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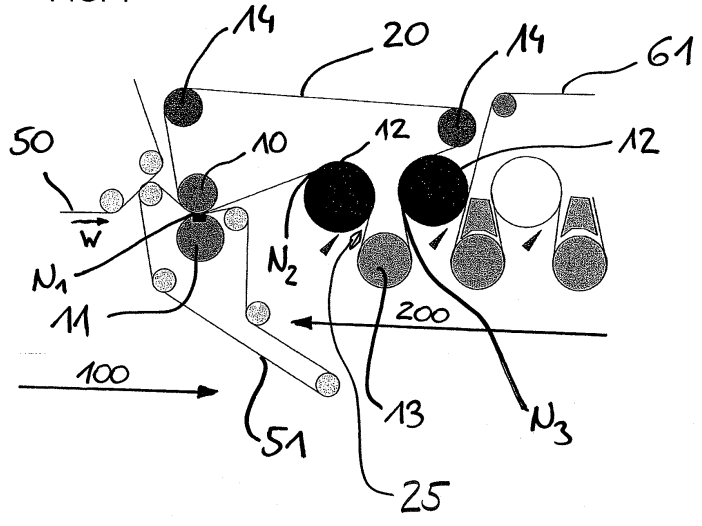
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(54) **Belt assembly for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine**

(57) The present invention relates to a belt assembly for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine. The belt assembly comprises a first press roll (10) and a second press roll (11) which are arranged at the press section and form a press nip, a drying roll (12) which is heatable and arranged downstream of the press nip in the web moving direction, and a heat conductive belt (20) which forms an endless loop and which is impervious to fluids runs through the press nip and contacts the drying roll (12), wherein the drying roll (12) and the heat conductive belt (20) form a nip which is extended in the web moving direction and in which the web (W) is sandwiched between the drying roll (12) and the heat conductive belt (20) such that the web is simultaneously in contact with the drying roll (12)and the heat conductive belt (20). Further, a method for moving the web from the press section of the paper- or board-making machine to the dryer section of the machine is provided.

FIG. 1




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## Description

**[0001]** The invention relates to a belt assembly for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine and to a method for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine.

Description of the prior art

**[0002]** Generally, drying of a web in a dryer section has a considerable influence on the properties of the web (i.e. product). One property which may be influenced is, for example, the change of shape during drying, in particular a phenomenon which is known as curling, i.e. a tendency to curl around an axis extending in the length direction of the web so that edges of the web in the machine direction tend to curl inwardly. The curling tendency in either of these directions is considered a loss of quality because it may cause problems in the further processing and later use of the paper or board materials. It is known that curling tends to occur towards the side which has been dried last, e.g. when dried with a one-sided drying in a single tier. In order to cope with this problem, the prior art suggests solutions using a double tier with both-sided drying, moisturizing, or impingement dryers. However, these solutions still leave room for improvements with regard to space requirements, energy consumption and cost.

**[0003]** In common dryer sections, in particular, at the beginning of such dryer sections in a web moving direction, heat originating sticking problems due to a high heat load may occur on the surfaces of cylinders used in the dryer section for drying the web. Thus, in order to avoid these heat originating sticking problems, some of the first dryer cylinders used are very low, whereby the heat load transferred from to the dryer cylinders to the web is reduced. Thus, drying of the web can be carried out during a significantly long run of the web in the dryer section, so that the whole size of the dryer section is increased.

**[0004]** Although high temperatures shall be achieved in the dryer section, this is not possible when using low pressure paper mill steam used for heating drying cylinders in dryer section. Therefore, thermo rolls are provided in order to achieve a solution for high-temperature demands in dryer sections. However, the surface temperature of such a thermo roll may be very high so that, in normal dryer sections using common wires for supporting and carrying the web along the dryer section, these wires cannot be used since these wires can be damaged due to the high temperatures generated by the thermo rolls.

**[0005]** Further, it is further generally known to use metal belt pressing solutions for increasing a dry content of the web in a press section before moving the web in the dryer section. The metal belt pressing solutions also provide a good smoothness to the web surface which is arranged at the belt side. Additionally, with heated metal belt solutions, a web temperature can already be increased in the press section before entering the dryer section. However, it is a problem that the side of the web which is not in contact with the belt remains unsmoothed when a so-called one-sided belt solution is applied.

**[0006]** Furthermore, when transferring the web from the press section to the dryer section by common suction pick-up means (e.g. suction rolls or the like); this may result in some wire markings in the web surface arranged adjacent to the suction pickup-up means and transfer wire.

Summary of the invention

**[0007]** It is an object of the invention to provide a belt assembly for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine as well as a method for moving a web from a press section of a paper-or board-making machine to a dryer section of the machine so that drying efficiency of the web and smoothness of the web surfaces are simultaneously improved and a transfer from the press section to the dryer section is stably ensured.

**[0008]** The object of the invention is achieved by each feature combination as defined in the independent claims.

**[0009]** Further advantageous developments and presently preferred embodiments of the invention are set forth in the dependent claims.

**[0010]** According to an aspect of the invention, a belt assembly for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine is provided. The belt assembly comprises a first press roll and a second press roll, which are arranged at the press section and which form a press nip, a drying roll, which is heatable and arranged downstream of the press nip in the web moving direction, and a heat conductive belt, which forms an endless loop and which is impervious to fluids runs through the press nip and contacts the drying roll, wherein the drying roll and the heat conductive belt form a tension nip which is extended in the web moving direction and in which the web is sandwiched between the drying roll and the heat conductive belt such that the web is simultaneously in contact with the drying roll and the heat conductive belt.

**[0011]** By the constitution of the belt assembly according to this aspect of the invention, in the press nip formed by the first and second press rolls, the web is transferred to the belt surface and is additionally dewatered in the press nip. Thus, the web transfer from the press section to the belt is stably ensured. Further, the heat conductive belt forms the extended tension nip in a downstream side with respect to the press side and the web moving direction. This tension nip is extended in the web moving direction. In this extended tension nip, the web is sandwiched between the drying roll and the heat conductive belt such that the web is simultaneously in contact with the drying roll and the heat conductive belt. By this con-

struction, since the belt wraps around (i.e. along the surface of) the drying cylinder which corresponds to the first drying cylinder of the dryer section, the tension nip extended in the web moving direction along the drying cylinder surface is provided. In this tension nip, the web is both heated by the drying cylinder and/or the, preferably preheated, belt and smoothed by the surfaces of the belt and the drying cylinder. Thus, the web is dried and smoothed simultaneously.

**[0012]** Therefore, according to the aspect of the invention, both surface sides of the web are smoothed in the extended tension nip since the web is sandwiched between the drying roll and the heat conductive belt. Thus, there is no need to provide an additional smoothing press in the dryer section.

**[0013]** According to the invention, at least the drying roll is heated in order to try the web from its surface side which directly contacts the surface of the drying roll. Heat transfer through the web also heats the heat conductive belt so that the web is also dried from its other surface side which directly contacts the surface of the belt in the extended tension nip, resulting in that the web can be efficiently heated and dried from both sides

**[0014]** By adjusting a wrapping angle of the belt around the drying roll surface, the tension of the belt is varied and, thus, by application of pressure in the extended tension nip forming a pressure contact zone, heat transfer for moisture removal from the web can be intensified, while the pressure applied to the web has a calendering or flattening effect on the web surfaces. That is, when the pressing load of the belt against the drying roll is increased by increasing the wrapping angle of the belt around the drying roll in the extended tension nip, the heat transfer to the web is improved. Thus, web smoothness is improved.

