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(54) Runnability component for the drying section of a paper machine and method for drying a paper web

(57) The invention relates to a box-like elongated runnability component (10) and a method for a drying section of a paper machine or the like. The runnability component comprises an entry side surface (10a) and an exit side surface (10b), which are connected to each other at least by a lower surface, whereby the entry side surface, exit side surface and lower surface delimit the inner volume of the runnability component. Further, it has a first end and a second end (10', 10"), between which it extends in its length direction, as well as a first blowing element (11), which is arranged in connection with the entry side surface to blow air upwards, and a first sealing element (20), which is arranged in connection with the entry side surface, beneath the first blowing element, whereby the first sealing element divides the surface of the entry side into a first region and a second region. Furthermore, the lower surface of the runnability component is provided with a first suction element, which is formed by at least one suction gap or by at least one row of suction holes (31, 31', 31"), extending from the first end of the runnability component towards the second end thereof, wherein the runnability component comprises means for adjusting the size of the suction holes or the width of the suction gap.

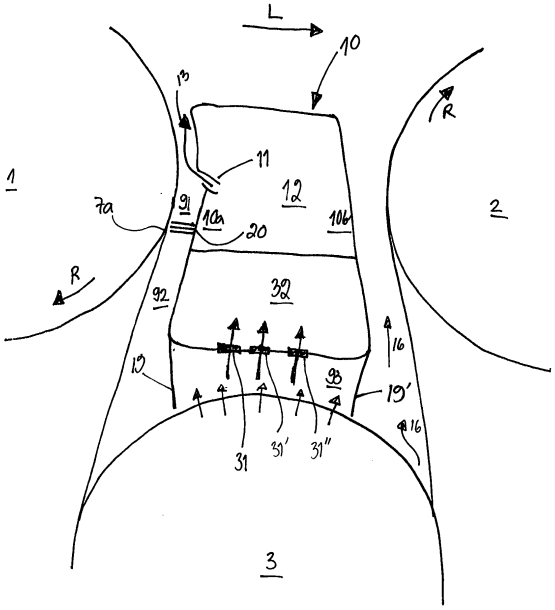

FIG. 2

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Description

[0001] The invention relates to a runnability component and a method for drying a paper web according to the preambles of the enclosed independent claims.

[0002] In a drying section of a paper or board machine the web to be dried is conveyed supported by one or two wires in contact with a plurality of heated drying cylinders. In single-felting draw the paper web runs supported by a drying wire through a drying cylinder group so that the drying wire presses the web against the heated cylinder surfaces of the drying cylinders. Thus, in single-felting draw the drying cylinders are arranged outside the wire loop, and turn rolls are arranged inside the loop. A pocket space is formed, which is defined by the wire and two adjacent drying cylinders and the turn roll situated between the drying cylinders at a different level. An opening nip, or opening gap, is formed on the entry side of the pocket space on an area where the drying wire separates from the first drying cylinder and, correspondingly, a closing nip, or a closing gap, is formed on the entry side of the pocket space when the wire runs to the turn roll. In a similar manner, when the wire leaves the turn roll, an opening nip, i.e. an opening gap, is formed on the exit side of the pocket space and, correspondingly, when the wire runs to the adjacent, second drying cylinder, a closing nip, i.e. a closing gap, is formed on the exit side between the wire and the second drying cylinder.

[0003] Runnability problems occur, when the paper web has a tendency to detach, at certain points, from the contact with the drying wire. Problematic points are especially the above described opening nips, i.e. points where the web and the wire disengage from the drying cylinder surface. Up to that point, the web has been travelling between the wire and the cylinder, and when the wire detaches from the cylinder, the web tends to follow the cylinder surface and thereby to disengage itself from the wire. Similar problems occur at closing nips, where the web and the wire are brought into contact with the cylinder surface. At that point, the web tends to disengage from the wire due to an overpressure formed in the nip.

[0004] Different kinds of runnability components, such as blow boxes or suction boxes, are arranged in the pocket space between the succeeding drying cylinders and the turn roll. Runnability components are used to create suitable underpressure in the pocket space, which promotes the keeping of the web in contact with the wire and improves the runnability of the dryer section of a paper machine. Blow boxes are typically used in connection with grooved and drilled vacuum turn rolls, where the air is sucked into the roll through holes in the roll shell. The suction is created by using a vacuum forming device, such as a fan or the like, which is arranged in connection with the interior of the roll. The underpressure inside the vacuum turn roll is typically about 2000 - 2500 Pa. On the other hand, suction boxes are typically used with so-called passive turn rolls, which have cut-outs in the roll shell. Suction box, which is arranged in the pocket space at the portion of the turn roll free from the wire, is arranged to suck air through the cut-outs of the turn roll. The open area of the passive roll is relatively large, typically around 4 - 10, more typically 6 - 8 %. The interior of the passive roll has normally no direct connection with the vacuum forming devices.

[0005] Sometimes, especially when paper machines are renewed and rebuilt, there is a need to change the runnability components in the pocket space without changing the turn rolls. However, turn rolls that has been designed to operate with suction boxes are not optimal for operation with blow boxes. There has been a need to find a simple and economical solution that would enable the change of runnability components in the pocket space without any other extensive modifications of the existing turn rolls, drying cylinders, other machinery and/or apparatuses. Furthermore, there is a need for runnability components with which the underpressure in the pocket space can be more accurately and easily controlled.

[0006] An object of this invention is to minimise or even totally eliminate the disadvantages existing in the prior art.

[0007] An object is also to provide a runnability component with which a good underpressure can be created to the pocket space and which can be used together with different types of turn rolls.

[0008] A further object of the invention is to provide a runnability component enabling good control of the different underpressure zones in the pocket space.

[0009] Another object of the invention is to provide an alternative method for creating the required underpressure in the pocket space, especially suitable for rebuild applications.

[0010] These objects are attained with the invention having the characteristics presented below in the characterising parts of the independent claims.

[0011] Typical runnability component according to the present invention for a drying section of a paper machine or the like comprises

- an entry side surface and an exit side surface, which are connected to each other at least by a lower surface, whereby the entry side surface, exit side surface and lower surface delimit the inner volume of the box-like elongated runnability component,
- a first end and a second end, between which the runnability component extends in its length direction,
- a first blowing element, which is arranged in connection with the entry side surface to blow air upwards,
- a first sealing element, which is arranged in connection with the entry side surface, beneath the first blowing element, the first sealing element dividing the entry side surface into a first region and a second region, whereby

the lower surface of the runnability component is provided with a first suction element, which is formed by at least one suction gap or by at least one row of suction holes,

extending from the first end of the runnability component towards the second end of the runnability component, the runnability component comprising means for adjusting the size of the suction holes or the width of the suction gap.

[0012] Typical arrangement for a paper machine or the like comprises

- a turn roll, which has cut-outs, such as perforations, and
- a runnability component according to the present invention, arranged at least partially around the surface of the turn roll.

[0013] Typical method according to the present invention for drying a paper web or the like in a drying section of a paper machine or the like comprises

- supporting a paper web with a drying wire,
- guiding the paper web over a part of a heated surface of a first drying cylinder, turning travel direction of the paper web by using a turn roll, and guiding the paper web over a part of a heated surface of a succeeding second drying cylinder, whereby a pocket space is defined by the first and second drying cylinders, arranged parallel at a distance from each other, and the turn roll arranged between the first and second drying cylinders, parallel with them and having its axis of rotation on a different level from the axis of the first and second drying cylinder,
- arranging, at least partly, a box-like elongated runnability component to the pocket space, the runnability component having an entry side surface, which faces the first drying cylinder, and an exit side surface, which faces the second drying cylinder, the surfaces being connected to each other at least by a lower surface, which faces the turn roll, whereby the entry side surface, exit side surface and lower surface delimit the inner volume of the box-like elongated runnability component, runnability component extending from a first end to a second end in its length direction over the width of the paper web,
- blowing air against the travel direction of the paper web, which is guided from the first drying cylinder to the turn roll, by a first blowing element, which is arranged in connection with entry side surface of the runnability component to create a negative pressure space on the entry side surface, and
- increasing underpressure in the pocket space by removing air by suction from a space between the turn roll and the lower surface of the runnability component into the runnability component with a first suction element, which is formed by at least one suction gap or by at least one row of suction holes, extending from the first end of the runnability component towards the second end of the runnability component, and
- adjusting the size of the suction holes or the width of the suction gap of the first suction element for controlling the suction through the lower surface of the runnability component.

[0014] The embodiments mentioned in this text relate, where applicable, to the runnability component, the arrangement as well as to the method according to the invention, even if this is not always separately mentioned.

[0015] Now it has been surprisingly found out that the underpressure in the pocket space can be enhanced by sucking air from the area between the lower surface of the runnability component and the turn roll by first suction means arranged to the lower surface of the runnability component, which also comprises a blowing element on the entry side for creating the underpressure. Furthermore, it has been found out that the underpressure in the pocket space can be more accurately, efficiently and easily controlled for each operational situation by adjusting the size of the suction holes or width of the suction gap, which forms the first suction element. The air is sucked from the interior of the turn roll through the cut-outs on the roll shell, thus creating at least a part of the necessary underpressure in the turn roll to stabilise the turning path of the wire and the web over the turn roll surface. In this manner part of the air is removed through the turn roll and the underpressure in the pocket is improved. The invention enables use of runnability components with blowing elements also in connection with turn rolls with high open shell area without extensive increase in used air volumes and energy consumption. The present invention combines the good runnability and sealing of the pocket space towards the wire on the entry side of the runnability component that are traditionally achieved with a blow-box with a use of a passive turn roll, while providing good control of the underpressure in the pocket space due to the adjustable first suction element.

