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(54) **SMOOTHING DEVICE**

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(57) **ABSTRACT**

A smoothing device of a press arrangement for dewatering a fibrous web in a machine for producing or finishing the fibrous web including a rough belt, a smooth belt and a smoothing element. The rough belt being endless and water-absorbing. The rough belt arranged on a side of the fibrous web. The smooth belt is endless and arranged on an opposite side of the fibrous web. The rough belt, the fibrous web and the smooth belt running through a press nip together and the rough belt is led away from the fibrous web after passing through the press nip. The smoothing element forms a smoothing nip with the smooth belt after the rough belt is led away from the fibrous web, the smoothing element having a smooth pressing surface.

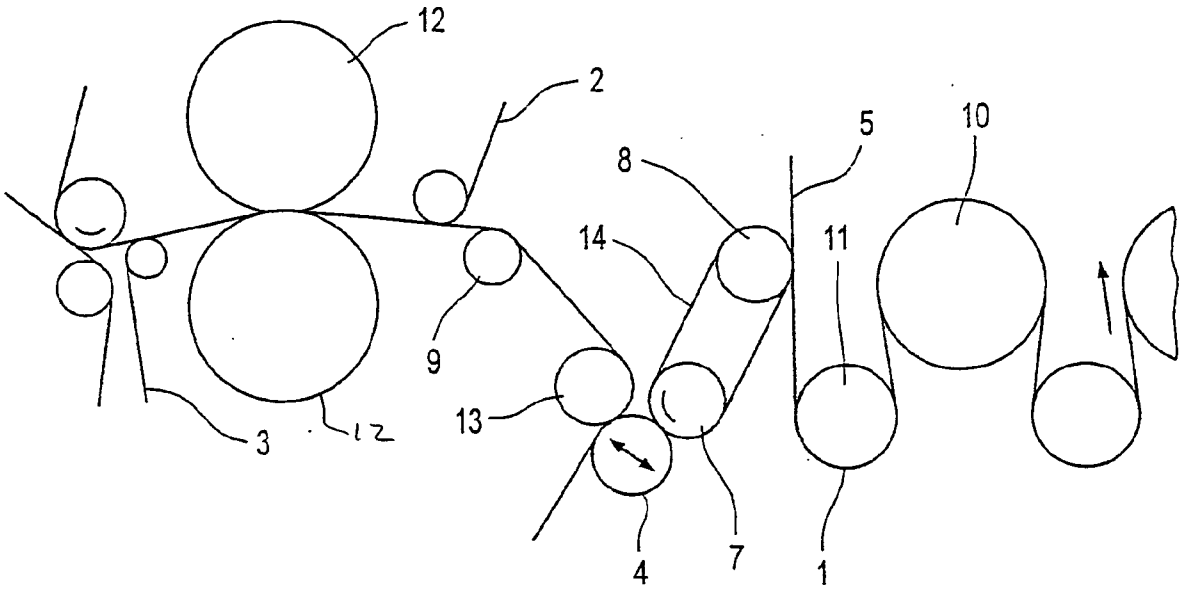


Fig.1

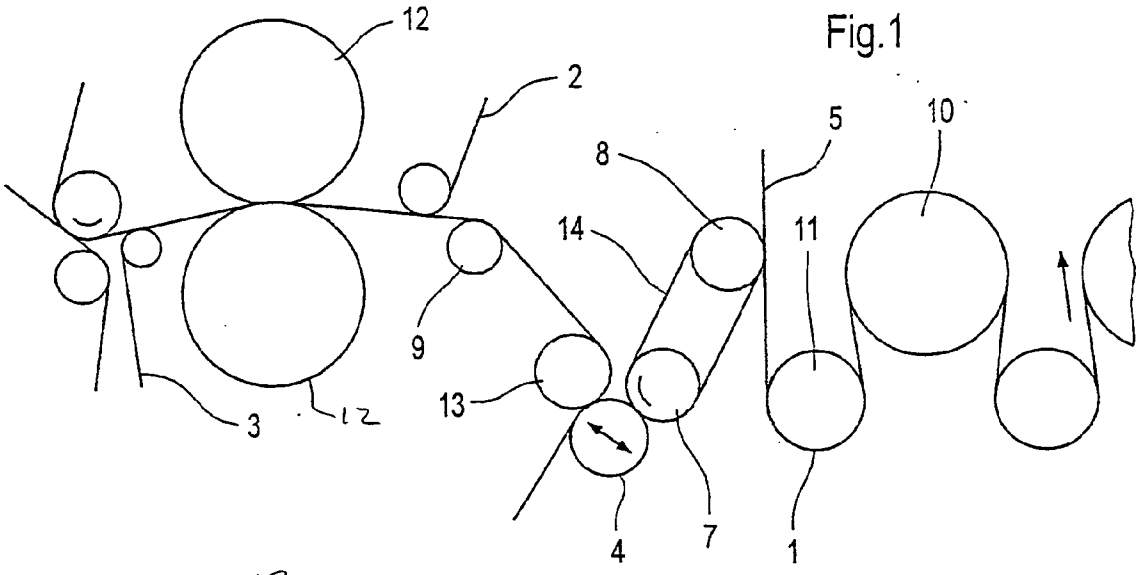


Fig.2

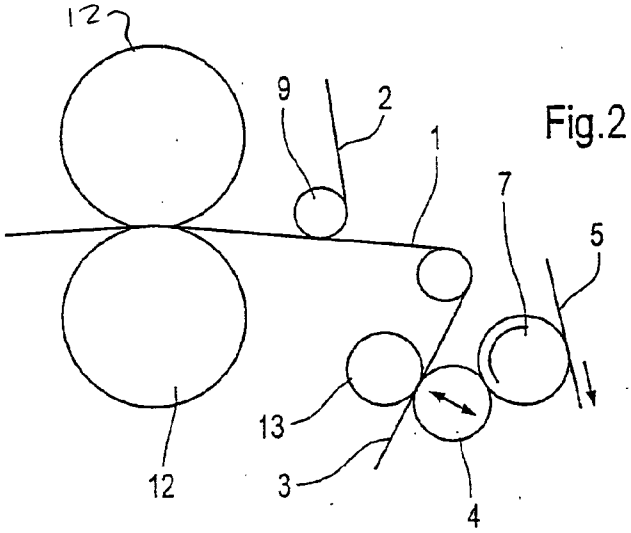
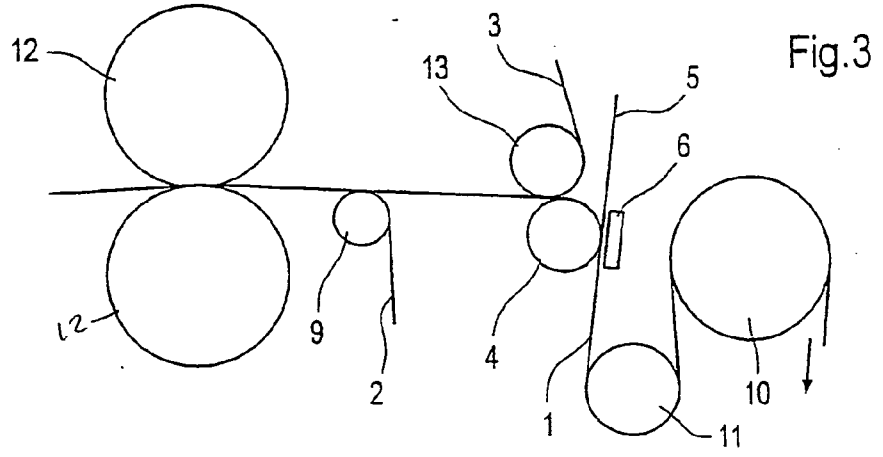


