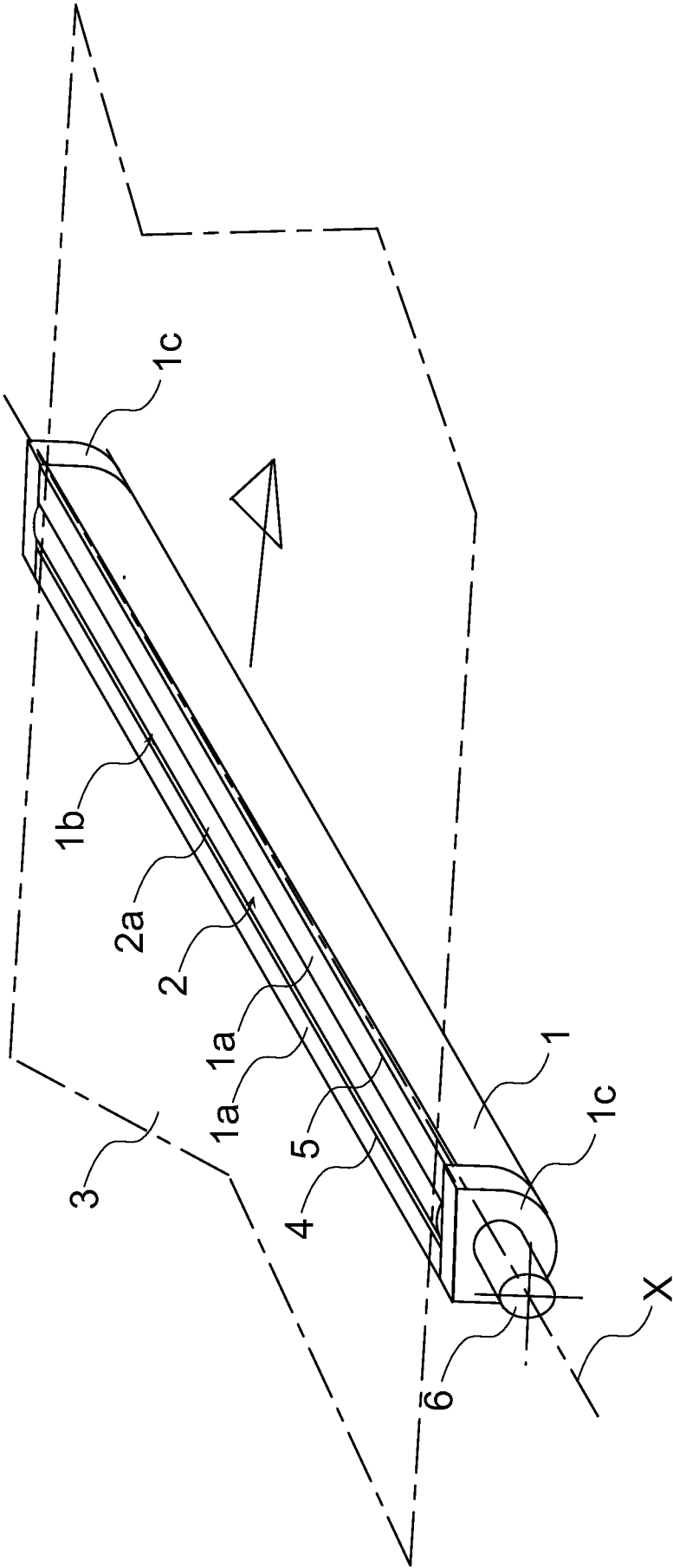
10. The apparatus according to any of the claims 1 to 9, **characterized** in that at least the width of the first gap (7a) is controllable in such a way that the roll (2) or the first beam (4) is transferrable in a direction substantially transverse or crosswise in relation to the wire (3).

5

11. A method for removing liquid from a running wire and from a web placed on the wire, **characterized** in that liquid is removed by means of an apparatus according to any of the claims 1 to 10, wherein a suction effect is maintained in the chamber (1) of the apparatus.

