(19) Europäisches Patentamt
European Patent Office
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(11) **EP 2 719 826 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.04.2014 Bulletin 2014/16

(51) Int Cl.:
D21H 19/54 *(2006.01)*

(21) Application number: **12187736.9**

(22) Date of filing: **09.10.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) **Process for producing a fiber web and arrangement for producing a fiber web**

(57) The invention relates to a process for producing a fiber web in which process by surface sizing of the web sizing agent is applied onto the fiber web. The sizing agent comprises a mixture of at least two different starch solutions and that the fiber web is heated and/or dried before or after or during the surface sizing. The invention also relates to an arrangement for producing a fiber web. The arrangement for producing fiber web (W) comprises means (11) to apply sizing agent that comprises partially native starch on the surface of the fiber web and means (10; B) for heating and/or drying the web (W).

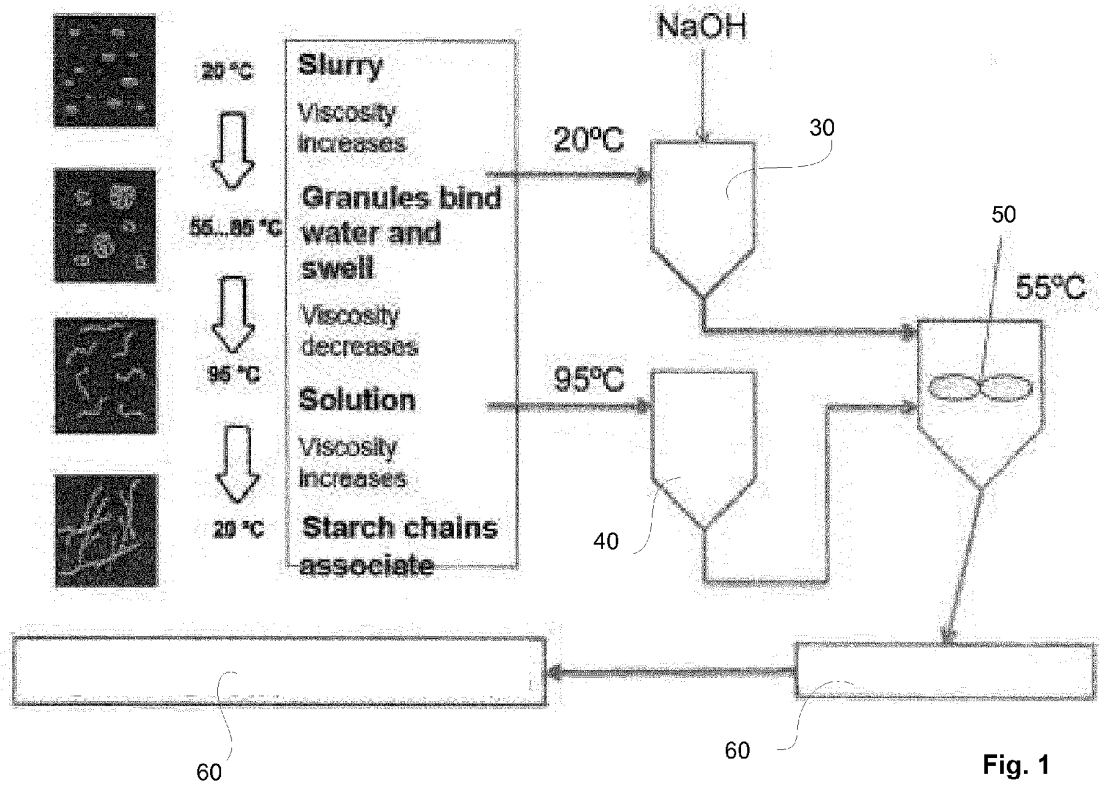

Fig. 1

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Description

[0001] In general present invention relates to producing fiber web in a fiber web machine. More especially the present invention relates to a process according to preamble part of claim 1 and to an arrangement according to preamble part of claim 7.

[0002] As known from the prior art in fiber web producing processes typically comprise an assembly formed by a number of apparatuses arranged consecutively in the process line. A typical production and treatment line comprises a head box, a wire section and a press section as well as a subsequent drying section and a reel-up. The production and treatment line can further comprise other devices and sections for finishing the fiber web, for example, a sizer, a calender, a coating section. The production and treatment line also comprises at least one winder for forming customer rolls as well as a roll packaging apparatus. In this description and the following claims by fiber webs are meant for example paper and board webs.