Fig.3



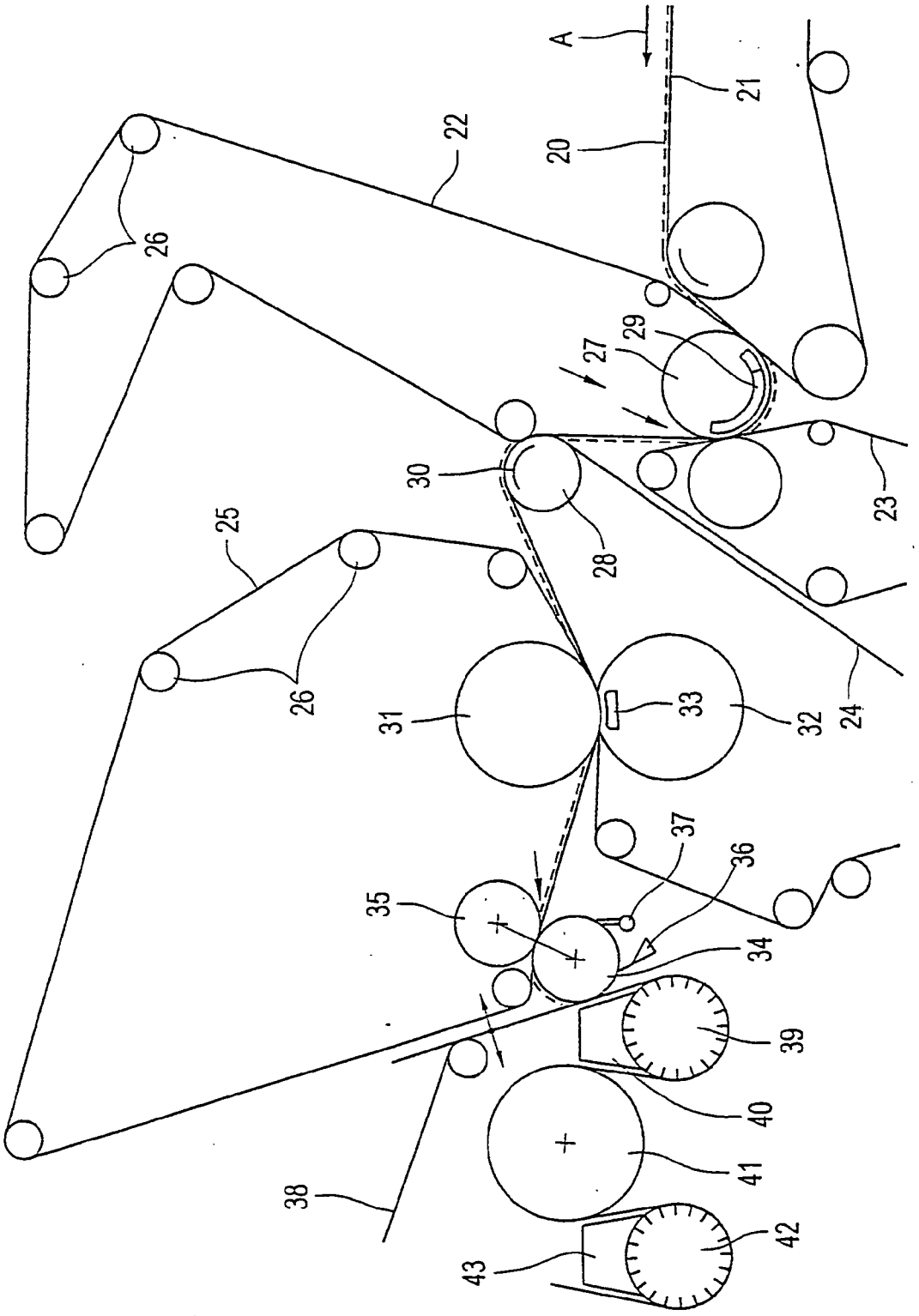

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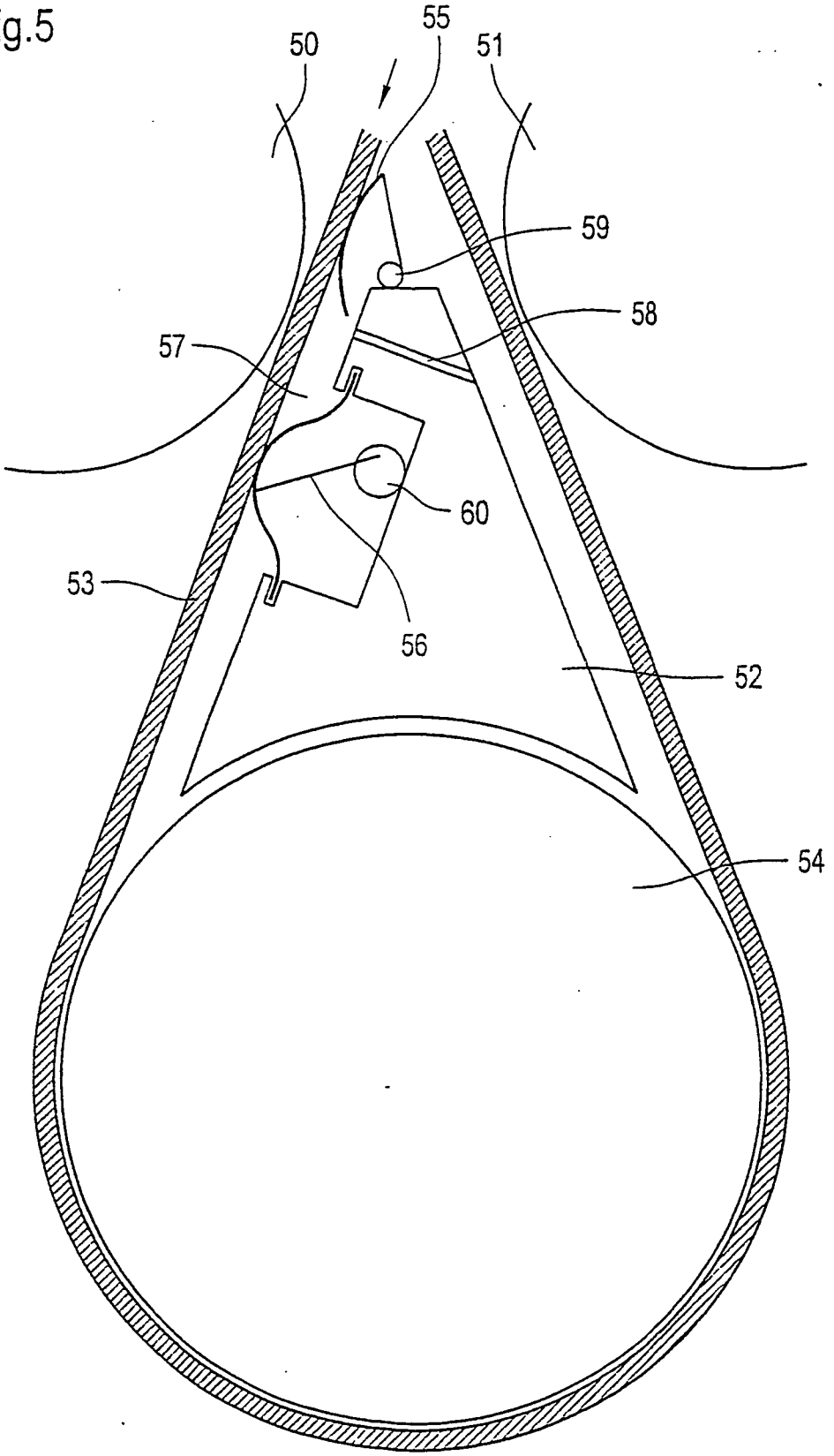
Fig.4

Fig.5



SMOOTHING DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation of PCT application No. PCT/EP03/01315, entitled "SMOOTHING DEVICE", filed Feb. 11, 2003.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a smoothing device for a press arrangement for dewatering a paper, board, tissue or other fibrous web in a machine for producing and/or finishing the same.

[0004] 2. Description of the Related Art

[0005] Press arrangements lead to pronounced two-sidedness of the fibrous web with regard to smoothness, since the smooth belt smoothes the fibrous web while the other belt, because of the necessary porosity in order to ensure the water absorption capability, has a certain surface roughness and therefore roughens the fibrous web. However, the smooth belt provides advantages in guiding the fibrous web, so that omitting the latter would not be desired.

[0006] What is needed in the art is, an apparatus to reduce the two-sidedness of the fibrous web in the simplest possible way.

SUMMARY OF THE INVENTION

[0007] According to the present invention, a smooth belt forms a smoothing nip with a smoothing element having a smooth pressing surface after the rough belt is led away. This smoothing nip increases the smoothness on both sides of the fibrous web while reducing the two-sidedness with minimum expenditure. The smoothing element simultaneously guides the fibrous web after the smoothing nip, that is to say that the smoothing belt transfers the fibrous web to the smoothing element.

[0008] In order to assist the transfer of the fibrous web, the surface of the smooth belt is softer than that of the smoothing element.

[0009] In order to make it possible to discharge broke into the machine basement, it is advantageous if the smoothing element and/or the smooth belt are arranged such that they can be moved away from each other and, as a result, a discharge gap is implemented.

[0010] Since the fibrous web is still relatively moist in the region of the press arrangement, it is sufficient, for the purpose of smoothing, if the smooth belt and the smoothing element are pressed against each other with a contact force which is between 3 kN/m and 100 kN/m, preferably between 5 kN/m and 20 kN/m. For the purpose of optimization, in the interests of the lowest possible two-sidedness of the fibrous web, it is advantageous if the smooth belt and the smoothing element are pressed against each other with a contact force which is set or controlled as a function of the level of two-sidedness of the fibrous web after the smoothing device, preferably at the end of the machine.