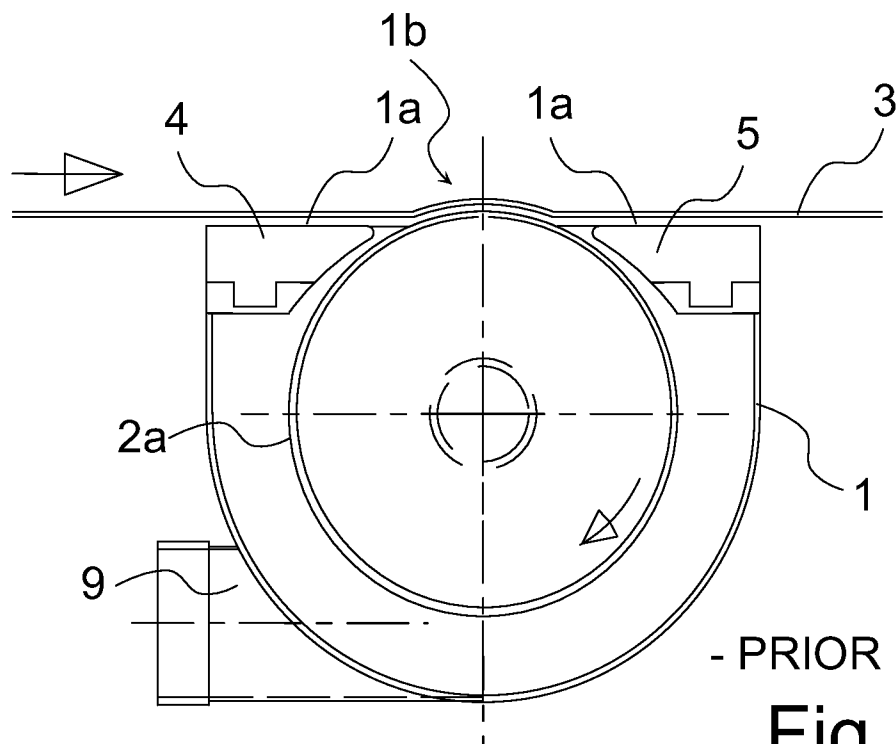
10

12. The use of an apparatus for cleaning a running wire, felt or another fabric, **characterized** in that an apparatus according to any of the claims 1 to 10 is used for the cleaning.



