(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 038 463 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
18.11.2009 Bulletin 2009/47

(21) Application number: **07788721.4**

(22) Date of filing: **27.06.2007**

(51) Int Cl.:
D04H 1/74 *(2006.01)* ***D04H 13/00*** *(2006.01)*

(86) International application number:
PCT/FI2007/000179

(87) International publication number:
WO 2008/000889 (03.01.2008 Gazette 2008/01)

(54) **METHOD FOR MANUFACTURE OF MINERAL FIBER PRODUCT AND INTEGRATED MINERAL FIBER PRODUCT**

VERFAHREN ZUR HERSTELLUNG VON MINERALFASERPRODUKTEN UND INTEGRIERTES MINERALFASERPRODUKT

PROCÉDÉ DE FABRICATION D'UN PRODUIT EN FIBRES MINÉRALES ET PRODUIT À BASE DE FIBRES MINÉRALES INTÉGRÉES

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR

(30) Priority: **28.06.2006 FI 20060625**

(43) Date of publication of application:
25.03.2009 Bulletin 2009/13

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Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a method for the manufacture of a mineral fiber product and a mineral fiber product according to the preambles of the claims below.

[0002] Mineral wool, such as stone wool, is manufactured by melting suitable raw materials, for example diabase, limestone or slag, in a melting furnace. The mineral melt obtained is discharged from the melting furnace in the form of a melt jet to a fiberising apparatus, where the melt is formed into mineral fibers. Normally a fiberising apparatus of the cascade type is used, which comprises a series of rotating fiberising rotors or spinning rotors, typically 3 to 4 rotors. The mineral melt from the melting furnace is directed toward the mantle surface of the first rotor where it gets hold of the mantle surface of the rotor to a certain extent before it is thrown out as a cascade of drops towards the mantle surface of the adjacent second rotor in the series. A part of the mineral melt then gets sufficient hold of the mantle surface of the second rotor in order to be formed into fibers due to the effect of the centrifugal force. Another part of the mineral melt is thrown further towards the mantle surface of the third rotor. In this way the mineral melt is "transported" as a jet of melt drops or a drop cascade, successively from one rotor to the subsequent one through the whole fiberising apparatus, while a part of the mineral melt is formed into mineral fibers. A binder may be applied on the formed mineral fibers, either during the fiber formation or after it.

[0003] The mineral fibers formed at the fiberising rotors are transported away from the fiberising apparatus by means of blowing off. The blowing off of mineral fibers can take place with so-called primary blow-off means, which have been placed at the peripheries of the rotors, and/or with secondary blow-off means, which have been arranged at a distance from the fiberising apparatus. The mineral fibers are transported from the fiberising apparatus through a collecting chamber towards a collecting member, which is arranged in front of the fiberising apparatus. The collecting member can be, for example, a belt conveyor or a rotating drum.

[0004] The mineral fibers are usually collected as a thin fiber web, a so-called primary fiber web or a primary mat. The primary fiber web is normally collected with the aid of underpressure on a travelling perforated surface forming the collecting surface of the collecting member. The primary web can be after-treated in many different ways, for example through cross-lapping or overlapping, whereby a secondary fiber web is created. This secondary mat or web comprises a number of layers, which lay partly on top of each other, and the edges of the original primary web make up a part of the large surfaces of the secondary web.

[0005] The secondary web can be treated in numerous ways before it is finally hardened in a continuous hardening furnace.

[0006] The document SE 452 040 shows a method for the manufacture of mineral fibers. The formed mineral fibers are collected by two collecting members, which are arranged on top of each other. The collected webs are run together and overlapped so that the edge parts of the primary webs make up the edge parts of the secondary web.

[0007] EP 0 280 338 B1 presents a method for the manufacture of mineral fibers where loose additional material is applied onto the primary web, which is thereafter overlapped to form a secondary web. The object of the added loose material is to improve the water absorption ability of the final product.

[0008] Mineral wool has numerous applications. It is used among others as an insulating material in various building constructions, as a component in construction panels, acoustic or interior design products, or for technical insulation of pipes, turns and other equipment. Depending on the intended use different requirements are made for the properties of the manufactured mineral wool, for its strength, compressibility etc. The properties of mineral wool are influenced among other by the properties of the individual mineral fibers, in other words by the thickness, length, as well as space orientation of individual fibers in the mineral wool.

[0009] Mineral fiber products have been produced in which one of the properties of the product is changed or varied in the height direction or width direction of the product. Variations in the height direction of the product have been achieved by laminating different fiber webs on top of each other, whereby a product with different horizontal sheets has been obtained. The problem has however been that the horizontal layers in the product are easily delaminated from each other when pressing or bending.

[0010] Another way to manufacture products with a varying property is to press a part of the primary web to a higher density before its crosslapping or overlapping. During the overlapping a secondary web is then obtained, which contains a horizontal sheet with a higher density. Through pressing of the primary web only variations in the density of the final product can however be obtained, not in any other properties.

[0011] Therefore the object of this invention is to provide a method for the manufacture of mineral fibers and a mineral fiber product, where the above-mentioned disadvantages are minimised.

[0012] The object is thereby to provide a method with which an integrated mineral fiber product can easily be produced.

[0013] An object of the present invention is to provide an integrated mineral fiber product, where the properties of the product can be varied.

[0014] These objects are attained with a method and a product having the characteristics presented in the characterising parts of the independent claims below.