[0011] In this case, the smoothing element is formed as a smooth, endlessly circulating smoothing belt or else as a smooth, rotatable smoothing roll. In the case of the smoothing roll, for the purpose of drying and for the purpose of increasing the smoothness of the rough side of the fibrous web, it is advantageous if the smoothing roll is heated and, in particular, is formed as a drying cylinder.

[0012] Because of the low accumulation of water in the press nip, smooth belts are preferably used at the end of the press section. This means that the press nip should preferably be the last press nip of the machine.

[0013] In order to improve the guidance of the fibrous web, particularly at high speeds, in particular if the fibrous web is transferred from the smoothing element to a drying group for drying the fibrous web, the transfer should be assisted by at least one suction device. However, it can also be advantageous if the fibrous web runs from the smoothing element to a following element with a short free draw, that is to say a short unsupported distance. In the drying group, the fibrous web is supported by a drying fabric, and is led alternately over heated drying cylinders and guide rolls. The drying cylinders are arranged under the fibrous web in order to improve the web guidance, to simplify the construction and to permit simple discharge of broke.

[0014] If the smooth belt runs above the fibrous web, then the fibrous web can be transferred in a secure and simple way from the smoothing element to a drying fabric of a following drying group. The drying fabric is led past a suction device, preferably in the form of a suction box, in the transfer region. However, somewhat better web guidance results if the smooth belt runs under the fibrous web. In this case, the fibrous web is simply transferred from the smoothing element to a transfer suction roll. The suction roll then, in turn, transfers the fibrous web to the drying fabric of the drying group. However, it is also possible for the fibrous web to be transferred from the smoothing element to an air-permeable transfer belt which, in the transfer region, wraps around a suction device. The suction device being in the form of a suction roll, and it transfers the fibrous web to the drying fabric of the following drying group.

[0015] In a development of the invention, provision is made for a suction device for attracting the fibrous web by suction that is arranged downstream of the smoothing element in the running direction of the fibrous web. In this case, the arrangement of the suction device is independent of the conveying mechanism onto which the fibrous web is transferred. Thus, the fibrous web can be transferred, for example, onto a transfer belt or directly onto a drying fabric. By way of the suction device, the fibrous web is detached from the preceding smoothing element, in particular a smoothing roll, under a defined suction force. Web flutter and breaks, such as can occur in the case of an open draw without support by a suction device, are thereby avoided. The suction device is preferably configured in such a way that it includes a suction box and/or a suction roll. The suction roll is preferably equipped on its circumferential surface with a helical or spiral groove, in which holes for extracting air and water are made at fixed intervals. For this purpose the perforated roll shell is connected to a vacuum source. The suction box is preferably configured in such a way that it immediately adjoins an unwrapped region of the circumferential surface of the suction roll. In a particular refinement, the suction box has a first and a second element that is pressed resiliently against the fibrous web, between

which, at least one suction zone, for attracting the fibrous web by suction, is formed. In one embodiment of the present invention, provision is made for a plurality of zones to be evacuated with different pressures to be arranged after and/or beside one another in the region of the suction box. In this manner the desired suction pressure can be set very precisely and in accordance with the web speed and other web parameters. Here, it also proves to be advantageous if the contact pressure of at least one of the two elements can be set.

[0016] In another embodiment of the present invention, provision is made for it to be possible for the fibrous web, after being transported past the suction device, to be conveyed over a drying cylinder and at least one further suction device.

[0017] The present invention is also suitable for use when threading a strip of a fibrous web. For this purpose, it is sufficient, for example, if the suction roll is evacuated only in a section over which the threading strip is guided. In this case, if a suction box is also present, the latter does not necessarily have to be evacuated. However, the suction box can also be evacuated in accordance with the width of the evacuated section of the suction roll. Using this method for threading the start of a fibrous web, it is possible to lead the web on without a rope. The strip can be expanded to the full width of the fibrous web with the aid of a couching device, the suction roll and/or the suction box then being evacuated over the full width of the fibrous web.

[0018] The drying fabric is brought into contact with the smoothing roll. For this purpose, the suction roll and the suction box are arranged such that it can be pivoted.

[0019] In a further embodiment of the present invention, the drying fabric is driven at a somewhat higher speed than the belt of the press section. In this way, the fibrous web can be detached more easily from the smoothing element, in particular the smoothing roll. In addition, the technological paper properties of the web, in the web running direction, are influenced positively as a result. A speed difference of between 0.5% and 5.0% is preferred.