- PRIOR ART -
Fig. 1

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- PRIOR ART -
Fig. 2

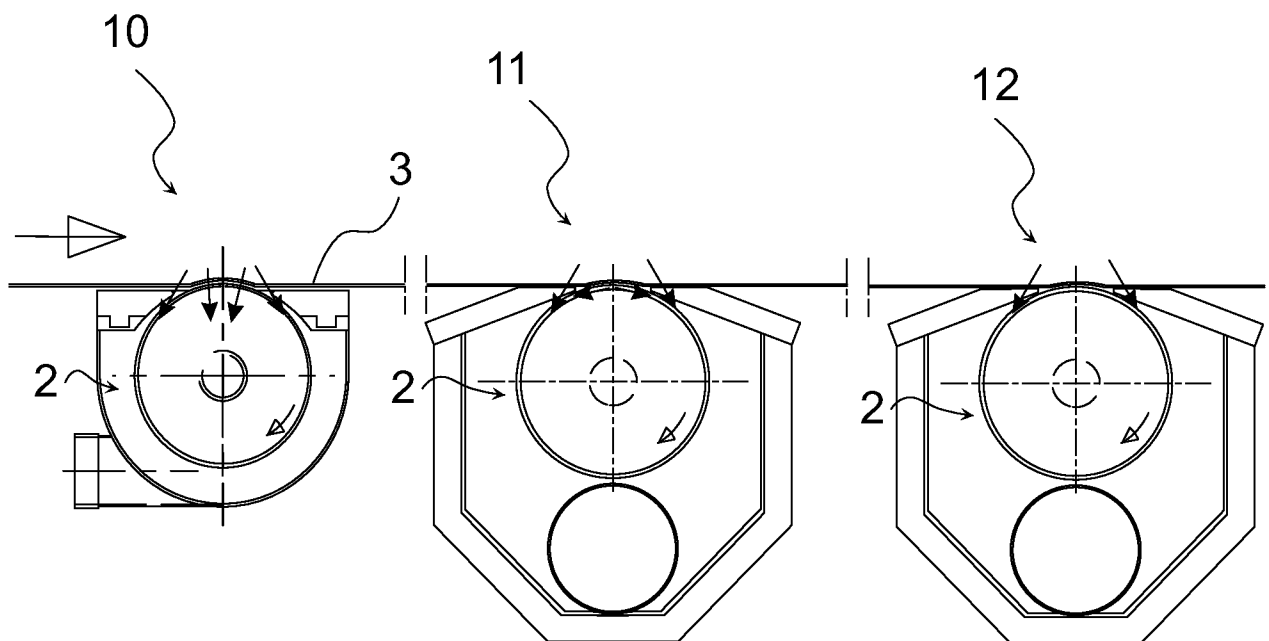