**[0015]** Besides, it has been found that the intensified drying effect while improving web quality (i.e. smoothness of the web) has the further effect that drying of the web can be carried out during a significantly shorter run of the web, so that the size of the dryer section can be considerably reduced. For example, the number of drying cylinders in the dryer section can be reduced.

**[0016]** Since the belt and the drying cylinder are in direct contact with the web surfaces in the extended tension nip along the web moving direction, smoothing effects of the web are provided and no wire markings occur on the web surfaces. Furthermore, there is no need for a provision of a transfer wire in the belt assembly of the invention.

**[0017]** In this respect, it is also noted that the web is interposed between two impervious surfaces in the extended tension nip so that the moisture is released from the web immediately when the web leaves the extended tension nip, i.e. when the two impervious surfaces start to separate, the moisture is allowed to escape from the web.

**[0018]** Preferably, the belt assembly further comprises a belt heating means adapted to heat the heat conductive belt. Here, since the heat conductive belt may be alternatively or additionally heated by belt heating means, the drying load of the web in the belt assembly can be further increased. By selecting (adjusting) the temperatures of the surface of the belt and/or the surface of the drying cylinder, the direction and intensity of moisture release can be controlled. For example, the temperature of the belt (surface which is in contact with the web) can be adjusted with respect to the temperature of the drying cylinder (cylinder surface thereof which contacts the web). In such an arrangement, if the side (surface) of the web being in contact with the belt is the cold side (i.e. temperature of the belt surface is lower than that of the surface of the drying cylinder forming a hot side), the moisture evaporated from the web driven by the heat from the hot side to the cold side.

**[0019]** Preferably, the belt heating means is arranged upstream of the press nip in the web moving direction. Here, the side of the web contacting the belt may be maintained at a higher temperature than the other press nip surface contacting the web, so that the moisture to be removed is condensed on the belt surface. Alternatively, the side of the web contacting the belt may be maintained at a lower temperature than the other press nip surface (lower support surface) contacting the web, so that the moisture to be removed is condensed on the lower support surface arranged below the belt surface contacting the other surface side of the web. Advantageously, the support surface may be a porous surface in the pores of which the condensed moisture is collected. The support surface may be a surface of a dewatering felt/fabric running through the press nip and contacting the web surface.

**[0020]** Preferably, the felt/fabric is interposed between the bottom side of the web and an impermeable support surface. In such an arrangement, if the side of the web which is exposed to the fabric is the cold side (the fabric is arranged between the web and the cold impermeable surface), the moisture evaporated from the web driven by the heat from the hot side is condensed and trapped in the fabric, so that an efficient transport of the moisture away from the web is obtained.

**[0021]** The press nip may be an extended nip in the web moving direction. The second press roll may be a shoe press roll. With this arrangement(s), significant moisture removal accompanied by pressing provides efficient water removal from the web already before entering the extended tension nip which may be the drying nip in the dryer section. Here, in the press nip, the web is additionally pressed against the impervious heat conductive belt by way of a pressing element (e.g. a shoe press roll or the like). The pressing element and the belt may form a press nip in which the pressure on the web in the pressure contact zone is locally increased. Using the pressing element, it is possible to control the pressure on the web in a desired pressure profile, that is, the pressure exerted on the web while being in the pressure contact zone is not constant but may follow a desired profile

of pressure increase or decrease. It is noted that this pressure profile is superimposed on the pressure exerted on the web due to its sandwiched position between two surfaces in the pressure contact zone. The pressure refers to the force with which the web is pressed against the respective surfaces.

**[0022]** Preferably, the belt assembly further comprises at least one impingement dryer for drying the web arranged downstream of the tension nip formed by the drying roll and the heat conductive belt in the web moving direction. Further, another tension nip, which is formed between another drying roll and the belt, which is extended in the web moving direction and in which the web is sandwiched between the another drying roll and the belt such that the web is simultaneously in contact with the another drying roll and the belt, may be arranged between subsequent impingement dryers in the web moving direction. Here, the combination of the belt assembly and the at least one impingement dryer may increase the dry content of the web before entering the dryer section in order to further reduce the size of the dryer section using several drying cylinders. Thus, improved web quality and a high dry content before cylinder drying in the dryer section are provided. Further, due to the high dry content of the web when using the impingement dryer, the runnability of the web to and in the dryer section is stable. Further, the temperature and tension in the extended tension nip as well as the drying conditions of the impingement dryer can be controlled and adjusted to each other further improving the runnability of the web and the web grade. These parameters can be suitably adjusted for different uses of web grades (e.g. paper or board grades).

**[0023]** Preferably, the belt assembly may comprise a ventilation zone provided immediately after leaving the tension nip in the web moving direction, in which zone a boundary layer removal (removing) means is arranged to blow and suck off gas introduced in the web in the nip from the web. Here, firstly the boundary layer is blown with, e.g. dry and warm (e.g. preheated) air to enhance evaporation and exchange the evaporated gases. Then, said gas introduced in the web and/or evaporating moisture can be removed by suction. For this purpose, preferably, the ventilation zone having blowing and suction means for removing the boundary layer is arranged at a position where running directions of the belt surface and of the drying cylinder deviate from each other and expose the web, so that gas introduced in the web and/or moisture evaporating from the exposed web can be sucked off. The boundary layer suction means may comprise at least one of the following elements: a blowing nozzle, a suction box, an air knife, a blow box and a doctor blade.

**[0024]** Preferably, the belt assembly further comprises a heating means for heating the back side of the belt which is arranged/positioned opposite to the side of the belt that is in contact with the web, wherein the heating means is arranged along the extension of the tension nip in the web moving direction. A compact and reliable heating structure along the circumference of the drying roll can be provided. The heat for heating the back side of the belt can directly be used for dewatering the web running through the tension nip. Thus, heat loss is avoided since the heating means are arranged/positioned at positions in the belt assembly where the thus heated belt supports the heat transfer to the web for evaporating moisture from the web. In other words, at the same time, the belt is heated from the back side it releases heat via the belt surface contacting the web.

**[0025]** Preferably, at least one steam box or hot fluid box is provided on one or both sides of the belt as the heating means for heating the belt. If the steam box or hot fluid box is operated such that condensation occurs on the belt surface to be heated, a very efficient heat transfer can be obtained allowing the transfer of large amounts of heat into the web to be dried, so that quick and effective drying can be obtained.

**[0026]** A contact period of the web between the drying roll and the belt along the nip in the web moving direction may be 10 to 400 ms. Temperatures of the belt and/or the drying roll contacting the web (preferably the surfaces thereof) may be 80 to 150 °C, advantageously 95 to 120 °C.

**[0027]** It is preferred that the drying roll is a first drying cylinder arranged in the dryer section. The drying roll may also form the last press nip in the press section. Thus, both the size of the press section and the size of the dryer section can be further reduced.

**[0028]** Preferably, the heat conductive belt is made of metal. It is also possible that said belt used in the belt assembly is made of one of a metal, synthetic, or ceramic material, or of various different combinations of at least two of these materials. However, most preferably, the belt is a metal belt. In case the belt material is made of metals, synthetics and/or ceramics, a corresponding hardness, durability and heat transfer capacity of the belt are achieved. Such materials exhibit only small deterioration phenomenon during operations of the belt, so that the belt assembly has good performance characteristics throughout its durability, especially the belt. Further, the heat transfer capacity of the belt supports a dewatering effect and/or and drying effect of the web while the web is moved along the extended nip and sandwiched between the drying roll and the belt during passage of the web through the nip.

**[0029]** Preferably, the belt assembly further comprises at least one stretcher/guiding roll, which is arranged between or within the press section and/or the dryer section, such that the belt runs over the at least one stretcher/guiding roll.