[0003] In production of fiber webs, for example of paper or board webs, sizing is used to alter the properties of a fiber web by adding sizing agents, for example glue chemicals. Sizing can be divided to internal sizing and surface sizing. In internal sizing the sizing agent is added to pulp in the wet end of the fiber web machine before forming. In surface sizing the sizing agent is added onto the surface of the fiber web at the dry end of the fiber web machine. Internal sizing is done in the beginning of the wet end of the fiber web machine by using different kinds of chemical treatments in order to influence the penetration of a liquid, for example of water into the fiber web.

[0004] In production of fiber webs, for example of paper or board webs, surface sizing is used to alter the properties of a fiber web by adding sizing agents, for example starch or other glue chemicals. In surface sizing the sizing agent is added onto the surface of the fiber web at the dry end of the fiber web machine. Surface sizing is used in production of many fiber web grades, for example of uncoated fine papers and of several board grades. The sizing of paper and board web typically utilise a separate sizer. In connection with the sizer different kinds of sizing technology are employed in prior art arrangements, for example pond sizing technology or film transfer technology or spray sizing technology. WO publication 03/004770 A1 discloses a further method for manufacturing a surface sized web of paper of paperboard, the method comprising a step of applying to at least one side of the web an aqueous furnish of size and according to the method the solids content of the size furnish being applied is at least 15% and the size furnish is applied to one side of the web by amount not greater than 5 g/m2 as aqueous furnish of size applied to the web. As one suitable, among others, applicator apparatus for the method disclosed the publication mentions spray applicators. Further, WO publication 2006/058961 A1 discloses a method and arrangement for processing a paper or board web or similar fiber web. In this prior art method a processing mixture is spread on the surface of the web with spray nozzles. In the method the web to be processed is lead from a press nip and between rolls in this nip. Before the web enters the nip such an amount of processing mixture is spread onto at least one side of the web that the processing mixture is still wet when it enters the nip. In the prior art arrangement according to this publication the arrangement comprises at least one press nip, elements for taking the web to the press nip an elements for spreading the processing mixture and the element for spreading the processing mixture are spray nozzles which are arranged at an adjustable distance in the arrival direction of the web from the press nip to feed the processing mixture to at least one surface of the web.

[0005] In surface sizing with a size press for increasing the strength of the web the solid contents of the web must be sufficiently high in order to achieve good runnability of the web and infiltrating of cooked starch. Due to this the solid contents of the web are to be at least 90 % before surface sizing, which decreases the solid content level to 70 % or even below. Low solid content of the web raises runnability problems and may cause web breaks.

[0006] In GB patent publication 333,226 is disclosed a process of coating paper in the form of a web or sheet which comprises applying thereto an aqueous slurry containing raw starch and contacting the wet coated paper with steam. In the process the aqueous slurry may also contain a pigment and the coated paper is subjected to sufficient heat without substantial drying to gelatinize the starch and the coated paper is dried and finished. The heating of the coated paper to gelatinizing temperature of the starch is performed in the presence of sufficient moisture to effect the gelatinization of the starch. The wet coated paper may be contacted with steam or with saturated or slightly superheated steam. In this process only raw starch is used as binding agent in coatings.

[0007] In DE patent application publication 102008040057 is disclosed a process for surface treatment, preferably for surface sizing, of material web, preferably paper or board. The process comprises applying a starch containing surface treatment agent as a predosed film on assigned surface of the material web using a film applying device. The starch is a thermally-chemically modified starch and the solid content of the surface treatment agent is reduced, when compared to native starch viscosity. The object is to decrease the need for drying of the material web after the surface sizing.

[0008] In the internal sizing at highest about 2 % of sizing agent can be added since too high amount of sixing agent added at the wet end lowers the drying properties of the web as the moisture infiltrates into the starch granules during drying. It is known to use native i.e. raw i.e. uncooked starch in internal sizing but its retention is rather low as mentioned only up to 2 %. For improving the retention agents are used. Native starch is used as sizing

agent in single webs but it can also be used in multilayer forming to improve the adherence of layers.

[0009] The capability of native starch to form hydrogen bonds is based on the presence of heat and moisture, which swell the starch granules, whereby the infiltrated moisture creates hydrogen bonds. By the heat also the moisture is evaporated and the stabile bonds are created as the starch dries.