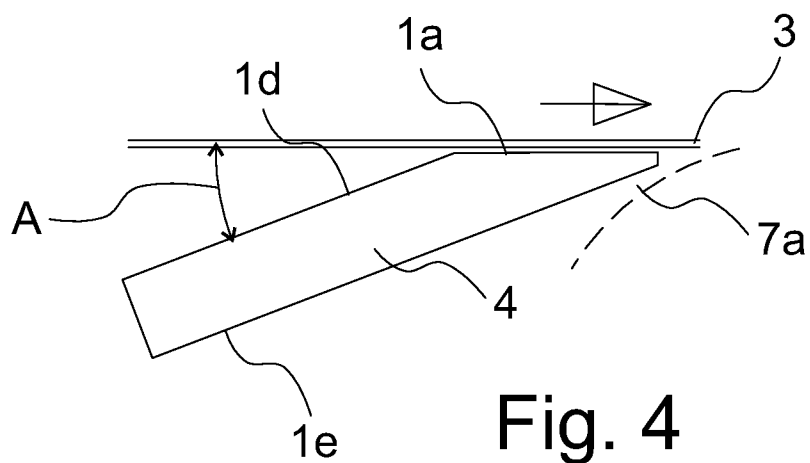
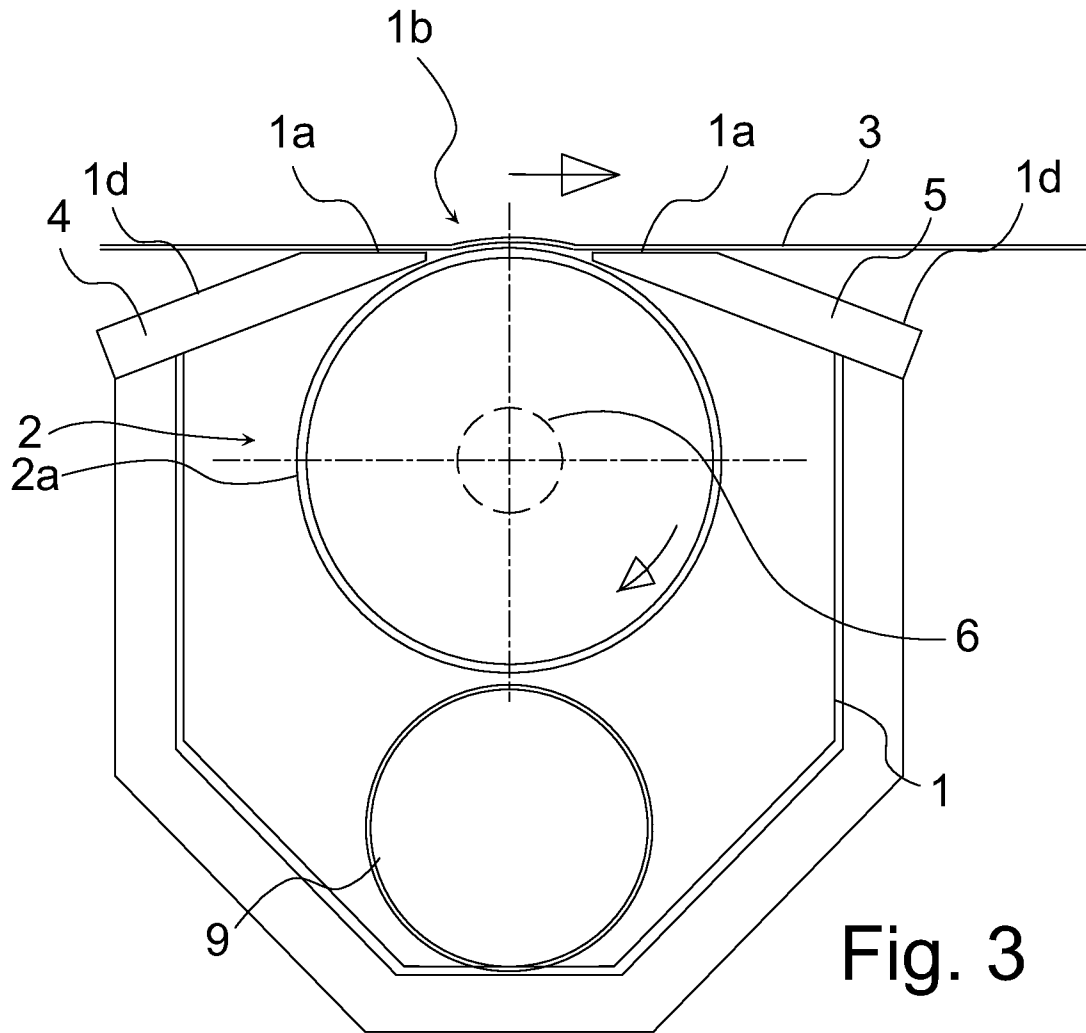
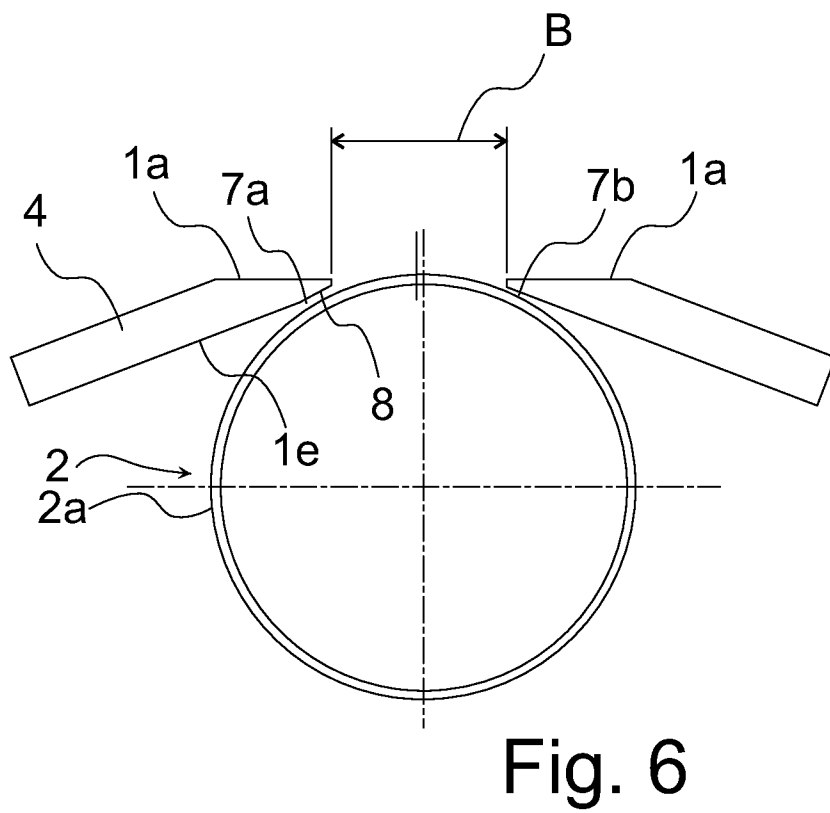
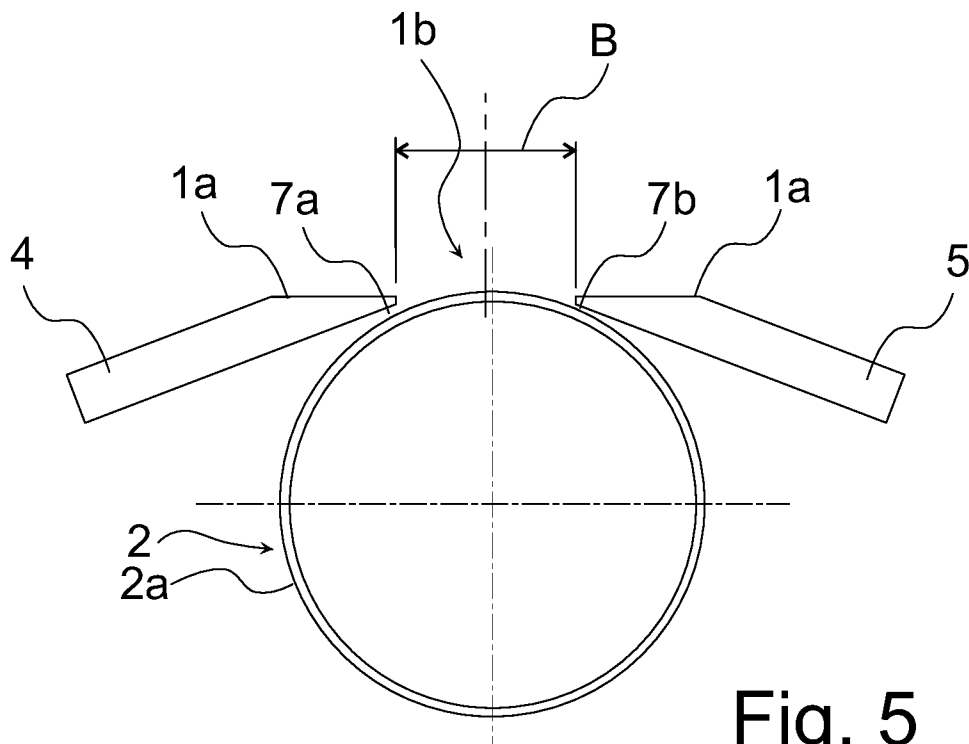