**[0030]** According to another aspect of the invention, a method for moving a web from a press section of a paper- or board-making machine to a dryer section of the machine is provided. The method comprises the steps of: forming a press nip between a first press roll and a second press roll which are arranged at the press section; pressing the web running through the press nip within the press nip; traveling a belt that is thermally conductive and im-

pervious to fluids through the press nip in an endless loop such that the web is taken over to the belt within the press nip; heating a drying roll arranged downstream of the press nip in the web moving direction; forming a tension nip extended in the web moving direction between the belt and the drying cylinder; and travelling the web contacting and being disposed on the belt along the extended tension nip such that the web is sandwiched between the drying roll and the belt and is simultaneously in contact with the drying roll and the heat conductive belt.

**[0031]** By this method, the same effects and advantages can be achieved as mentioned above when describing the aspect of the invention.

Brief description of the drawings

**[0032]** The invention is described in more detail below, referring to the embodiments shown in the accompanying drawings, to which the invention is not restricted.

Fig. 1 schematically shows a belt assembly according to a first embodiment of the invention, in which a metal belt loop is arranged between a press section and a dryer section.

Fig. 2 schematically shows a belt assembly according to a second embodiment of the invention.

Fig. 3 schematically shows a belt assembly according to a third embodiment of the invention.

Fig. 4 schematically shows heating constitutions for heating the belt assembly of the invention.

Fig. 5 schematically shows a belt assembly according to a fourth embodiment of the invention, in which an additional impingement dryer is used.

Fig. 6 schematically shows another belt assembly according to the invention, in which an additional impingement dryer is used.

Fig. 7 schematically shows another belt assembly according to the invention, in which an impingement dryer with a big wrap roll is used.

Description of the preferred embodiments

**[0033]** Fig. 1 schematically shows a belt assembly according to a first embodiment of the invention, in which a metal belt loop is arranged between a press section 100 and a dryer section 200.

**[0034]** The belt assembly is adapted to move a web W from the press section 100 (arranged on the left side in Fig. 1) of a paper- or board-making machine to the dryer section 200 (see right side in Fig. 1) of the machine. The belt assembly is thus arranged between the press section 100 and the dryer section 200 in respect of the moving direction of the web W. The belt assembly is used in the paper- or board-making machine for removing fluids from the web W (i.e. for adjusting the dry content of the web W before entering the dryer section using drying cylinders).

**[0035]** In the belt assembly, a first press roll 10 and a second press roll 11 form a press nip $N_1$. These press rolls 10, 11 are arranged at the press section 100 and form the last press nip $N_1$ in this press section in the web moving direction. A drying roll 12 which is heatable (e.g. by using paper plant steam flowing through the roll longitudinal direction, which is transverse to the web moving direction, i.e. through the machine direction; or which is formed as a thermo roll having electrical heating elements in its shell or barrel surface) and arranged downstream of the press nip $N_1$ in the web moving direction.

**[0036]** Another drying roll (here: second drying roll) 12 which is also heatable and arranged downstream of the press nip $N_1$ as well as of the first drying roll 12 in the web moving direction is provided. This second drying roll 12 already forms the second drying roll (drying cylinder) of the dryer section 200.

**[0037]** Furthermore, a stretcher/reversing roll 13 is arranged between the two drying rolls 12 with respect to the web moving direction in order to adjust a belt tension, e.g. by moving the position of the roll axis with respect to the positions of the drying rolls 12. Two guiding rolls 14 and 14 are arranged to the reversing loop of belt upstream of the press nip $N_1$ in a belt loop moving direction, respectively.

**[0038]** As shown in Fig. 1, a heat conductive belt 20 which is preferably made of metal (a so-called metal belt) is arranged to pass along the first press roll 10, the drying roll 12, the reversing roll 13, the second drying roll 12 and the two guiding rolls 14, so that the heat conductive belt 20 forms an endless loop in the belt assembly. Stretching/guiding rolls can be one or two of the rolls 13, 14 so that the belt 20 can be provided with necessary tension and cross direction guiding control.

**[0039]** The heat conductive belt 20 is impervious to fluids and runs through the press nip $N_1$ and through a tension nip $N_2$ which is formed by (between) the drying roll 12 and the belt 20. Besides, the heat conductive belt 20 is extended in the web moving direction along the cylinder surface of the drying roll 12.

**[0040]** Thus, the drying roll 12 and the heat conductive belt 20 form the tension nip $N_2$ in which the web W is sandwiched between the drying roll 12 and the heat conductive belt 20 such that the web W is simultaneously in contact with the drying roll 12 and the heat conductive belt 20. In the nip $N_2$, both surface sides of the web W can be smoothed by the cylinder surface and the belt surface.

**[0041]** Further, since the drying roll 12 is heated and the belt 20 is heat conductive, an efficient heating of the web W from both sides is provided. In particular, since the heat conductive belt 20 forms the tension nip $N_2$ which is extended in the web moving direction along the surface

of the drying roll 12, a belt tension is provided which also improves a heat transfer process. For example, by adjusting a wrapping angle of the belt 20 around the drying roll surface, the tension of the belt 20 can be varied and thus by application of pressure in the extended tension nip $N_2$ forming a pressure contact zone, heat transfer for moisture removal from the web W can be intensified, while the pressure applied to the web W has a calendering or flattening effect on the web surfaces. That is, when the pressing load of the belt 20 against the drying roll 12 is increased by increasing the wrapping angle of the belt 20 around the drying roll 12 in the extended nip $N_2$, the heat transfer to the web is improved. Thus, web smoothness can be improved.

**[0042]** Furthermore, since no transfer wire or other wire arrangements are provided between both web surfaces and the cylinder surface of the drying roll 12 and the surface of the belt 20, which are in direct contact with the respective web surfaces, a stable heat transfer can be provided and no heat is transferred to wires running trough the nip $N_2$.

**[0043]** As can be also seen from Fig. 1, the belt assembly also comprise a ventilation zone provided immediately after leaving the tension nip $N_2$ in the web moving direction. In this zone, a boundary layer removal (removing) means 25 is arranged to blow and suck off gas introduced in the web W in the nip from the web W. Here, firstly the boundary layer is blown with, e.g. dry and warm (e.g. preheated) air to enhance evaporation and exchange the evaporated gases. Then, said gas introduced in the web W and/or evaporating moisture can be removed by suction. For this purpose, in the ventilation zone, the boundary layer removal (removing) means 25 is provided between the drying roll 12 and the reversing roll 13 in the web moving direction. Here, said means 25 has a blowing and suction means (e.g. a blowing nozzle followed by a suction portion/box) for removing the boundary layer and which is arranged at a position where running directions of the belt surface and of the drying roll deviate from each other and expose the web, so that gas introduced in the web and/or moisture evaporating from the exposed web can be sucked off. The boundary layer suction means may comprise at least one of the following elements: a blowing nozzle, a suction box, an air knife, a blow box and a doctor blade.

**[0044]** As further shown in Fig. 1, when the web W runs (moves) from the press section 100 to the dryer section 200, the web W is supported by a fabric (felt/transfer wire) 50, 51, the belt 20 and a drying wire 61 at respective transfer positions as shown in Fig. 1.

**[0045]** As can be seen from Fig. 1, the web W is supported by the felt 51 and the other side of the web, which is not in contact with the felt 51, gets in contact with the surface of the belt 20 upstream of the press nip $N_1$ by moving the felt 51 in its felt loop direction. Then, the belt 20 supporting the web W moves along (around) the first press roll 10. In other words, running of the web W through the press nip $N_1$ is guided by the belt 20 and the felt 51. Thus, the web W which is supported by the felt 51 and the belt 20 is moved through the press nip $N_1$ which is formed by the first press roll 10 and the second press roll 11.

