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(54) Method and apparatus for the production of a particle based element

(57) The present invention relates to a method for the production of a particle based element, wherein a particle mass 1 is arranged for further processing, and a liquid is injected in between the particles of the particle mass 1. According to the invention, the liquid comprises water and a surface tension reducing component, to facilitate the distribution of the liquid within the particle mass 1. The present invention further relates to an apparatus for the production of a particle based element, comprising an injection means 3,11,15 which is adapted to introduce a liquid in between the particles of a particle mass 1. According to the invention, the injection means 3,11,15 is adapted to introduce the liquid at a discrete location inside the particle mass 1, wherein the liquid comprises water and a surface tension reducing component to facilitate the distribution of the liquid within the particle mass. Further, the present invention relates to the use of a liquid comprising water and a surface tension reducing component to locally alter the compressibility of a particle mass 1.

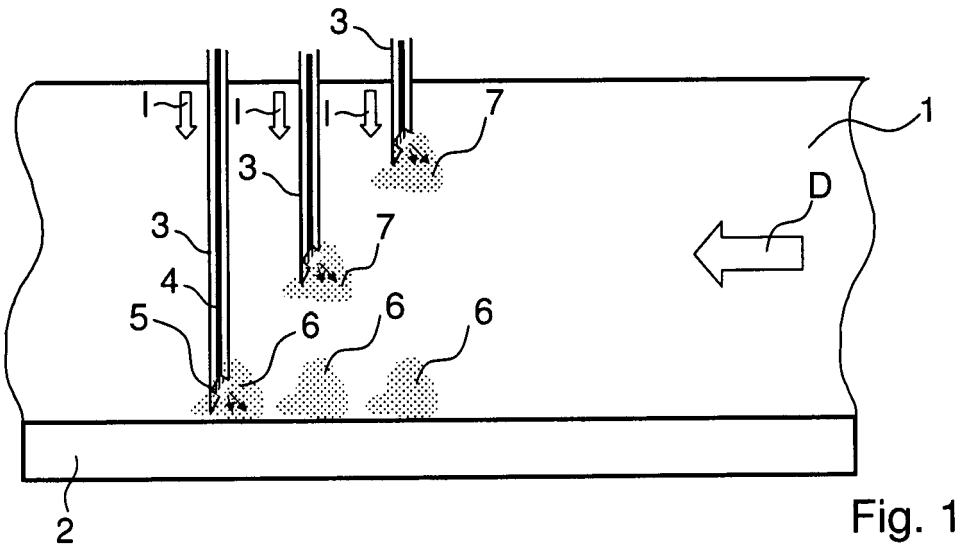

Fig. 1

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Description

[0001] The present invention relates to a method and apparatus for the production of a particle based element.

[0002] Generally, particle based elements are manufactured from particles such as wood chips, wood fibers, sawmill shavings, sawdust or other organic or non-organic fibers. The most common forms of particle based elements are particle boards, but also more complicated geometries may be realized.

[0003] The manufacture of particle based elements is usually carried out by mixing a particle mass with a resin, such as amino, formaldehyde based resins, urea melamine, phenol formaldehyde or resorcinol resins. Furthermore, other components may be mixed into the particle mass such as wax, dyes, wetting agents and release agents. After the resin has been mixed into the particle mass, the particle mass is arranged for further processing and pressed under high temperature to form the particle based element.

[0004] It is known in the prior art to cut an arranged pre-pressed particle mass in its middle and to inject hot steam into the middle before rejoining the two halves of the particle mass. Thus, the particle mass can be heated from the inside, which is supposed to be more efficient than heating from the outside of the particle mass.

[0005] However, the aforementioned method does not allow to only locally increase the moisture content in the particle mass, as the pressurized steam is subjected along the whole cutting line to both parts of the particle mass. Further, the pressure with which the steam is injected distributes the moisture through the whole particle mass, which is a desired effect in the aforementioned teaching. Furthermore, additives may be injected, however always with the focus of trying to obtain an even distribution throughout the particle mass.

[0006] The present invention has the object to provide a method and apparatus for the production of a particle based element, which allows to locally change the compression qualities of the particle based element before pressing, in a cost efficient and reliable manner.

[0007] In particular, the inventive method and apparatus should be capable of producing particle based elements with locally increased densities to increase the strength of the particle based elements.

[0008] The object is attained by injecting a liquid which comprises water and a surface tension reducing component, to facilitate the distribution of the liquid within the particle mass.

[0009] Thus, it is possible to locally increase the moisture content of the particle mass. As in contrast to the prior art liquid instead of steam is injected, it can be ensured that a more locally defined moisturization of the particle mass is obtained. However, if only water would be injected into the particle mass, the water would not be properly distributed in between the particles, but would just remain at the point of injection and would not be quickly absorbed by the particles of the particle mass. However, by providing water with a surface tension reducing component it is enabled to reduce the surface tension of water, which is a polar fluid, and thus to facilitate the distribution of the water in between the particles and the absorption of the water by the particles. Thus, at all locations where the liquid will be injected into the particle mass a defined volume of the particle mass will be soaked with the liquid. The particle mass, which is processed in this manner, is then provided to a press and a high pressure is applied to the particle mass, such that the particles are bond to each other. Those particles which are soaked with the liquid have different compression properties. In particular, the particles soaked with liquid can be more easily deformed and will thus be compressed into a state of higher density, than the other particles, which have not been subjected to the liquid. Thus, a structure of higher density can be obtained at defined locations in the particle based element.