[0016] In context of the present application the runnability component is arranged in a pocket space, which is defined by the first and second drying cylinder and a turn roll between them. The drying cylinders are parallel, i.e. their longitudinal axes are parallel with each other, and they are arranged at a distance from each other.

[0017] Typically the adjacent drying cylinders are arranged horizontally on the same level and the turn roll is arranged between the two adjacent drying cylinders so that the longitudinal axis of the turn roll is substantially parallel with the longitudinal axes of the drying cylinders, but located on a different level in the vertical direction than the axes of the drying cylinders. Turn roll is thus arranged on a higher or lower level than the drying cylinders, typically on a lower level. Furthermore, the turn roll is placed between the drying cylinders so that its surface does not touch the surfaces of the drying cylinders, i.e. is free from contact with the drying cylinder surfaces. In a typical paper machine the box-like runnability component, the drying cylinders and the turn rolls are elongated in the cross direction of the paper machine or the like, and extend substantially over the entire width of the

web run. Therefore the pocket space defined by them is also elongated in the cross direction of the paper machine. The ends of the pocket space are typically sealed, for example by means of end plates according to prior art, such as gap plates. The vertical end plates are arranged in machine direction, on both ends of the pocket space.

[0018] In this application, the entry side and the exit side of the pocket space have the following meaning: The pocket space may be divided, in machine cross direction at its centre point, by an imaginary vertical level having the width of the web run into an entry side and an exit side. On the entry side, i.e. between the first drying cylinder and the turn roll, and on the exit side, i.e. between the turn roll and the second drying cylinder, the pocket space is delimited by the wire, and therefore, during the operation of the paper machine, also by the web path formed by the wire and the web. The lower surface of the runnability component means the surface of the runnability component, which is located nearest to the turn roll, and which is arranged substantially towards the turn roll.

[0019] In this application, a higher underpressure means a lower absolute pressure. Respectively, a lower underpressure means a higher absolute pressure. An underpressure means a pressure, which is lower than the normal atmospheric pressure ca. 1 bar, i.e. 100 kPa.

[0020] The runnability component comprises a first blowing element, which is arranged in connection with the entry side surface of the runnability component to blow air upwards. The first blowing element on the entry side is arranged at the opening nip between the wire and the cylinder, for blowing air away from the gap between the wire and the runnability component. The air jet discharging from the first blowing element maintains a negative pressure in the space between the runnability component and the web, and creates a negative pressure space at the opening nip on the entry side. The first blowing element may be a blow nozzle or a blowing gap, extending from the first end towards the second end of the runnability component, preferably to the second end of the runnability component. The blow nozzle diameter or gap width of the first blowing element is typically 1 - 3 mm, preferably 1.5 - 2.5 mm. In case the blowing element is a blowing element using compressed air, the nozzle diameter or gap width may be 0.1 mm - 0.5 mm.

[0021] The runnability component comprises also a first sealing element, which is arranged in connection with the entry side surface of the runnability component, beneath the first blowing element. The first sealing element is arranged at a short distance from the opening nip between the wire and the cylinder, to project from the surface of the runnability component towards the wire and dividing the entry side surface into a first region and a second region. The first sealing element divides thus the negative pressure space on the entry side into a first region of an intensified negative pressure confined to the location of the opening nip and into a second region of a lower negative pressure, i.e. lower underpressure, at the lower part of the pocket space on the entry side, near the closing nip of the entry side. The first sealing element may be a mechanical sealing element, such as a sealing strip or a labyrinth sealing, such as single-chambered labyrinth sealing or multi-chambered labyrinth sealing. The material of the mechanical sealing element may be, for example, Teflon, plastic, rubber, composite or metal, such as steel or aluminium. A requirement for the material is a sufficient rigidity, with which the free flow of air may be prevented. Preferably the first sealing element is a mechanical sealing element, which is made of Teflon or of material comprising carbon fibres.

[0022] The lower surface of the runnability component is provided with a first suction element. The first suction element removes air from the pocket space, from the space between the lower surface of the runnability component and the turn roll. Indirectly the first suction element is also used for creating a underpressure to the turn roll, as the suction of the first suction element creates an air flow through the open areas of the turn roll surface from the inside of the turn roll to the space between lower surface of the runnability component and the turn roll. The first suction element is connected to a suction channel, arranged inside the runnabilty component, as described later in the application. The first suction element is formed by at least one suction gap or by at least one row of suction holes, extending from the first end of the runnability component towards the second end, preferably to the second end, of the runnability component. The first suction element may also comprise a plurality of adjacent suction gaps or rows of suction holes. For example, the first suction element may preferably comprise 2 - 4 adjacent rows of suction holes or adjacent suction gaps. The suction holes may have a diameter of 15 - 50 mm, preferably 20 - 40 mm, and the distance between two adjacent holes in a row is typically 50 - 500 mm, preferably 150 - 350 mm. In case the suction means comprise a uniform suction gap, the width of the gap is 2 - 10 mm, typically 2 - 4 mm, preferably 2 - 3 mm. The form of the suction holes may be selected freely, for example they may be circular or oval-shaped.

[0023] The suction through the lower surface of the runnability component is controlled by adjusting the suction of the first suction element according to the requirements of one or several of the process parameters, such as web speed, web tension or weight of the paper web which is produced. It is possible to adjust the suction of the first suction element by adjusting the size of the suction holes or the width of the suction gap with adjustment means. Thus the runnability component comprises means for adjusting the size of the suction holes or the width of the suction gap of the first suction element. The adjustment means may be, for example, a movable hole plate, which is arranged on top of the suction hole row in the cross direction of the paper machine. When the holes of the hole plate and the suction holes completely overlap, the suction is as the strongest. When the hole plate is moved, the overlap of the holes of the hole plate and

the suction holes decrease, and the suction through the suction holes is reduced.

[0024] According to one embodiment of the invention the runnability component further comprises a second suction element, which is arranged on the entry side surface of the runnability component, beneath the first sealing element, the second suction element being formed by at least one suction gap or by at least one row of suction holes, extending from the first end of the runnability component towards the second end of the runnability component, preferably to the second end of the runnability component. The second suction element is thus arranged to remove air by suction from the negative pressure space on the entry side of the runnability component. The second suction element may be connected to a suction channel, which is arranged inside the runnability component, as described later in the application. The second suction element may also comprise a plurality of adjacent suction gaps or rows of suction holes. For example, the second suction element may preferably comprise 2 - 4 adjacent rows of suction holes or adjacent suction gaps. The suction holes may have a diameter of 15 - 50 mm, preferably 20 - 40 mm, and the distance between two adjacent holes in a row is typically 50 - 500 mm, preferably 150 - 350 mm. In case the suction means comprise a uniform suction gap, the width of the gap is 2 - 10 mm, typically 2 - 4 mm, preferably 2 - 3 mm. The form of the suction holes may be selected freely, for example they may be circular or oval-shaped.

[0025] Optionally the second suction element comprises means for adjusting suction through the second suction element. In this manner the suction effect of the second suction element is adjusted for controlling the suction from the negative pressure space through the entry side surface of the runnability component according to the requirements of the process parameters, such as web speed, web tension or weight of the paper web which is produced. For example, the second suction element may be attached to a connection provided with a damper with which the direct suction from the negative pressure space between the entry side of the runnability component and the wire may be adjusted. It is also possible to adjust the suction of the second suction element by adjusting the size of the suction holes or the width of the suction gap with adjustment means. Thus the runnability component comprises second means for adjusting the size of the suction holes or the width of the suction gap of the second suction element. The second adjustment means may be, for example, a movable hole plate, which is arranged on top of the suction hole row in the cross direction of the paper machine. When the holes of the hole plate and the suction holes completely overlap, the suction is as the strongest. When the hole plate is moved, the overlap of the holes of the hole plate and the suction holes decrease, and the suction through the suction holes is reduced.

[0026] The first and/or second suction element may be connected to an external suction device or vacuum air system. It is possible to connect the suction element(s) to existing suction air systems intended for creating an underpressure to the pocket space or for the turn roll. This is advantageous when existing paper machine constructions are rebuilt, as no new suction systems need to be built, which saves time, costs and usually also space. The suction of the first and/or second suction means may be adjusted according to the process parameters and/or process situation. The first and/or second suction means may be connected to the external suction device or vacuum air system with a connection, which is provided with a regulating means for regulating the air flow, such as valve or a throttle. The regulating means may be automatically adjustable or they may be adjustable manually.

[0027] According to one embodiment of the invention the runnability component comprises at least one second sealing element, preferably a plurality of second sealing elements, arranged in connection with the lower part of the runnability component, preferably with the lower surface of the runnability component. The second sealing element(s) may be arranged to extend outwards from the surface of the runnability component. The second sealing element may be a mechanical sealing element or a sealing blow nozzle, preferably a mechanical sealing element. The at least one second sealing element is arranged to seal the gap between the runnability component and the turn roll, in order to intensify the suction from the turn roll to the runnability component and from the space between the lower surface of the runnability component and the turn roll. The second sealing element also helps to guide the air flow, which moves the exit side surface of the turn roll, in the rotational direction of the roll, away from the contact with the surface of the turn roll.

[0028] In case the second sealing element is a sealing blow nozzle, it is provided on the exit side surface of the runnability component, i.e. on the side of the opening nip from the turn roll. The control of the underpressure in the pocket space between the drying cylinders and the turn roll may be improved with the second sealing element, which is an exit side sealing blow nozzle with which air is ejected out of the pocket space and/or the entry of the air into the pocket space via the gap between the exit side surface of the runnability component and the second drying cylinder is prevented.