[0010] In surface sizing uncooked i.e. native starch or cooked starch with high viscosity remain at surface of the web and thus inner strength of the web does not increase. The gelatinization of the native starch requires temperatures of 55 - 86 °C for the starch to create strong bonds with the fibers of the web.

[0011] It is also problematic to apply native starch in high consistency since the starch precipitates easily creating a hard and concentrated mixture.

[0012] An object of the invention is to create a process for producing fiber web and an arrangement for producing fiber web, in which the problems and disadvantages of prior art are eliminated or at least minimized.

[0013] In order to solve the above problems and those that will come apparent later the inventive process is mainly characterized by the features of claim 1. The inventive arrangement in turn is mainly characterized by the features of claim 7.

[0014] According to the invention in the process for producing the fiber web by surface sizing of the web sizing agent is applied onto the fiber web, which sizing agent comprises a mixture of at least two different starch solutions, which mixture comprises at least a starch solution with high viscosity and a starch solution with low viscosity. The starch mixture has low viscosity, advantageously less than 100 mPas (Br100) which improves the sizing of starch mixture of high starch content, for example starch content is 8-20 % solids content.

[0015] Preferably the mixture comprises as one starch solution native i.e. uncooked i.e. raw starch and water.

[0016] According to according to one aspect of the invention the sizing agent mixture preferably comprises a native i.e. uncooked starch solution and a cooked starch solution. Advantageously 30-70 % of the starch content is native starch and 30-70 % of the starch content is cooked starch. The temperature of the mixture in sizing is held below the gelatinization temperature of 30-55 °C. By mixing native starch solution and cooked starch solution a stabile mixture with high consistency is achieved that does not concentrate in the pipes of the device or on the bottom of the container.

[0017] Advantageously the uncooked starch is modified, oxygenized or enzymatically converted cooked starch.

[0018] By altering the ratio of starch solutions the size content of the web can be adjusted in the thickness direction of the web.

[0019] One of the starch solutions may also function as carrier agent for hydrophilic agents, optical brighteners etc. in case in particular the surface properties of the web are to be modified.

[0020] The sizing agent may also comprise fines for improving or pigmenting the surface of the web.

[0021] Advantageously according to one aspect of the invention the sizing agent mixture comprises a native i. e. uncooked starch solution and a cooked solution. According to this aspect of the invention before mixing the solutions of native and cooked starch the native starch is dispersed into a lye solution of 0,1 - 0,5 %. By this the gelatinization temperature of native starch is lowered to a desired level and a fast reaction and early gelatinization is achieved thus creating a longer time, more moisture and more heat for sizing reaction.

[0022] According to one advantageous feature of the invention the viscosity is adjusted. For example mixture of pearl starch, borax, caustic soda and water can be suspended in a paste of cooked starch. The addition of caustic soda helps gelatinize the starch. An increase in the amount of caustic soda, based on the total starch, will lower the gel temperature of the entire adhesive. The primary value of borax is to buffer the caustic soda present in the formula. It also provides viscosity control and adds tack to the finished adhesive. Generally, 15-20 % of the starch is fully cooked in part of the water with caustic to provide a carrier for the pearl starch. Starch solids levels usually are 23-35 % to achieve finished adhesive viscosity of 30-50 Stein Hall seconds. After the adhesive is applied to the flute tips and heated, the pearl starch gelatinizes in place. When the starch swells and gelatinization begins, a green bond is formed. Nearly all of the corrugated board produced today is bonded with a starch-based adhesive. Since the quality and bonding properties of the starch directly affect final board quality, decisions regarding starch should be made carefully and treated with importance in the process.

[0023] According to the invention the arrangement for producing fiber web comprises means to apply sizing agent that comprises partially native starch on the surface of the fiber web and means for heating and/or drying the web.

[0024] Advantageously the means to apply sizing agent are micro jet or film or bond or spray sizing means.

[0025] Advantageously the means for drying and/or heating are belt and/or cylinder and/or infra and/or airborne and/or steam and/or other drying means in such known to one skilled in the art.

[0026] According to one advantageous feature of the invention as a sizing nip a heated belt nip or roll nip is used for gelatinization of starch before drying.

[0027] According to one advantageous feature of the invention in the arrangement a blade or a rod is located after means to apply sizing agent that is a mixture of at least two different starch solutions for smoothening the applied sizing agent.