[0010] Preferably, the liquid is injected at discrete locations in the particle mass. Thus, by providing several discrete locations which are bordering to each other and by means of the distribution caused by the better distribution properties due to the surface tension reducing component, a continuous region of the particle mass can be provided with the liquid, such that locally a continuous area of higher densities is obtained after pressing.

[0011] Otherwise, the liquid can also be injected along a line, and not only at discrete points, which also has benefits over the known prior art regarding the injection of steam, as no steam generators are necessary, but water with surface tension reducing component can be injected in its liquid phase. Thus, the method is cheaper and safer.

[0012] Preferably, the surface tension reducing component is a tenside. A tenside is a surfactant which enables to lower the surface tension of a liquid. Tensides are usually amphiphilic, containing both hydrophobic groups and hydrophilic groups, and reduce the surface tension of water by arranging themselves on the surface of water.

[0013] Alternatively, the surface tension reducing component may be a foaming agent, a non-polar fluid, or small particles which enable to reduce the surface tension of water.

[0014] More specifically, the surface tension reducing component is a detergent. Detergents such as soap are readily available on the market and there are various detergents which are also eco-friendly, such that they can be used in environment-friendly products.

[0015] The liquid may comprise up to fifty volume per cent of surface tension reducing component or even more, however in a preferred embodiment it has been shown that up to four volume per cent of the surface tension reducing component is enough to obtain the desired results. For many surface tension reducing components, such as detergents like soap, a concentration of up to three volume per cent is sufficient.

[0016] In one embodiment, the liquid is introduced at

several discrete locations to form a continuous and/or discontinuous freeform-surface of liquid within the particle mass, enabled by the distribution of the liquid within the particle mass. The particle mass can be pre-pressed before the introduction of liquid, such that the later deformation of the particle mass in the press is reduced and the location of the freeform-surfaces can be defined more precisely. The pre-pressing may be carried out at different compression levels. The freeform-surface or the freeform-surfaces can be arranged such that they are supporting the bending, tear or shear stability of the particle based element. In particular, the freeform-surface may be in the form of a wave in between the upper and the lower surface of the particle based element, which is preferably in the form of a particle board. As a wave-like surface provides a continuous structure which is arranged at both sides of the neutral axis respectively neutral plain of the particle board, the bending stability of the particle board can be efficiently increased. The wave-like structure may be provided only in one direction of the particle mass, wherein the free-form surface remains at a constant height along the other direction in the particle mass. Alternatively, the freeform surface may be composed by superposition of two wave-like structures in perpendicular directions in the particle mass.

[0017] In a further embodiment, the liquid is also applied to the outside layers of the particle mass. Thus, the outside of the particle mass can be hardened during the pressing process due to the higher compressibility of the particles provided with the liquid. Thus, a harder outside of the particle based element can be obtained.

[0018] In a preferred embodiment, the liquid has a substantially ambient temperature, as it is not heated before injection. Thus, in contrast to many prior art teachings no additional heating element has to be provided which renders the method more cost efficient. Furthermore, the method can be operated safer, as any operating personal cannot be injured by hot water or steam. It is emphasized that the only restriction is that the liquid should have a temperature which is higher than zero degrees, as otherwise the distribution would not be carried out properly. However, ambient temperature is preferred for the purpose of localized distribution of the liquid.

[0019] The above-mentioned object is further obtained by providing an apparatus with an injection means which is adapted to introduce the liquid at a discrete location inside the particle mass, wherein the liquid comprises water and a surface tension reducing component to facilitate the distribution of the liquid within the particles. In contrast thereto it is not known in the prior art to introduce liquid comprising water at discrete locations, as the distribution of water in between the particles is too slow. The water would not be absorbed by the particles during the time in between the injection of the water and the pressing process of the particle based element, as the absorption of water into the particles is very slow. Thus, in the prior art it is only known to inject steam along a line into the particle mass. Thus, the inventive apparatus allows to provide the particle mass with water at discrete locations, such that these discrete locations have different compressing properties, and will in particular be compressed more and thus have a higher density after a pressing operation. The apparatus may also be operated with any other fluid in a beneficial manner, such that at least an aspect of the invention is not restricted to the use of water and the surface tension reducing component.

[0020] In a preferred embodiment, the injection means is a needle, which is adapted to be introduced into the particle mass, the needle comprising at least one discrete opening, which serves the purpose of injecting the liquid into the particle mass. The discrete opening refers to a point opening which allows a very precise injection of the liquid into the particle mass. Further, the needle allows to be inserted into the particle mass, without rearranging the particles too much or without cutting or destroying a pre-compressed particle mass. It is emphasized that the discrete opening is not necessarily at the tip of the needle, but may also be provided at any other position along the needle or at several positions along the needle.

[0021] In a preferred embodiment, the discrete opening is provided at the tip of the needle. This allows, that the depth of the insertion of the needle for the purpose of injecting the liquid in the particle mass is only minimal. Preferably, the opening can be provided at the side of the tip of the needle, to avoid that particles enter the opening during the insertion process. The needle can be provided with an inclined, sharpened or pointed tip to facilitate the insertion in the particle mass.

[0022] In a preferred embodiment, several needles are provided at a holder and are adapted to be moved and/or rotated together with the same. Usually, the liquid is injected at various discrete locations. By providing several needles, this process can be accelerated. Further, by providing the several needles on one holder, only one drive has to be provided which moves the holder. This reduces the complexity and cost of the machine in contrast to operating several needles with separate drives.