Fig. 9

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4 / 8



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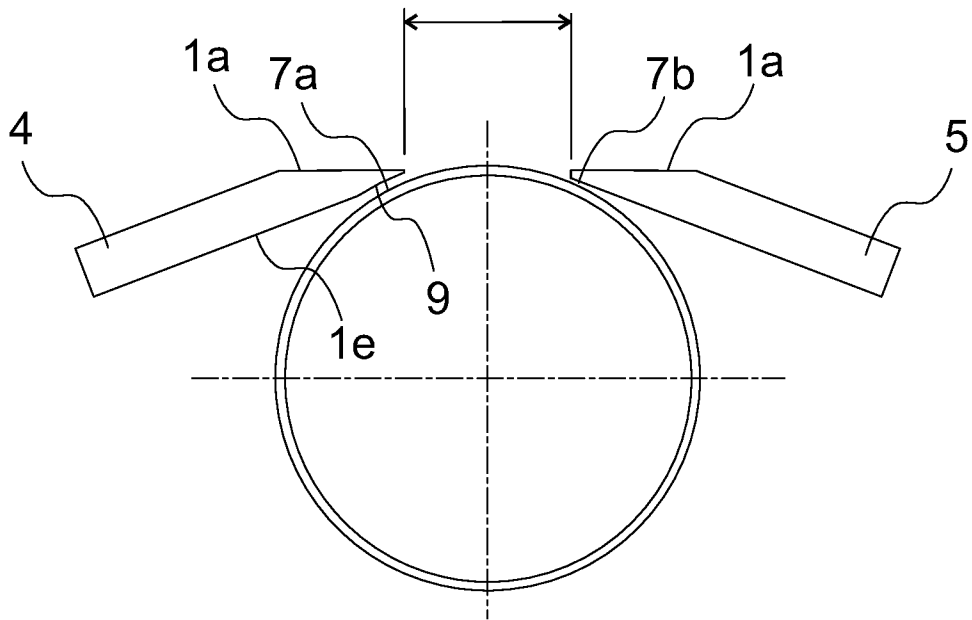