[0028] According to one advantageous feature of the invention the arrangement comprises means for applying the native starch solution directly after sizing, for example the arrangement comprises a spray device without nip.

[0029] According to one advantageous feature of the invention the location of the means to apply sizing agent that comprises partially native starch are located at wire section, at press section or at drying section of the fiber web production line. The means to apply sizing agent could even be located at head box section, for example the means to apply sizing agent could be a water jet of a double (twin) head box.

[0030] The invention can be utilized in production of different fiber web grades, for example container boards. The fiber web is advantageously already internally sized.

[0031] By the invention many advantages are achieved: for example strength and/or surface strength and/or rigidity of the web can be optimized by rationing the starch solutions, for example raw material costs can be decreased by using bigger ratio of native starch that is less expensive than cooked starch and for example the surface of the web can be modified by filling and/or coating and/or sizing it by native starch.

[0032] According to one example of the invention the sizing agent is applied in or directly before a treatment zone in which the web is threated by pressure and heat. The sizing agent is applied by a spray sizing device or corresponding spraying device and the web is guided into a nip formed between a roll or a cylinder and a belt, advantageously a metal belt. In the nip the surface pressure of the belt provides for the sizing agent to penetrate into the web. Simultaneously the belt provides for heating of the web surface, by which the moisture evaporates and rises the temperature of the sizing agent over the gelatinization temperature. The moisture evaporation also provides for the sizing agent to penetrate further into the web. In this example the web is surface sized on at least one surface during closed web transfer, with sizing agent mixture of at least two different starch solutions as explained above. In this example the belt can be heated or not heated and also the roll or the cylinder can provide for the heat. The web can be supported by a fabric and one-sidedness created by the fabric can be used in creating the properties of the final fiber web product or it can be modified by coating and/or calendering. The fabric can also be porous such that is receives moisture. The fabric can also be provided with a coating for decreasing adherence of the web. The roll or the cylinder can also be provided with suction for increasing the moisture removal and penetrating of the sizing agent. The location of the sizing means and the treatment zone can be for example in connection with a press section, a drying section, a metal belt drying device, a sizing press, a calender or a reel-up of the fiber web production line.

[0033] According to another example of the invention the sizing agent mixture comprising at least two starch solutions is applied onto the web before drying section of the fiber web production line such that the solid content of the fiber web after applying the sizing agent is below 80% and thus there is high amount of moisture which as it evaporates due to the heat of a treatment zone in which the web is threated by pressure and heat the sizing agent is activated. The temperature in the treatment zone is such that the gelatinization temperature is reached, for example 60-85 °C, advantageously 80-100 °C, and also the drying is efficient and bonds are created is the sizing agent and the strength properties of the web are improved. The treatment time in the treatment zone is advantageously over 50 ms and the surface pressure in the treatment zone is 20 - 500 kPa, in case where metal belt is used and 2 - 20 kPa if a fabric is used. A cooling device may follow the treatment zone.

[0034] In the following the invention is describe in more detail with reference to the accompanying drawing in which

Figure 1 shows schematically an example of cooking and mixing starch.

Figures 2A - 2G show schematically examples of starch microstructure during corn starch gelling process.

Figure 3 shows schematically one example of the arrangement according to the invention.

Figure 4 shows schematically another example of the arrangement according to the invention.

[0035] In the figure 1 is schematically shown an example of cooking and mixing of starch. At left side of the figure is shown how the microstructure of starch changes as the temperature increases and decreases and as how the properties of the starch develop during the cooking and mixing of the starch. At temperature 20 °C viscosity of the starch s still in slurry form increased and when the temperature of the starch is 55 - 85 °C the starch granules bind to water and the granules begin to swell and simultaneously the viscosity decreased until temperature of 95 °C has been reached after which the starch is in solution form. During the temperature decrease from 95 °C to 20 °C the viscosity increases and starch chains associate. According to the invention two starch solutions are mixed one with high viscosity at temperature of 20 °C from uncooked stage 30 and one with low viscosity at temperature of 95 °C from cooked stage 40 and mixed in mixing stage 50 with temperature of 55 °C. After which the starch agent as mixture of the two starch solution are applied in sizing process 60, in which by the energy obtained from the fiber web and from drying in drying stage the starch is gelatinized and strong bonding is created. By before mixing the solutions of native and cooked starch in stages 30, 40 into the native starch is dispersed into a lye solution of 0,1 - 0,5 % (NaOH). By this the gelatinization temperature of native starch is lowered to a desired level of 60 °C and a fast reaction and early gelatinization is achieved thus creating a longer time, more moisture and more heat for sizing reaction.