[0029] When the second sealing element is a mechanical sealing element, the second sealing element extends outwards from the lower part, preferably lower surface, of the runnability component, preferably towards the turn roll. According to one embodiment of the invention the second sealing element is arranged to the lower surface of the runnability component on the exit side. According one preferred embodiment, the mechanical second sealing element is arranged at at least one, preferably at both lower corners of the runnability component, extending towards the surface of the turn roll. The mechanical second sealing element(s) serve(s) as a concrete physical obstacle(s) for the entry of air into the space between the

runnability component and the turn roll. Thus, only a minute amount of air possibly enters into the said space.

[0030] The second mechanical sealing element may be a mechanical sealing element, such as a sealing strip or a labyrinth sealing, such as single-chambered labyrinth sealing or multi-chambered labyrinth sealing. The material of the mechanical sealing element may be, for example, Teflon, plastic, rubber, composite or metal, such as steel or aluminium. A requirement for the material is a sufficient rigidity, with which the free flow of air may be prevented. Preferably the second sealing element is a mechanical sealing element, which is made of Teflon or of material comprising carbon fibres.

[0031] The first and second sealing elements may be similar to each other or they may be different from each other. According to one embodiment of the invention the first and/or second sealing element is a mechanical sealing element, which is provided with means for adjusting the distance of the sealing element(s) to the turn roll or the drying cylinder. The length of the sealing element extending outwardly from the surface of the runnability component may be adjusted with the adjusting means. For example, the distance between the first drying cylinder surface and the first sealing element may be adjusted according to the needs of the process situation, and air may be leaked to the pocket space or to the intensified negative pressure space at the opening nip on the entry side, if need be. Similarly the distance between the second sealing element(s) and the turn roll may be adjusted and the air leaked to the area between the lower surface of the runnability component and the turn roll. Sometimes the first and/or second sealing element(s) create(s) such an effective sealing that the underpressure in the pocket space or at the opening nip is significantly enhanced. The location of the second sealing element may then be adjusted further away from the turn roll, whereby a gap between the second sealing element and the turn roll is formed or increased. From this gap air may be allowed to leak to the pocket space or to the space between the lower surface of the runnability component and the turn roll from the opening nip on the exit side.

[0032] The first and second mechanical sealing elements are preferably elongated in the cross direction of the paper machine or the like and extend substantially over the entire width of the web run. According to an embodiment of the invention, the first and/or second sealing element are mechanical sealing elements which are formed of at least two parts, preferably of several parts, in the lateral direction, i.e. cross direction, of the machine. Thus their mounting, transportation and storage is easier.

[0033] The runnability component may comprise a by-pass channel leading from a first region on the entry side to the second region on the entry side of the runnability component. The by-pass channel enables a more precise control of the underpressure difference between the first and second region in the negative pressure space at the opening nip on the entry side. This improves also the overall pressure balance in the pocket space, whereby the operation of the turn roll may be considerably intensified and the control of the web may be enhanced with low energy consumption. The by-pass channel allows air to be transferred between the first and second pressure region, which makes it possible to control the underpressure by adjusting the flow, for example to balance the pressure differences between the first and second pressure region in a desired manner. According to an embodiment of the invention, a valve, a throttle or other device or means adjusting the air flow in the by-pass channel is arranged in the by-pass channel. The by-pass channel may therefore be considered as a controlled active leak channel. The by-pass channel is preferably elongated in the cross direction of the paper machine or the like and extends substantially over the entire width of the web run.

[0034] According to another embodiment of the invention the runnability component may comprise a by-pass channel leading from the entry side of the runnability component to the exit side of the runnability component or to the upper surface of the runnability component. Also in this case by-pass channel may be used for balancing the pressure conditions in the first and/or second region on the negative pressure space on the entry side. If the underpressure on the entry side is too high the by-pass channel leading to the exit side or to surroundings may be opened, which leads reduced underpressure on the entry side.

[0035] According to one embodiment of the invention a second blowing element is arranged in connection with the entry side surface, beneath the first sealing element. The second blowing element may be a blow nozzle or a blowing gap, arranged on the first underpressure region. The second blowing element extends from the first end towards the second end of the runnability component, preferably to the second end of the runnability component. The second blowing element may be arranged to blow upwards, against the moving direction of the wire. Typically the goal is to intensify the underpressure level especially in the closing nip on the entry side and generally in the negative pressure region on the entry side, which makes the prevention of the wire bending more accurate and easy. The second blowing element creates an air cushion which prevents the pumping/pulsating effect, otherwise typical for suction. The blow nozzle diameter or gap width of the second blowing element is typically around 2 - 3 mm, and the blow speed 10 - 50 m/s, preferably 20 - 40 m/s. The air which is ejected from the second blowing element may be led to a second suction element, arranged above the second blowing element. By means of the second suction element the air from the second blowing element is led to the suction channel inside the runnability component.

[0036] According to one embodiment of the invention second blowing element is arranged to blow into the by-pass channel extending from the entry side of the runnability component, especially into a by-pass channel leading from the entry side of the runnability component

to the exit side of the runnability component or to the upper surface of the runnability component.

[0037] The runnability component preferably comprises a suction channel extending from the first end to the second end of the runnability component, and a blow channel extending from the second end to the first end of the runnability component. The suction channel and blow channel are arranged inside the runnability component, inside the space, which is defined by the outer walls, i.e. surfaces, of the runnability component. Typically the blow channel is arranged at the upper part of the runnability component and the suction channel is arranged at the lower part of the runnability component, beneath the blow channel. Preferably the runnability component comprises a tapering suction channel extending from the first end to the second end of the runnability component and a tapering blow channel extending from the second end to the first end of the runnability component. Tapering suction and blow channels are advantageous as they enable the keeping of the pressure on even level along the length of the channels, in cross direction of the paper machine, and they minimise the pressure losses in the channels between the first and the second end of the runnability component. According to one embodiment of the invention the runnability component comprises an inclined division wall extending from the first end to the second end and dividing the inner volume of the runnability component into tapering suction channel and tapering blow channel.

[0038] The suction channel and the blow channel may be connected to adjustment means for adjusting the air flows to and/or from the runnability components. The air flows are preferably controlled independently from each other, i.e. the suction in the suction channel and the blow in the blow channel of the runnability component are controlled independently from each other.

[0039] According to one embodiment of the invention the runnability component comprises a tail threading zone. The tail threading zone may be located, with respect to the web run, on the tending side and/or on the driving side, in the area of the first end and/or the second end of the runnability component. During tail threading the suction force in the tail threading zone may be controlled into one value and after the tail threading, i.e. in a normal running situation with a wide web run, to a second value. The tail threading zone is defined by a dividing wall arranged inside the runnability component, dividing the suction channel it a tail threading zone and normal operation zone. The dividing wall is normally vertical and it is arranged perpendicular to the length axis of the runnability component, i.e. the dividing wall is vertical and arranged parallel with the machine direction and with direction of web movement. The adjustment of suction force between the tail threading zone and the normal operation zone may be achieved by appropriate control means. For example, the tail threading zone may be connected to a separate and individual suction means, which are controlled independently from the suction devices or the like that create the suction to the normal operation zone of the suction channel.

[0040] According to one preferred embodiment of the present invention the control of the suction force at the tail threading zone and at the normal operation zone is achieved by using an integrated control means. The integrated control means comprise a first and a second coaxial pipe with different diameter. The first pipe is in contact the suction element of the tail threading zone and the second pipe is in contact with the suction element of the normal operation zone. Both the first and the second pipe of the integrated control means are in contact with the suction device or vacuum air system. A damper is arranged to the second pipe, so that the air flow through it may be restricted or totally terminated. When the damper is open, the suction is evenly divided to both the first and the second pipe, and the suction through suction element on the tail threading zone is equal to the suction through the suction element on the normal operation zone. When the damper is partially or wholly closing the second pipe, the suction is mainly or only occurring through the first pipe, i.e. mainly or only through suction element on the tail threading zone. According to one preferred element the cross section of the first pipe is circular and cross section of the second pipe is angular, preferably rectangular.

[0041] The turn roll used in connection with the invention may be a perforated turn roll, a grooved turn roll or a turn roll provided with both perforations and grooves, known per se. According to one preferred embodiment of the present invention the turn roll has an open area of at least 4 %, preferably 4 - 10 %, more preferably 6 - 8 %. This means that the surface of the turn roll comprises a large amount of cut-outs, such as perforations. The turn roll is typically so-called passive turn roll, which means that the turn roll is free of internal suction devices. In other words, there are no internal suction devices or suction connections to the turn roll but the air is sucked from the turn roll, through the cut-outs on its surface, by external suction means, elements or devices, arranged in the runnability component.

[0042] According to one embodiment of the invention the runnability component comprises a distribution chamber, which is arranged on the entry side surface of the runnability component. The distribution chamber comprises a front plate, and it extends from the first end of the runnability component towards the second end of the runnability component, preferably to the second end of the runnability component. The front plate may be attached on the entry side surface of the runnability component by welding, or by using attachment means, such as bolts, rivets, or the like. The distribution chamber is preferably formed beneath the first sealing element, on the area between the opening nip of the first drying cylinder and the closing nip of the turn roll. The front plate comprises at least one row of leak holes, preferably a plurality of parallel rows of leak holes. The diameter of a single leak hole may be 15 - 50 mm, preferably 20 - 40

mm and the distance between the adjacent leak holes in a row is typically 150 - 350 mm, preferably 200 - 300 mm.