[0023] In another embodiment, the needle is adapted to be moved and/or rotated individually. Thus, the needle or each of the needles can be brought into the preferred orientation and location for the injection process, and can in particular be inserted from various angles into the particle mass to allow an injection of liquid at defined locations.

[0024] Further, a combination of a holder with needles and individually driven needles can be provided. Alternatively or additionally the holder can be provided with needles which can be moved or rotated relatively to the holder.

[0025] In particular, the needle can be moved and/or rotated during the injection process, and the liquid can be provided continuously during the movement of the needle and is thus distributed along a line in the particle mass.

[0026] In one embodiment, the injection means is a blade which is adapted to be introduced into the particle

mass, the blade comprising at least one discrete opening, which serves the purpose of injecting the liquid into the particle mass. The blade allows easily to be inserted into the particle mass by cutting and to introduce the liquid at at least one discrete location which corresponds to the discrete opening of the blade.

[0027] Preferable, the discrete opening is provided at the edge of the blade. Thus, the injection can be carried out directly at the location of the cut through the particle mass, such that both sides of the particle mass are provided with the liquid.

[0028] In a preferred embodiment, a high frequency source, preferably an ultrasound source, is used to accelerate the distribution of the liquid within the particle mass. The high frequency source facilitates the distribution of the liquid in between the particles and the absorption of the liquid by the particles.

[0029] The present invention further relates to the use of liquid comprising water and a surface tension reducing component to locally alter the compressibility of a particle mass, in particular before pressing the particle mass to form a particle based element. Preferably, the compressibility is increased. The surface tension reducing component may be provided in the particle mass before the injection of water and may be mixed with the injected water in the particle mass.

[0030] In the following, exemplary embodiments of the invention will be described, which are illustrated in following figures:

Figure 1 shows an apparatus for the production of a particle based element according to a first embodiment of the invention.

Figure 2 shows the distribution of the liquid in a cross section of the particle mass obtained with the first embodiment of the apparatus according to the invention.

Figures 3a and 3b show different embodiments of the needle for an apparatus according to an embodiment of the invention.

Figure 4 shows an apparatus according to a second embodiment of the invention.

Figure 5 shows the distribution of the liquid in a cross section of the particle mass obtained with the second embodiment of the apparatus according to the invention.

Figure 6 shows an apparatus according to a third embodiment of the invention.

Figure 7 shows an apparatus according to a fourth embodiment of the invention.

Figure 8 shows the movement of the apparatus according to the fourth embodiment of the invention.

Figure 9 shows an apparatus according to a fifth embodiment of the invention.

Figure 10 shows an apparatus according to a sixth embodiment of the invention.

[0031] In the following the method and the apparatus according to the invention will be explained by means of exemplary embodiments.

[0032] In Figure 1, a particle mass 1 is shown which is transported on a conveyance means 2, such as a belt, in the conveyance direction D. The particle mass 1 comprises a mixture of wood fibers, chips and resin, respectively glue, in the form of a board and is shown in cross section. The height of the board which can be seen in the upright direction in Figure 1 is substantially smaller than the width of the board which is perpendicular to the figure plan. The length of the board is not defined, as Figure 1 shows a continuous production process, wherein the individual boards will be obtained by means of cutting the continuously produced board.

[0033] Three individual needles 3 are shown, which have been inserted into the particle mass 1 from above in the insertion direction **1.** The needles 3 comprise a channel 4, through which a liquid being water provided with a small amount of detergent is injected via an opening 5 into the particle mass 1. The distribution of the liquid in the particle mass 1 is indicated as moisturized areas 6, 7. The moisturized areas 6 are provided close to the lower side of the particle mass 1, while the moisturized areas 7 are provided within the particle mass in a distance to the outside of the particle mass 1. As can be seen in Figure 1, each needle 3 can first inject liquid close to the lower side of the particle mass 1 as shown for the leftmost needle to create a moisturized area 6, and then inject liquid at a discrete location within the particle mass 1 to create a moisturized volume 7. The needle 3 has a pointed tip to facilitate the insertion of the needle 3 into the particle mass 1. In particular, the opening 5 is provided in the inclined portion of the pointed tip.

[0034] The needles 3 reciprocatingly move in the vertical direction and are further adapted to move synchronized with the conveyance velocity in the horizontal direction during the injection process. In another embodiment, the conveyance means 2 may stop during the insertion of the needles 3. Just before being retracted from the particle mass 1, another small quantity of liquid is injected into the particle mass 1, such that the moisturized volume 8 as shown in Figure 2 is created at the top of the particle mass 1.

[0035] In Figure 2 the particle mass 1 with the moisturized volumes 6, 7 and 8 after the injection of the liquid through the needles 3 is shown in cross section. Thus, it can be seen that approximately a flat volume close to the top of the particle mass and a flat volume close to the bottom of the particle mass 1 are moisturized, and

further a wave-like structure within the particle mass is moisturized. It is emphasized that the wave structure can either only be provided in one direction, or the wave-like structure can be provided in two directions, that is additionally in the plain perpendicular to the section shown in Figure 2, such that a 3D wave structure is provided in the particle mass 1.