**[0046]** As shown in Fig. 1, the second press roll 11 is a shoe press roll so that the pressure load profile along the press nip $N_1$ may be adjusted. In the press nip $N_1$, the transfer of the web from the felt 51 to the belt 20 is provided such that downstream of the press nip $N_1$ in the web moving direction, the web W is only supported (carried) by the belt 20.

**[0047]** Here, the press nip $N_1$ is the extended nip in the web moving direction and the second press roll 11 is the shoe press roll. With this arrangement(s), significant moisture removal accompanied by pressing provides efficient water removal from the web W already before entering the extended tension nip $N_2$ which is the first drying nip in the dryer section 200. In the press nip, the web is pressed against the impervious heat conductive belt 20 by the shoe press roll in order to form a press nip in which the pressure on the web W in the pressure contact zone is locally increased. Using the shoe press roll, it is possible to control the pressure on the web W in a desired pressure profile, that is, the pressure exerted on the web W while it is in the pressure contact zone is not constant but may follow a desired profile of pressure increase. The pressure in the nip $N_1$ refers to the force with which the web W is pressed against the respective surfaces of the felt 51 and of the belt 20.

**[0048]** The felt 51 forms a support surface for the web W and has a porous surface in the pores of which the water of the web W due the pressure in the nip $N_1$ is collected. Thus, the support surface is a surface of the felt 51, which is preferably formed as a dewatering felt running through the press nip $N_1$ and contacting the web surface.

**[0049]** Then the web W which is supported on the belt 20 runs through the tension nip $N_2$ which is the extended tension nip $N_2$ in the web moving direction and in which the web W is sandwiched between the drying roll 12 and the heat conductive belt 20. In particular, in this extended tension nip $N_2$, the web is sandwiched between the drying roll 12 and the heat conductive belt 20 such that the web is simultaneously in contact with the drying roll and the heat conductive belt. By this arrangement, since the belt 20 wraps around (i.e. along the surface of) the drying roll 12 which corresponds to the first drying cylinder of the dryer section 100, the tension nip as such extended in the web moving direction along the drying cylinder surface is provided. In this tension nip, the web W may be heated by the drying roll 12 and/or the, preferably preheated, belt 20 and smoothed by the surfaces of the belt 20 and the drying roll 12. Thus, the web W is dried and smoothed simultaneously. In other words, both surface sides of the web W are smoothed in the extended tension nip $N_2$ since the web W is sandwiched between the drying roll 12 and the heat conductive belt 20.

**[0050]** According to this embodiment, at least the dry-

ing roll 12 may be heated in order to try the web W from its surface side which directly contacts the surface of the drying roll 12. Heating means can be also provided on the other side of the belt 20. So, the web W can be efficiently heated and dried from both sides of the web.

**[0051]** By adjusting the wrapping angle of the belt 20 around the drying roll surface, the tension of the belt 20 can be varied and thus, by application of pressure in the extended tension nip $N_2$ forming a pressure contact zone, heat transfer for moisture removal from the web W can be intensified, while the pressure applied to the web W has a smoothening (i.e. calendering or flattening) effect on the web surfaces. That is, when the pressing load of the belt 20 against the drying roll 12 is increased by increasing the wrapping angle of the belt 20 around the drying roll 12 or tension in the extended tension nip $N_2$, the heat transfer to the web W can be improved. Thus, web smoothness is improved.

**[0052]** After the web W has been moved through the tension nip $N_2$, the web W supported on the belt 20 and the belt 20 move along the reversing roll 13 (along its outer circumference) to the second drying roll 12. At this point, the web W is transferred to the surface of the second drying roll 12 in another extended tension nip $N_3$, wherein the second drying roll 12 corresponds to the second drying roll (drying cylinder) in the dryer section 200.

**[0053]** Then, the web W guided along the surface of the second drying roll 12 is handed over to a wire (i.e. the drying wire 61) of the dryer section 200 (forming a so-called "single tier dryer section arrangement) and is then running along common drying cylinders of the dryer section 200 which is known from the prior art and is thus not further described in detail.

**[0054]** By the arrangement of the present embodiment according to the invention, i.e. by providing the described belt assembly for moving the web W from the press section 100 of the paper- or board-making machine to the dryer section 200 of the machine, it has been found that, due to the intensified drying effect in the extended tension nips $N_1$, $N_2$ while improving the web quality (i.e. smoothness of the web W) in the extended tension nips $N_2$, $N_3$ as mentioned above, drying of the web W can be carried out during a significantly shorter run of the web W, so that the size of the dryer section 100 may be considerably reduced compared to a common dryer section in which such a belt assembly is not provided. Thus, the number of drying cylinders within the dryer section can be reduced.

**[0055]** Fig. 2 schematically shows a modification of the embodiment of Fig. 1, which has been described above in detail, as a second embodiment of the invention. The arrangements, devices and operation in the present modification of the belt assembly are substantially the same, so that the basic structure will not be described again, but it is here focused on the difference between the first embodiment and the present embodiment shown in Fig. 2. Furthermore, the same reference signs as in Fig. 1 are used for the same or functionally same elements in the assembly of Fig. 2, so that the above description of these elements also applies for Fig. 2.

**[0056]** The difference to the first embodiment as mentioned above is that the web W is transferred to a first drying wire 61 arranged in the dryer section 200 so that the web W is supported on the first drying wire 61 along the second drying cylinder of the dryer section 200. In the dryer section 200 as shown in Fig. 2, a second drying wire 62 is provided in order to guide the web in the dryer section 200 by means of the first drying wire 61 and/or the second drying wire 62 in the common way through the dryer section. This arrangement is a so-called "double tier dryer section arrangement" which is known from the prior art and is thus not further described in detail.

**[0057]** Fig. 3 schematically shows a third embodiment of a belt assembly of the invention. Similar elements or functionally similar elements as in the first embodiment have the same reference signs in Fig. 3, so that a detailed description thereof is omitted here. The respective description of the first embodiment also applies to the third embodiment and is included herein by way of reference to the above.

**[0058]** In Fig. 3, in the belt assembly according to the third embodiment, the drying roll 12 which corresponds to the first drying cylinder of the dryer section 200 forms the extended tension nip $N_2$ together with the belt 20, wherein downstream of the extended tension nip $N_2$ in respect of the web moving direction, a transfer nip $N_4$ is formed between the surface of the drying roll 12 and the drying wire 61. Here, the web W guided along the surface of the drying roll 12 is handed over to the drying wire of the dryer section 200 which is formed as the so-called "shingle tier dryer section arrangement. Thus, compared to the first embodiment, the second drying roll is omitted. Thus, the size of the belt assembly is further reduced.

**[0059]** In Fig. 4, a belt assembly according the invention is schematically shown, wherein similar elements or functionally similar elements as in the first embodiment have the same reference signs in Fig. 4, so that a detailed description thereof is omitted here. The respective description of the first embodiment also applies to the present embodiment and is included herein by way of reference to the above.

**[0060]** In Fig. 4, different positions and arrangements of heating chambers 40, 70 for heating the belt 20 (i.e. its belt surfaces) are provided.

**[0061]** That is, e.g. a heating chamber 70 can be provided as shown in Fig. 4 which is adapted to heat both sides of the belt 20. Respective positions for arrangement of these chambers in the belt assembly are gathered from the figure. Furthermore, it is alternatively and/or additionally possible to provide a heating chamber 40 which is arranged such that the heating chamber faces along the surface (i.e. follows/contours the surface shape or formed in conformity with the surface shape) of the drying roll(s) 12 as shown in Fig. 4.