[0043] The web bending at and after the first drying cylinder may be controlled by distributing leak air by the distribution chamber arranged on the entry side surface of the runnability component. The web bending at the opening nip of the first drying cylinder increases the negative pressure in the space between the web and the runnability component. The increased negative pressure in its turn increases the web bending, thus leading to a vicious circle. This negative phenomenon may be counteracted by distributing a small amount of leak air through the holes in the front plate of the distribution chamber. The control of the web bending is clearly improved and the runnability of the web increased.

[0044] A transversal flow may be arranged to the distribution chamber by bringing the leak air into the distribution chamber from the ends of the chamber. Regulating means, such as a damper or the like, may be arranged on the end(s) of the distribution chamber to control the flow to the distribution chamber.

[0045] The invention is described in more detail below with reference to the enclosed schematic drawings, in which

Figure 1 shows a schematic view of a pocket space between two drying cylinders and one turn roll,
Figure 2 shows an arrangement according to a first embodiment of the present invention,
Figure 3 shows an arrangement according to a second embodiment of the present invention,
Figure 4 shows an arrangement according to a third embodiment of the present invention,
Figure 5 shows an arrangement according to a fourth embodiment of the present invention,
Figure 6 shows an arrangement according to a fifth embodiment of the present invention,
Figure 7 shows an arrangement according to a sixth embodiment of the present invention, and
Figure 8 shows an arrangement according to a seventh embodiment of the present invention.

[0046] Figure 1 shows a schematic general view of a pocket space 9 between two drying cylinders 1, 2 and one turn roll 3 in the drying section of a paper machine. The pocket space 9 is delimited by a first drying cylinder 1, a second drying cylinder 2, a turn roll 3 and a web run 5a, 5b. Described more in detail, the pocket space 9 is delimited, on its entry side 9a, by a web run 5a between the first drying cylinder 1 and the turn roll 3, and on the exit side 9b of the pocket space, by a web run 5b between the turn roll 3 and the second drying cylinder 2. The location of the turn roll in a horizontal direction x and in a longitudinal direction L of the paper machine is between the drying cylinders 1, 2, but in a vertical direction y lower than said cylinders 1, 2. The directions of rotation of the cylinders 1, 2 are shown by arrows R. It is to be understood, that the above-presented arrangement is repeated by its substantial parts in the drying section of a paper or a board machine.

[0047] Figure 1 also shows

- an opening nip 7a of the first drying cylinder 1 on the entry side 9a, i.e. the point where the wire and the web detach from the periphery of the first drying cylinder 1 towards the turn roll 3,
- a closing nip 8a of the turn roll 3 on the entry side 9a, i.e. the point where the wire enters into connection with the turn roll 3 after the first drying cylinder 1,
- an opening nip 8b of the turn roll 3 on the exit side 9b, i.e. the point where the wire detaches from the periphery of the turn roll 3 towards the second drying cylinder 2, and
- a closing nip 7b of the second drying cylinder 2 on the exit side 9b, i.e. the point where the wire and the web enter into connection with the second drying cylinder 2 after the turn roll 3.

[0048] Figure 2 shows an arrangement according to a first embodiment of the present invention. A runnability component 10 is arranged in connection with a pocket space between the drying cylinders 1, 2 and the turn roll 3 of a paper machine. The entry side 10a of the runnability component 10 is provided with a first blowing element 11, such as a blow nozzle. The first blowing element 11 blows air upwards, as indicated with arrow 13, against the travel direction of the paper web, which is guided from the first drying cylinder 1 to the turn roll 3, in order to create an intensified first negative pressure space 91 on the entry side 10a. The first blowing element 11 ejects air away from the pocket space and prevents the air entailed by the web from entering into the pocket space via the gap between the first drying cylinder 1 and the entry side 10a of the runnability component. A blow channel 12, which communicates with the first blowing element 11, is arranged inside the upper part of the runnability component 10.

[0049] A first sealing element 20, such as a labyrinth sealing, is arranged in connection with the surface of the entry side 10a of the runnability component 10 and in connection with the opening nip 7a between the runnability component 10 and the first drying cylinder 1. The first sealing element 20 is arranged beneath the first blowing element 11 and it divides the surface of the entry side 10a into a first region and a second region. At the same time the first sealing element 20 divides the negative pressure space on the entry side of the pocket space into an intensified first negative pressure space 91 and a second negative pressure space 92.

[0050] The lower surface of the runnability component 10 is provided with a first suction element. The first suction element comprises three parallel rows 31, 31', 31" of suction holes, through which the air is sucked from the space 93 between the turn roll 3 and the lower surface of the runnability component 10. A suction channel 32 is

arranged inside the lower part of the runnability component 10. The suction created by the suction channel 32 removes also air from the interior of the turn roll 3, through cut-outs or perforations on the surface of the turn roll 3. The air flows are indicated with arrows.

[0051] Second sealing elements 19, 19', such as sealing strips are arranged in connection with the lower part of the runnability component 10. The purpose of the second sealing elements 19, 19' is to intensify the suction from the suction space 93 between the lower surface of the runnability component and the turn roll and prevent leakage of air to the suction space 93. The second sealing element 19' guides also the air flow 16 so that it does not enter the suction space 93 but is guided after the opening nip 8b of the turning suction roll 3 on the exit side away from the pocket space in the direction of the web run 5b.

[0052] Figure 3 shows an arrangement according to a second embodiment of the present invention. In a similar manner as in Figure 2 a runnability component 10 is arranged in connection with a pocket space between the drying cylinders 1, 2 and the turn roll 3 of a paper machine. The structure of the runnability component 10 corresponds generally to that what is presented in Figure 2, except that the lower surface of the runnability component 10 is provided with a first suction element, which comprises two parallel suction gaps 31, 31', through which the air is sucked from the suction space 93 between the turn roll 3 and the lower surface of the runnability component 10. Furthermore, in Figure 3 the runnability component 10 comprises one second sealing element 19, such as sealing strip, which is arranged in connection with the lower part on the entry side 10a of the runnability component 10. Another second sealing element, which is an exit side blow nozzle 15, is arranged on the exit side 10b of the runnability component 10. The exit side blow nozzle 15 blows air in the travelling direction of the web run 5b according to arrow 14, and thereby ejects air away from the pocket space and prevents the air from entering into the pocket space via the gap between the exit side 10b of the runnability component 10 and the second drying cylinder 2. The exit side blow nozzle 15 is connected to the blow channel 12 arranged inside the runnability component 10.

[0053] Figure 4 shows an arrangement according to a third embodiment of the present invention. In a similar manner as in Figure 2, a runnability component 10 is arranged in connection with a pocket space between the drying cylinders 1, 2 and the turn roll 3 of a paper machine. The structure of the runnability component 10 corresponds generally to that what is presented in Figure 2, except that the lower surface of the runnability component 10 is provided with a first suction element, which comprises two parallel rows 31, 31' of suction holes, through which the air is sucked from the suction space 93 between the turn roll 3 and the lower surface of the runnability component 10. Furthermore, a second suction element 33 is arranged on the entry side 10a of the runnability component 10, beneath the first sealing element 20. The second suction element removes air from the second negative pressure space 92, and thus intensifies the overall underpressure in the pocket space. The second suction element 33 is connected to the suction channel 32 arranged inside the lower part of the runnability component 10.

[0054] Figure 5 shows an arrangement according to a fourth embodiment of the present invention. In a similar manner as in Figure 2, a runnability component 10 is arranged in connection with a pocket space between the drying cylinders 1, 2 and the turn roll 3 of a paper machine. The structure of the runnability component 10 corresponds generally to that what is presented in Figure 2. The entry side 10a of the runnability component 10 is provided with a by-pass channel 22, which is extending between the first negative pressure space 91 and the second negative pressure space 92. The by-pass channel 22 may be used to regulate, for example, to balance, the underpressures of or the pressure difference between the negative pressure spaces 91, 92 in a controlled and desired manner.

[0055] Figure 6 shows an arrangement according to a fifth embodiment of the present invention. In a similar manner as in Figure 2, a runnability component 10 is arranged in connection with a pocket space between the drying cylinders 1, 2 and the turn roll 3 of a paper machine. The runnability component 10 comprises a by-pass channel 25 leading from the entry side 10a of the runnability component 10 to the exit side 10b of the runnability component 10. The by-pass channel 25 may be used for balancing the pressure conditions in the second negative pressure space 92 on the entry side 10a. Furthermore, a second blowing element 24 is arranged to blow into the by-pass channel 25.

[0056] Figure 7 shows an arrangement according to a sixth embodiment of the present invention. In principle, the runnability component 10 in Figure 7 corresponds to that presented in Figure 2. A distribution chamber 4 is arranged on the entry side 10a of the runnability component 10. The distribution chamber 4 has a front plate, which is attached on the entry side surface of the runnability component 10 beneath the first sealing element 20. The front plate comprises parallel rows 16, 16' of leak holes. The web bending at the second negative pressure space 92 is controlled by distributing leak air from the distribution chamber 4 through the rows 16, 16' of the leak holes. The leak air is supplied to the distribution chamber 4 from the ends of the chamber 4, whereby a transversal flow is created. Regulating damper (not shown) can be arranged on the end of the distribution chamber 4 to control the inflow to the distribution chamber.

