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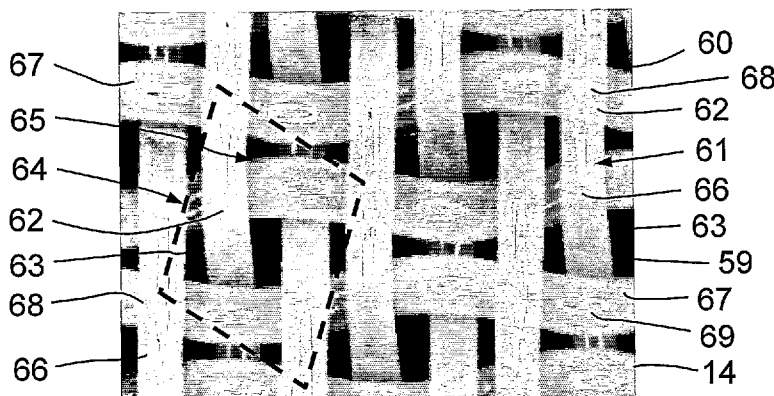


Fig. 11

(57) Abstract: A clothing for structuring a wet fibre web (1') in a press section of a tissue papermaking machine is described which has a three-dimensional woven structure forming elevations (62) and depressions (63), said elevations, like the depressions, are repeated and distributed to form a pattern of polygonal, geometrically similar smallest unitary surfaces (64), each of said unitary surfaces having an area a and covering a plurality of depressions with the mean depth d. According to the invention, the area a and the mean depth d of each unitary surface (64) are adapted in relation to each other in such a way that, calculated by the length unit mm, their ratio is equal to or greater than 30 mm, wherein a is selected within the range of 1.0-3.0 mm<sup>2</sup> and d is selected within the range of 0.03-0.09 mm. The invention also relates to a method for manufacturing a creped tissue paper web by using said structuring clothing.



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A structuring clothing and method of manufacturing a tissue paper web

The present invention relates to a structuring clothing for structuring a wet fibre web in a press process in a press section of a tissue papermaking machine, said structuring clothing comprising a carrying layer and a structured layer which contacts the fibre web and is supported by the carrying layer, said structured layer having a three-dimensional woven structure comprising longitudinal and transverse threads plaited into each other and forming elevations and depressions which are defined by the elevations, said elevations, like the depressions, are repeated and distributed in the longitudinal and transverse directions of the structuring clothing to form a pattern of polygonal, geometrically identical smallest unitary surfaces which are located adjacent each other and have common boundary lines, each of said smallest unitary surfaces having an area  $a$  and covering a plurality of depressions with the mean depth  $d$ , wherein the position and the alignment of each smallest unitary surface are defined by the fact that the corners thereof are coinciding with elevations which are displaced in relation to each other and formed by four consecutive longitudinal threads.

The invention relates also to a method of manufacturing a creped tissue paper web with high bulk in a tissue papermaking machine, said method comprising

- forming a fibre web in a wet section which comprises a headbox, a forming roll and a first clothing running about and in contact with the forming roll,
- pressing the formed fibre web in a press section which comprises a main press comprising a first

press element, a second press element, said press elements defining a press nip therebetween with a predetermined pressure, a first clothing in form of a press felt running in an endless loop around a plurality of guide rolls and through said press nip together and in contact with the formed fibre web, the second press element being disposed within the loop of the press felt, a second clothing running in an endless loop around a plurality of guide rolls and through said press nip together and in contact with the formed fibre web, the first press element being disposed within the loop of the second clothing, and a transfer roll disposed within the loop of the second clothing,

- 15 - drying the structured fibre web in a drying section comprising a drying surface, and
- creping the dried fibre web from the drying surface with a creping doctor so that a creped tissue paper web is taken off from the drying surface,

20 said transfer roll being arranged to define together with the drying surface a transfer nip for transferring the structured fibre web to the drying surface without compression in the transfer nip.

The expression "structuring" in the present invention means that a three-dimensional pattern of a structuring clothing is embossed into the wet fibre web during a pressing process when the dryness of the fibre web increases, and the fibres in the wet fibre web are movable in relation to each other so that in an advantageous manner they are brought to new positions and directions in relation to each other under the action of the elastic compressible press felt which presses the wet fibre web

into the three-dimensional pattern of the structuring clothing. This all together contributes to an increased bulk at the same grammage and to higher MD and CD tensile strengths in the finished tissue paper web and improved structure thereof.

In manufacturing tissue paper in a conventional manner the formed wet fibre web is dewatered partly before the Yankee cylinder, usually either by a pressing technique or by a blowing technique known as TAD (through-air-drying). Conventional pressing technique for a press with a smooth press felt or a smooth press nip against the Yankee cylinder result in small thickness of the fibre web. It has been proposed to use shoe presses, i.e. extended press nips, which result in less pressure and less rewetting, to improve the quality, i.e. bulk, by increased thickness of the web. The aim has been to achieve the same high quality (bulk) or thickness as achieved with the TAD technique, however, this has hitherto not been found possible. The TAD technique is therefore still superior to the pressing technique with respect to paper web quality, however, it has the great disadvantage that an essentially higher energy consumption is required than is the case with a pressing technique.

US 6,547,924 describes a papermaking machine of the kind defined in the preamble of claim 8. However, the papermaking machine described in said patent specification cannot simply produce tissue paper of sufficiently high quality to meet the requirements and wishes of the customers.

Additional examples of tissue papermaking machines equipped with embossing or structuring belts are EP 1 078 126, EP 0 526 592, US 6,743,339, EP 1 075 567,

EP 1 040 223, US 5,393,384, EP 1 036 880 and  
US 5,230,776.

After extensive test, the present inventors came to the understanding that the structure of the structuring  
5 clothing is of major and probably crucial significance for being able to achieve higher bulk in tissue paper than has hitherto been possible in a papermaking machine which uses the press technique, and that the structure of the structuring clothing can also be used as a parameter  
10 for controlling and achieving a high dryness in connection with the pressing in the press section where the structuring of the wet fibre web occurs.

The object of the invention is to enable the manufacturing of a tissue paper web of high bulk at a low energy  
15 cost. The invention therefore excludes said TAD technique for removal of water from the fibre web for the purpose of increasing the dryness.

This object is achieved according to the invention by the structuring clothing having the characteristic that the  
20 area  $\underline{a}$  and the mean depth  $\underline{d}$  of each smallest unitary surface of the structured layer are adapted in relation to each other in such a way that, calculated by the length unit mm, their  $\frac{\underline{a}}{\underline{d}}$  ratio is equal to or greater than 30 mm, wherein  $\underline{a}$  is selected within the range of  
25 1,0-3,0 mm<sup>2</sup> and  $\underline{d}$  is selected within the range of 0,03-0,09 mm.

The method for manufacturing a tissue paper web according to the invention is characterised in that the pressing and structuring of the formed wet fibre web are carried  
30 out while using said second clothing which is in form of a structuring clothing to provide a three-dimensional, structured fibre web in the press step in the press nip,

said structuring clothing having a carrying layer and a structured layer, which is to contact the fibre web and is supported by the carrying layer, said structured layer having a three-dimensional woven structure comprising longitudinal and transverse threads plaited into each other and forming elevations and depressions which are defined by the elevations, said elevations, like the depressions, are repeated and distributed in the longitudinal and transverse directions of the structuring clothing to form a pattern of polygonal, geometrically similar smallest unitary surfaces which are located adjacent each other and have common boundary lines, each of said smallest unitary surfaces having an area  $\underline{a}$  and covering a plurality of depressions with the mean depth  $\underline{d}$ , wherein the position and the alignment of each smallest unitary surface are defined by the fact that the corners thereof are coinciding with elevations which are displaced in relation to each other and formed by four consecutive longitudinal threads, wherein the area  $\underline{a}$  and the mean depth  $\underline{d}$  of each smallest unitary surface of the structured layer are adapted in relation to each other in such a way that, calculated by the length unit mm, their  $\frac{\underline{a}}{\underline{d}}$  ratio is equal to or greater than 30 mm, wherein  $\underline{a}$  is selected within the range of 1,0-3,0 mm<sup>2</sup> and  $\underline{d}$  is selected within the range of 0,03-0,09 mm.

Structuring clothing means primarily woven fabrics.

The invention is described further in the following with reference to the drawings.

Figures 1 to 10 show ten different tissue papermaking machines with a structuring clothing according to the invention.

Figure 11 shows a structuring clothing according to a first embodiment of the invention.

Figure 12 shows a structuring clothing according to a second embodiment of the invention.

5 Figure 13 shows a structuring clothing according to a third embodiment of the invention.

Figure 14 shows a structuring clothing according to a fourth embodiment of the invention.

10 Figure 13 is a graphic representation showing the relationship between two magnitudes which can be measured and calculated for structuring clothings with pattern-forming smallest unitary surfaces in order to indicate whether a structuring clothing is usable in a method and in a tissue papermaking machine according to the present  
15 invention.

Figures 1-10 show schematically various embodiments of a tissue papermaking machine for manufacturing a tissue paper web 1 in accordance with the present invention without using through-air-drying (TAD) for drying the  
20 paper web. The various embodiments all comprise a wet section 2, a press section 3 and a drying section 4. The wet section 2 of each tissue papermaking machine according to the embodiments shown comprises a forming section 5 comprising a headbox 6, a forming roll 7 and a  
25 first forming clothing 8 which runs about and in contact with the forming roll 7. In the embodiments according to Figures 1 to 8, the forming section 5 also has a second forming clothing 9 that is a woven fabric which runs in an endless loop about a plurality of guide rolls 10 and  
30 about the forming roll 7 in contact with the first forming clothing 8 in order to receive between itself and the first clothing a jet of stock from the headbox 6. The

stock is then dewatered for obtaining a formed fibre web 1'.

The press section 3 comprises a main press 11 comprising a first press element 12 and a second press element 13  
5 which cooperate with each other to define a press nip therebetween. The press section 3 further comprises first and second clothings, the second clothing of which being in form of a structuring clothing 14 which runs in an endless loop about a plurality of guide rolls 15, about a  
10 smooth transfer roll 16 located adjacent to the drying section 4, and through the press nip of the main press 11 together and in contact with the formed fibre web 1' in order to provide a structuring of the formed fibre web 1' when the fibre web 1' passes through the press nip, so  
15 that a structured fibre web 1" will leave the press nip. The structured fibre web 1" is carried by the structuring clothing 14 up to the transfer nip between the transfer roll 16 and the drying cylinder 19, in which nip no pressing or dewatering occurs but merely a transfer of  
20 the fibre web 1" to the surface of the drying cylinder 19. Said first clothing of the press section 3 is in form of a water-receiving press felt 17 which in the z direction is elastically formable and compressible and runs in an endless loop about a plurality of guide rolls 18 and  
25 through the press nip of the main press 11 together with the structuring clothing 14 and in contact with the formed fibre web 1'. The first press element 12 is located in the loop of the structuring clothing 14, and the second press element 13 is located in the loop of the  
30 second press felt 17. In the embodiments shown in Figures 1-10, both of the press elements 12, 13 are press rolls. The press felt 17 separates from the structured fibre web 1" immediately after it has passed through the press nip, to prevent rewetting of the fibre web 1". One of the



press elements 12, 13 can be designed as a press roll of a press having an extended or long nip press including but not limited to shoe press roll which can be arranged in an upper or lower position of the press.

5 Immediately before the first guide roll 18 after the main press 11, there is a spray device 53 disposed on the inside of the press felt 17 to supply fresh water into the wedge-shaped narrowing space between the press felt 17 and the guide roll 18, said water being pressed into  
10 the press felt 17 and displaces the contaminated water, which is present in the press felt 17 after the pressing in the main press 11, through and out from the press felt 17 when the latter runs about the guide roll 18. Upstream of the following guide roll 18 there are suction boxes 54  
15 disposed on the outside of the press felt to withdraw water out from the press felt. The high-pressure spray device cleans the surface of the press felt 17 without this being saturated with water.

After the structuring clothing 14 has left the transfer  
20 roll 16 and before it reaches the main press 11, the structuring clothing 14 passes a cleaning station 30 for cleaning the three-dimensional structuring layer of the structuring clothing.