[0036] After the particle mass 1 has been processed by means of injecting the liquid through the needles 3, the particle mass 1 provided in the state as shown in Figure 2 to a press, which applies pressure to the particle mass 1 in the vertical direction from both sides and compresses the particles. Additionally, heat may be provided to the particle mass to further activate the glue and resin comprised therein. In the moisturized volumes 6,7,8, the particles of the particle mass will have a lower resistance to compression and will thus be compressed more than the particles in the areas where no liquid has been provided. Thus, the moisturized volume will form a volume of higher density in the pressed particle board.

[0037] In all embodiments, a high frequency source, in particular a microwave source, can be provided to apply microwave radiation to the particle mass 1 after the injection of liquid and before the further processing with the press. As the liquid comprises water, the water molecules will be excited by the microwave radiation, and thus the particle mass will be locally heated, which further facilitates the absorption of water in the particles and thus allows obtaining an even higher compressibility of the particles in the moisturized volume.

[0038] Alternatively or additionally, the particle mass can be subjected to another form of high frequency source, i.e. an ultra-sound source, generating ultrasound vibration to improve the distribution and absorption of the liquid. Further, the compression properties of the particle mass will be improved due to local relative movement of the particles due to the vibration such that a higher compression ratio during the pressing process can be obtained.

[0039] It is crucial for the locally injected liquid to comprise the surface tension reducing component in addition to water to facilitate the distribution of the liquid within the particle mass, as otherwise the distribution and absorption of the liquid in the particle mass close to the opening of the needle would not be obtained in a time sufficient for the processing of a particle board at high speed. Typically, the absorption of water comprising a small fraction of detergent takes only a fraction of a second when applied to a wood particle, while it may take up to 30 minutes for water only to be absorbed by a wood particle. This applies for all embodiments.

[0040] In Figures 3a and 3b alternative geometries regarding the opening 5 of the needle 3 are shown.

[0041] The opening 5 according to Figure 3a is provided slightly above the tip and at one side of the needle 3, only. It is supplied with the liquid through the channel 4.

[0042] In Figure 3b, the needle is provided with a channel 4 which splits at its downstream end into several channels to supply an opening 5 which is circumferentially open to all sides of the needle 3. The opening 5 is arranged slightly above the tip of the needle 3.

[0043] In Figure 4 a second embodiment of the apparatus according to the invention is shown, with respect to which the apparatus and method according to the invention will be further explained. In Figure 4 similarly to Figure 1, a particle mass 1 will be transported in the conveyance direction D on a conveyance means 2, such as a belt. However, in contrast to the first embodiment of the invention, the needles 3 according to the second embodiment of the invention are inserted at an inclined angle into the particle mass 1 in the insertion direction I**.** The inclined angle for insertion is usually 20-70 degrees with respect to the horizontal plain. When the needle 3 reaches its lowermost position as shown for the left needle 3 in Figure 4, the injection of liquid is started and is maintained during the retraction of the needle 3 out of the particle mass 1 in the retraction direction which is opposite to the insertion direction I**.** Thus, a moisturized volume 9 along the retraction path of the needle 3 is provided by means of distribution and absorption of the liquid within the particle mass 1 facilitated by the surface tension reducing component comprised in the injected water. After the injection as shown in Figure 4 the same or other needles are inserted in the opposite inclination, such that moisturized areas 10 are provided, which connect the moisturized areas 9.

[0044] Thus, a zigzag structure or a wave like structure in the particle mass is provided as shown in Figure 5. The particle mass 1 in Figure 5 may optionally be sprayed with the liquid according to the invention at its upper and lower side before being pressed such as to enable a higher density in the upper and lower surfaces of the particle mass. Alternatively, further processing by injecting liquids through needles may be carried out to obtain moisturized volumes 6 and 8 as shown in Figure 2 near the upper and lower surface of the particle board.

[0045] In Figure 6, a third embodiment of an apparatus according to the invention is shown, in accordance with which the method according to the invention will be further explained. In this embodiment, several horizontal needles 11 are provided, which comprise an opening for injecting liquid at least at their tip 12. The particle mass 1 is transported on a conveyance means 2 in the conveyance direction D. In a first zone P of the conveyance means 2, the particles are poured from a container from above onto the conveyance means 2. In this area, before the needles 3 extend into the particle mass 1, the needles 11 are fixed by fixation means 12. As the needles 11 are relatively long and thin and extend in the horizontal direction, it may be necessary to provide further supporting means to maintain the correct position of the needles 11 in the particle mass 1. Thus, a magnet 13 may be provided at each needle 11, or at least at the longest needle 11 as shown in Figure 6. By means of an electromagnetic field, the needles 11 can be supported in the vertical direction. Furthermore, a controlled variation of the elec-

tromagnetic field allows a controlled movement of the needles 11, such that a variety of injection patterns, that is shapes of moisturized volumes, can be provided in the particle mass 1. Further needles are provided in parallel to the needles 11 shown in Fig. 6 along the width of the particle mass 1.

[0046] The embodiment of Fig. 6 can be modified to comprise only one needle instead of several needles arranged above each other.

[0047] In Figure 7, a fourth embodiment is shown, wherein a plurality of needles 3 is fixed on a holder 14 and moved together with same with respect to the particle mass 1. The plurality of needles may comprise 5 to 5000 needles 3. It can be seen that the needles 3 are arranged along the whole width of the holder 14 in the direction perpendicular to the conveyance direction D of the particle mass 1. All needles 3 will be lowered together into the particle mass 1, wherein individual sets of needles are provided with a common liquid supply to their channel. By activation of the liquid supply to some of the needles at certain defined times, a defined pattern of moisturized volumes can be obtained in the particle mass 1 as shown in Figure 8. Furthermore, it can be seen that the holder 14 does not only carry out a vertical motion, but also a horizontal motion which is synchronized with the conveyance speed of the conveyance means 2. Thus, the holder 14 carries out a substantially elliptical motion, at least while the needles 3 are inserted in the particle mass 1. The holder 14 carries out a retraction motion in the direction opposite to the conveyance direction D when the needles 3 are retracted from the particle mass 1, wherein the retraction motion may as well be linear in contrast to Figure 8.