**[0062]** Furthermore, as shown in Fig. 5 and 6, a belt assembly according to a fourth embodiment of the inven-

tion is schematically shown. Similar elements or functionally similar elements as in the first embodiment have the same reference signs in Fig. 5, so that a detailed description thereof is omitted here. The respective description of the first embodiment also applies to the third embodiment and is included herein by way of reference to the above.

**[0063]** Here, according to the belt assembly shown in Fig. 5, there is provided another metal belt 21 for transferring the web W to a normal single tier dryer section 200.

**[0064]** Further, according to the belt assembly shown in Fig. 5, there is provided an impingement dryer 80 arranged downstream of the tension nip $N_2$ formed by the drying roll 12 and the heat conductive belt 20 in the web moving direction in order to further increase the drying content of the web W. The respective constitution of such an impingement dryer when provided in a belt assembly is also shown in Fig. 6.

**[0065]** Here, the inventors have found that it is advantageous to combine the belt assembly having the extended dewatering nip $N_1$ and the extended drying and smoothing tension nip $N_2$ in which the web W is simultaneously in contact with the surface of the drying roll 12 and the surface of the heat conductive belt 20 with the impingement dryer 80 before the web W runs through cylinder drying of the dryer section 200. By such an arrangement, the conditions in the nips (temperature of the roll and/or belt, nip pressure, moving speed of the web, etc.) as well in the impingement dryer (temperature, impingement fluid speed, etc.) can be suitably controlled (i.e. coordinated to each other) in order to set optimum web quality, runnability and web (paper- or board) grade.

**[0066]** In Fig. 7, another belt assembly according to the invention is shown, in which an impingement dryer 90 having a big roll 92 (a roll having a big diameter compared to the other drying rolls and drying cylinders of the belt assembly or the dryer section) is used. This big roll 92 generally has a diameter which is two to four times greater than the other drying rolls and drying cylinders used. Around the surface of the big roll 92, an impingement chamber 94 is provided. Thus, the same or even a longer process time compared to the impingement dryers shown in Fig. 5 to 7 can be achieved since the contact surface of the big roll with the web W in the web moving direction is the same as or even greater than it is by the solutions shown in Fig. 5 to 7. Thus, a compact impingement dryer structure can be provided.

**[0067]** According to the above solutions having the impingement dryer(s), web quality can further be improved and dry content of the web can further be increased before the web is dried with the common drying cylinder in the dryer section.

**[0068]** The impingement drying can be executed with gas or steam heaters.

**[0069]** Since the belt and the drying roll are in direct contact with the web surfaces in the extended nip along the web moving direction, smoothing effects of the web are provided and no wire markings occur in the web surfaces because it is not necessary to provide a wire in the belt assembly of the invention.

**[0070]** It is also noted in this respect that the web is interposed between two impervious surfaces in the extended tension nip so that the moisture is released from the web immediately when the web leaves the extended tension nip; i.e. when the two impervious surfaces start to separate, the moisture is allowed to escape from the web. Preferably, the belt assembly may comprise a ventilation zone provided immediately after leaving the tension nip in the web moving direction, in which zone a boundary layer removing means is arranged to blow and suck off gas introduced in the web from the web. Here, gas introduced in the web and/or evaporating moisture can be removed by suction. For this, preferably, the ventilation zone having the boundary layer removing means is arranged at a position where running directions of the belt surface and of the drying cylinder deviate from each other and expose the web, so that gas introduced in the web and/or moisture evaporating from the exposed web can be sucked off. The boundary layer removing means may comprise at least one of the following elements: a blowing means, a suction box, an air knife, a blow box and a doctor blade.

## Claims

1. Belt assembly for moving a web (W) from a press section (100) of a paper- or board-making machine to a dryer section (200) of the machine, comprising
   a first press roll (10) and a second press roll (11) which are arranged at the press section (100) and form a press nip ($N_1$),
   a drying roll (12) which is heatable and arranged downstream of the press nip ($N_1$) in the web moving direction, and
   a heat conductive belt (20) which forms an endless loop and which is impervious to fluids runs through the press nip (N) and contacts the drying roll (12), wherein
   the drying roll (12) and the heat conductive belt (20) form a tension nip ($N_2$) which is extended in the web (W) moving direction and in which the web (W) is sandwiched between the drying roll (12) and the heat conductive belt (20) such that the web (W) is simultaneously in contact with the drying roll (12) and the heat conductive belt (20).

2. Belt assembly according to claim 1, further comprising a belt heating means (12; 40; 70) adapted to heat the heat conductive belt (20).

3. Belt assembly according to claim 2, wherein the belt heating means (70) is arranged upstream of the press nip ($N_1$) in the web moving direction.

4. Belt assembly according to any of the preceding

claims, wherein the press nip ($N_1$) is an extended nip ($N_1$) in the web moving direction.

**5.** Belt assembly according to claim 4, wherein the second press roll (11) is a shoe press roll.

**6.** Belt assembly according to any of the preceding claims, further comprising at least one impingement dryer (80; 90) for drying the web (W) arranged downstream of the tension nip ($N_2$) formed by the drying roll (12) and the heat conductive belt (20) in the web moving direction.

**7.** Belt assembly according to claim 6, wherein another tension nip ($N_3$), which is formed between another drying roll (12) and the belt (20), which is extended in the web moving direction, and in which the web (W) is sandwiched between the another drying roll (12) and the belt (20) such that the web (W) is simultaneously in contact with the another drying roll (12) and the belt (20), is arranged between subsequent impingement dryers (80) in the web moving direction.

**8.** Belt assembly according to any of the preceding claims, further comprising a ventilation zone provided immediately after leaving the tension nip in the web moving direction, in which zone a boundary layer removing means is arranged to blow and suck off gas introduced in the web from the web.

**9.** Belt assembly according to any of the preceding claims, further comprising a heating means (40) for heating the back side of the belt (20) which is opposite to the side of the belt (20) that is in contact with the web (W), wherein the heating means (40) is arranged along the extension of the tension nip ($N_2$) in the web moving direction.

**10.** Belt assembly according to any of the preceding claims, wherein a contact period of the web (W) between the drying roll (12) and the belt (20) along the tension nip ($N_2$) in the web moving direction is 10 to 400 ms.

**11.** Belt assembly according to any of the preceding claims, wherein the drying roll (12) is a first drying cylinder (12) arranged in the drying section (200).

**12.** Belt assembly according to any of the preceding claims, wherein a temperature of surfaces of the belt (20) and/or the drying roll (12) contacting the web (W) is 80 to 150 °C, advantageously 95 to 120 °C.

**13.** Belt assembly according to any of the preceding claims, wherein the heat conductive belt (20) is made of metal.

**14.** Belt assembly according to any of the preceding claims, further comprising at least one stretcher/guiding roll (13, 14), which is arranged between or within the press section (100) and/or the dryer section (200), such that the belt (20) runs over the at least one stretcher/guiding roll (13, 14).

**15.** A method for moving a web (W) from a press section (100) of a paper- or board-making machine to a dryer section (200) of the machine, comprising
forming a press nip ($N_1$) between a first press roll (10) and a second press roll (11) which are arranged at the press section (100),
pressing the web (W) running through the press nip ($N_1$) within the press nip ($N_1$),
traveling a belt (20) that is thermally conductive and impervious to fluids through the press nip ($N_1$) in an endless loop such that the web (W) is taken over to the belt (20) within the press nip ($N_1$),
heating a drying roll (12) arranged downstream of the press nip ($N_1$) in the web moving direction,
forming a tension nip ($N_2$) extended in the web moving direction between the belt (20) and the drying cylinder (12), and
travelling the web (W) contacting and being disposed on the belt (20) along the extended tension nip ($N_2$) such that the web (W) is sandwiched between the drying roll (12) and the belt (20) and is simultaneously in contact with the drying roll (12) and the heat conductive belt (20).