The drying section 4 comprises a first drying cylinder 19  
25 which in the embodiments shown is the only drying cylinder which advantageously is a Yankee drying cylinder. Alternatively, other types of drying sections can be used, e.g. one having more cylinders, or other drying sections known in papermaking industry. The drying  
30 cylinder 19, with which the transfer roll 16 defines a transfer nip, has a drying surface 20 for drying the structured fibre web 1". A creping doctor 21 is disposed at a downstream location of the drying surface 20 to

crepe the dried fibre web 1" away from the drying surface 20 in order to obtain the tissue paper web 1, which is creped. Preferably but not necessarily, the drying cylinder 19 is covered by a hood 22. Said transfer roll 16 and drying cylinder 19 define between them a transfer nip. The structuring clothing 14 and the structured fibre web 1" run together through said transfer nip, but they leave the transfer nip separated from each other because the structured fibre web 1" adheres to and is transferred to the drying surface 20 of the drying cylinder 19. The pressure in the transfer nip that is defined by the roll 16 and the drying cylinder 19 is less than 1 MPa in order to transfer the web without compressing. In order to ensure that the fibre web 1" is adhered to the drying surface 20, a suitable adhesive agent is applied by a spray device 23 onto the drying surface 20 at a point between the creping doctor 21 and the transfer nip where the drying surface 20 is free from the paper web.

The forming section 5 may be a so-called C-former as shown in Figures 1, 2, 7 and 8 or a so-called Crescent former as shown in Figures 3 to 6 or a so-called suction breast roll former as shown in Figures 9 and 10.

The main press 11 may be a roll press in which the two press elements 12, 13 are rolls with smooth mantle surfaces, or, as preferred, a press with extended nip including a shoe press (not shown), wherein the first press element 12 is a smooth counter-roll and the second press element 13 comprises a press shoe and an endless belt which runs through the press nip of the shoe press in sliding contact with the press shoe, which exerts a predetermined pressure against the inside of the belt and against the counter-roll 12. Thus, the press shoe is a device which forms an extended press nip. In a further

preferred embodiment of the main press 11, the first press element 12 is a smooth counter-roll and the second press element comprises a device for forming an extended press nip, said device comprising an elastic support body  
5 which is arranged to press in the direction towards the counter-roll. Alternatively, both of the press elements 12, 13 can each include an elastic support body. In an alternative embodiment, the press element 13 is a smooth counter-roll and the second press element 12 comprises a  
10 device which forms an extended nip of any one of the types mentioned above.

In the embodiment according to Figure 1, the press felt 17 of the main press is also used as the inner first forming clothing 8 of the forming section 5 so that the  
15 forming roll 7 is also located within the loop of the press felt 17. In this case the wet section also comprises a predewatering device 24 comprising a suction roll 25 located within the loop of the press felt 17, and a steam box 26 located on the outside of the loop of the  
20 press felt 17 opposite the suction roll 25 for heating the water in the formed fibre web 1' in order to decrease the viscosity and promote the dewatering. By means of such a suction roll 25 and steam box 26 the amount of water in the formed fibre web 1' and in the press felt 17  
25 is reduced so that the formed fibre web 1' obtains a desired increased dryness of 16-28% before the main press 11 which ensures the runability of the press. The following press provides a dryness of the web of 38-52% resulting in an energy saving in the dry section since  
30 the amount of water to be evaporated therein is reduced. A high-pressure spray device 55 is disposed on the outside of the forming felt 8 upstream of the forming roll 7 to clean the forming felt 8 so that the latter is

not saturated with water when arriving at the forming roll 7.

The embodiment according to Figure 2 is similar to that in Figure 1 with the exception that it comprises in addition a preheating device 27 downstream of the main press 11 to raise the temperature of the fibre web 1" before the fibre web 1" reaches the drying cylinder 19.

In the embodiment according to Figure 3, the structuring clothing 14 is also utilized as the inner first forming clothing 8 of the forming section so that the forming roll 7 is also located within and enclosed by the loop of the structuring clothing 14. The dewatering occurs for the most part through the clothing 9. In this case the press felt 17 of the main press 11 runs in its own loop about a plurality of guide rolls 28 and the second press element 13. The guide roll located upstream of the second press element 13 is a suction roll 29 by which water is removed from the press felt 17 before the press felt 17 runs into the press in order to ensure the ability of the felt 17 to absorb water. A particular effect of this embodiment, in which the structuring clothing 14 also passes around the forming roll 7, is that it enables fibres of the stock to penetrate into and orientate themselves in the depressions of the structuring clothing 14 so that part of the formed fibre web 1' is already oriented in the depressions before the pressing in the main press 11 commences. Such a preorientation of fibres in the depressions is therefore advantageous. Immediately before the first guide roll 28 after the main press 11, a spray device 53 is disposed on the inside of the press felt 17 to supply fresh water into the wedge-shaped narrowing space between the press felt 17 and the guide roll 28. This water is pressed into the press felt 17 and displaces the contaminated water which is present in the

press felt 17 after the pressing in the main press 11 through and out from the press felt 17 when the latter runs around the guide roll 28. Upstream of the next guide roll 28 there are suction boxes 54 disposed on the  
5 outside of the press felt 17 to withdraw water out from the press felt 17, and a high-pressure spray device 55 which cleans the press felt 17.

The embodiment according to Figure 4 is similar to that in Figure 3 with the exception that it is supplemented in  
10 addition with a preheating device 27 in accordance with the embodiment according to Figure 2, and that a steam box 31 is disposed on the outside of the press felt 17 opposite the suction roll 29.

In the embodiment according to Figure 5, the inner first  
15 forming clothing 8, the press felt 17 and the structuring clothing 14 have their own loops, the forming clothing 8 being a felt which runs around a plurality of guide rolls 18'. The press section 3 comprises in this case a pre-press 32 comprising a first press element 33 located  
20 within the loop of the press felt 17 and a second press element 34 located within the inner first forming felt 8, said press elements 33, 34 forming a press nip with each other through which the forming felt 8 carrying the fibre web 1' runs to meet the press felt 17, which also runs  
25 through the last-mentioned press nip in order to receive the formed fibre web 1' and carry it forward to the main press 11. The forming felt 8 thus also forms the second press felt of the pre-press 32. The guide roll located nearest upstream to the second press element 34 is a  
30 suction roll 35 by which water is removed from the forming felt 8. A steam box 36 is located on the outside of the forming felt 8 opposite the suction roll 35. Immediately before the first guide roll 18' after the pre-press 32, a spray device 53' is disposed on the

inside of the forming felt 8 to supply fresh water into the wedge-shaped narrowing space between the forming felt 8 and the guide roll 18', said water being pressed into the forming felt 8 and displaces the contaminated water which is present in the forming felt 8 after the pressing in the pre-press 32 through and out from the forming felt 8 when the latter runs around the guide roll 18'.  
Upstream of the next guide roll 18' there are suction boxes 54' disposed on the outside of the forming felt 8 to withdraw water out from the forming felt 8, and a high-pressure spray device 55' which cleans the forming felt 8. The pre-press 32 can include a press with an extended nip including a shoe press.

The embodiment according to Figure 6 is similar to that in Figure 5 with the exception that it comprises in addition a preheating device 27 in accordance with the embodiment shown in Figure 2.

In the embodiment according to Figure 7, the inner first forming clothing 8, which is a forming fabric, the press felt 17 and the structuring clothing 14 have their own loops similar to the embodiment according to Figure 5. In this case the forming section 5 is thus a twin-wire C-former. The forming roll 7 may be a suction roll, if desired. Also in this case the press section 3 comprises a pre-press 32 comprising a first press element 33 located within the loop of the press felt 17, and a second press element 34 located within a second press felt 37 which runs in a loop around a plurality of guide rolls 38, the guide roll located nearest upstream to the second press element 34 being a suction roll 39 by which water is removed from the second press felt 37. A steam box 50 is disposed on the outside of the second press felt 37 opposite the suction roll 39. The second press felt 37 runs in contact with the inner first forming

fabric 8 to form a transfer zone in which the press felt 37, the formed fibre web 1' and the forming fabric 8 form a sandwich structure. When the fibre web 1' leaves the transfer zone, it is carried by the second press felt 37.

5 A suction device 51 may be disposed within the loop of the second press felt 37 in connection to the transfer zone in order to ensure that the fibre web 1' is transferred. Immediately before the first guide roll 38 after the pre-press 32, a spray device 53' is disposed on

10 the inside of the press felt 37 to supply fresh water into the wedge-shaped narrowing space between the press felt 37 and the guide roll 38, said water being pressed into the press felt 37 and displaces the contaminated water which is present in the press felt 37 after the

15 pressing in the pre-press 32 through and out from the press felt 37 when the latter runs around the guide roll 38. Upstream of the next guide roll 38 there are suction boxes 54' disposed on the outside of the press felt 37 to withdraw water out from the press felt 37, and a

20 high-pressure spray device 55' which cleans the press felt 37 so that the latter is not saturated with water when arriving at the suction device 51. The pre-press 32 can include a press with an extended nip including a shoe press.

25 The embodiment according to Figure 8 is similar to that in Figure 7 with the exception that it is supplemented in addition with a preheating device 27 after the main press in accordance with the embodiment shown in Figure 2.

The embodiment according to Figure 9 is similar to that

30 in Figure 7 apart from the wet section, which has in this case a forming section of a different type from the previously mentioned C-former and Crescent former. The forming section according to Figure 9 is a so-called suction breast roll former which comprises a headbox 6,

a forming roll 7 which is a suction breast roll, and a forming clothing 8 which is a forming fabric running in a loop around the suction breast roll 7 and guide rolls and forms a transfer zone with the second press felt 37 in accordance with the embodiment shown in Figure 7. The suction breast roll 7 has a suction zone 52 forming a forming zone above which the forming fabric 8 passes together with stock which is delivered in a jet from the headbox 6 and is dewatered within the forming zone 52 to form a formed fibre web 1'.

The embodiment according to Figure 10 is similar to that in Figure 9 with the exception that it is supplemented in addition with a preheating device 27 in accordance with the embodiment shown in Figure 2.

The pre-press 32 which is included in the embodiments according to Figures 5 to 10 may be a press selected from the group of different presses described above with respect to the main press 11.

The structuring clothings 14 as mentioned for the tissue papermaking machines shown are impermeable. This means that neither liquid nor air can pass through them. Partly water permeable structuring clothings may also be used. This means that when pouring a liquid onto one side of the clothing the liquid will be forced therethrough and can be seen on the rear side of the clothing.

The structuring clothing 14 for structuring a wet fibre web 1' has a carrying layer 59 and a structured layer 60 which is supported by the carrying layer 59 and constitutes the forming side of the structuring clothing. The layer 60 has a web-contacting surface 61 of a three-dimensional structure formed by elevations 62 and depressions 63 which are defined by the elevations 62.



The elevations 62, like the depressions 63, are regularly recurrent and distributed in the longitudinal and transverse directions of the structuring clothing to form a pattern defined by tetragonal, geometrically similar, smallest unitary surfaces, i.e. unitary surfaces 64, which are located adjacent each other and have common boundary lines, said unitary surfaces 64 forming the repeating unitary basic pattern of the structuring clothing 14. The unitary surfaces 64 are thus imaginary and are located adjacent to and merge with each other without visible boundaries in the structure of the clothing. Each unitary surface 64 has an area, designated  $a$ . Each unitary surface 64 covers a plurality of depressions 63 which together form a pocket 65 with the volume  $v$  and the mean depth  $d$ . These unitary surfaces 64 and associated pockets 65 are utilized for measuring and calculating said magnitudes and hence determining the characteristics and usefulness in a tissue papermaking machine in order to make a fibre web with sufficiently high dryness before the drying section and a tissue paper with satisfactory structure/bulk and with other properties within the intervals which are shown below. It is understood that each such unitary surface 64 is planar (two-dimensional) and coincides with the plane of the structuring clothing which is tangent to the tops of the elevations.