[0048] In Figure 9, a further embodiment is shown, wherein the injection of liquid is carried out by means of a blade 15. In the blade 15, several channels 16 are provided, which terminate at several discrete openings 17. The blade 15 is mounted by means of a hinge 18, a rotation around which allows inserting the blade 15 into the particle mass 1. The blade 15 generally has a crescent shape, the cutting edge being provided on the concave edge. Through the openings 17, the liquid is injected at defined times, such that only discrete locations in the particle mass are provided with the liquid. Then, due to the surface tension reducing component, the liquid is quickly locally distributed in the particle mass 1 and absorbed by the particles. The hinge 18 may either be provided stationary or may be provided on the conveyance means 2, such that the blade 15 moves along together with the conveyance means 2. In Figure 9, the openings are provided at the downstream edge of the blade opposite to the cutting edge. However, in other embodiments, the openings may as well be provided at the cutting edge of the blade. In further embodiments, the openings 17 may be provided at the flat sides of the blade 15. Furthermore, the blade 15 may as well be oriented in the opposite direction, wherein the cutting edge of the blade 15 is provided at the convex side of the crescent shaped blade 15. Several blades 15 may be provided in parallel and/or subsequently.

[0049] In further embodiments, straight blades may be used.

[0050] In Figure 10, another embodiment regarding the use of blades 15 as injection means is shown. The particle mass 1 moves on a conveyance means 2 in the conveyance direction D, while a wheel 19 rotates in a rotation direction R around an axis perpendicular to the conveyance direction at a speed which keeps the blades 15 substantially synchronized with the speed of the particle mass 1 such that a smooth insertion of the blades 15 into the particle mass 1 is possible. While being inserted in the particle mass 1, the liquid is introduced through the openings 17 of the blades 15 at defined times, such that a defined distribution of liquid in the particle mass 1 can be obtained.

[0051] In other embodiments, the insertion of the liquid may be obtained by means of nozzles which are provided close to the particle mass. Then, by means of pressure, the liquid is injected into preformed slim holes in the particle mass, which are preferably formed by needles. In other embodiments, the insertion of the liquid may be obtained by shooting liquid at high pressure into the particle mass.

Claims

1. A method for the production of a particle based element, comprising
   arranging a particle mass (1) for further processing, and
   injecting a liquid in between the particles of the particle mass (1),
   characterized in that
   the liquid comprises water and a surface tension reducing component, to facilitate the distribution of the liquid within the particle mass (1).

2. The method according to claim 1, wherein the liquid is injected at discrete locations in the particle mass (1).

3. The method according to claim 1 or 2, wherein the surface tension reducing component is a tenside, in particular a detergent.

4. The method according to one of the previous claims, wherein the liquid comprises up to 4 volume per cent of the surface tension reducing component.

5. The method according to one of the previous claims, wherein the liquid is introduced at several discrete locations to form a continuous and/or discontinuous freeform-surface of liquid within the particle mass (1), enabled by the distribution of the liquid within the particle mass (1).

6. The method according to claim 5, wherein the free-form-surface has a wave-like structure.

7. The method according to one of the previous claims, wherein the liquid is further applied to the outside layers of the particle mass (1).

8. The method according to one of the previous claims, wherein the liquid has substantially ambient temperature, as it is not heated before injection.

9. Apparatus for the production of a particle based element, comprising an injection means (3,11,15) which is adapted to introduce a liquid in between the particles of a particle mass (1),
characterized in that
the injection means (3,11,15) is adapted to introduce the liquid at a discrete location inside the particle mass (1), wherein the liquid comprises water and a surface tension reducing component to facilitate the distribution of the liquid within the particle mass.

10. Apparatus according to claim 9, wherein the injection means is a needle (3,11) which is adapted to be introduced into the particle mass (1), the needle (3,11) comprising at least one discrete opening (5,12), which serves the purpose of injecting the liquid into the particle mass (1), and the discrete opening (5,12) is in particular provided at least at the tip of the needle (3,11).

11. Apparatus according to claim 10, wherein several needles (3) are provided at a holder (14) and adapted to be moved and/or rotated together with same.

12. Apparatus according to claim 10, wherein the needle (3,11) is adapted to be moved and/or rotated.

13. Apparatus according to claim 9, wherein the injection means is a blade (15) which is adapted to be introduced into the particle mass (1), the blade comprising at least one discrete opening (17), which serves the purpose of injecting the liquid into the particle mass (1), and the discrete opening (17) is in particular provided at the edge of the blade-like formed injection means (15).

14. Apparatus according to any one of the claims 9 to 13, wherein a high frequency source, preferably an ultra sound source, is used to accelerate the distribution of the liquid within the particle mass (1).

15. Use of a liquid comprising water and a surface tension reducing component to locally alter the compressibility of a particle mass (1).