[0036] Figures 2A - 2G show schematically examples of starch microstructure during corn starch gelling proc-

ess when the temperature increases from 30 °C to 90 °C. As can be seen from the figures first the starch begins to swell and from the gelling temperatures of about 65 °C the dispersing begins.

[0037] In the figures 3 - 4 same reference signs are used for corresponding parts, components or part components unless otherwise mentioned.

[0038] In the schematical example of figure 3 the fiber web W is supported by a fabric F. Onto the fiber web sizing agent mixture comprising at least two starch solutions is applied by a sizing device 11 after which the web is guided into a nip or treatment zone formed in between a heated cylinder 10 and a belt B. The guide rolls 13 guide the belt B and by a roll 12 further pressure is provided in the treatment zone.

[0039] In the schematical example of figure 4 onto the fiber web sizing agent mixture comprising at least two starch solutions is applied by a sizing devices 11 after which the web is guided into a nip or treatment zone formed in between a heated cylinder 10 and a belt B. The guide rolls 13 guide the belt B. The example comprises three sizing devices 11 and three treatment zones.

Claims

1. Process for producing a fiber web in which process by surface sizing of the web sizing agent is applied onto the fiber web, **characterized in, that** the sizing agent comprises a mixture of at least two different starch solutions and that the mixture comprises a starch solution with high viscosity and a starch solution with low viscosity.

2. Process according to claim 1, **characterized in, that** the mixture comprises as one of the starch solutions native i.e. uncooked i.e. raw starch and water.

3. Process according to any of claims 1 or 2, **characterized in, that** the sizing agent mixture comprises a native i.e. uncooked starch solution and a cooked starch solution and that 30-70 % of the starch content is native starch and 30-70 % of the starch content is cooked starch.

4. Process according to claim 1, **characterized in, that** temperature of the mixture during sizing is held below the gelatinization temperature of 30-55 °C.

5. Process according to claim 1, **characterized in, that** the uncooked starch is modified, oxygenized or enzymatically converted cooked starch.

6. Process according to claim 1, **characterized in, that** the fiber web is heated and/or dried before or after or during the surface sizing.

7. Arrangement for producing a fiber web, **characterized in, that** the arrangement for producing fiber web (W) comprises means (11) to apply sizing agent that is a mixture of at least two different starch solutions.

8. Arrangement according to claim 7, **characterized in, that** the arrangement for producing fiber web (W) comprises means (10; B) for heating and/or drying the web (W).

9. Arrangement according to claim 7, **characterized in, that** the means to apply sizing agent are micro jet or film or bond or spray sizing means.

10. Arrangement according to claim 8, **characterized in, that** the means for drying and/or heating are belt and/or cylinder and/or infra and/or air-borne and/or steam drying means.

11. Arrangement according to claim 7, **characterized in, that** in the arrangement a heated belt nip or a heated roll nip is used for gelatinization of starch before drying.

12. Arrangement according to claim 7, **characterized in, that** in the arrangement a blade or a rod is located after means (11) to apply sizing agent that is a mixture of at least two different starch solutions for smoothening the applied sizing agent.

13. Arrangement according to claim 7, **characterized in, that** the arrangement further comprises means for applying the native starch solution directly after sizing, for example the arrangement comprises a spray device without nip.

14. Arrangement according to claim 7, **characterized in, that** the arrangement comprises a treatment zone formed between a roll (10) or a cylinder and a belt (B).