[0057] Figure 8 shows an arrangement according to seventh embodiment of the present invention. Runnability component 10 is presented without the entry side cover plate and without tending side end plate. The interior of the runnability component comprises a tapering suction channel 32 and a tapering blow channel 12. The

suction channel inlet 17 extends from the first end 10' of the runnability component 10 on tending side to the second end 10" on the driving side, through the whole runnability component 10. Correspondingly, the blow channel 12 extends from the second end 10" to the first end 10' of the runnability component 10. An inclined division wall 21 is arranged inside of the runnability component 10 for dividing its inner volume into the tapering suction channel 32 and tapering blow channel 12. The diameter of suction and blow channels 32, 12 are uniformly decreasing from the channel inlets 17, 18 onwards. This counteracts the pressure decrease in the channels 32, 12.

[0058] Figure 8 shows also a tail threading zone 42, which is arranged on the first end 10' of the runnability component 10. The tail threading zone 42 is defined by a dividing wall 40 arranged inside the runnability component 10. The wall 40 divides the suction channel 32 in a tail threading zone and a normal operation zone. The wall 40 is normally arranged perpendicular to the length axis of the runnability component 10.

[0059] The suction between the tail threading zone 42 and the normal operation zone can be changed by using control means integrated to the suction channel inlet 17. These control means comprise a first circular pipe element 43 and a second rectangular pipe element 44. The second pipe element 44 is arranged inside the first pipe element 43 and coaxially with it. The pipe elements 43, 44 have different diameter. When the second pipe element 44 is open the suction is performed both through the first and second pipe element 43, 44, which is the normal suction operation during paper making. When the second pipe element 44 is closed the suction is performed only through the first element 43, and the suction is concentrated only on the tail threading zone 42.

[0060] Even if the invention was described with reference to what at present seems to be the most practical and preferred embodiments, it is appreciated that the invention shall not be limited to the embodiments described above, but the invention is intended to cover also different modifications and equivalent technical solutions within the scope of the enclosed claims.

Claims

1. Runnability component (10) for a drying section of a paper machine or the like, comprising

   - an entry side surface and an exit side surface, which are connected to each other at least by a lower surface, whereby the entry side surface, exit side surface and lower surface delimit the inner volume of the box-like elongated runnability component (10),
   - a first end (10') and a second end (10"), between which the runnability component (10) extends in its length direction,
   - a first blowing element (11), which is arranged in connection with the entry side surface to blow air upwards,
   - a first sealing element (20), which is arranged in connection with the the entry side surface, beneath the first blowing element (11), the first sealing element (20) dividing the entry side surface into a first region and a second region, whereby

   the lower surface of the runnability component (10) is provided with a first suction element, which is formed by at least one suction gap or by at least one row of suction holes (31, 31', 31"), extending from the first end (10') of the runnability component (10) towards the second end (10") of the runnability component (10),
   characterised in that
   the runnability component (10) comprises means for adjusting the size of the suction holes (31, 31', 31 ") or the width of the suction gap.

2. Runnability component according to claim 1, **c**haracterised in that it comprises a second suction element (33), which is arranged on the entry side surface of the runnability component (10), beneath the first sealing element (20), the second suction element (33) being formed by at least one suction gap or by at least one row of suction holes, extending from the first end (10') of the runnability component (10) towards the second end (10") of the runnability component (10), and optionally comprising means for adjusting the suction through the second suction element.

3. Runnability component according to claim 1 or 2, **characterised in that** it comprises at least one second sealing element (19, 19'), preferably a plurality of second sealing elements, arranged in connection with the lower part of the runnability component (10).

4. Runnability component according to any of claims 1, 2 or 3, **characterised in that** the first and/or second sealing element (20, 19, 19') is a mechanical sealing element, which is provided with means for adjusting the distance of the sealing element to a turn roll (3) or a drying cylinder (1, 2).

5. Runnability component according to any of preceding claims 1 - 4, **characterised in that** it comprises a second blowing element (24) arranged in connection with the entry side surface, beneath the first sealing element (20), the second blowing element (24) being preferably arranged to blow into a by-pass channel (25) extending from the entry side surface of the runnability component (10).

6. Runnability component according to any of preced-

ing claims 1 - 5, **characterised in that** it comprises a tapering suction channel (32) extending from the first end (10') to the second end (10") and a tapering blow channel (12) extending from the second end (10") to the first end (10').

7. Runnability component according to claim 6, **characterised in that** it comprises a tail threading zone (42), which is defined by a dividing wall (40) arranged inside the runnability component (10), dividing the suction channel (32) in a tail threading zone (42) and a normal operation zone.

8. Runnability component according to claim 7, **characterised in that** it comprises integrated control means comprising a first and a second coaxial pipe (43, 44) with different diameter, the first pipe (43) being in contact the suction element of the tail threading zone (42) and the second pipe (44) is in contact with the suction element of the normal operation zone.

9. Runnability component according to any of preceding claims 1 - 8, **characterised in that** a distribution chamber (4) extending from the first end (10') of the runnability component (10) towards the second end (10") of the runnability component (10) and comprising a front plate, is arranged on the entry side surface of the runnability component (10).

10. Method for drying a paper web or the like in a drying section of a paper machine or the like, comprising

- supporting a paper web with a drying wire,
- guiding the paper web over a part of a heated surface of a first drying cylinder (1), turning travel direction of the paper web by using a turn roll (3), and guiding the paper web over a part of a heated surface of a succeeding second drying cylinder (2), whereby a pocket space (9) is defined by the first and second drying cylinders (1, 2), arranged parallel at a distance from each other, and the turn roll (3) arranged between the first and second drying cylinders (1, 2), parallel with them and having its axis of rotation on a different level from the axis of the first and second drying cylinder (1,2),
- arranging, at least partly, a box-like elongated runnability component (10), to the pocket space, the runnability component (10) having an entry side surface, which faces the first drying cylinder (1), and an exit side surface, which faces the second drying cylinder (2), the surfaces (1, 2) being connected to each other at least by a lower surface, which faces the turn roll (3), whereby the entry side surface, exit side surface and lower surface delimit the inner volume of the box-like elongated runnability component (10), runnability component (10) extending from a first end (10') to a second end (10") in its length direction over the width of the paper web,
- blowing air against the travel direction of the paper web, which is guided from the first drying cylinder (1) to the turn roll (3), by a first blowing element (11), which is arranged in connection with the entry side surface of the runnability component (10) to create a negative pressure space on the entry side surface,
- increasing underpressure in the pocket space (9) by removing air by suction from a space between the turn roll (3) and the lower surface of the runnability component (10) into the runnability component (10) with a first suction element, which is formed by at least one suction gap or by at least one row of suction holes (31, 31', 31"), extending from the first end (10') of the runnability component (10) towards the second end (10") of the runnability component (10),

characterised in

- adjusting the size of the suction holes (31, 31', 31") or the width of the suction gap of the first suction element for controlling the suction through the lower surface of the runnability component (10).

11. Method according to claim 10, **characterised in** removing air by suction from the negative pressure space on the entry side surface by arranging a second suction element (33) on the entry side surface of the runnability component (10), beneath the first sealing element (20).

12. Method according to claim 11, **characterised in** adjusting the suction effect of the second suction element (33) for controlling the suction from the negative pressure space through the entry side surface of the runnability component (10).

13. Method according to claim 10, 11 or 12, **characterised in** sealing the gap between the runnability component (10) and the turn roll (3) with at least one second sealing element (19, 19'), preferably a plurality of second sealing elements, arranged in connection with the lower part of the runnability component (10), and optionally adjusting the distance of the first and/or second sealing element (20, 19, 19') to the turn roll (3) or the drying cylinder (1, 2).

14. Method according to any of preceding claims 10 to 13, **characterised in** arranging a tapering suction channel (32) in the runnability component (10) extending from the first end (10') to the second end (10") of the runnability component (10) and a tapering blow channel (12) extending from the second end

(10") to the first end (10') in order to minimise the pressure losses between the first and the second end (10', 10") of the runnability component (10).

15. Method according to any of preceding claims 10 to 14, **characterised in** controlling the web bending at and after the first drying cylinder (1) by distributing leak air by a distribution chamber (4) arranged on the entry side surface of the runnability component (10).