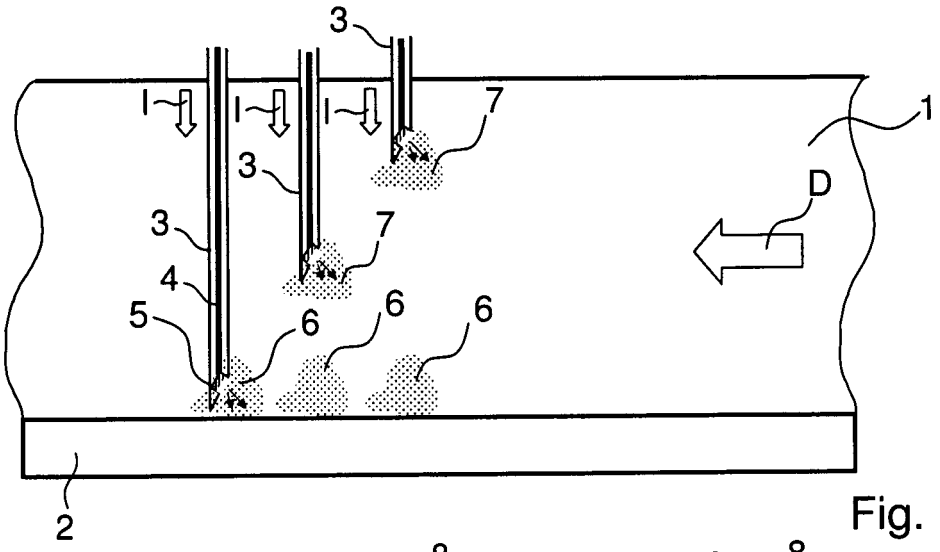

Fig. 1

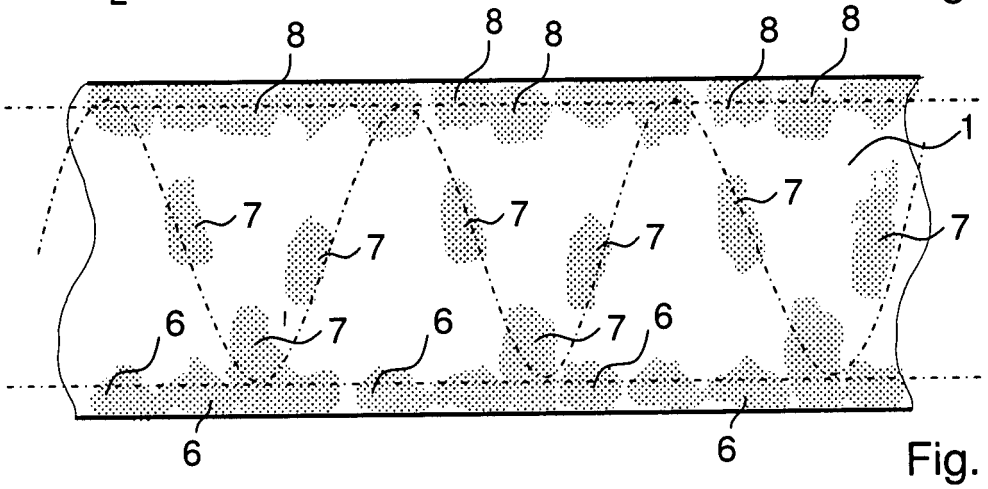

Fig. 2

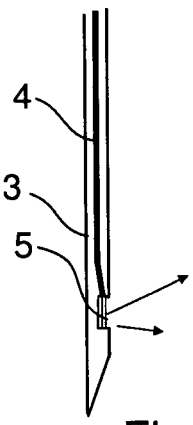

Fig. 3a

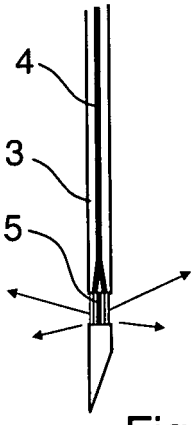

Fig. 3b

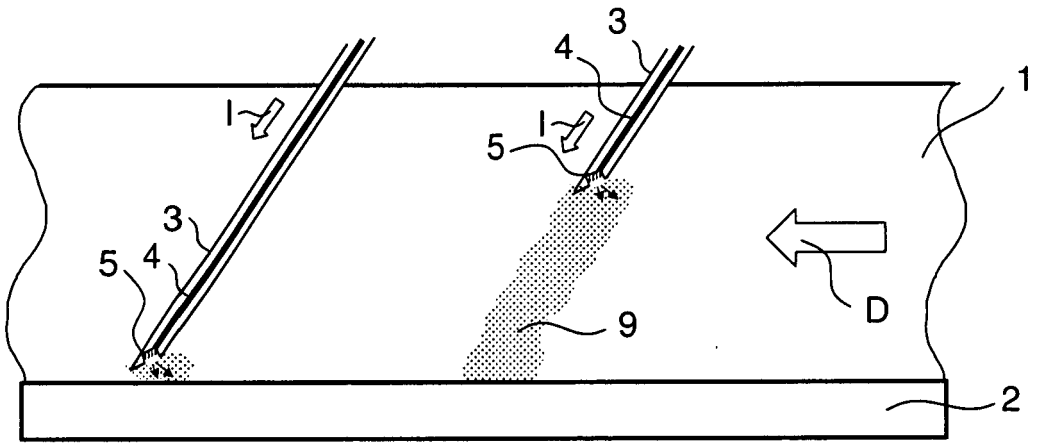

Fig. 4

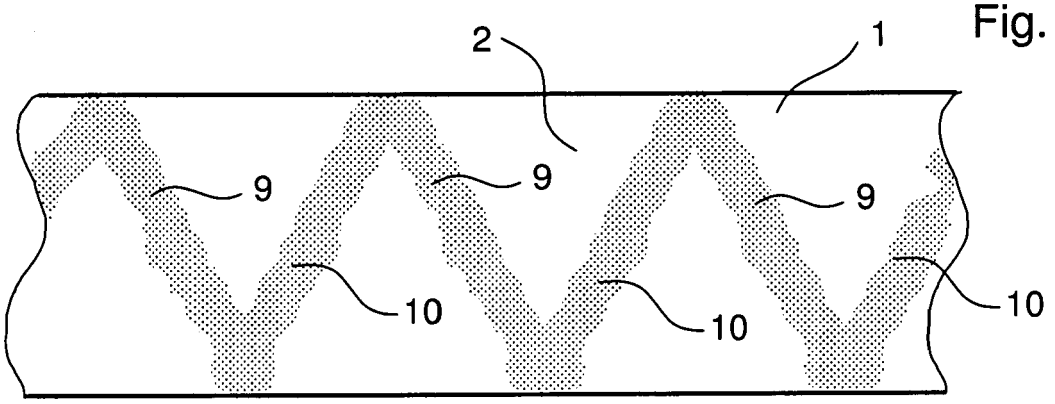