[0020] With the present invention, closed web guidance from the wet end as far as the drying section is implemented and web flutter and web breaks of the fibrous web are avoided. The press arrangement ensures low two-sidedness of the web with respect to the smoothness with a simultaneously very high level of smoothness and reliable web threading. This is based on the fact that the fibrous web has no, or only a short, free draw region, that is to say a region in which it is not supported.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0022] **FIG. 1** shows a schematic side view of a press arrangement with a smoothing device of an embodiment of the present invention;

[0023] **FIG. 2** shows a press arrangement with another embodiment of a smoothing device;

[0024] **FIG. 3** shows a schematic side view of another embodiment of a press arrangement with a smoothing device;

[0025] **FIG. 4** shows a further schematic view of another embodiment of a press arrangement with a smoothing device; and

[0026] **FIG. 5** shows a suction roll in conjunction with a suction box in an enlarged illustration of the present invention.

[0027] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate one preferred embodiment of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

[0028] In every case, fibrous webs **1**, **20** and **53** are led through a press nip together with an endlessly circulating, water-absorbing, relatively rough belt **2** or **24** in the form of a press felt and a likewise endlessly circulating, smooth belt **3** and **25** arranged on the opposite side of fibrous webs **1**, **20** or **53**. In at least one case, the press nip is the last or even the only press nip of a press section of a papermaking machine for dewatering fibrous web **1**, **20** and **53** and is generally formed by two press rolls **12** or **31** and **32** pressed against each other. In the press nip, only relatively little water is pressed out of fibrous web **1**, **20** or **53**, so that only one press felt is sufficient to pick up the water pressed therefrom. Smooth belt **3** or **25** improves the guidance of fibrous web **1**, **20** or **53**, in particular at high machine speeds. The two belts **2** and **3** or **24** and **25** are respectively led over guide rolls **9** or **26** outside the press nip.

[0029] From the press section, fibrous web **1**, **20** or **53** is led to a drying group of the papermaking machine. There, fibrous web **1**, **20** and **53** is supported by a drying fabric **5** or **38**, and is led alternately over heated drying cylinders **10**, **41** and **51** and evacuated guide rolls **11** and **42**. Drying cylinders **10**, **41** and **51** are arranged under and guide rolls **11** and **42** are arranged above fibrous web **1**, **20** or **53**. The meandering run of fibrous web **1**, **20** or **53** results in a simple and space-saving construction of the drying group. In addition, drying groups of this type are highly suitable for high machine speeds and have fast and reliable discharge of broke.

[0030] In the press nip fibrous web **1**, **20** and **53** is smoothed on one side as a result of the contact with smooth belt **3** or **25**, while the other side remains rough or even becomes rougher as a result of the contact with the relatively rough press felt. Although this two-sidedness can be reduced in the calendaring units, arranged at the end of the machine, it can seldom be entirely corrected.

[0031] After the press nip, however, fibrous web **1**, **20** and **53** is still relatively moist, so that the two-sidedness can be influenced with relatively simple means and low pressing forces. For this purpose, the press felt is led away from fibrous web **1**, **20** and **53** after the press nip. Fibrous web **1**, **20** or **53** can then run through a smoothing device, in which the two-sidedness of the fibrous web **1**, **20** and **53** is counteracted by smoothing. There then follows the transfer

of fibrous web **1**, **20** or **53** to a respective drying fabric **5** or **38** of the following drying group.

[**0032**] The smoothing device is formed by a smoothing roll **4**, **34** or **50**, which is pressed against smooth belt **3**, **25** with fibrous web **1**, **20** or **53** therebetween. In this case, smooth belts **3** and **25** are respectively, supported by a press roll **13** and **35** on the opposite side of the fibrous web. The position of smoothing roll **4**, **34** or **50** can be changed in such a way that the smoothing nip can also be opened in order to discharge broke. Of course, it is also possible to arrange press roll **13** or **35** to be displaceable. Furthermore, smoothing roll **4**, **34** or **50** can also be replaced by a smoothing belt, which is forced toward smooth belt **3** or **25** by a roll or likewise wraps around press roll **13** or **35** with smooth belt **3** or **25**.

[**0033**] In the press arrangements that are illustrated in **FIGS. 1 and 2**, smooth belt **3** runs under fibrous web **1**, which offers advantages in the guidance of the web.