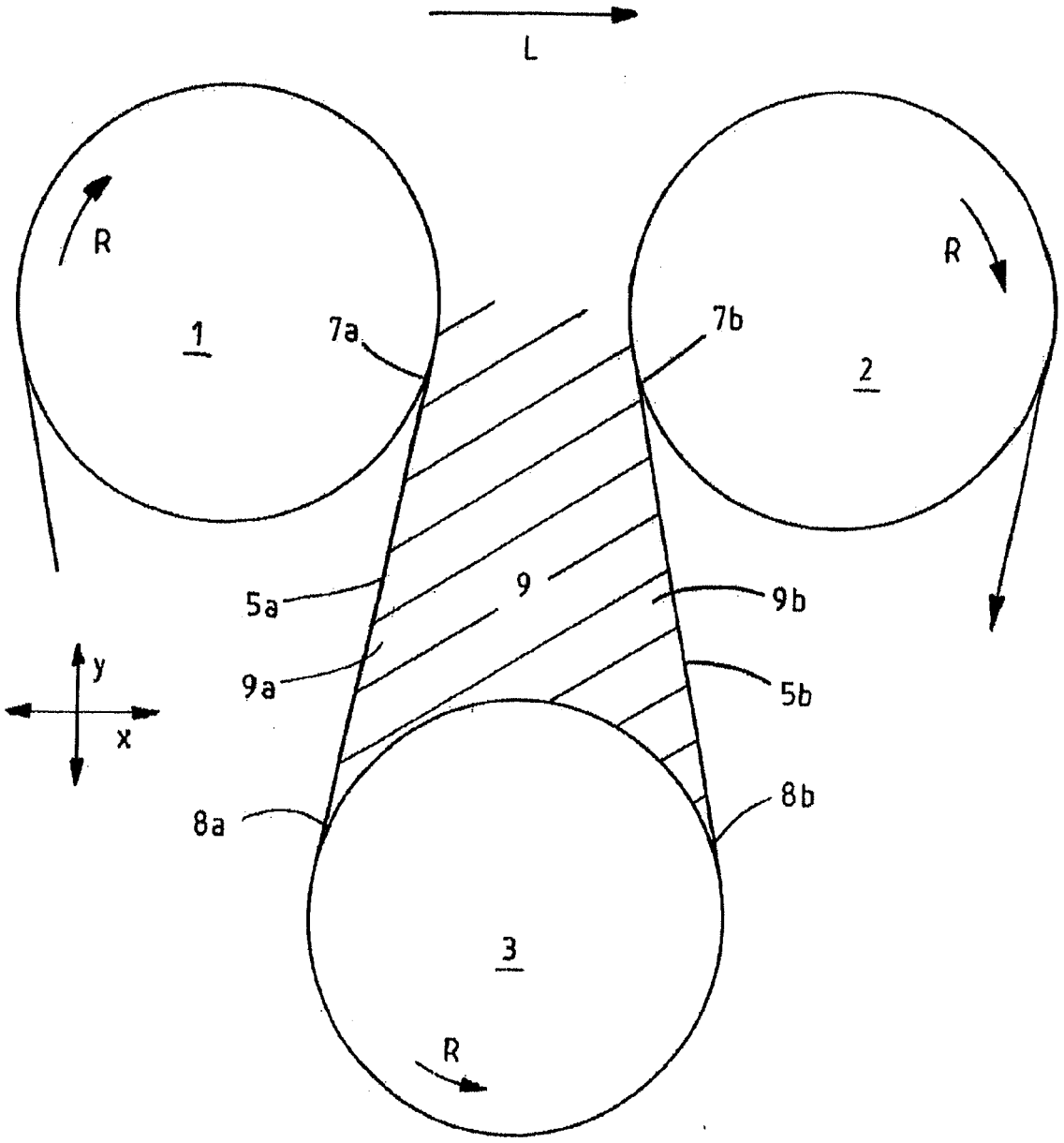

FIG. 1

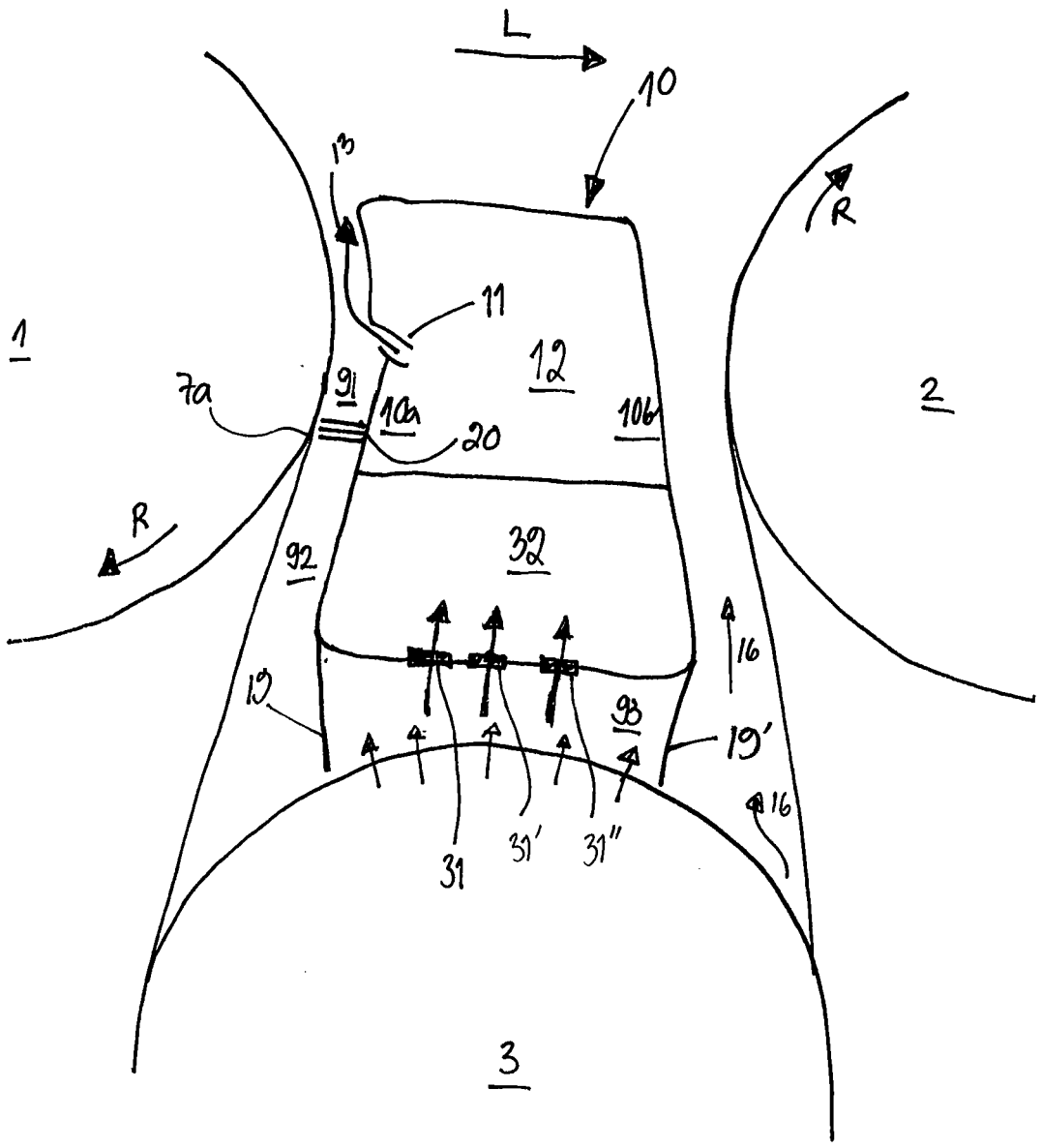

FIG. 2

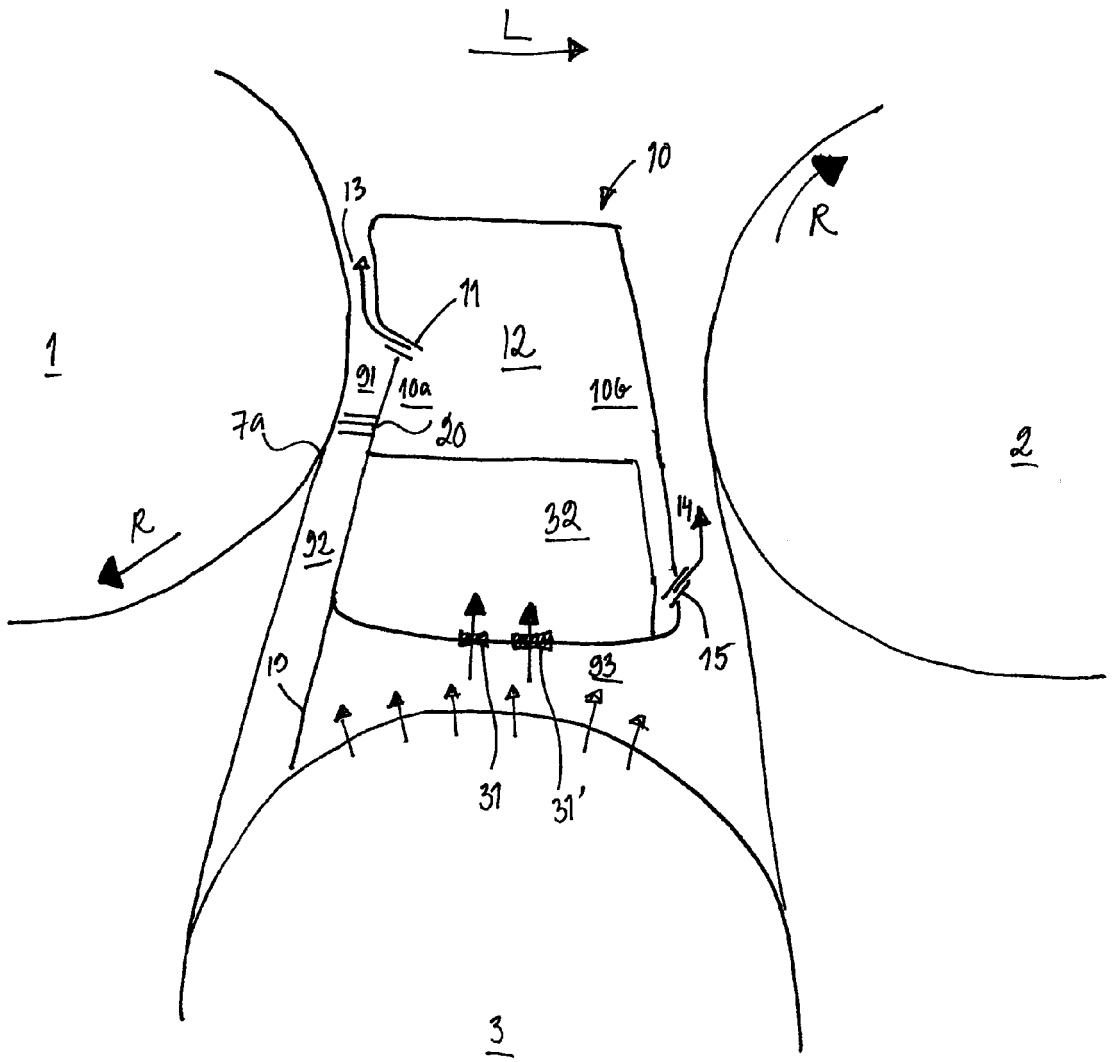

FIG. 3

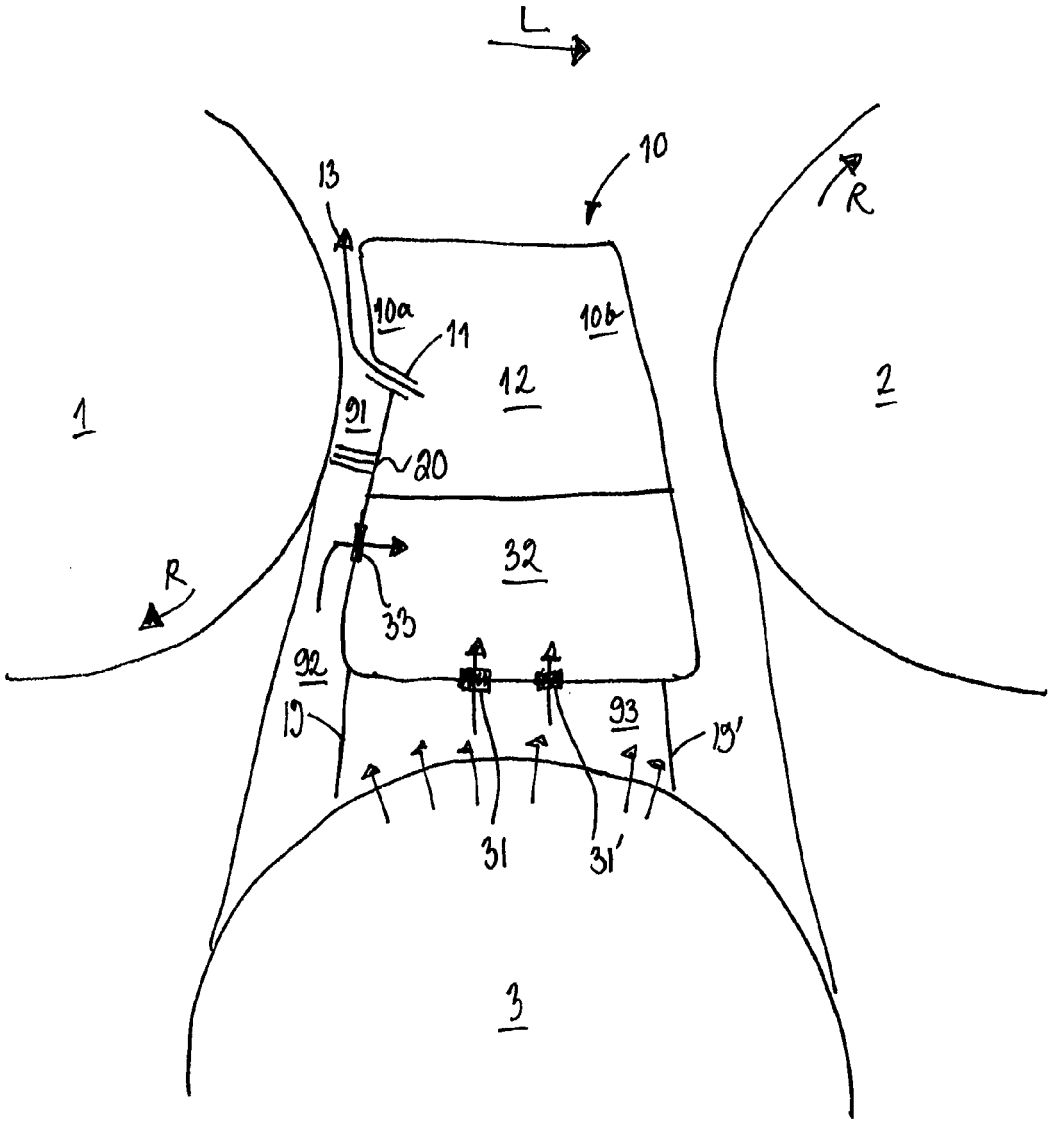

FIG. 4

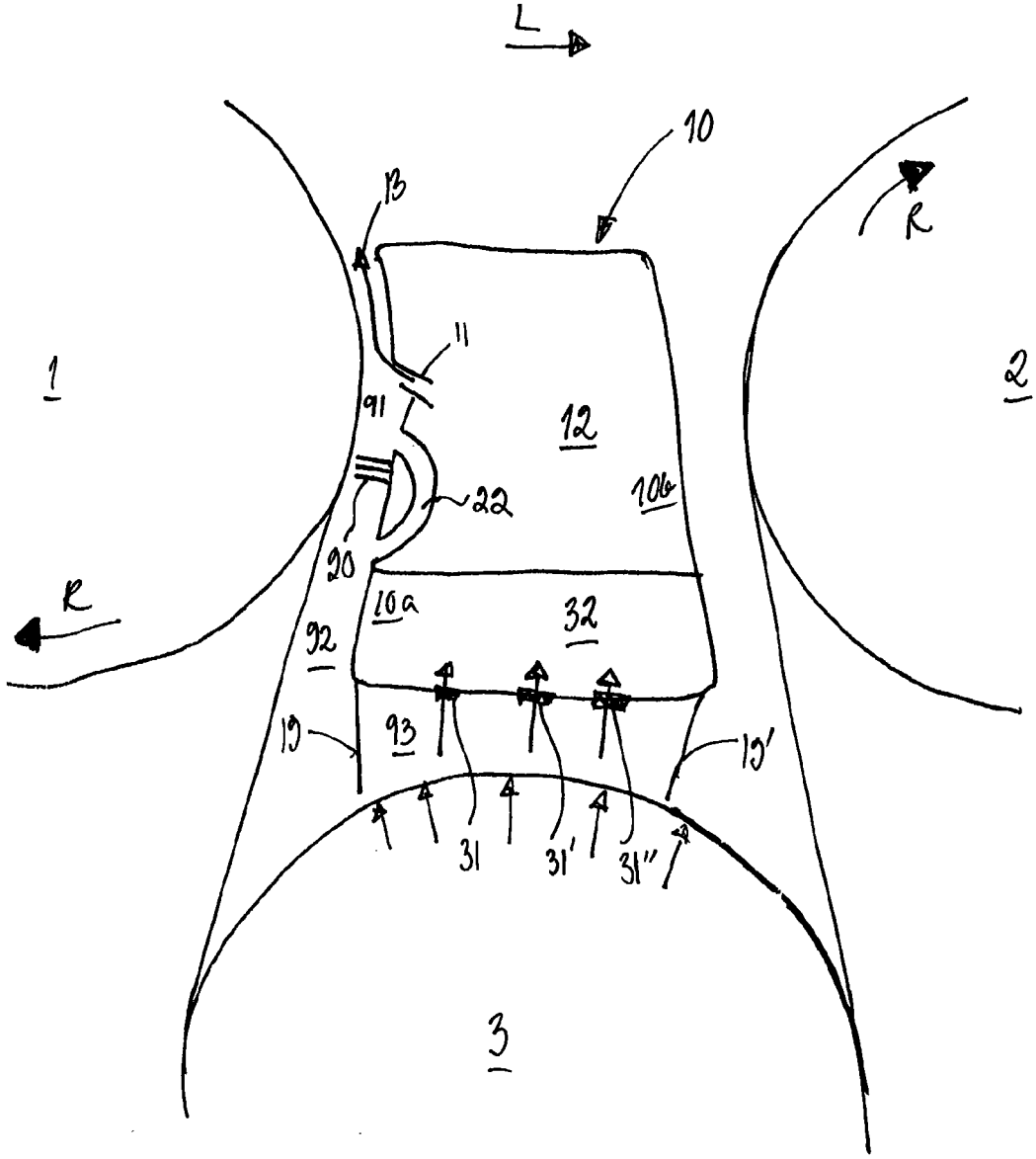