To achieve optimum structure and dryness of the web it is important that the structuring clothing 14 allows the wet fibre web 1' can be formed into the depressions 63 or pockets 65 when the fibre web 1' passes through the press nip together with the press felt 17 and the structuring clothing 14 with the wet fibre web 1' enclosed therebetween. It is also important that during the pressing step the press felt 17 can reach down into all the depressions of the pockets 65 in order to build up a

sufficiently high hydraulic pressure to enable water in the wet fibre web 1' to move into the press felt 17 and not remain in the fibre web at the end of the pressing step. The pockets 65 have to be large enough to allow the press felt 17 to reconfigure itself around the elevations 62 and penetrate into the pockets 65. Each pocket 65 has to have a largest depth which enables water in the bottom of the pocket 65 to be transported away. In other words, the depth of the pocket 65 must not be too large, since too large a depth would prevent the desired hydraulic pressure from being achieved. The mean depth of the pockets 65 is therefore defined by the elastic deformation ability of the press felt, i.e. the deeper the pockets 65 are the more elastic deformation of the press felt 17 is required in order to reach the bottom of the deepest depressions during the press step and vice versa. The shallower the pockets 65 are the less elasticity of the press felt 17 is required. On the other hand, when the pockets 65 are too small the three-dimensional structure of the clothing will be too low and as a result thereof the three-dimensional structure or bulk of the fibre web will be too low. When the pockets 65 are too deep the elastic deformation of the press felt 17 is not sufficient to reach the bottom of the pocket 65 in order to create the hydraulic pressure required, resulting in a decreased dewatering, i.e. reduced dryness, and deteriorated releasing properties resulting in web rupture. This explains the press and structuring process and the reason to the fact that the fibre web obtains a higher bulk than what is possible in conventional pressing.

The structuring clothing 14 with its specific well-defined, structured, web-contacting surface 61 is now an important parameter for controlling the structure and dryness level which may be expected in the structured

fibre web 1" after the press nip before the final drying. It is of course a prerequisite that the pressure in the press nip is not too high but is within normal conventionally applied values for pressing and that the press felt 17 is of the conventional elastically compressible type which, in addition to its necessary water-receiving capacity, during the compression reconfigures itself elastically against the structured web-contacting surface with the wet fibre web located therebetween in the manner and for the purposes indicated above.

Figures 11 and 12 show preferred embodiments of a structuring clothing 14, said layer 60 of the structuring clothing which faces the forming side, comprising a network structure constituting the basis for said elevations 62 and depressions 63. The network structure takes the form in each case of a fabric made of plaited or woven threads 66, 67 of suitable material, e.g. metal or plastic (polyester/polyamide), for obtaining a mesh pattern. In Figure 11, the mesh pattern is formed by extending each longitudinal thread 66 (in the machine direction) over three transverse threads 67 (cross to the machine direction) and thereafter under two transverse threads 67, with offsetting of two transverse threads in this plaiting process for the next longitudinal thread 66. In Figure 12 the mesh pattern is formed by extending each longitudinal thread 66 over four transverse threads 67 and thereafter under one transverse thread 67 with offsetting of two transverse threads in this plaiting process for the next longitudinal thread 66. The surface of the fabric facing the fibre web is coated with a layer of a polymer which causes the surface of the fabric to maintain its structure. The thickness of the polymer layer is also a valuable control factor for regulating

the volume of the depressions by building up the plastic layer by one or more steps of film coatings.

The plaited mesh pattern described gives the elevations 62 a knuckle-like shape at both the longitudinal and the transverse threads 66, 67, the knuckles 68 of the longitudinal threads being essentially longer than the knuckles 69 of the transverse threads. In Figure 11, like Figure 12, a polygonal, more precisely tetragonal, smallest unitary surface 64 is depicted, the position and orientation of which are determined by the fact that the corners of the tetragon coincide with the approximate midpoints of four neighbouring knuckles 68 of four successive longitudinal threads 66, said knuckles 68 being displaced in the longitudinal direction in relation to each other. In the cases shown, the unitary surfaces 64 are parallelograms. A unitary surface 64 shown in Figure 11 can be read off, marked, depicted, etc., wherever so desired on the structuring clothing 14 at different points in the machine direction and the cross machine direction. The unitary surface 64 and its associated pocket 65, which is covered by the unitary surface, are utilized for measuring purposes. In order to achieve satisfactory measurement results while taking inevitable tolerances into account, smallest unitary surfaces 64 and their pockets 65 are measured at a plurality of places selected at random along and across the structuring clothing 14 in order to calculate mean values of all measured values divided with the number of measuring places.

30 The carrying layer 59 of the structuring clothing may be impermeable or permeable.

Tests

Four different structuring clothings, hereinafter denoted structuring belts, were investigated with respect to the size of the smallest unitary surface 64 and the volume of the associated pocket 65 of each belt. The structuring belts chosen were denoted Belt A, Belt C, Belt D and Belt E. Belt A, Belt D and Belt E had a thread structure according to Figure 11, and Belt C a thread structure according to Figure 12. The measurements were done with a measuring device of the type MarSurf WS1 from Carl Mahr Holding GmbH, Carl-Mahr-Strasse 1, D-37073, Germany, said measuring device enabling rapid three-dimensional contact-free measurement with a vertical resolution of 0.1 nm. The measurements were done in each case at five different locations of unitary surfaces 64 in order to calculate a mean value while taking tolerances in the manufacturing of the belts in consideration. The measured values were used to calculate the ratio of the volume  $\underline{v}$  and the area  $\underline{a}$  in order to obtain a length value expressed in mm designated as  $\underline{d}$  which is a mean value of the depth of all depressions 63 of the pocket 65, the bottom surface of which was highly uneven. The measured values of volume  $\underline{v}$  and area  $\underline{a}$  and the ratios calculated therefrom are shown in Table 1 below.

Table 1

	Volume mm <sup>3</sup> <u>v</u>	Area mm <sup>2</sup> <u>a</u>	Volume/Area Mean depth <u>d</u> mm
Belt <b>A</b>	0.15685	1.7442	0.090
	0.152879	1.721	0.089
	0.15527	1.7453	0.089
	0.15278	1.71874	0.089
	0.15823	1.79305	0.088
Mean value	0.155	1.74	0.089
Belt <b>C</b>	0.18945	2.6596	0.071
	0.18318	2.63073	0.070
	0.18004	2.6349	0.068
	0.1813	2.64427	0.069
	0.18317	2.6117	0.070
Mean value	0.183	2.64	0.070
Belt <b>D</b>	0.08571	1.4843	0.058
	0.08169	1.4505	0.056
	0.09357	1.60606	0.058
	0.09422	1.57544	0.060
	0.08919	1.57337	0.057
Mean value	0.089	1.54	0.058
Belt <b>E</b>	0.05302	1.3754	0.039
	0.05272	1.39896	0.038
	0.04266	1.3659	0.031
	0.04483	1.38436	0.032
	0.04809	1.40119	0.034
Mean value	0.048	1.39	0.035

Each of the four structuring belts A, C, D and E was used in a tissue papermaking machine configured according to the embodiment shown in Figure 1. The machine was run at a speed of 1200 m/min and the manufactured creped and

reeled web had a grammage of 20 g/m<sup>2</sup>. In each case the formed fibre web 1' had a dryness of about 16% before the suction roll 25 and a dryness of about 25% after the suction roll 25. The main press 11 was a shoe press in which the press element 13 comprised a press shoe and an endless impermeable grooved belt which ran about the press shoe in contact with the rear side of the felt. The press nip was thus in this case an extended press nip. The specific pressure in the press nip was 4 MPa. The press felt used was supplied by Albany International and had a grammage of 1425 g/cm<sup>2</sup>. It had a thickness of about 2.4 mm in an unloaded state and an elastic compressibility which allowed the felt to be compressed in a roll press nip with a peak pressure of 7.3 MPa to a thickness of about 1.7 mm calculated at the middle of the roll press nip, where the load was greatest, and then resume its full thickness when the load ceases at the outlet end of the press nip. Each fibre web 1" structured in this way was then transferred to the Yankee cylinder for drying and was creped by being scraped off the cylinder surface by means of the creping doctor 21. The dryness of the web was measured immediately after the transfer roll 16, and the finished reeled paper web, which was wound on a reel-up, was examined with respect to bulk, tensile strength and elongation. The dryness of the structured fibre web 1" before the drying as above and the thickness of the finished reeled paper web are shown in Table 2 below.

Table 2

Belt	$\underline{a}$ $\underline{d}$	Dryness %	Thickness $\mu\text{m}$	Bulk $\text{cm}^3/\text{g}$
Belt A	19.6	32	$\approx 230$	11.5
Belt C	37.7	45	$\approx 250$	12.5
Belt D	26.6	31	$\approx 220$	11.0
Belt E	39.7	43	$\approx 210$	10.5

The results obtained show, surprisingly, that Belt C and Belt E, both having their area  $\underline{a}$  and mean depth  $\underline{d}$  adapted to each other in accordance with the present invention, result in a fibre web with very high dryness after the press nip, and that Belt A and Belt D, which did not have their area  $\underline{a}$  and mean depth  $\underline{d}$  adapted to each other in accordance with the present invention, result in a fibre web with substantially lower dryness after the press nip. The surprising results also show that the structuring belt resulting in a fibre web with the highest dryness, namely Belt C, also has the highest bulk. The higher bulk is due to the coarser structure of Belt C. The bulk obtained with Belt E is also acceptable. It is generally the case that a coarser belt structure results in higher bulk but lower softness, and conversely that a fine structure results in lower bulk but higher softness. Belt C and Belt E thus achieve the aim of reducing energy consumption essentially in the drying section.

The results obtained were plotted in a coordinate system in which the mean depth  $\underline{d}$  is a function of the area  $\underline{a}$ , as illustrated in the diagram in Figure 13. The  $\frac{\underline{a}}{\underline{d}}$  coordinates for the four structuring belts have been marked and give a straight line L through the origin with a slope coefficient k of 30. The region below this line L and



within the defined ranges of the area a and mean depth d represents structuring belts falling within the scope of the present invention and resulting in fibre webs with high dryness and satisfactory structures, whereas this is  
 5 not the case in the region above the line L as is shown in the comparative tests presented herein.

A tissue papermaking machine with structuring clothing according to the present invention enables manufacturing of creped reeled tissue paper with the following characteristics:  
 10

Grammage	10-50 g/m <sup>2</sup>
Thickness	160-400 μm
Bulk	8-20 cm <sup>3</sup> /g
MD tensile strength	50-300 N/m
15 CD tensile strength	30-300 N/m

The structuring clothing can be manufactured by forming a carrying layer 59 and a structured layer 60, which is to contact the fibre web 1' and is supported by the carrying  
 20 layer 59. The structured layer 60 has a three-dimensional woven structure formed of elevations 62 and depressions 63 which are defined by the elevations 62, said elevations 62, like the depressions 63, being repeated and distributed in the longitudinal and transverse directions  
 25 of the structuring clothing to form a pattern of polygonal, geometrically similar, smallest unitary surfaces 64 which are located adjacent each other and have common boundary lines. Each smallest unitary surface 64 has an area a and covers a plurality of depressions 63 with the mean depth d. The position and the alignment of each  
 30 smallest unitary surface 64 are defined by the fact that the corners thereof are coinciding with elevations 62 which are displaced in relation to each other and formed by four consecutive longitudinal threads so that the area  
 35 a and the mean depth d of each smallest unitary surface

64 are adapted in relation to each other in such a way that, calculated by the length unit mm, their  $\frac{a}{d}$  ratio is equal to or greater than 30 mm, wherein a is selected within the range of 1,0-3,0 mm<sup>2</sup> and d is selected within  
5 the range of 0,03-0,09 mm. A coating in form of a liquid polymer is applied onto the side of the fabric that then is to form the structuring layer 60 and is to contact the fibre web.

The expression "a plurality of depressions" covers not  
10 only such a depression which is located entirely within one and the same unitary surface but also a depression which comprises a portion located within a first unitary surface and another portion located within an adjacent second unitary surface. It is understood that in measur-  
15 ing each such a unitary surface also each portion of a depression related to this unitary surface is measured.

The expression "smallest unitary surfaces" means that all smallest unitary surfaces of one and the same structuring  
20 clothing have the same topography with respect to the underlying bottom surface, i.e. the same distribution and location or orientation of elevations 62 and depressions 63 which recur as repeating patterns in the structured layer.

The invention also relates to a method of rebuilding of a  
25 conventional tissue papermaking machine comprising a press section with first and second clothings, wherein the first clothing is an elastic, compressible press felt, by replacing the second clothing of the press section with a structuring belt according to any one of  
30 the claims 1 to 7.