Fig. 7

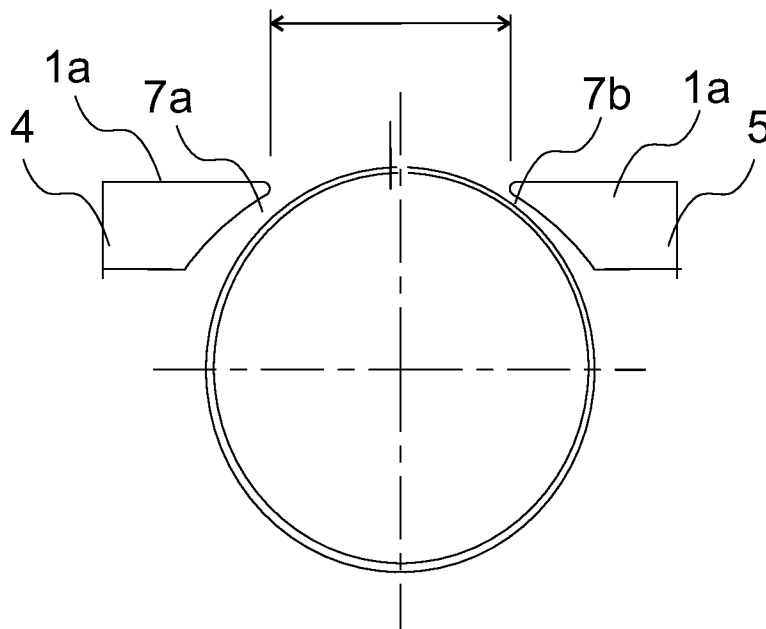
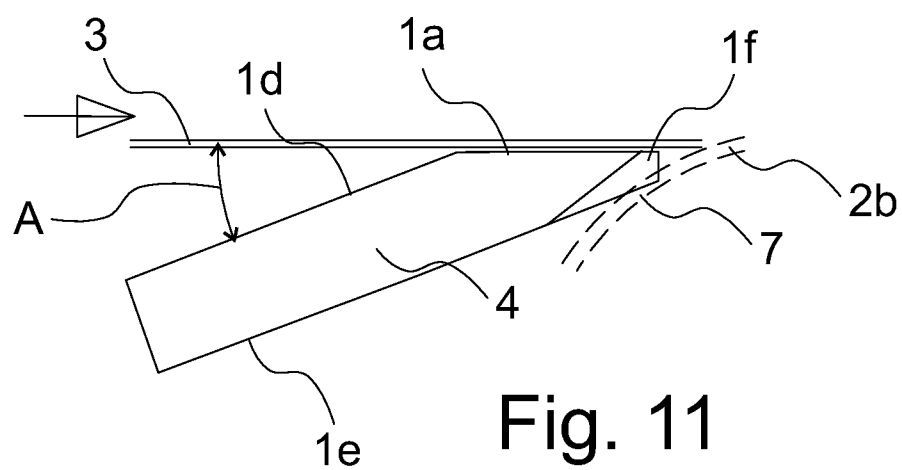
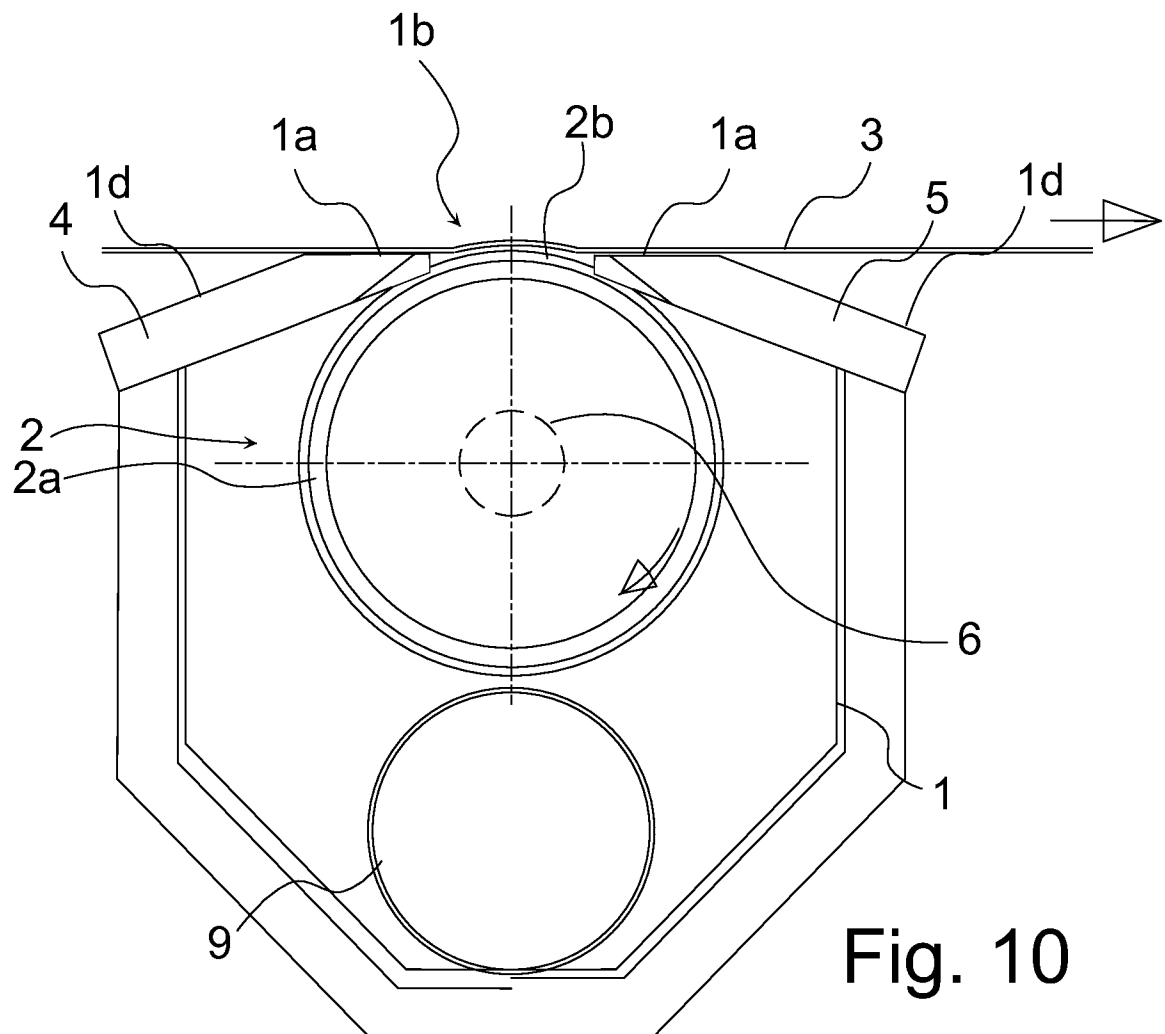