[**0034**] In **FIG. 1**, following the smoothing operation, fibrous web **1** is transferred from smoothing roll **4** to a transfer belt **14**, which, in turn, passes on fibrous web **1** to drying fabric **5**. Transfer belt **14** is associated with two transfer points, transfer belt **14**, wrapping around a roll **8**. The roll associated with smoothing roll **4** is designed as a suction roll **7** in order to assist the transfer.

[**0035**] According to **FIG. 2**, fibrous web **1** is transferred to transfer suction roll **7** then to drying fabric **5**. In contrast to this, smooth belt **3** in the press arrangement shown in **FIG. 3** is arranged above fibrous web **1**. This simplifies the transfer of fibrous web **1** after smoothing, since fibrous web **1** can be transferred from smoothing roll **4** to drying fabric **5** directly, that is to say without being turned. In order to assist the transfer, drying fabric **5** runs on a suction box **6** in the region of the transfer. The vacuum originating from suction box **6** pulls fibrous web **1** toward drying fabric **5**.

[**0036**] A fibrous web **20** as illustrated in **FIG. 4** is transported in the direction of an arrow A by transport belts **21**-**25**, each of which run over guide rolls **26**. At the transfer points between transport belts **21**-**25** there are suction rolls with stationary suction boxes and a roll shell that rotates therearound, such as suction rolls **27** and **28** with suction boxes **29** and **30**, respectively.

[**0037**] Between press rolls **31** and **32**, of which the lower is equipped with a pressing element **33**, fibrous web **20** is led to a pair of smoothing rolls **34** and **35**. Smoothing roll **34** is additionally equipped with doctors **36** and **37** for removing contaminants.

[**0038**] From transport belt **25**, fibrous web **20** is transferred onto drying fabric **38**. For this purpose, use is made of suction roll **39** in conjunction with suction box **40**, which is illustrated above suction roll **39** and, in one embodiment, has an approximately trapezoidal cross section. As a result of the arrangement of suction box **40** and of suction roll **39**, fibrous web **20** is transferred without a free draw directly from contact with smoothing roll **34** onto a suction region on the side facing suction roll **34**. Drying fabric **38** is rotated at a speed of 0.5 to 5.0% faster than transport belts **21**-**25**.

[**0039**] Fibrous web **20** is then led onward over drying cylinder **41** and from there to a further combination of suction roll **42** and suction box **43**.

[**0040**] **FIG. 5** shows a suction box **52** arranged between a smoothing roll **50** and a drying cylinder **51** or between two drying cylinders **50** and **51** in order to attract, by suction, fibrous web **53** (shown on only one side here for reasons of simplification) from smoothing roll **50** and to transfer it to drying cylinder **51**. Fibrous web **20** is led around suction roll **54** underneath suction box **52**. In order to attract fibrous web **20** by suction, suction box **52** is equipped with a suction region **57** bounded by springy elements **55** and **56** and having an outlet **58** for the discharge of extracted air and moisture. Elements **55** and **56** can be actuated by adjusting shafts **59** and **60** respectively in order to change their contact pressure against fibrous web **53**. Suction region **57** can be followed by further suction regions, which, just like suction region **57**, are bounded by resilient elements. It is possible for the suction force to be changed individually in each of the suction regions in order to achieve optimum transfer of fibrous web **53** to drying cylinder **51**.

[**0041**] While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. A smoothing device of a press arrangement for dewatering a fibrous web in a machine for one of producing and finishing the fibrous web, comprising:

a rough belt being endless and water-absorbing, said rough belt arranged on a side of the fibrous web;

a smooth belt being endless and arranged on an opposite side of the fibrous web, said rough belt, the fibrous web and said smooth belt running through a press nip together, said rough belt being led away from the fibrous web after passing through said press nip; and

a smoothing element forming a smoothing nip with said smooth belt after said rough belt is led away from the fibrous web, said smoothing element having a smooth pressing surface.

2. The smoothing device of claim 1, wherein said smooth belt transfers the fibrous web to said smoothing element.

3. The smoothing device of claim 1, wherein at least one of said smoothing element and said smooth belt are arranged so that they move from each other.

4. The smoothing device of claim 1, wherein said smooth belt has a first softness and said smoothing element has a second softness, said first softness greater than said second softness.

5. The smoothing device of claim 1, wherein said smooth belt and said smoothing element are pressed with a contact force of between approximately 3 kN/m and 100 kN/m.