## C L A I M S

1. A structuring clothing (14) for structuring a wet fibre web (1') in a press process in a press section of a tissue papermaking machine, said structuring clothing  
5 (14) comprising a carrying layer (59) and a structured layer (60) which contacts the fibre web (1') and is supported by the carrying layer (59), said structured layer (60) having a three-dimensional woven structure comprising longitudinal and transverse threads (66, 67)  
10 plaited into each other and forming elevations (62) and depressions (63) which are defined by the elevations (62), said elevations (62), like the depressions (63), are repeated and distributed in the longitudinal and transverse directions of the structuring clothing to form  
15 a pattern of polygonal, geometrically similar smallest unitary surfaces (64) which are located adjacent each other and have common boundary lines, each of said smallest unitary surfaces (64) having an area  $\underline{a}$  and covering more depressions (63) with the mean depth  $\underline{d}$ ,  
20 wherein the position and the alignment of each smallest unitary surface (64) are defined by the fact that the corners thereof are coinciding with elevations (62) which are displaced in relation to each other and formed by four consecutive longitudinal threads (66), **characterised**  
25 **in** that the area  $\underline{a}$  and the mean depth  $\underline{d}$  of each smallest unitary surface (64) of the structured layer (60) are adapted in relation to each other in such a way that, calculated by the length unit mm, their  $\frac{\underline{a}}{\underline{d}}$  ratio is equal  
30 to or greater than 30 mm, wherein  $\underline{a}$  is selected within the range of 1,0-3,0 mm<sup>2</sup> and  $\underline{d}$  is selected within the range of 0,03-0,09 mm.
2. The structuring clothing (14) according to claim 1, **characterised in** that the area  $\underline{a}$  is selected within the range of 1,3-2,6 mm<sup>2</sup>.

3. The structuring clothing (14) according to any one of claims 1 and 2, **characterised in** that the smallest unitary surfaces (64) are tetragonal, wherein the position and alignment of each unitary surface are defined by the fact that the corners thereof are coinciding with four adjacent elevations (62) displaced in relation to each other and formed by four consecutive, longitudinal threads (66).
4. The structuring clothing (14) according to any one of claims 1 to 3, **characterised in** that the structured layer (60) has a coating on the side which is to contact the fibre web (1'), said coating being formed by applying a polymer onto the plaited threads (66, 67), and that the carrying layer (59) is joined to the structured layer (60) to form a unit.
5. The structuring clothing (14) according to any one of claims 1 to 4, **characterised in** that it is impermeable.
6. The structuring clothing (14) according to any one of claims 1 to 4, **characterised in** that it is water permeable.
7. The structuring clothing (14) according to claim 4, **characterised in** that the structured layer (60) has threads (66, 67) plaited in each other and distributed in a first group of longitudinal threads (66) and a second group of transverse threads (67) to form said elevations (62) and depressions (63), wherein the elevations (62) have longitudinal and transverse knuckles (68 and 69 respectively), said knuckles (68, 69) of two neighbouring threads (66, 67) in the respective groups are displaced in relation to each other, wherein said unitary surface (64) is a parallelogram with its corners located at the

midpoints of the longitudinal knuckles (68) of four neighbouring and successive longitudinal threads (66).

8. A tissue papermaking machine for manufacturing a structured creped tissue paper web (1), comprising

- 5 - a wet section (2) for forming a fibre web (1') comprising
- a headbox (6),
  - a forming roll (7) and
  - a first clothing (8) running about and in  
10 contact with the forming roll (7),
- a press section (3) comprising
- a main press (11) comprising
    - a first press element (12),
    - a second press element (13), said press  
15 elements (12, 13) defining a press nip therebetween with a predetermined pressure,
    - a first clothing in form of an elastic compressible press felt (17) running in an  
20 endless loop around a plurality of guide rolls (18) and through said press nip together and in contact with the formed fibre web (1'), the second press element (13) being disposed within the loop of the  
25 press felt (17),
    - a second clothing (14) which runs in an endless loop around a plurality of guide rolls (15) and through said press nip

together and in contact with the formed fibre web (1'), the first press element (12) being disposed within the loop of the second clothing (14), and

- 5                   -     a transfer roll (16) disposed within the loop of the second clothing (14),
- a drying section (4) for final drying of the pressed fibre web (1''), which comprises
- 10                   -     a drying surface (20) for drying the fibre web (1''), and
- a creping doctor (21) for creping the web from the drying surface (20) so that a creped tissue paper web (1) is taken off from the drying surface (20), said transfer roll (16) being
- 15                   arranged to form together with the drying surface (20) a transfer nip for transferring the fibre web (1'') to the drying surface (20) without compression in the transfer nip,

**characterised in** that the second clothing is a structuring clothing (14) according to any one of claims 1 to 7, said structuring clothing (14) being arranged to effect a structuring of the formed fibre web (1') in said press nip so that a structured fibre web (1'') is leaving the press nip.

25     9.     The tissue papermaking machine according to claim 8, **characterised in** that the press felt (17) being arranged, at said predetermined pressure, to elastically reconfiguring itself in accordance with the structured layer (60) of the structuring clothing (14) so that the formed fibre

30     web (1') entirely penetrates into the depressions (63) and so that a structured fibre web (1'') leaves the press

nip with a dryness of more than 38%, and a structured tissue paper web (1) leaves the drying section in creped form with a bulk of 8-20 cm<sup>3</sup>/g.

10. The tissue papermaking machine according to claim 8 or 9, **characterised in** that the drying surface (20) consists of the envelope surface of a drying cylinder (19).

11. The tissue papermaking machine according to any one of claims 8 to 10, **characterised in** that the wet section (2) comprises a dewatering device (24) for increasing the dryness of the fibre web (1') to 16 to 25%.

12. The tissue papermaking machine according to claim 11, **characterised in** that the dewatering device comprises a suction roll (25) disposed in the loop of the first forming clothing (8) downstream of the forming roll (7), and a steam box (26) disposed on the outside of the loop of the forming clothing (8) opposite said suction roll (25).

13. The tissue papermaking machine according to any one of claims 8 to 12, **characterised in** that the main press (11) is a press with an extended press nip, and the second press element (13) of the press comprises a device for defining the extended press nip for cooperation with the first press element (12).

14. The tissue papermaking machine according to claim 13, **characterised in** that the main press (11) is a shoe press and that the device for defining the extended press nip comprises a press shoe and an endless belt which runs through the extended press nip, wherein the press shoe is arranged to press against the inside of the belt.

15. The tissue papermaking machine according to claim  
13, **characterised in** that the device for defining the  
extended press nip comprises an elastic support body  
arranged to pressing in the direction to the first press  
5 element.

16. The tissue papermaking machine according to any one  
of claims 8 to 15, **characterised in** that the press  
section (3) also comprises a pre-press (32) comprising a  
first press element (33) and a second press element (34),  
10 said press elements (33, 34) defining a press nip there-  
between, a press felt (8, 37) running in an endless loop  
around a plurality of guide rolls (18; 38) and through  
said press nip together with the press felt (17) of the  
main press (11), the second press element (34) being  
15 disposed within the loop of the press felt (8; 37) of the  
pre-press (32) and the first press element (33) being  
disposed within the loop of the press felt (17) of the  
main press, and wherein the formed fibre web (1') runs  
through the press nip of the pre-press enclosed between  
20 the two press felts (17, 8; 17, 37).

17. The tissue papermaking machine according to claim  
16, **characterised in** that the pre-press (32) comprises a  
press with an extended nip.

18. The tissue papermaking machine according to claim  
25 11, **characterised in** that the loop of the structuring  
clothing (14) extends between the main press (11) and the  
transfer roll (16) and that the loop of the press felt  
(17) of the main press (11) extends between the forming  
roll (7) and the main press (11), wherein the press felt  
30 (17) of the main press (11) also constitutes said first  
forming clothing (8).



19. The tissue papermaking machine according to claim 8, **characterised in** that the loop of the structuring clothing (14) extends between the forming roll (7) and the transfer roll (16) to also constitute said first forming clothing (8).

20. The tissue papermaking machine according to claim 16 or 17, **characterised in** that the structuring clothing (14) extends between the main press (11) and the transfer roll (16), that the press felt (17) extends between the pre-press (32) and the main press (11), and that said first forming clothing (8) extends between the forming roll (7) and the pre-press (32) and constitutes the press felt of the pre-press (32).

21. The tissue papermaking machine according to claim 16 or 17, **characterised in** that the structuring clothing (14) extends between the main press (11) and the transfer roll (16), that the press felt (17) extends between the pre-press (32) and the main press (11), that the press felt of the pre-press (32) extends between a transfer zone and the pre-press (32) and that the loop of the forming clothing (8) extends between the forming roll (7) and a guide roll disposed in connection to said transfer zone.

22. The tissue papermaking machine according to any one of claims 8 to 21, **characterised in** that a pre-heating device (27) is disposed downstream of the main press (11).

23. A press section for manufacturing a structured fibre web (1") and adapted to a tissue papermaking machine for manufacturing a creped tissue paper web (1) with high bulk, said press section comprising

- a main press (11) comprising

- a first press element (12),
- a second press element (13), said press elements (12, 13) defining a press nip therebetween with a predetermined pressure,
- 5 - a first clothing in form of an elastic compressible press felt (17) running in an endless loop around a plurality of guide rolls (18) and through said press nip together and in contact with the formed fibre web (1'), the second  
10 press element (13) being disposed within the loop of the press felt,
- a second clothing (14) running in an endless loop around a plurality of guide rolls (15) and through said press nip together and in contact  
15 with the formed fibre web (1'), the first press element (12) being disposed within the loop of the second clothing (14),

**characterised in** that the second clothing is a structuring clothing (14) according to any one of claims 1 to 7, said structuring clothing (14) being arranged to effect a structuring of the formed fibre web (1') in said press nip so that a structured fibre web (1'') is leaving the press nip.

24. The press section according to claim 1, **characterised in** that the press felt (17) is arranged, at said predetermined pressure, to elastically reconfiguring itself in accordance with the structured layer (60) of the structuring clothing (14) so that the formed fibre web (1') entirely penetrates into the depressions and so  
25 that a structured fibre web (1'') leaves the press nip  
30 with a dryness of more than 38%.

25. The press section according to claim 24, **characterised in** that said dryness is between 38 and 52%.

26. The press section according to any one of claims 23 to 25, **characterised in** that the main press (11) is a  
5 press with an extended press nip, and the second press element (13) of the press comprises a device for defining the extended press nip for cooperation with the first press element (12).

27. The press section according to claim 26, **characterised in**  
10 that the main press (11) is a shoe press and that the device for defining the extended press nip comprises a press shoe and an endless belt running through the extended press nip, wherein the press shoe is arranged to press against the inside of the belt.

15 28. The press section according to claim 26, **characterised in** that the device for defining the extended press nip comprises an elastic support body arranged to press in the direction towards the first press element.

20 29. A method of manufacturing a creped tissue paper web (1) with high bulk in a tissue papermaking machine, said method comprising

- forming a fibre web (1') in a wet section (2) which comprises a headbox (6), a forming roll (7) and a first clothing (8) running about and in contact with  
25 the forming roll (7),

- pressing the formed fibre web (1') in a press section (3) which comprises a main press (11) comprising a first press element (12), a second press element (13), said press elements (12, 13) defining  
30 a press nip therebetween with a predetermined pressure, a first clothing in form of a press felt

(17) running in an endless loop around a plurality of guide rolls (18) and through said press nip together and in contact with the formed fibre web (1'), the second press element (13) being disposed within the loop of the press felt, a second clothing (14) running in an endless loop around a plurality of guide rolls (15) and through said press nip together and in contact with the formed fibre web (1'), the first press element (12) being disposed within the loop of the second clothing (14), and a transfer roll (16) disposed within the loop of the second clothing (14),

- drying the structured fibre web (1'') in a drying section (4) comprising a drying surface (20), and
- 15 - creping the dried fibre web (1''') from the drying surface (20) with a creping doctor (21) so that a creped tissue paper web (1) is taken off from the drying surface (20),

said transfer roll (16) being arranged to define together with the drying surface (20) a transfer nip for transferring the structured fibre web (1'') to the drying surface (20) without compression in the transfer nip, **characterised in** that the pressing and structuring of the formed wet fibre web (1') are carried out while using said second clothing which is in form of a structuring clothing to provide a three-dimensional, structured fibre web (1'') in the press step in the press nip, said structuring clothing having a carrying layer (59) and a structured layer (60), which is to contact the fibre web (1') and is supported by the carrying layer (59), said structured layer (60) having a three-dimensional woven structure comprising longitudinal and transverse threads (66, 67) plaited into each other and forming elevations (62) and

depressions (63) which are defined by the elevations (62), said elevations (62), like the depressions (63), are repeated and distributed in the longitudinal and transverse directions of the structuring clothing to form a pattern of polygonal, geometrically similar smallest unitary surfaces (64) which are located adjacent each other and have common boundary lines, each of said smallest unitary surfaces (64) having an area  $\underline{a}$  and covering a plurality of depressions (63) with the mean depth  $\underline{d}$ , wherein the position and the alignment of each smallest unitary surface (64) are defined by the fact that the corners thereof are coinciding with elevations (62) which are displaced in relation to each other and formed by four consecutive longitudinal threads (66), wherein the area  $\underline{a}$  and the mean depth  $\underline{d}$  of each smallest unitary surface (64) of the structured layer (60) are adapted in relation to each other in such a way that, calculated by the length unit mm, their  $\frac{\underline{a}}{\underline{d}}$  ratio is equal to or greater than 30 mm, wherein  $\underline{a}$  is selected within the range of 1,0-3,0 mm<sup>2</sup> and  $\underline{d}$  is selected within the range of 0,03-0,09 mm.