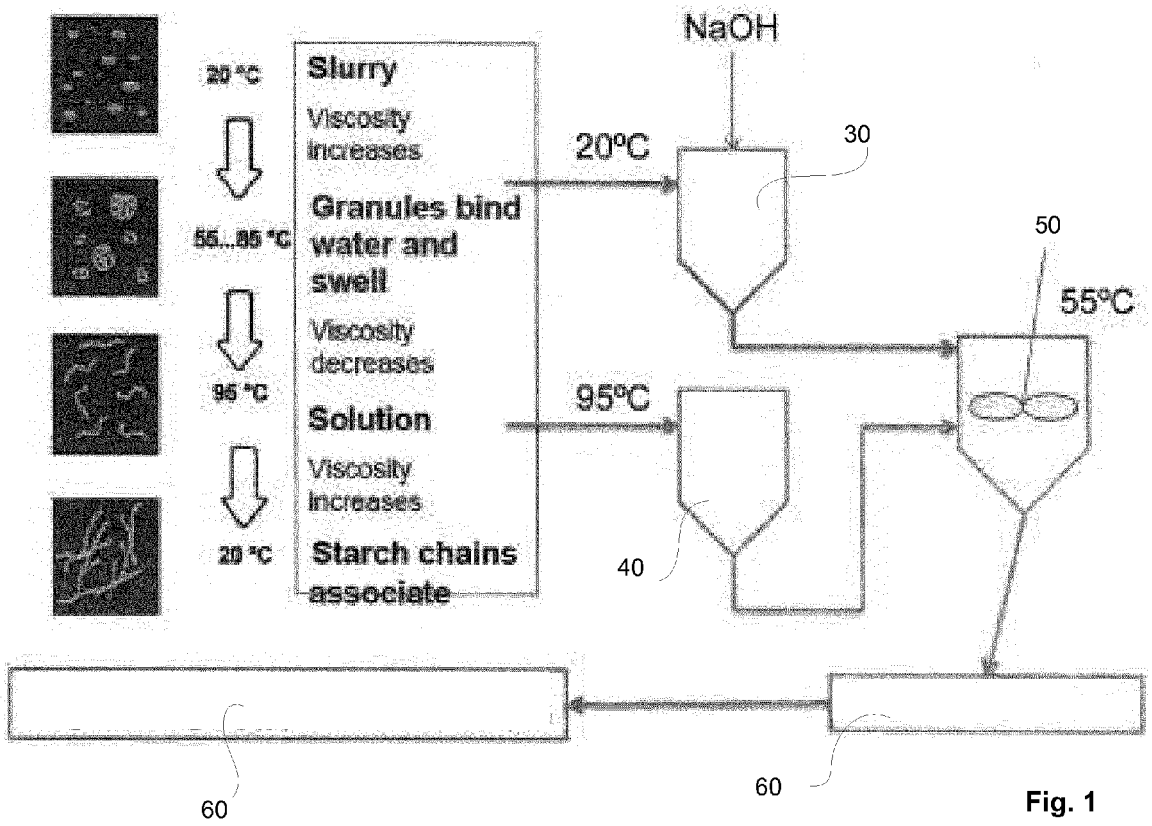
20 °C
Slurry
Viscosity increases
55...85 °C
Granules bind water and swell
Viscosity decreases
95 °C
Solution
Viscosity increases
20 °C
Starch chains associate
NaOH
20°C
30
50
55°C
95°C
40
60
60