6. The smoothing device of claim 5, wherein said contact force is between approximately 5 kN/m and 20 kN/m.

7. The smoothing device of claim 1, wherein said smooth belt and said smoothing element are pressed with a contact force which is one of set and controlled as a function of a level of two-sidedness of the fibrous web after the smoothing device.

8. The smoothing device of claim 1, wherein said smooth belt and said smoothing element are pressed with a contact force which is one of set and controlled as a function of a level of two-sidedness of the fibrous web after the machine.

9. The smoothing device of claim 1, wherein said smoothing element is a smoothing belt that is endless and circulating.

10. The smoothing device of claim 1, wherein said smoothing element is a smooth, rotatable smoothing roll.

11. The smoothing device of claim 10, wherein said smoothing roll is heated.

12. The smoothing device of claim 1, wherein said press nip is the last press nip of a plurality of press nips of the machine.

13. The smoothing device of claim 1, further comprising a drying group for drying the fibrous web, the fibrous web being transferred from said smoothing element to said drying group in a transfer region.

14. The smoothing device of claim 13, further comprising at least one suction device, the fibrous web being transferred in said transfer region with the assistance of said at least one suction device.

15. The smoothing device of claim 13, wherein said drying group further includes:

a drying fabric supporting the fibrous web;

a plurality of drying cylinders;

a plurality of guide rolls, said drying fabric supporting the fibrous web being alternately guided over one of said plurality of drying cylinders and one of said plurality of guide rolls.

16. The smoothing device of claim 15, wherein said plurality of drying cylinders are arranged under the fibrous web.

17. The smoothing device of claim 1, wherein said smooth belt runs above the fibrous web.

18. The smoothing device of claim 15, further comprising a suction device, the fibrous web being transferred to said drying fabric from said smoothing element in said transfer region, said suction device being proximate to said drying fabric in said transfer region.

19. The smoothing device of claim 18, wherein said suction device is a suction box.

20. The smoothing device of claim 15, wherein said smooth belt runs under the fibrous web.

21. The smoothing device of claim 20, further comprising a transfer suction roll, the fibrous web being transferred from said smoothing element to said transfer suction roll, the fibrous web then being transferred from said transfer suction roll to said drying fabric.

22. The smoothing device of claim 20, further comprising:

a suction device; and

an air permeable transfer belt wrapping around said suction device, the fibrous web being transferred from said smoothing element to said air permeable transfer belt, said air permeable transfer belt then transferring the fibrous web to said drying fabric.

23. The smoothing device of claim 22, wherein said suction device is a suction roll.

24. The smoothing device of claim 1, further comprising a suction device for attracting the fibrous web by suction, said suction device being arranged downstream of said smoothing element in a running direction of the fibrous web.

25. The smoothing device of claim 24, wherein said suction device includes at least one of a suction box and a suction roll.

26. The smoothing device of claim 25, wherein said suction box is arranged directly on an unwrapped region of a circumferential surface of said suction roll.

27. The smoothing device of claim 25, wherein said suction box includes a first element and a second element each of which are pressed resiliently against the fibrous web with a contact force, a zone between said first element and said second element being a suction zone for attracting the fibrous web by suction.

28. The smoothing device of claim 27, wherein said contact force of at least one of said first element and said second element is set to a predetermined value.

29. The smoothing device of claim 24, further comprising a transfer belt, the fibrous web being transferred from said smoothing element to said transfer belt.

30. The smoothing device of claim 24, further comprising a drying fabric, the fibrous web being transferred from said smoothing element to said drying fabric.

31. The smoothing device of claim 24, further comprising:

at least one further suction device; and

a drying cylinder, the fibrous web after being transported past said suction device is conveyed over said drying cylinder and said at least one further suction device.

32. The smoothing device of claim 25, wherein the fibrous web includes a threading strip associated with the fibrous web, at least one of said suction roll and said suction box including a region being separately evacuateable, said region corresponding to a width of said threading strip during the threading of the fibrous web.

33. The smoothing device of claim 25, wherein at least one of said suction roll and said suction box is one of set on and off said smoothing element.

34. A method of threading a strip of a fibrous web in a papermaking machine, comprising the step of applying a vacuum to the strip in a region proximate to one of a suction roll and a suction box.

35. The method of claim 34, further comprising the step of completing a threading operation, said completing a threading operation including the steps of:

bringing the strip to a full width of the fibrous web by way of a couching device; and

contacting a drying fabric with a smoothing roll.

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