30. The method of claim 29, **characterised in** that the press felt (17) is brought, at said predetermined pressure, to elastically reconfigure itself in accordance with the structured layer (60) of the structuring clothing (14) in order to maintain a necessary hydraulic pressure in the depressions (63) so that the formed fibre web (1') entirely penetrates into the depressions (63) and so that a structured fibre web (1'') leaves the press nip with a dryness of more than 38% and a structured tissue paper web leaves the drying section in creped form with a bulk of 8-20 cm<sup>3</sup>/g.

31. The method according to claim 29 or 30, **characterised in** that the dryness of the formed fibre web (1') is further increased before the main press (11) by means of a press-free and TAD-free dewatering device (24).
- 5 32. The method according to claim 31, **characterised in** that the dryness of the formed fibre web (1') is increased before the main press (11) by means of a pre-press (32).
33. The method according to any one of claims 29 to 31,  
10 **characterised in** that the structured fibre web (1'') is preheated before it reaches the drying cylinder (19).
34. The method according to any one of claims 29, 30, 32 and 33, **characterised in** that the fibre web (1') is formed on the structuring clothing (14), which runs in an  
15 endless loop about the forming roll (7) and the transfer roll (16), wherein the structuring clothing (14) carries the formed fibre web (1') all the way up to the main press (11).
35. The method according to any one of claims 28 to 34,  
20 **characterised in** that a creped tissue paper web (1) is manufactured which before reeling has the following characteristics:
- |                     |                         |
|---------------------|-------------------------|
| Grammage            | 10-50 g/m <sup>2</sup>  |
| Thickness           | 160-400 µm              |
| 25 Bulk             | 8-20 cm <sup>3</sup> /g |
| MD tensile strength | 50-300 N/m              |
| CD tensile strength | 30-300 N/m              |
36. A creped tissue paper web (1) manufactured by the  
30 method according to any one of claims 28 to 35.

37. A method of rebuilding a tissue papermaking machine comprising a press section according to the preamble of claim 23, **characterised in** that the second clothing of the press section is replaced by a structuring clothing (14) according to any one of claims 1 to 7.

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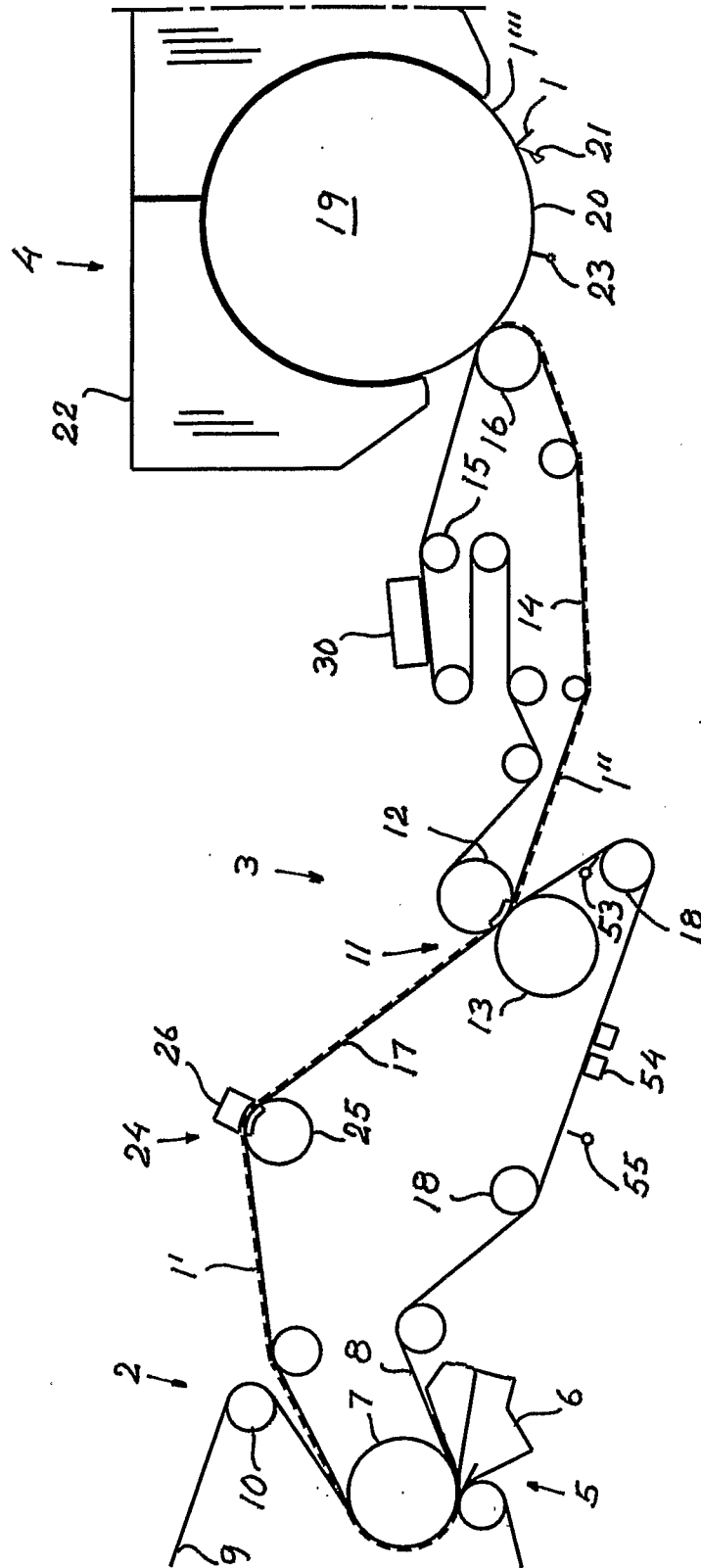


Fig. 1



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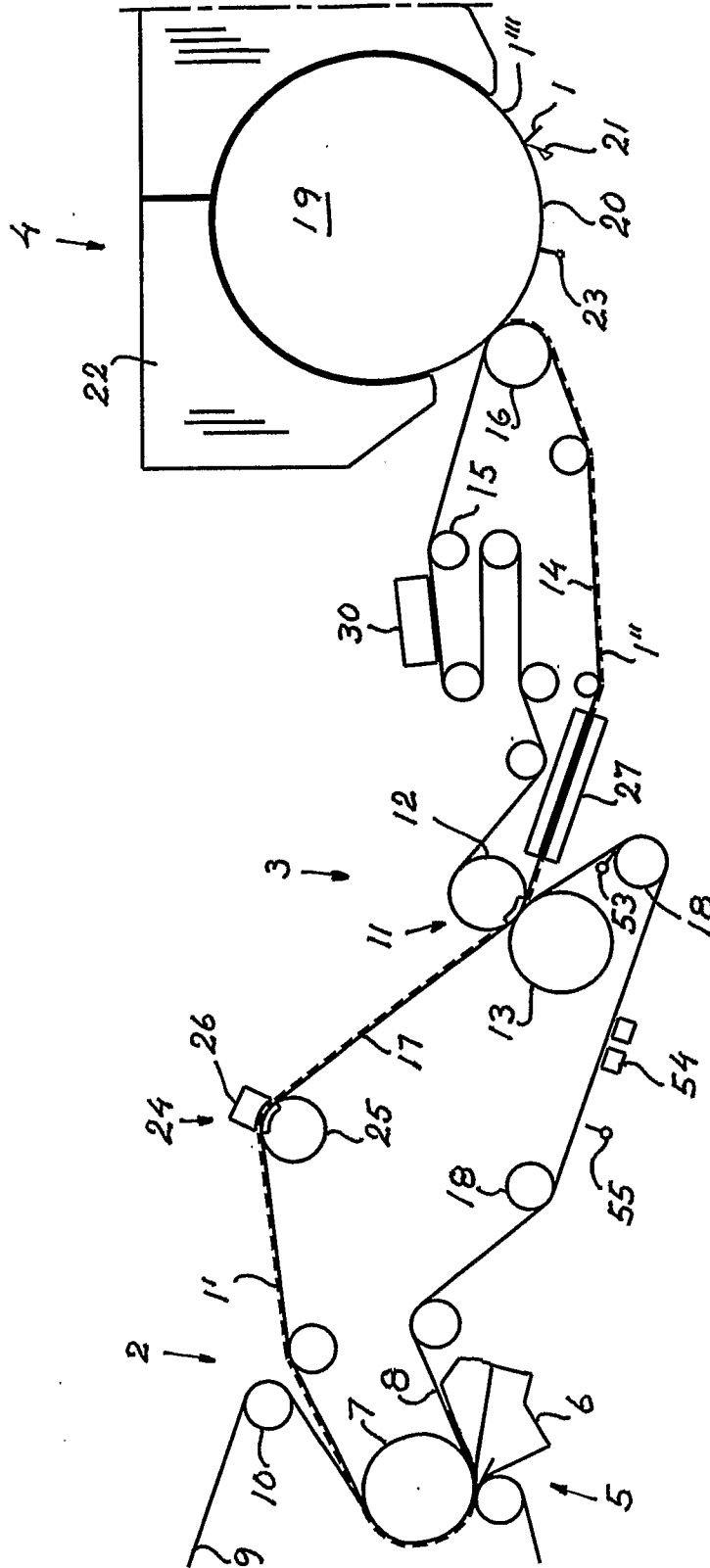