Fig. 8



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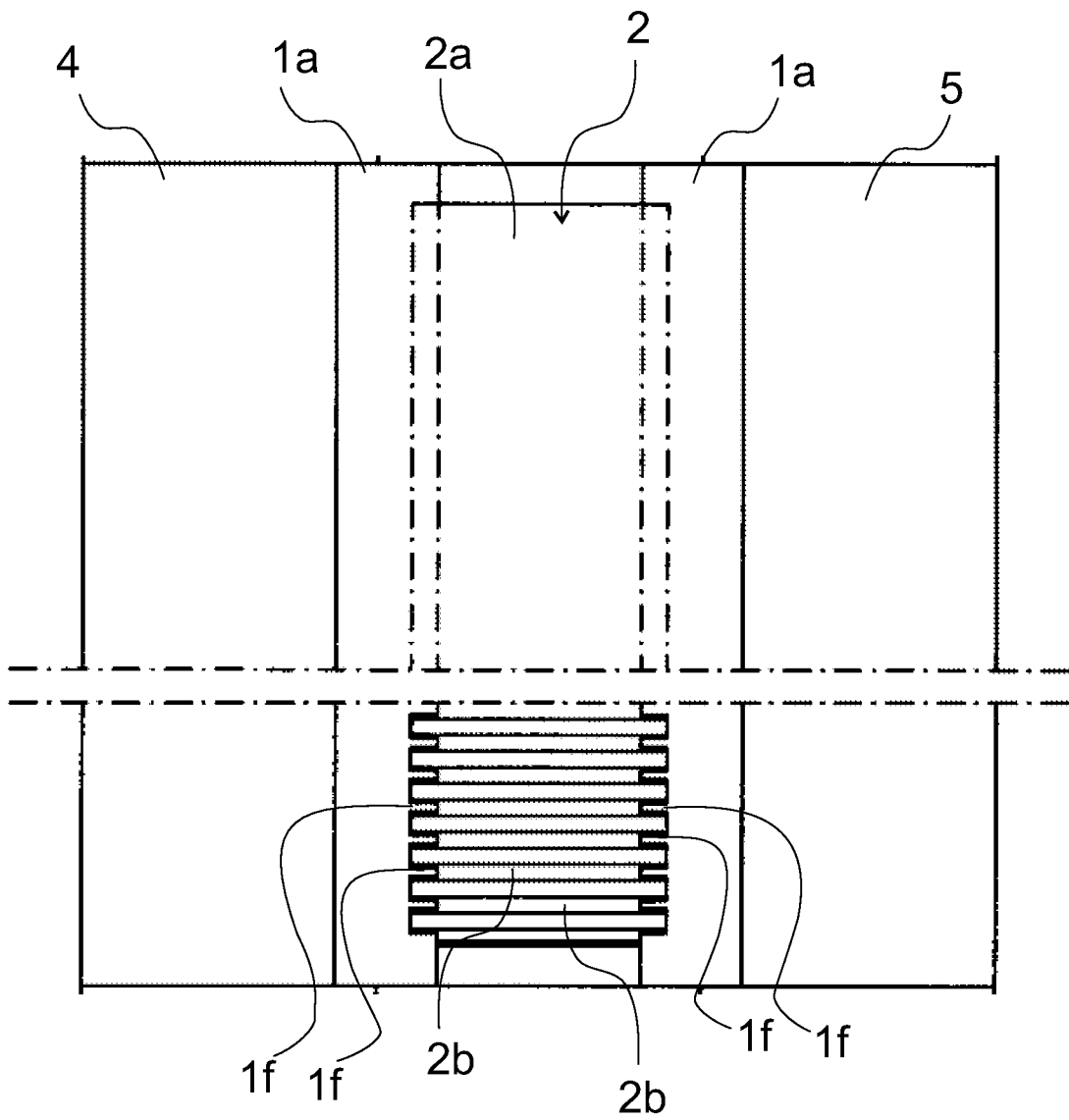