Fig. 1

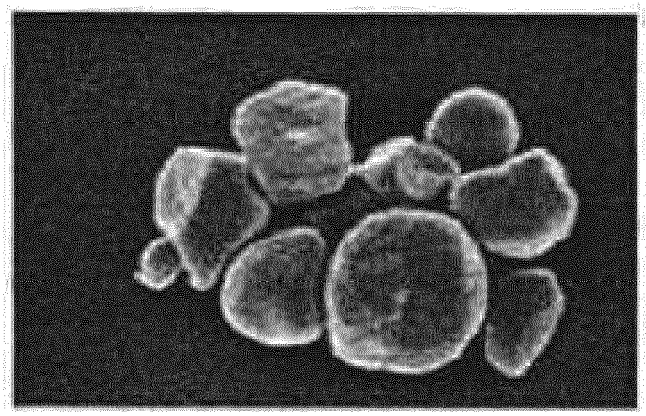

Fig. 2A

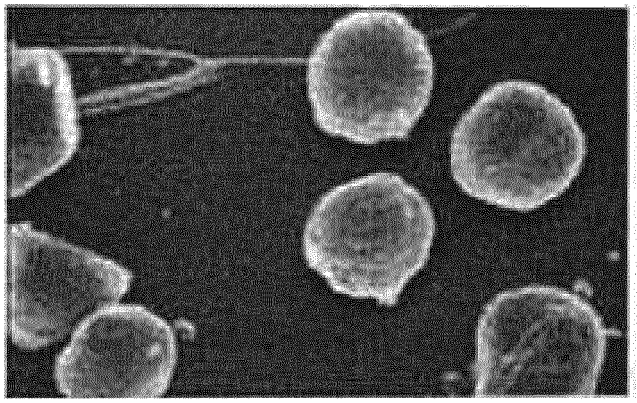

Fig. 2B

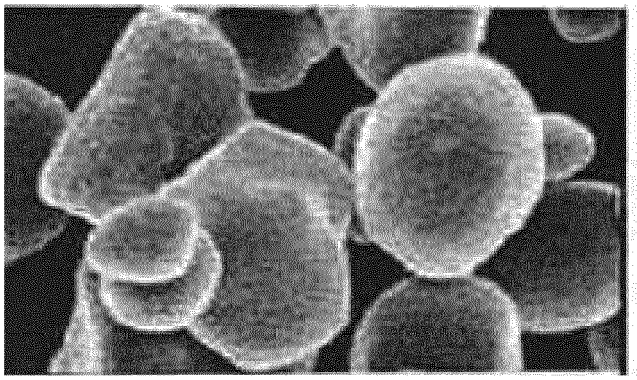

Fig. 2C

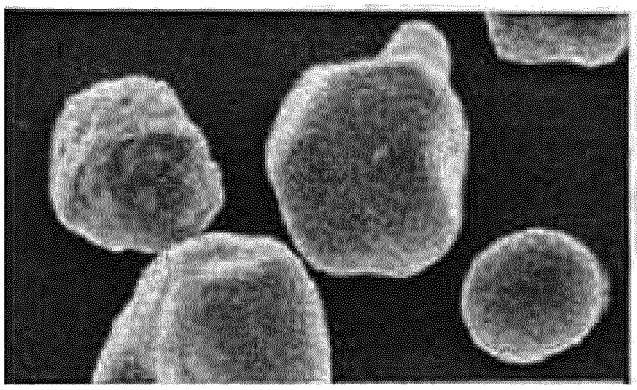

Fig. 2D

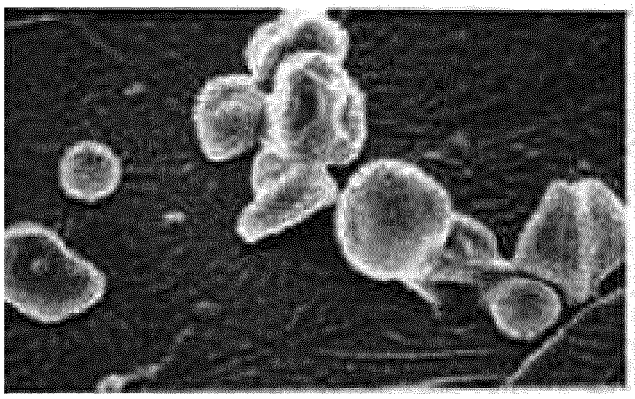

Fig. 2E

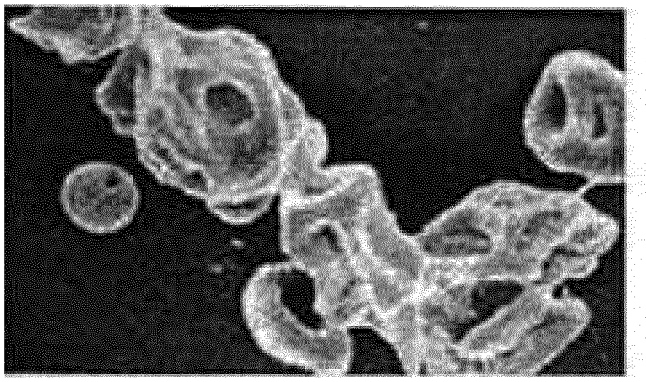

Fig. 2F

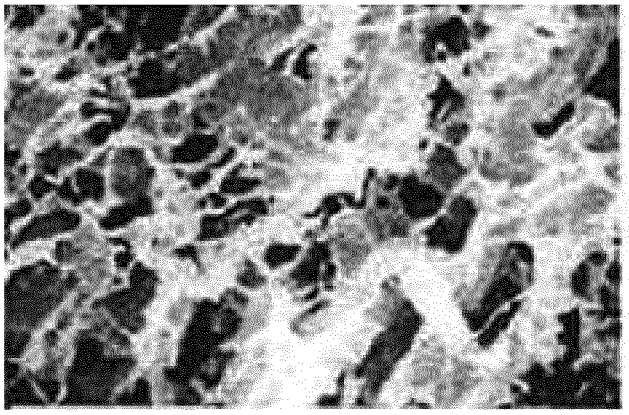

Fig. 2G

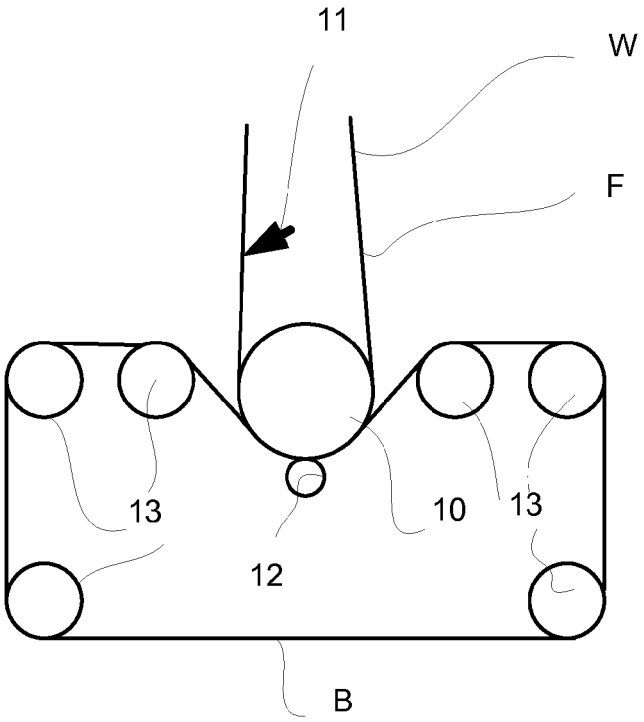