Fig. 2

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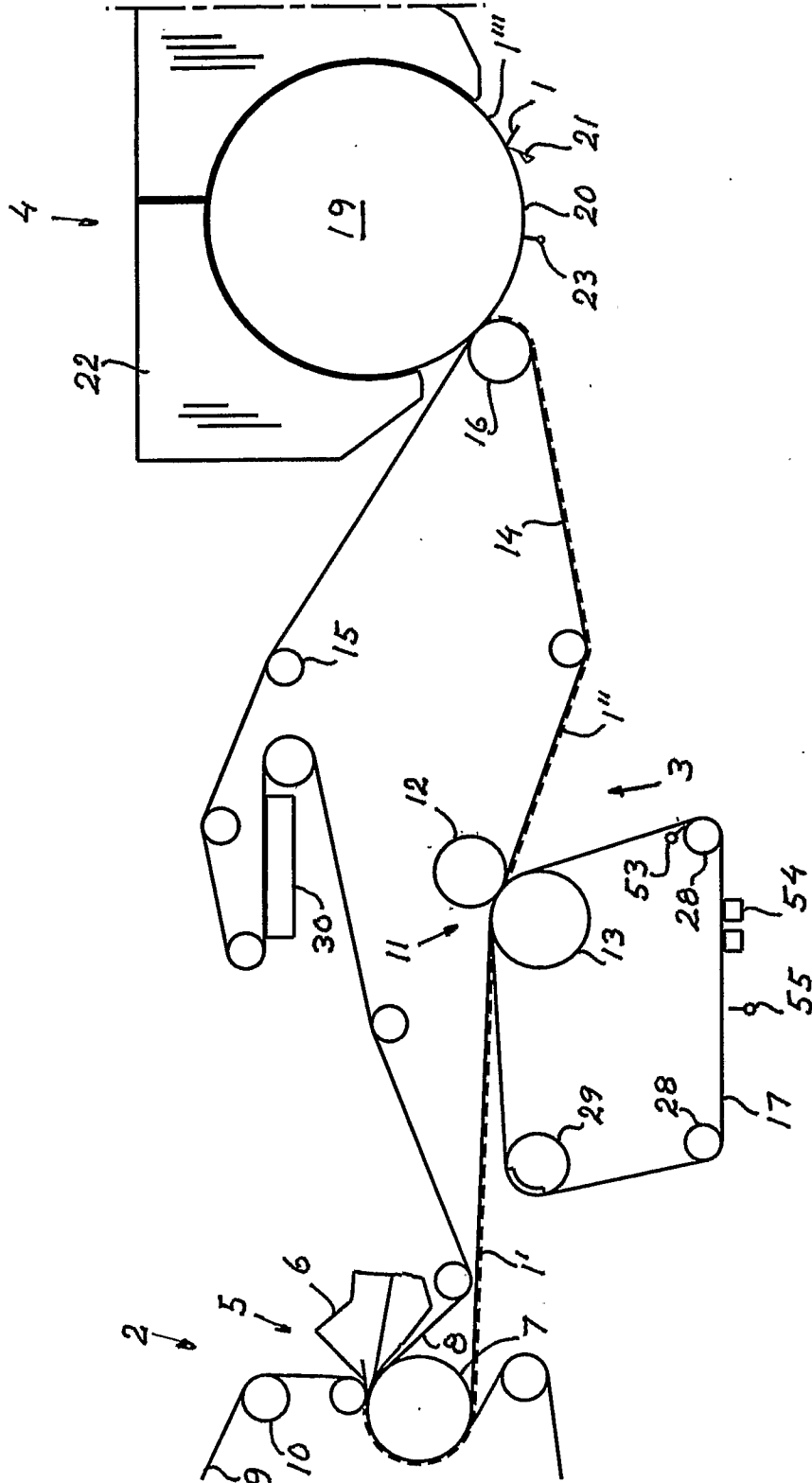


Fig. 3

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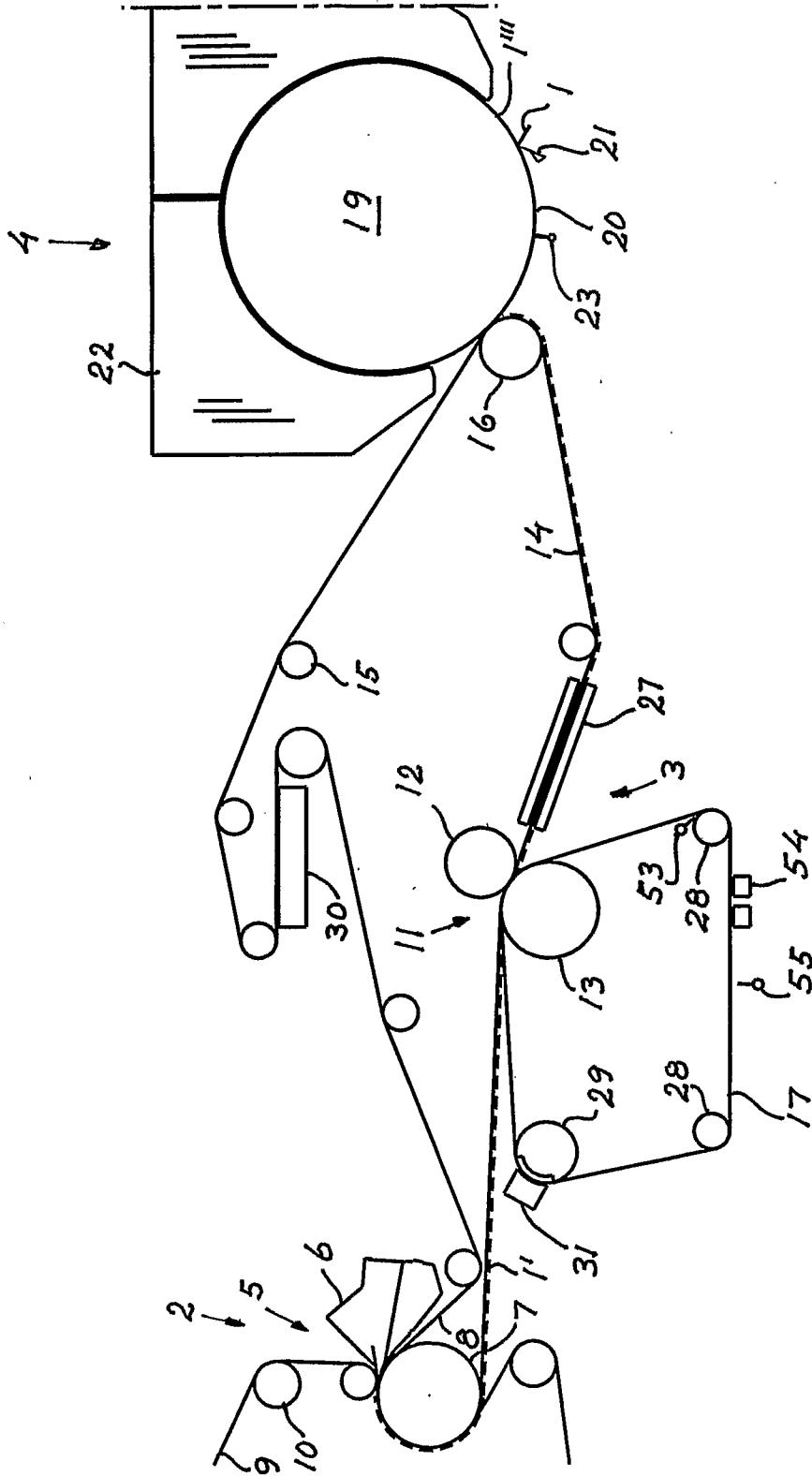


Fig. 4

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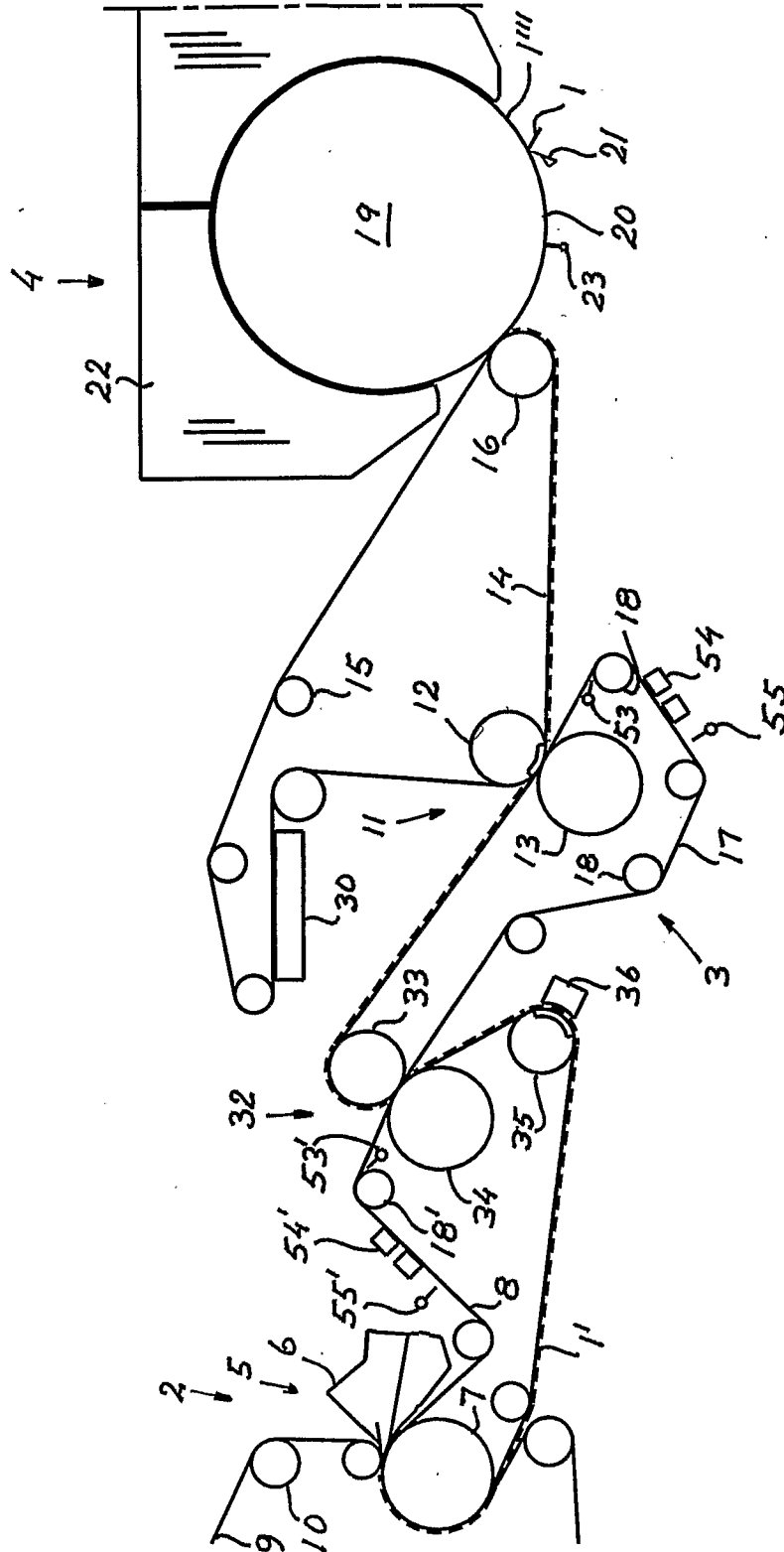


Fig. 5

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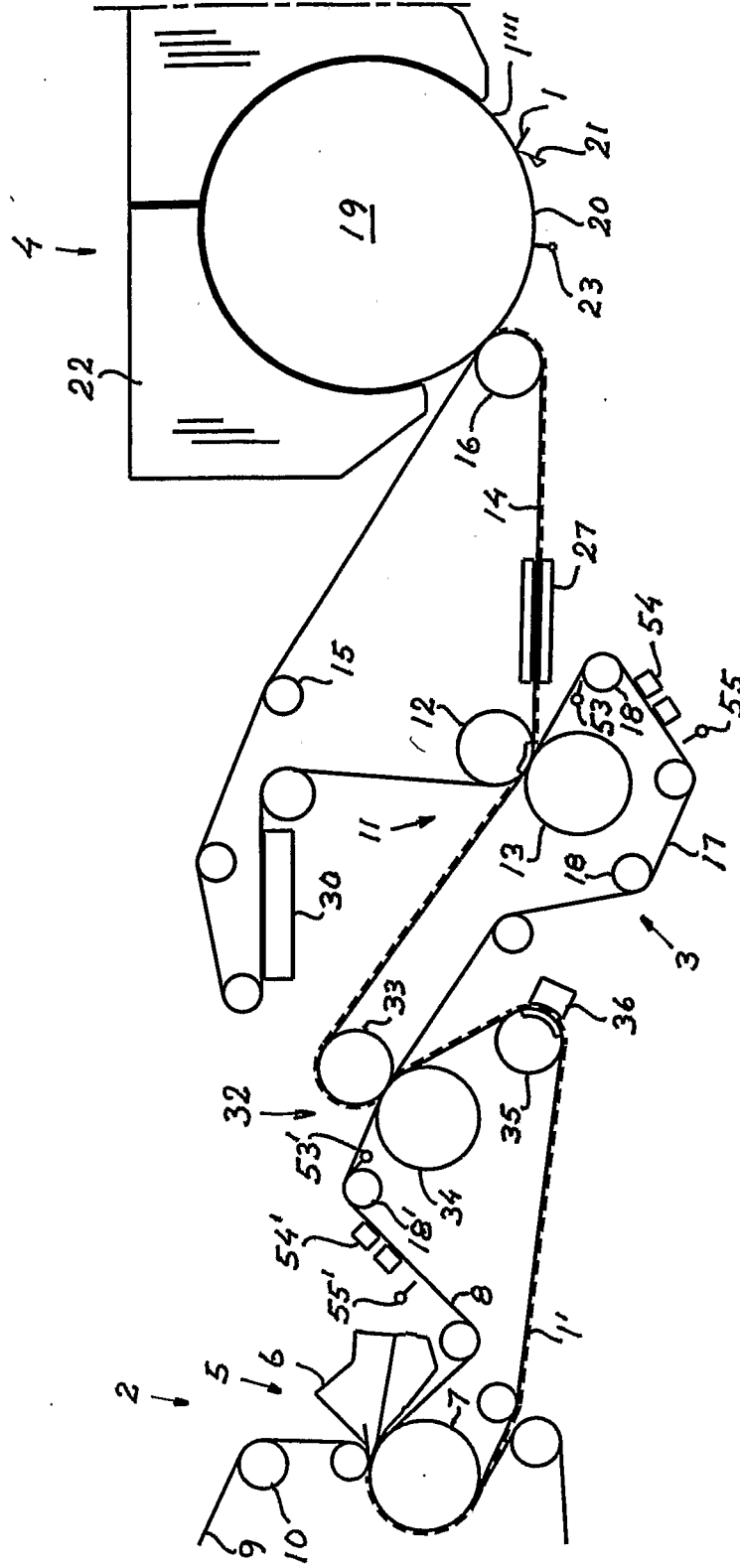