FIG. 5

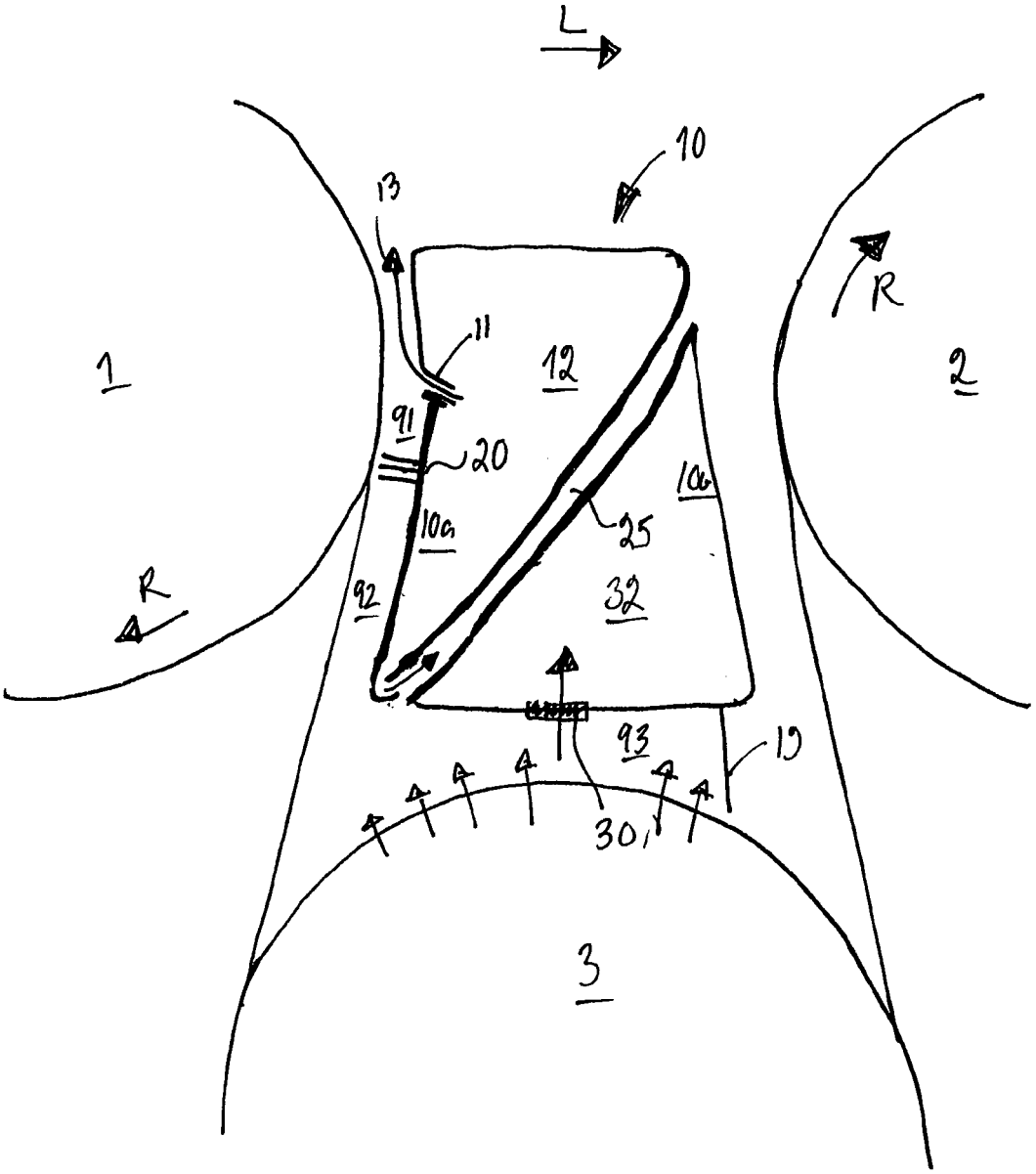

FIG. 6

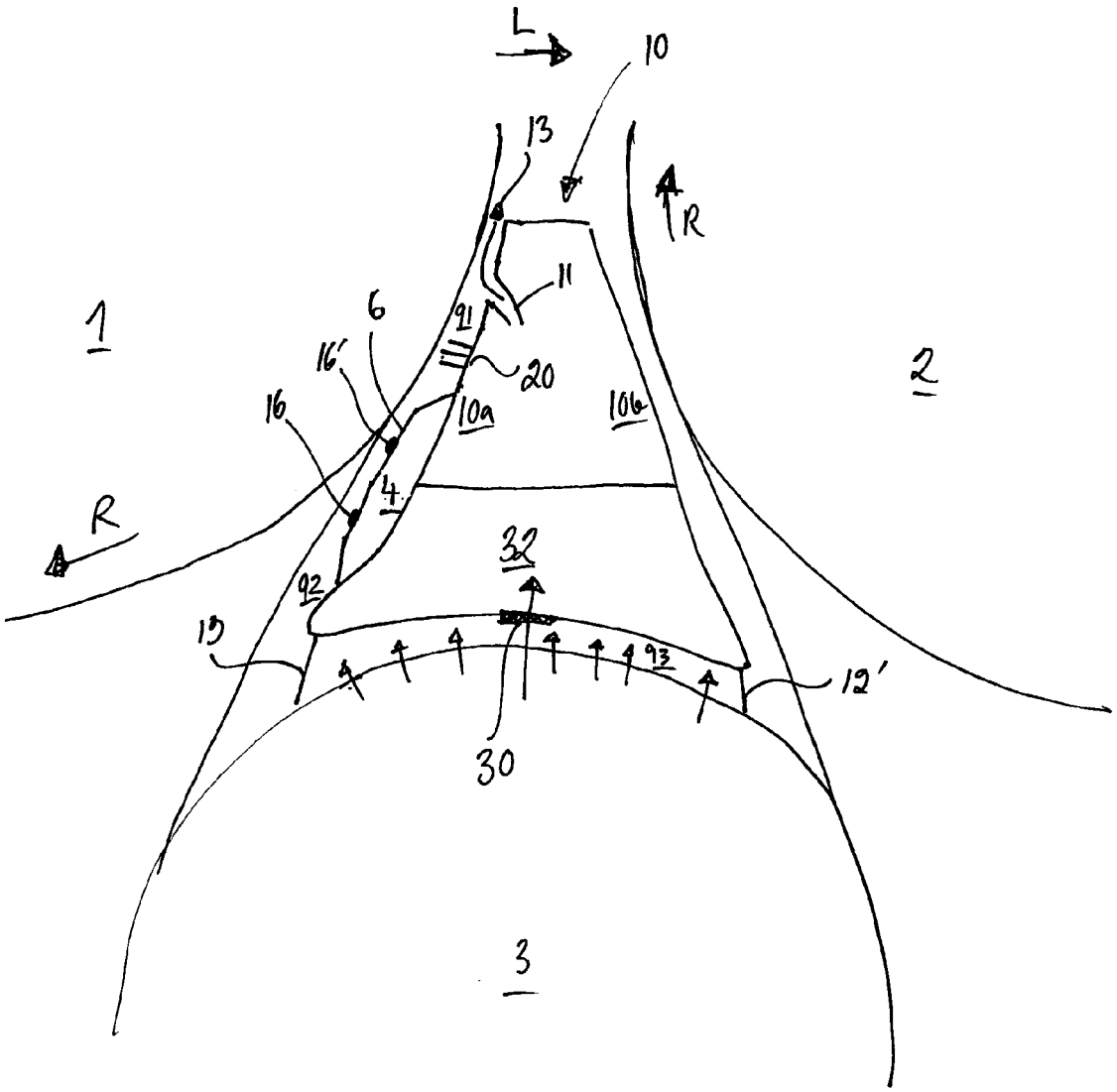

FIG. 7

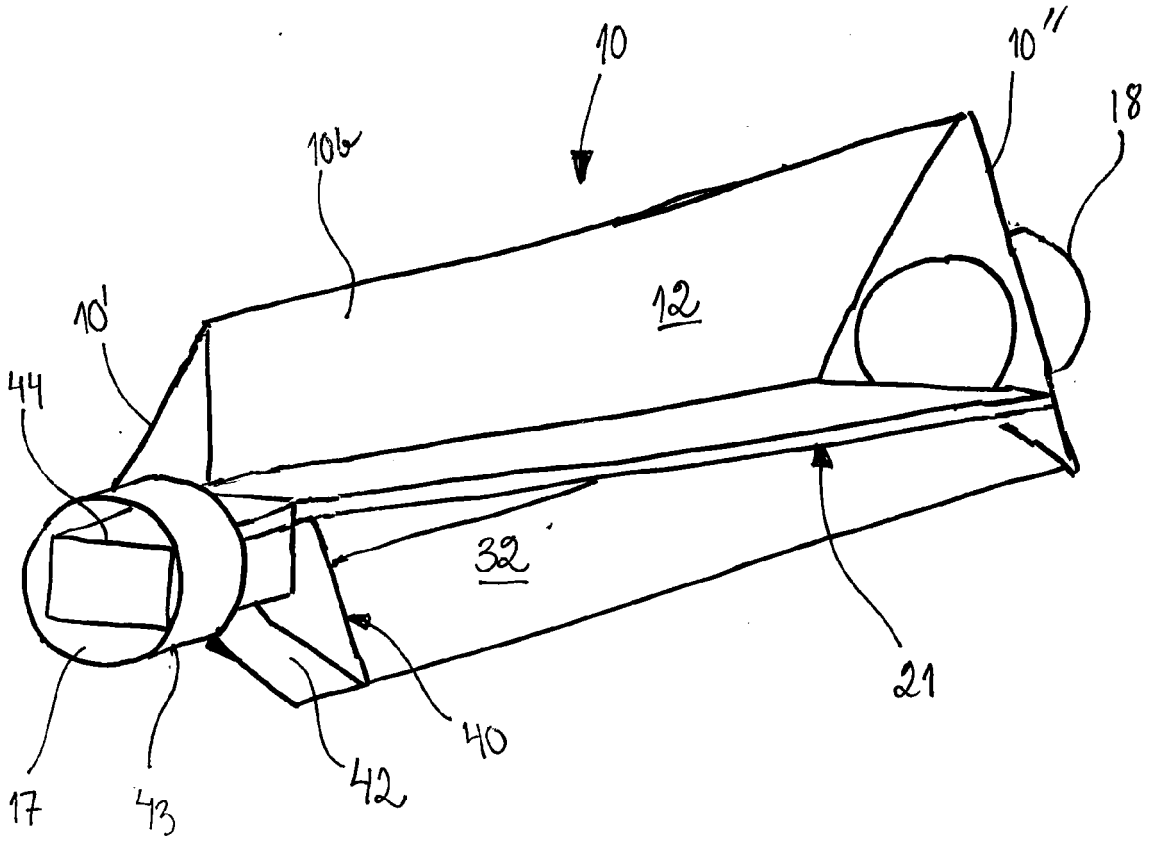

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 8076

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D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 February 2013	Maisonnier, Claire

CATEGORY OF CITED DOCUMENTS

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