Fig. 5

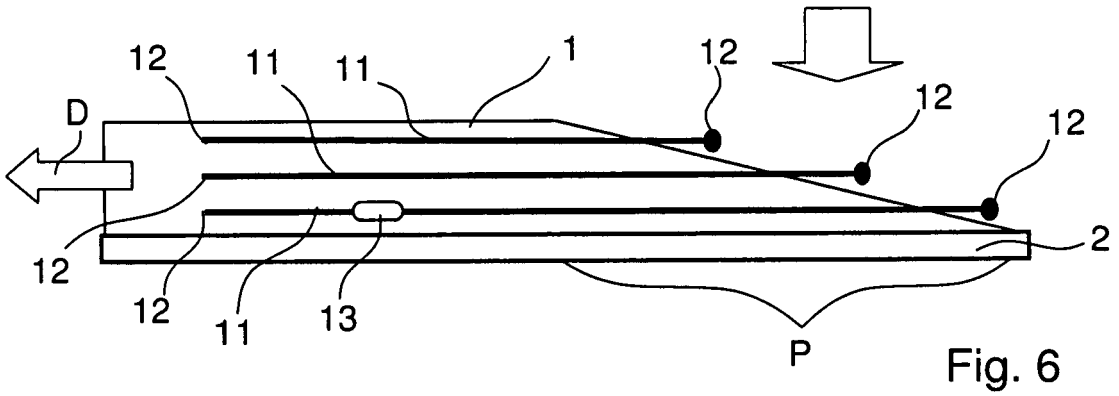

Fig. 6

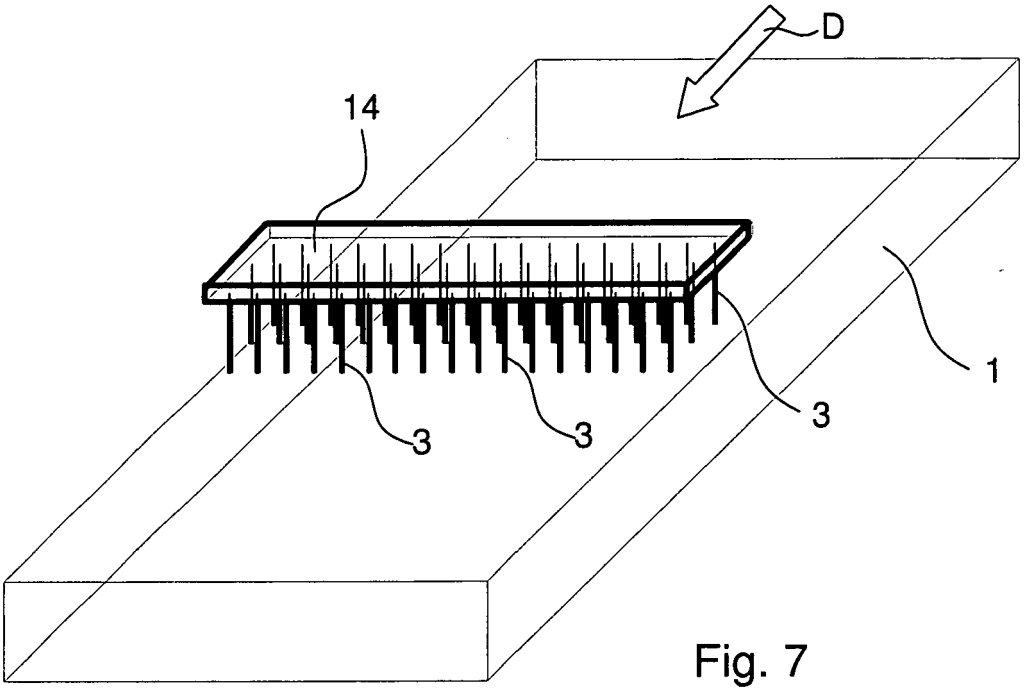

Fig. 7

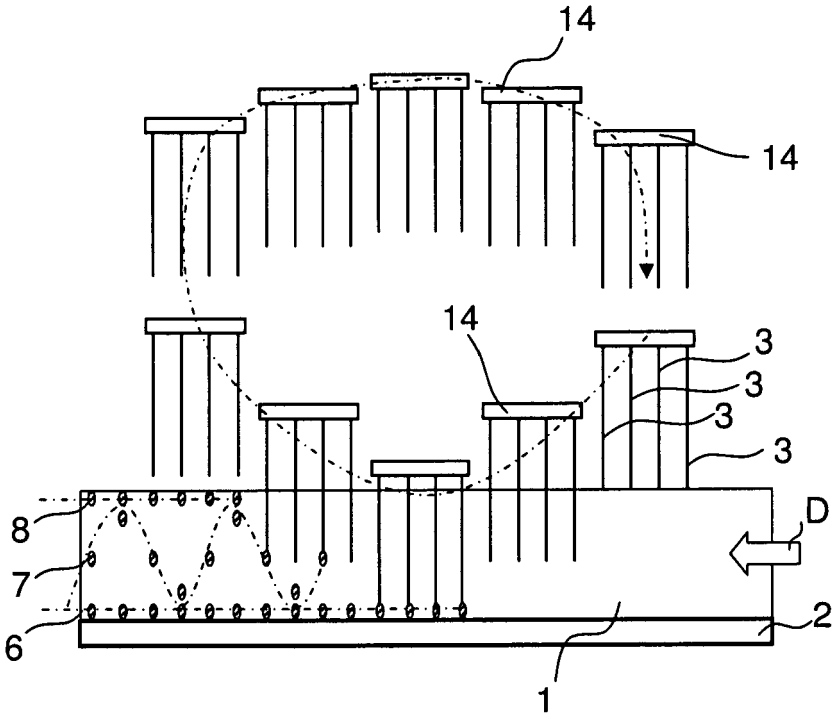

Fig. 8

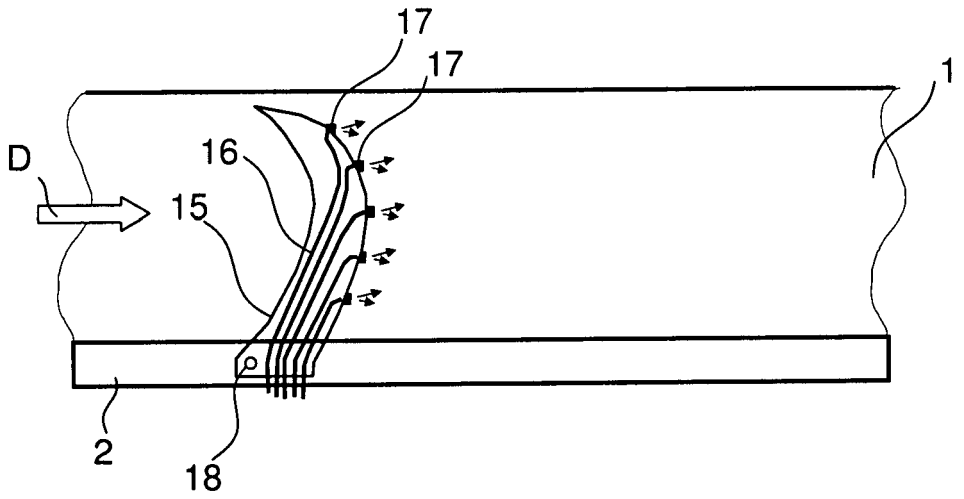

Fig. 9

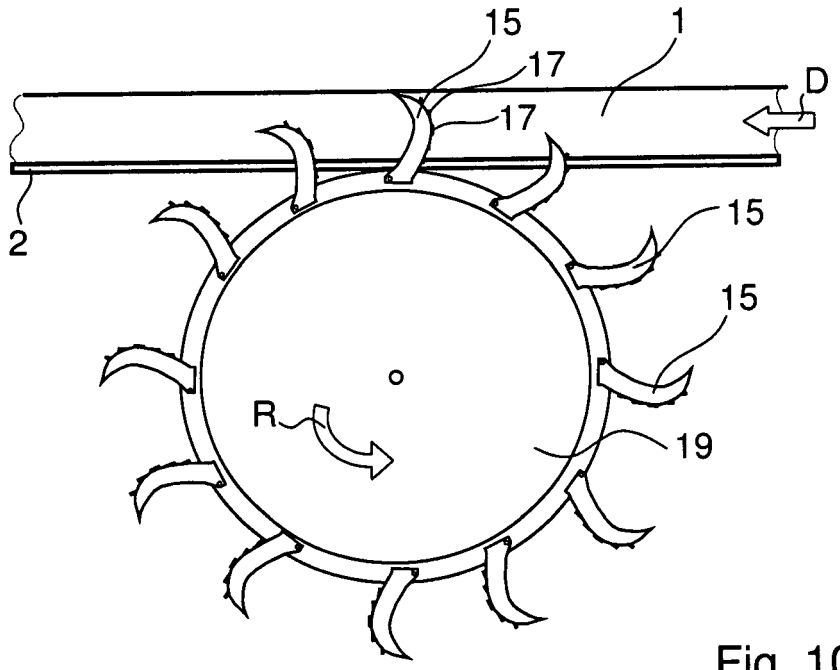

Fig. 10

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EUROPEAN SEARCH REPORT

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Place of search	Date of completion of the search	Examiner
The Hague	15 June 2011	Söderberg, Jan-Eric

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