Fig. 6

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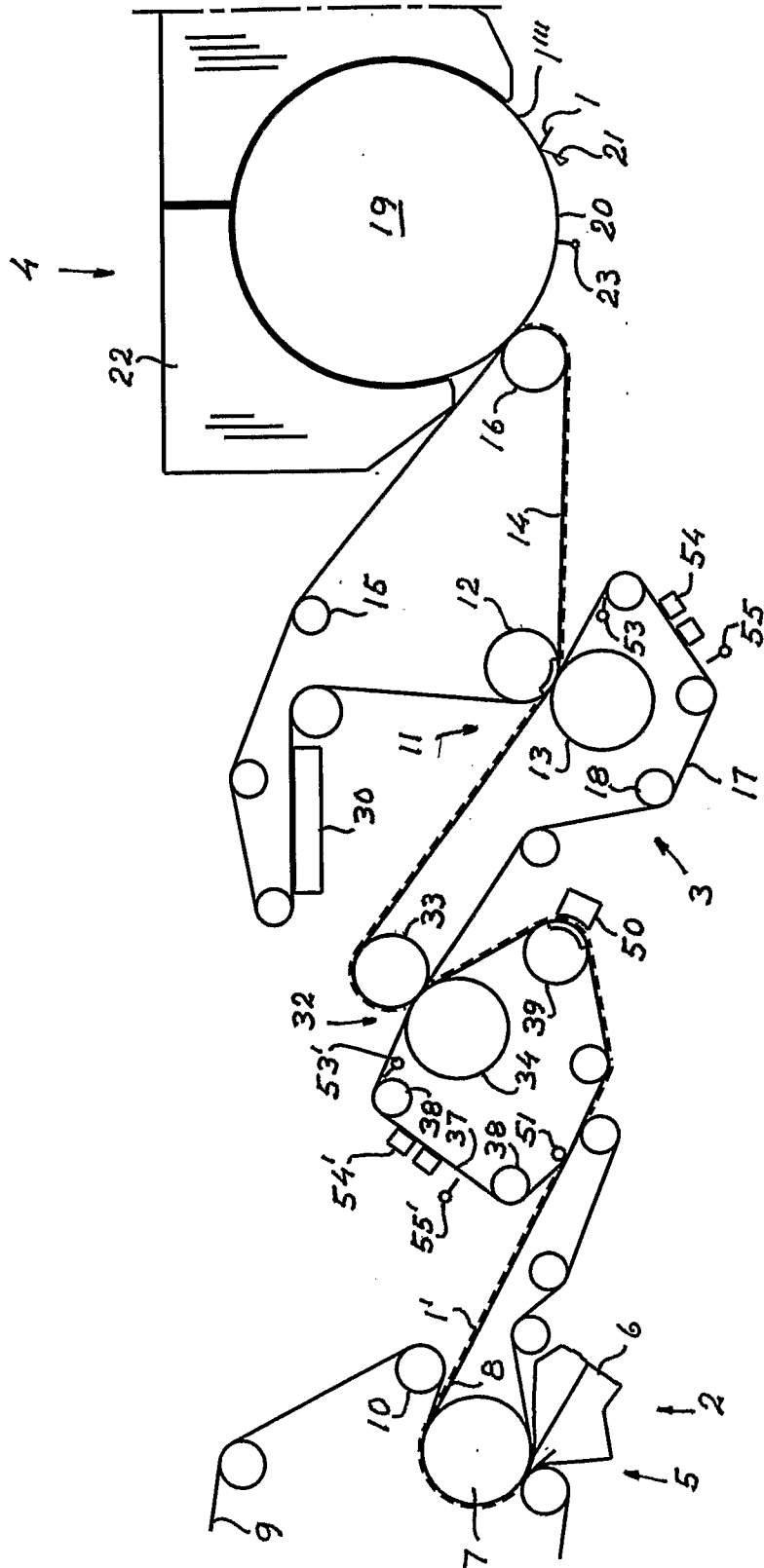