FIG. 1

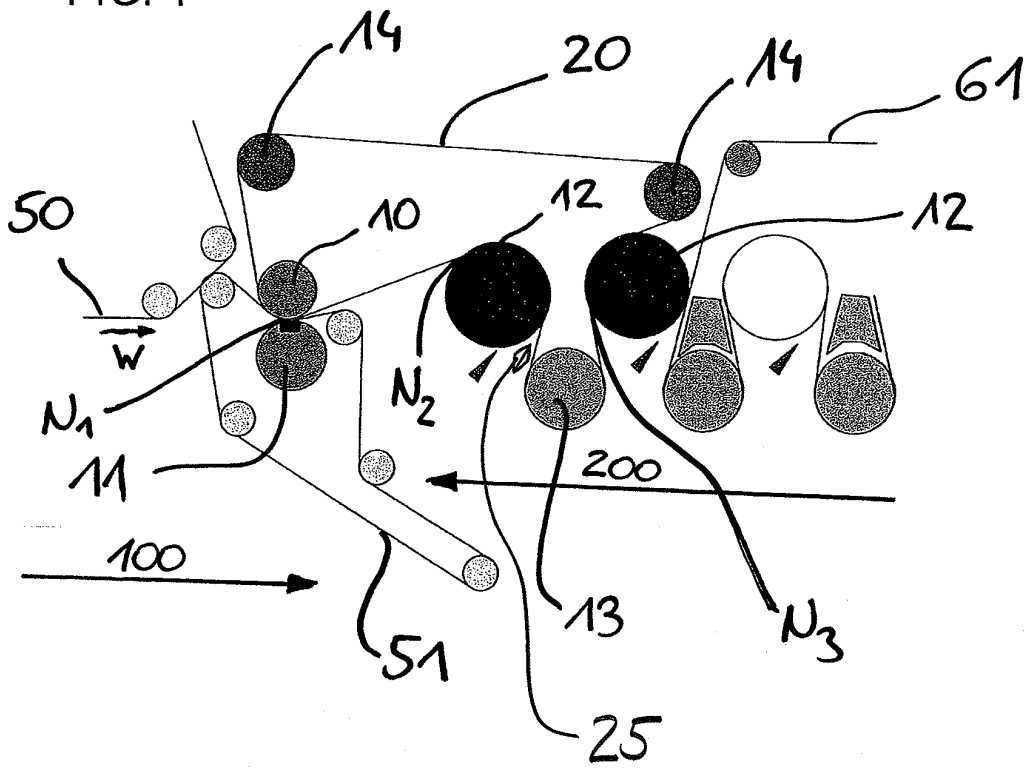


FIG. 2

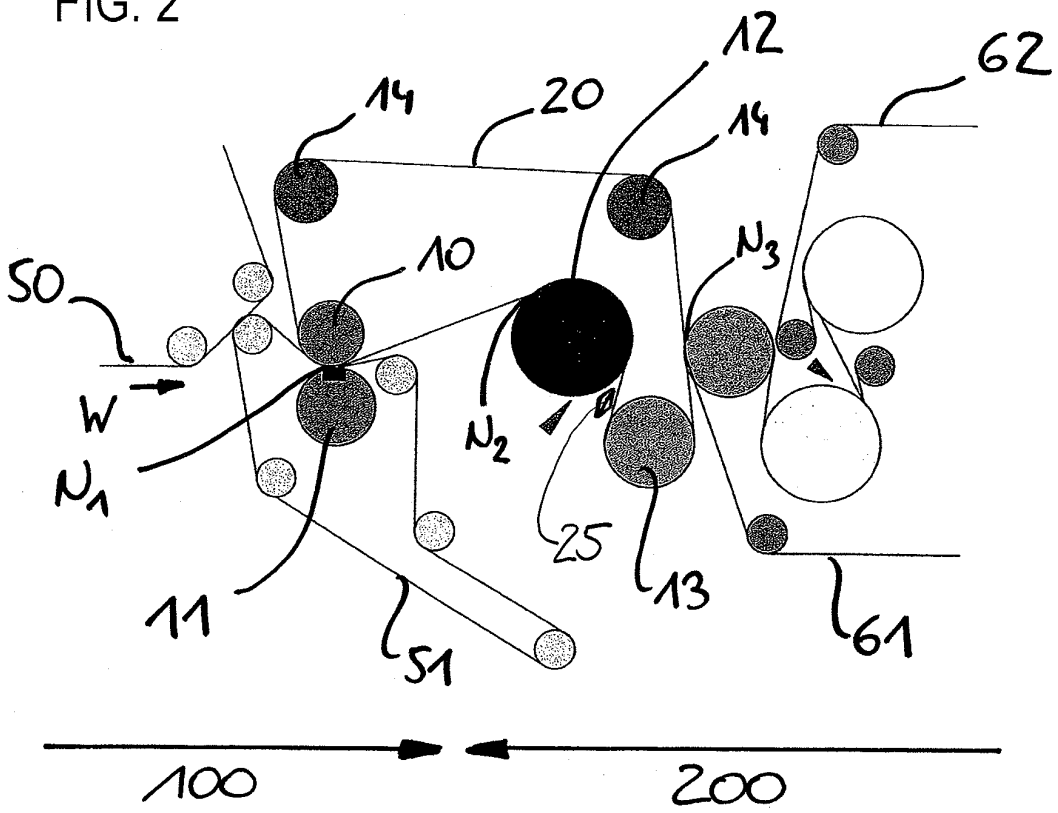


FIG. 3

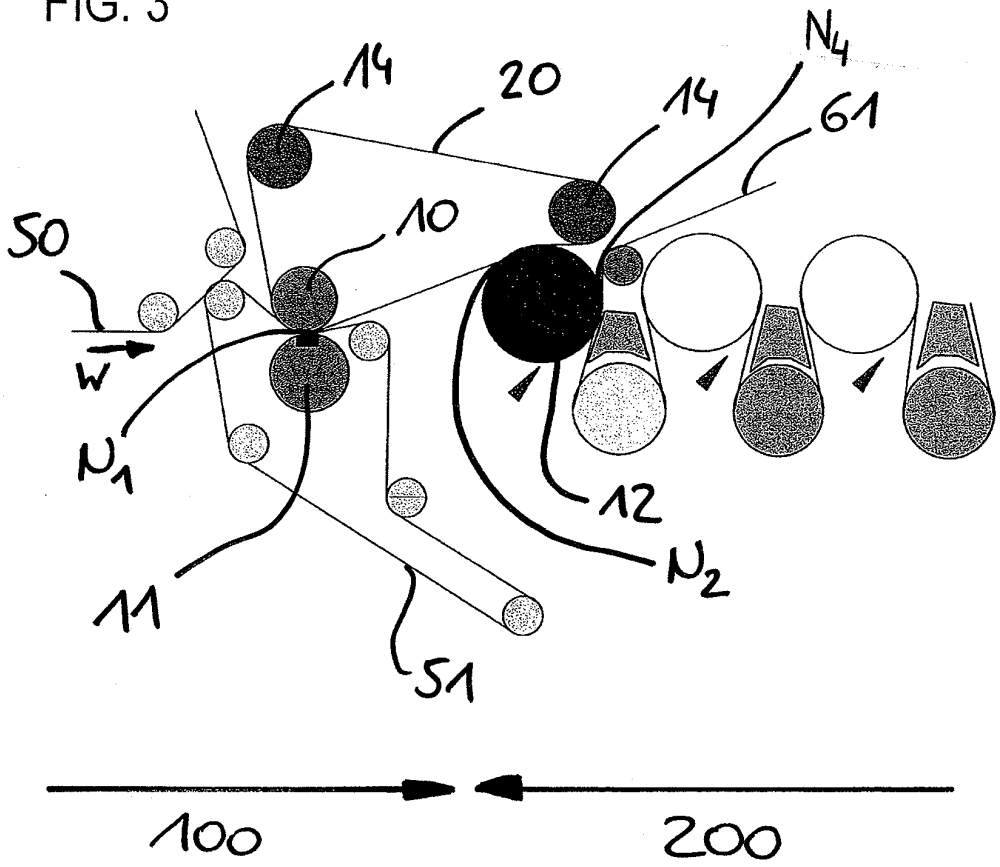


FIG. 4

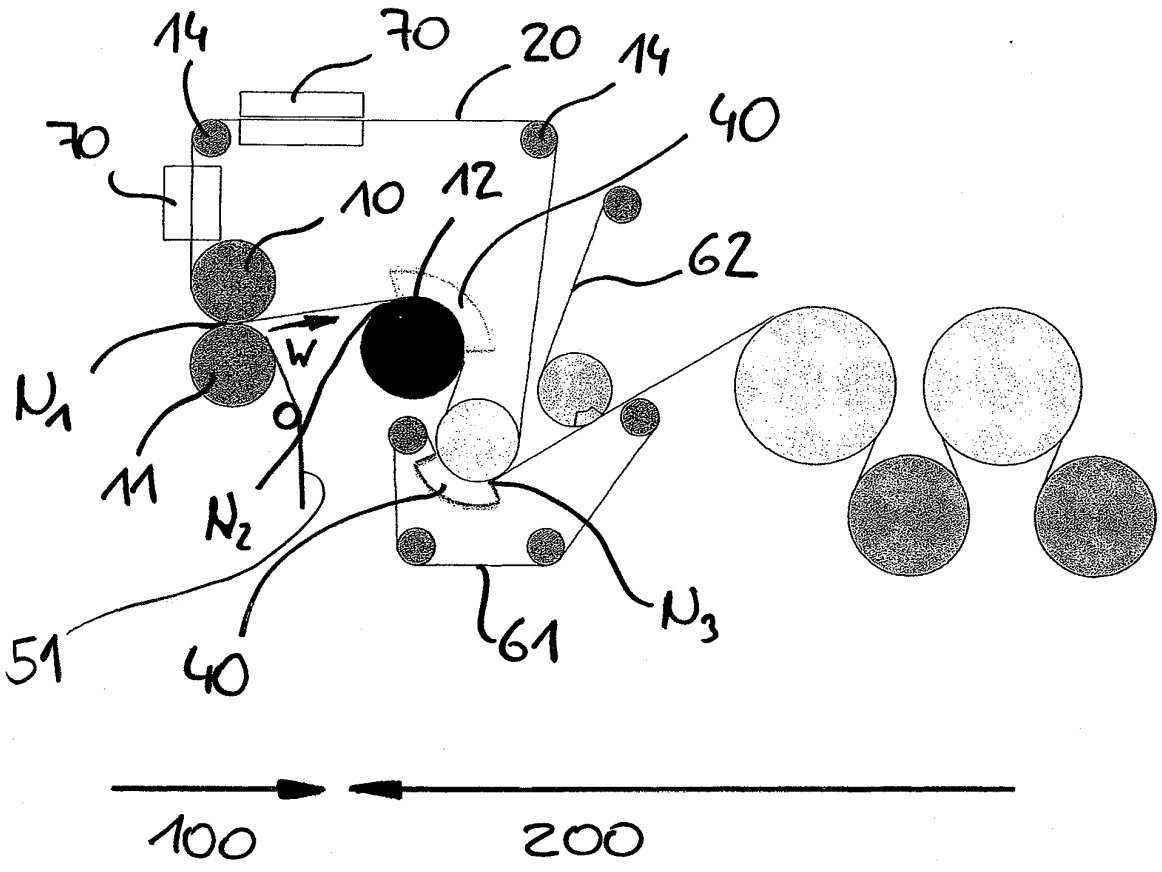


FIG. 5

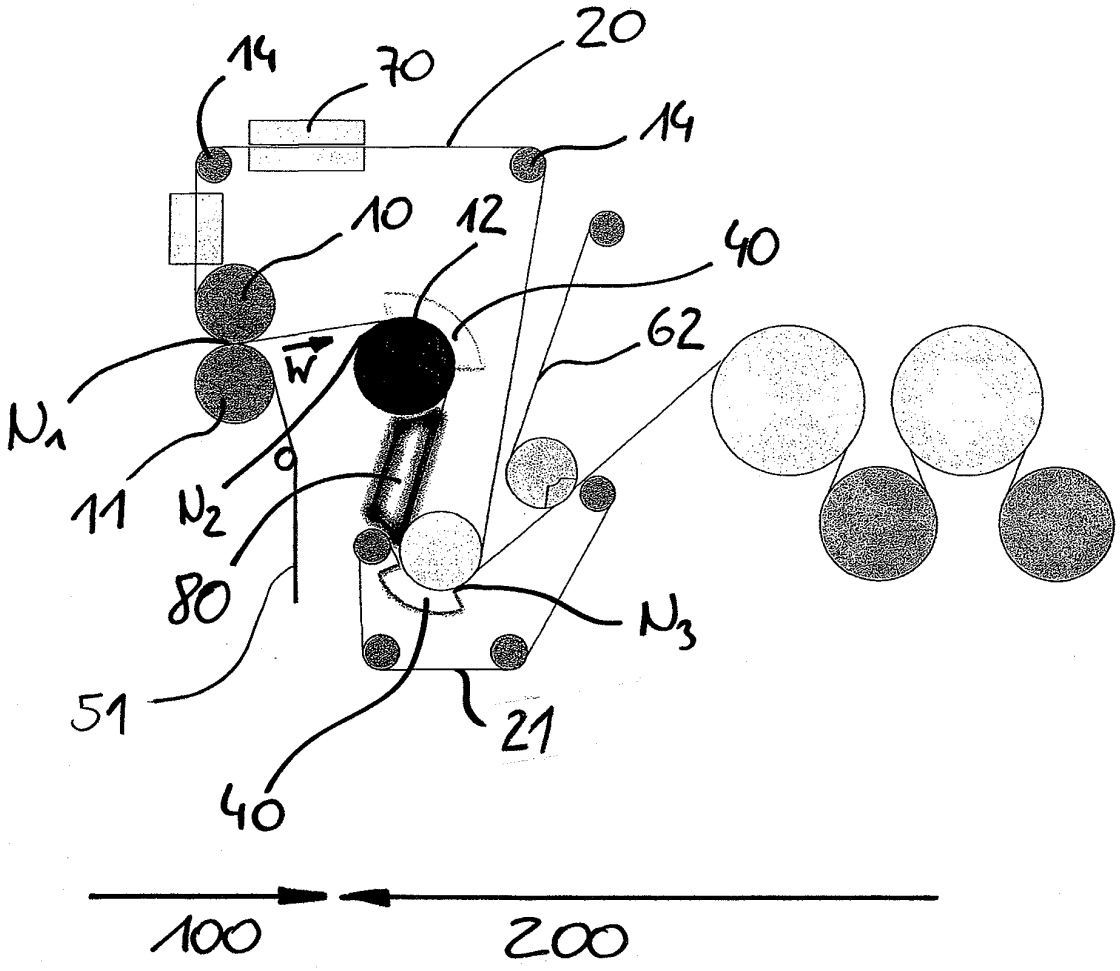


FIG. 6

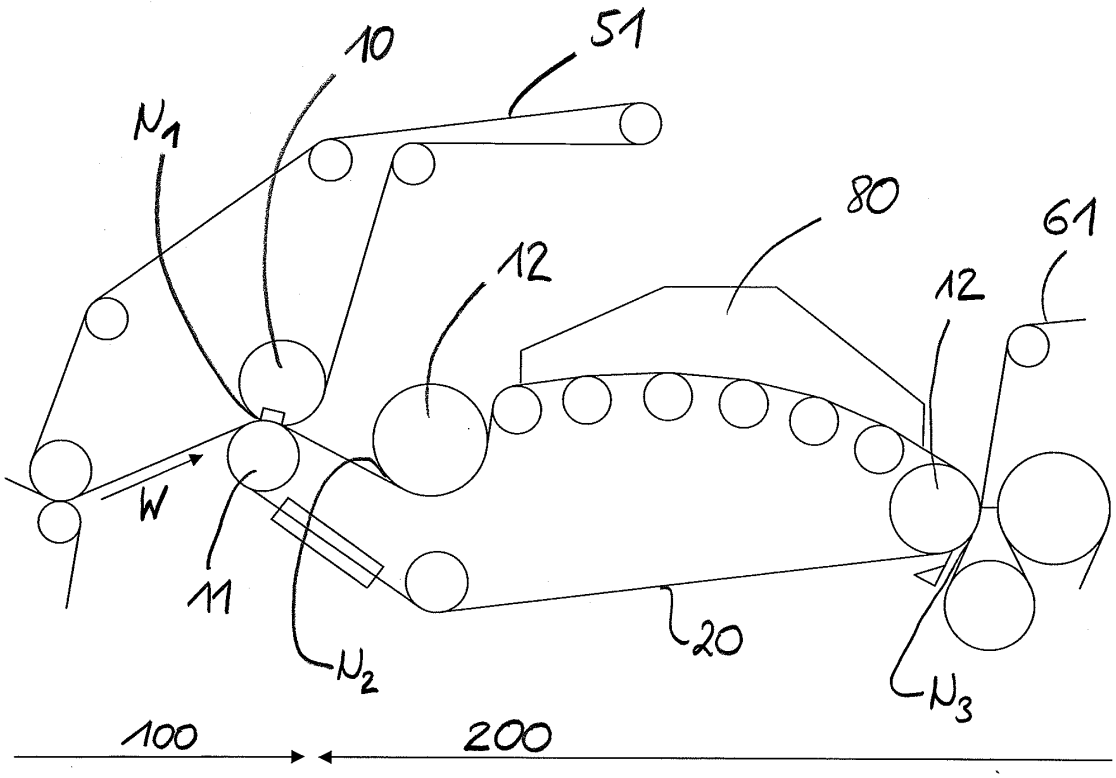
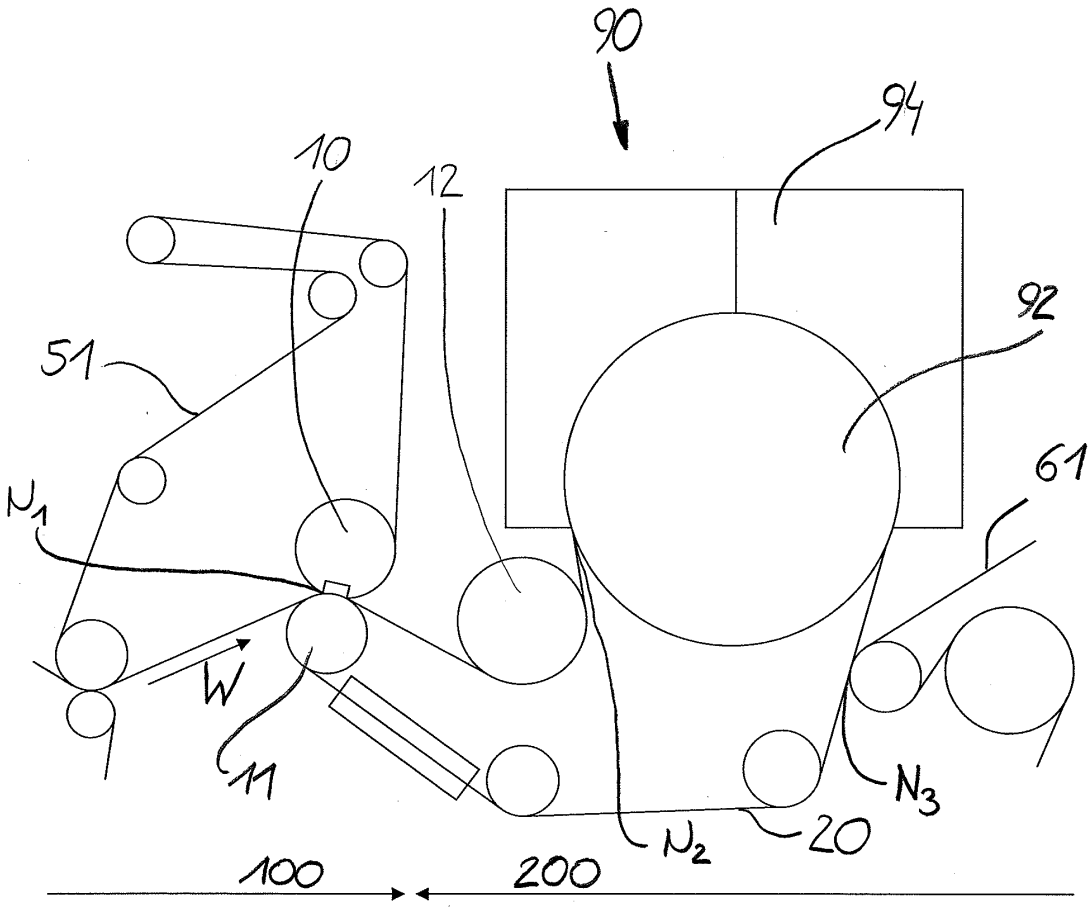


FIG. 7



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# EUROPEAN SEARCH REPORT

Application Number
EP 12 18 9018

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | DE 10 2012 202535 A1 (METSO PAPER INC [FI]) 23 August 2012 (2012-08-23)<br>* paragraphs [0040] - [0046]; figure 4 *<br>----- | 1-5, 10-15 | INV.<br>D21F2/00<br>D21F3/02<br>D21F3/04 |