Fig. 3

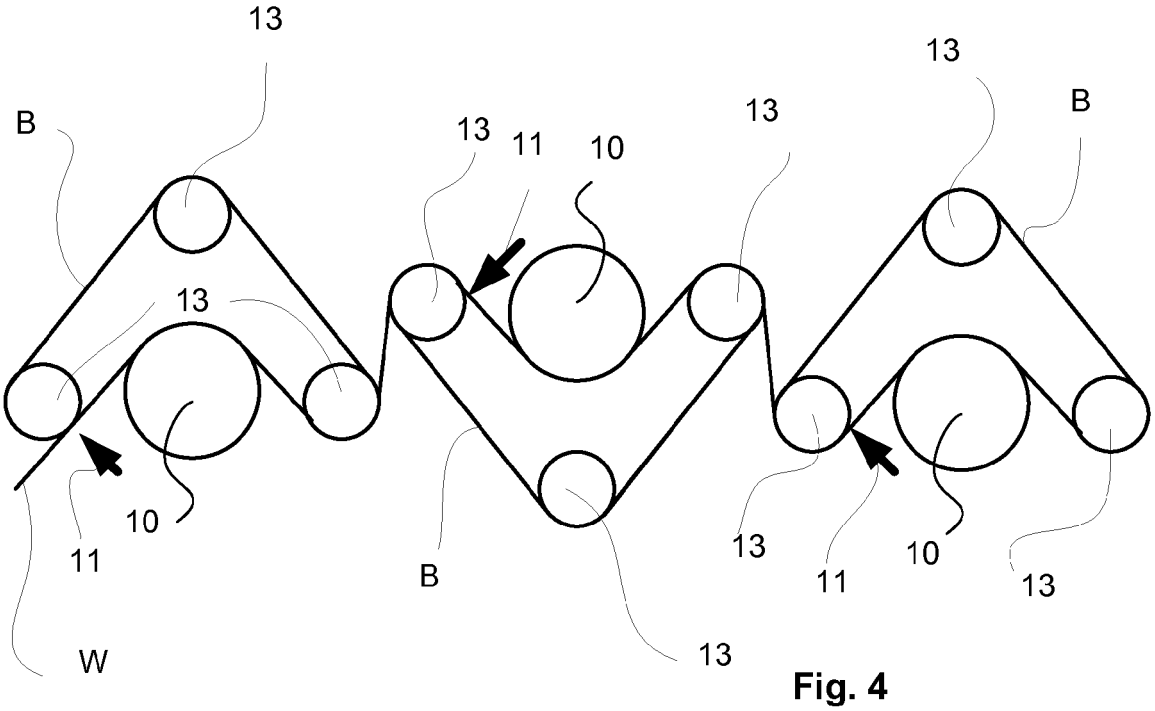

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 12 18 7736

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 February 2013	Karlsson, Lennart

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 18 7736

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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