Fig. 7

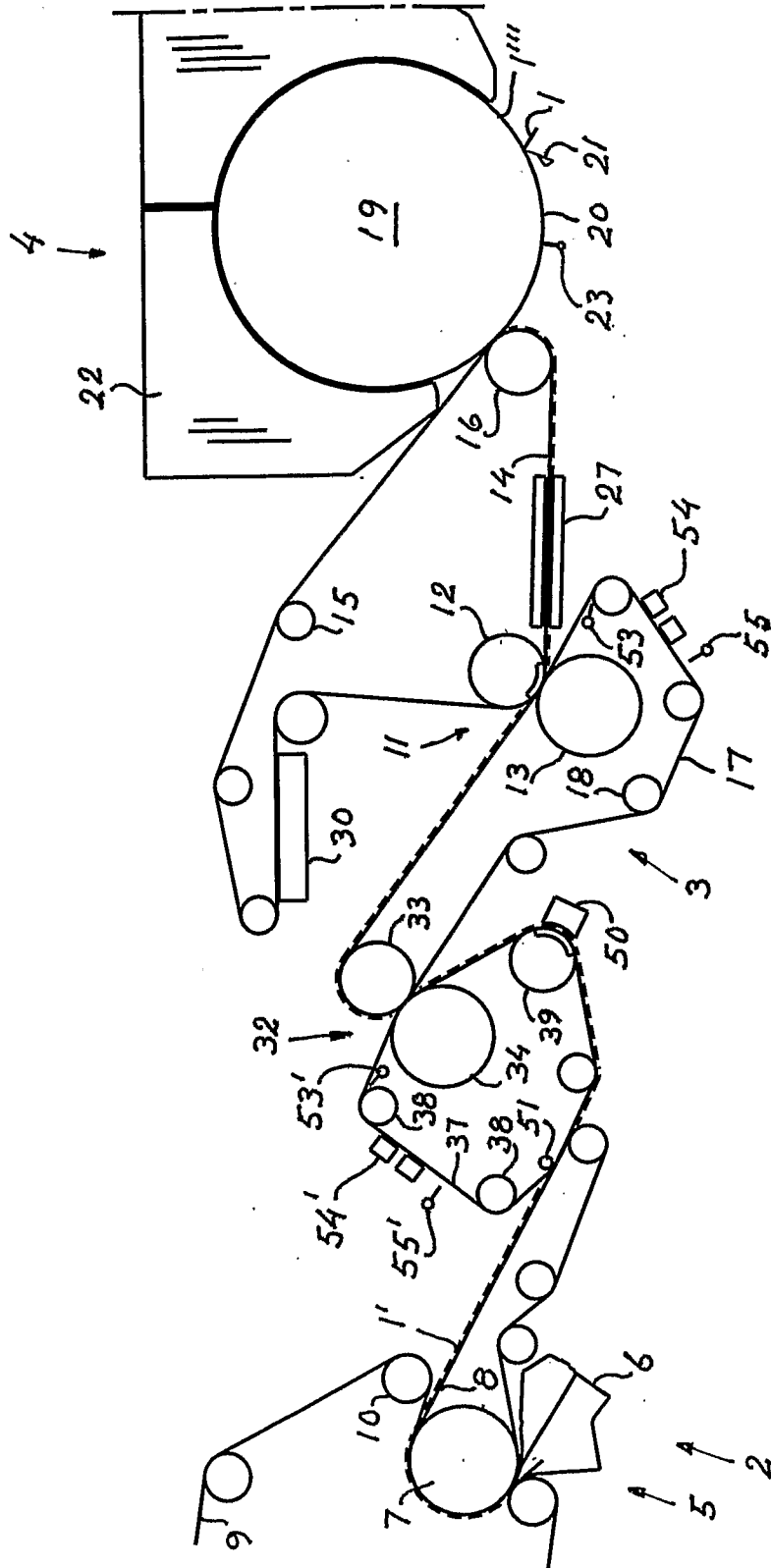


Fig. 8

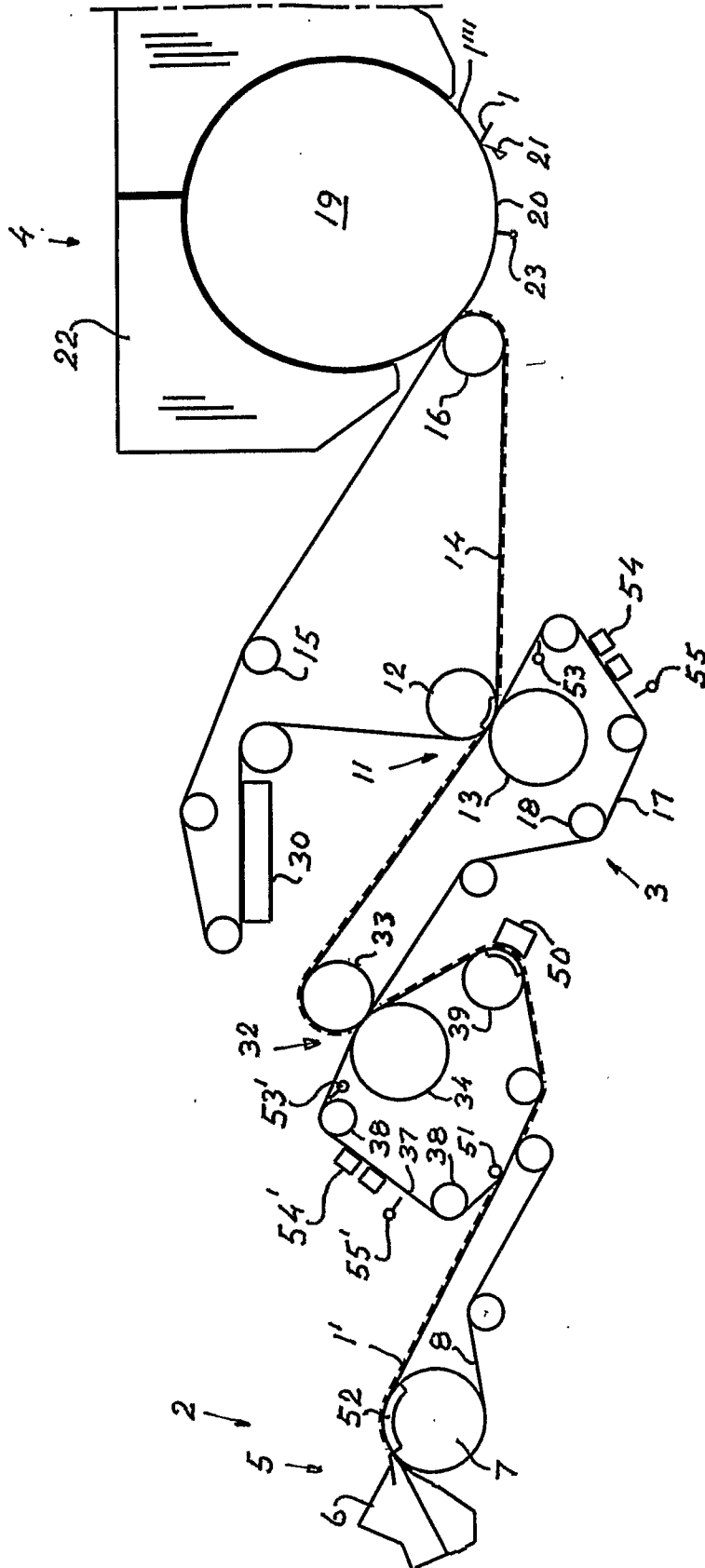


Fig. 9



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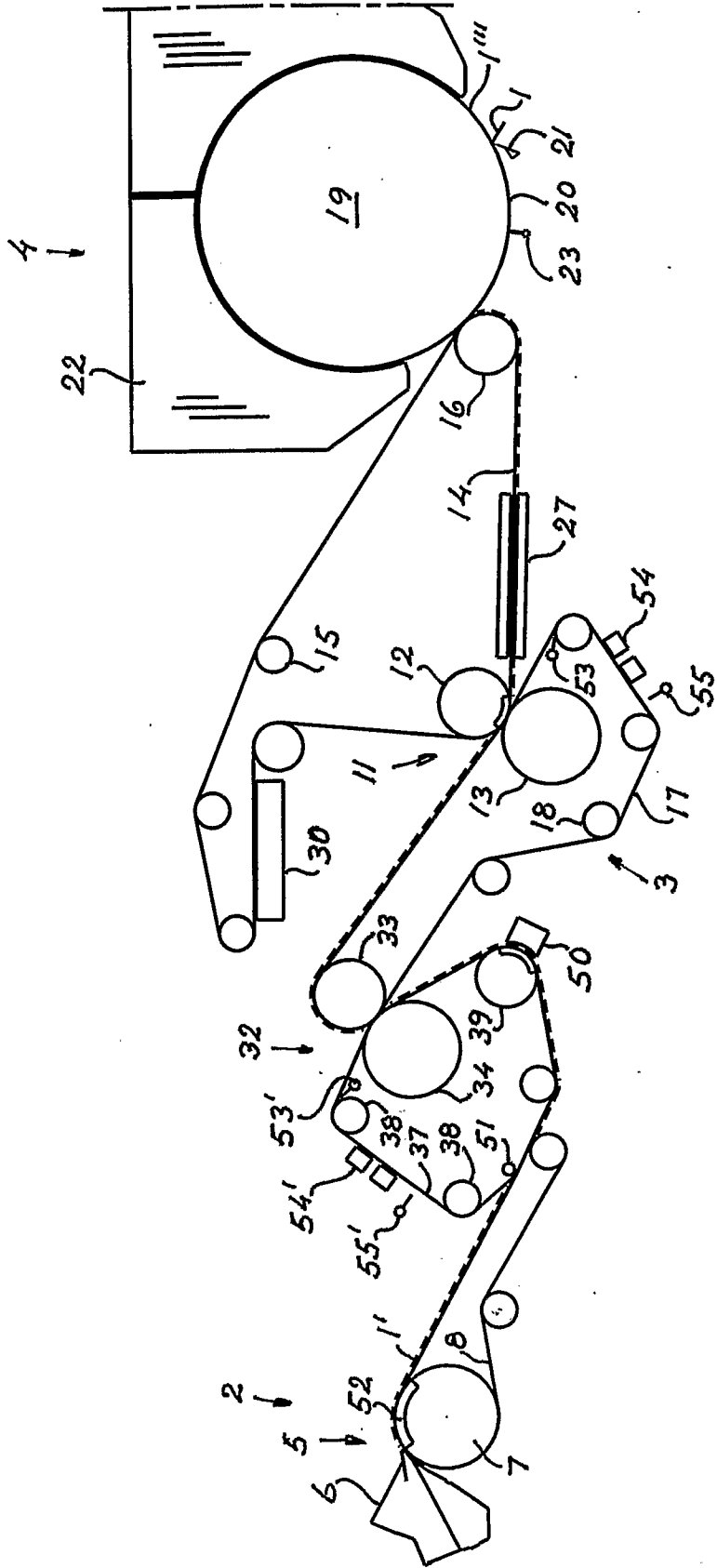


Fig. 10

Fig. 11

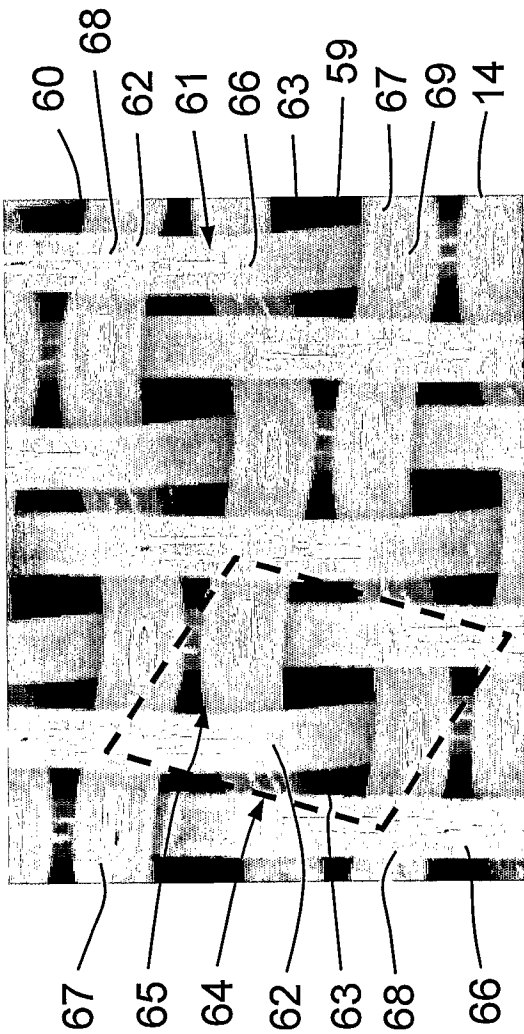
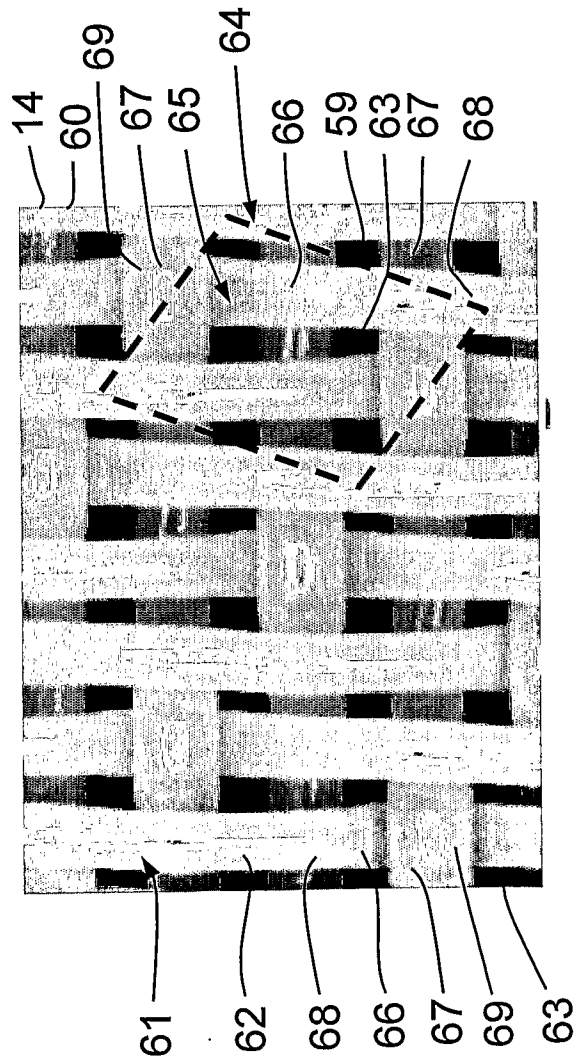


Fig. 12



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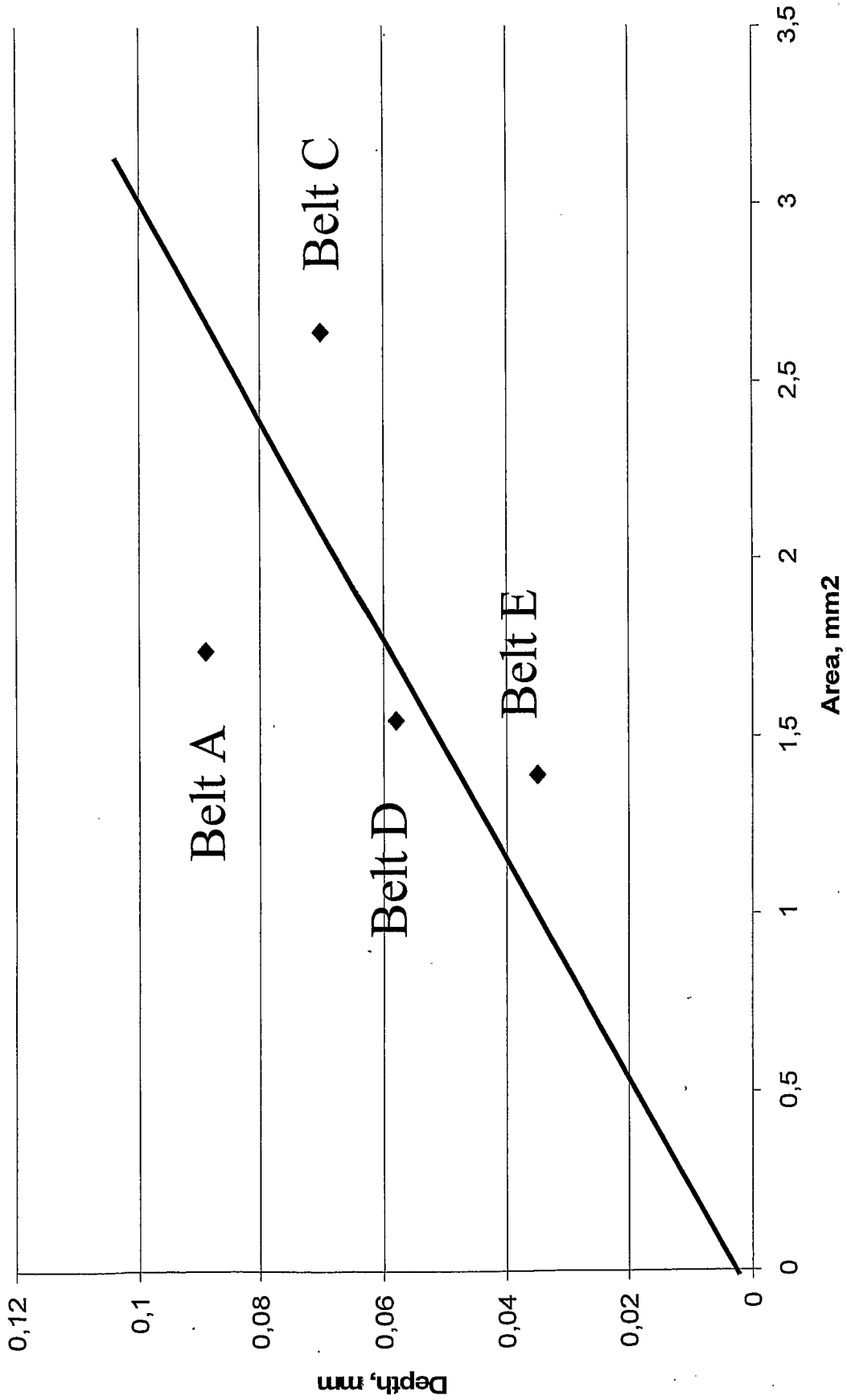


Fig. 13

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2008/000641

## A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

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

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D21F, D21H

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20020062936 A1 (KLERELID, I B E ET AL), 30 May 2002 (30.05.2002), figures 1-5, paragraphs [0003]-[0064] --	1-37
A	US 5456293 A (OSTERMAYER, V ET AL), 10 October 1995 (10.10.1995), abstract --	1-37
P,A	US 20080110591 A1 (MULLALLY C A ET AL), 15 May 2008 (15.05.2008), figure 11, abstract, paragraphs [0016],[0047] --	1-37



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

9 March 2009

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE2008/000641

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 4239065 A (TROKHAN P.D.), 16 December 1980 (16.12.1980), column 1, line 24 - column 3, line 26, figure 1, abstract  --	1-37
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**International patent classification (IPC)**

**D21F 11/00** (2006.01)

**D21F 7/08** (2006.01)

**D21F 3/02** (2006.01)

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SE2008/000641

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