Fig. 12

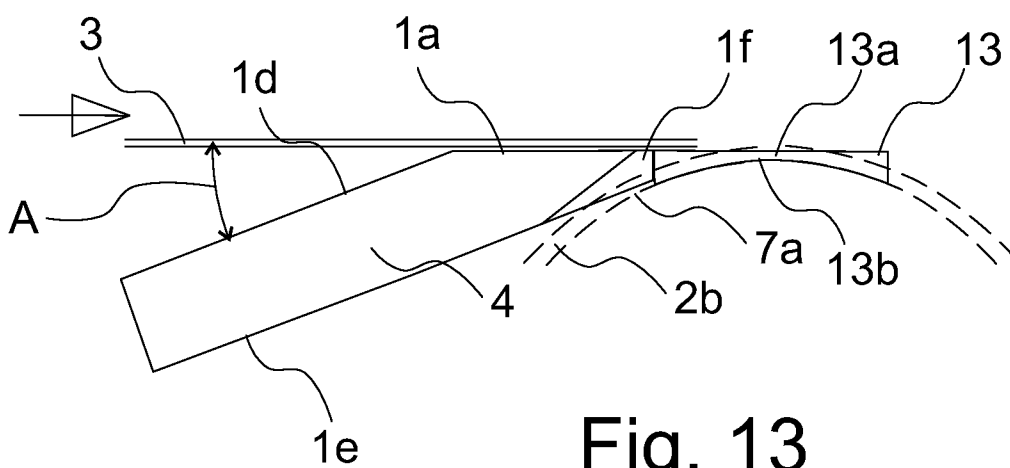


Fig. 13

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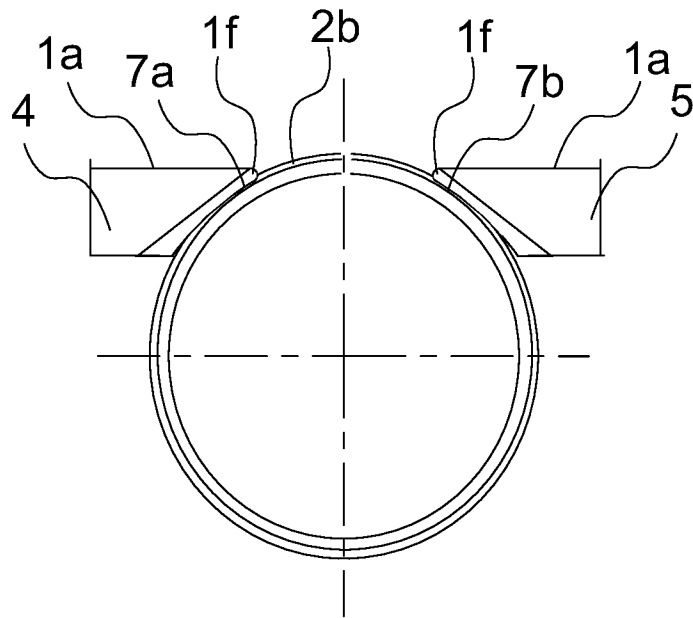


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2013/050569

A. CLASSIFICATION OF SUBJECT MATTER

INV. D21F1/50

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 81/02753 A1 (VALMET OY [FI]; KANKAANPAEAE M [FI]) 1 October 1981 (1981-10-01) page 18, line 32 - page 20, line 1; figure 6	1,5-7, 11,12
A	----- GB 381 819 A (SIDNEY HAROLD HOUGH; JASPER BENJAMIN JOSEPH PRIVETT) 13 October 1932 (1932-10-13) the whole document	1,3-12
A	----- WO 2006/090012 A1 (SAVOLAINEN OLAVI [FI]) 31 August 2006 (2006-08-31) cited in the application the whole document	1,5,11, 12



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search

24 July 2013

Date of mailing of the international search report

06/08/2013

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Beckman, Anja

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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