| A | WO 2008/000885 A1 (METSO PAPER INC [FI]; RAEISAENEN KARI [FI]; LAAPOTTI JORMA [FI]; HONKA) 3 January 2008 (2008-01-03)<br>* the whole document *<br>----- | 1-15 | D21F5/00<br>D21F5/02<br>D21F5/18 |
| A | EP 2 063 021 A1 (METSO PAPER INC [FI]) 27 May 2009 (2009-05-27)<br>* the whole document *<br>----- | 1-15 | |

TECHNICAL FIELDS SEARCHED (IPC)

D21F

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 13 March 2013 | Pregetter, Mario |

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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 18 9018

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13-03-2013

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE 102012202535 A1 | 23-08-2012 | DE 102012202535 A1 | 23-08-2012 |
| | | FI 20115178 A | 24-08-2012 |
| WO 2008000885 A1 | 03-01-2008 | FI 20065447 A | 29-12-2007 |
| | | WO 2008000885 A1 | 03-01-2008 |
| EP 2063021 A1 | 27-05-2009 | AT 523630 T | 15-09-2011 |
| | | CN 101463576 A | 24-06-2009 |
| | | EP 2063021 A1 | 27-05-2009 |
| | | EP 2072673 A1 | 24-06-2009 |
| | | EP 2369053 A1 | 28-09-2011 |

EPO FORM P0459

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