[0015] In a typical method according to the present invention for the manufacture of a mineral fiber product a first and a second primary mineral fiber web is obtained, both of which have a certain width. The first and the second primary mineral fiber web are placed at least partly on top of each other, so that a combined primary web is obtained, which shows a first and second edge part and a middle part between them, and the combined primary web is transported in a first direction. A secondary mineral fiber web is obtained by overlapping the combined primary web transversely in relation to the first direction, whereby the combined primary web is arranged to partly overlap itself so that the perpendicular distance between two successive foldings of the web defines the width of the secondary fiber web, and the edge parts of the combined web make up at least a part of the large surfaces of the secondary web. The obtained secondary fiber web is hardened in a hardening furnace, and cut into final products of a suitable size. According to the invention the first and second primary fiber web is selected or manufactured so that in the first primary fiber web at least one of the following properties: mean fiber diameter, mean fiber length, surface weight, fiber amount, chemical composition, binder concentration or binder composition, differs at least 5 % from the corresponding value in the second primary fiber web.

[0016] A typical integrated mineral fiber product comprises a first and a second large surface, which are parallel with each other, and the perpendicular distance between which defines the height direction of the product, and a first and a second side surface which connect the large surfaces, and the perpendicular distance between which defines the width direction of the product, which is transverse in relation to the height direction of the product. The product comprises a number of layers, which extend from the first side surface to the second side surface, and of which at least a part extend from the first large surface towards the second large surface. The layers originate from a first and a second primary fiber mat, and have, in the longitudinal direction of the product, which is transverse in relation to the height direction and width direction of the product, been arranged so that the product comprises a number of repeating sections, which comprise a layer originating from the first primary fiber mat, thereafter two adjacent layers, which originate from the second primary fiber mat and thereafter an adjacent layer originating from the first primary fiber mat. According to the invention a layer originating from the first primary fiber mat has at least one of the following properties: mean fiber diameter, mean fiber length, surface weight, fiber amount, chemical composition, binder percentage or binder composition, which differs at least 5 % from the corresponding value in a layer originating from the second primary fiber mat.

[0017] By an integrated mineral fiber product is in this context meant a product, which does not contain co-laminated sheets of different primary webs. The different layers in the product have not been preformed or pre-hardened and have also not been cut off a primary web before being arranged in the secondary web. Sharp gluing borders between the different layers cannot be discerned in the final product.

[0018] In this text the words "mat" and "web" are used so that they are interchangeable with each other, if nothing else is given.

[0019] Now it has surprisingly been discovered that a product with improved qualities can be obtained, when the product is built up of regular layers, the properties of which differ from each other. The product can be obtained by placing a number of thin primary mineral fiber webs on top of each other, whereby a combined primary mat is obtained. This combined primary web is then overlapped and a secondary mat with regular layers is obtained. By selecting the properties of the primary fiber webs in a careful manner, a product can be provided, which presents controlled property variations. The present invention provides possibilities to improve for example the heat transfer ability, and/or compressibility and/or processability of mineral fiber products.

[0020] By using "ready" formed, coherent conventional primary webs, which are combined prior to overlapping, products can be obtained, where all the used primary webs contribute to the final strength of the product. In certain earlier solutions, for example EP 0 280 339, loose additional material has been added onto the primary web to obtain a product with varying properties. Loose additional material can however not contribute to the final strength of the product to the same extent as defined "coherent" primary mineral fiber webs. By using "coherent" primary webs also the fiber orientation in the final product can be controlled better. By a "coherent" primary web is here meant a mineral fiber web, which is obtained from the collecting surface of the collecting member and which generally comprises unhardened binder, possibly also other additives.

[0021] The present invention also makes possible the use of thin primary fiber webs for the manufacture of mineral fiber products. Thin primary webs usually display a good fiber orientation, i.e. the fibers are surface-oriented in the longitudinal direction of the primary web, which improves the thermal insulation properties of the final product. Earlier the problem with using thin primary webs has been that they easily break when overlapping or otherwise treating. Now the thin primary webs are placed on top of each other, whereby a thicker combined primary web is obtained. This combined web is however not necessarily thicker than a conventional primary web, and it can easily be treated with existing equipment. The first and second primary fiber webs usually have a surface weight of 100 - 600 g/m^2, typically 150 - 400 g/m^2, sometimes 175 - 250 g/m^2. The surface weight of the combined primary web is usually 200 - 1200 g/m^2, typically 300 - 800 g/m^2. Typically the first and the second primary web thus have a density of about 5 - 25 kg/m^3, normally 10 - 20 kg/m^3 before they have been arranged on top of each other to form a combined primary web. Usually the density between the two webs differs with at the most 15 kg/m^3, more typically 10 kg/m^3 from each other.

[0022] Typically the used primary webs comprise a binder, which has been added already at the formation of the fibers before their collection. Typically the final product comprises at least 0.2 % by weight, more typically at least 0.5 % by weight, at the most 7 % by weight, more typically at the most 5 % by weight of binder and/or other additives. A typical binder is for example a phenol formaldehyde resin. The used binder and/or the possible additive can be organic or inorganic.

[0023] According to the invention the first and the second primary fiber webs are not the same with regard to their properties, i.e. they display at least one property, the value of which is not the same in the first and second primary web. The first and the second primary web thus have at least one property, with regard to which the two webs are not identical. The first and the second primary mineral fiber web can however be homogeneous webs, i.e. within the individual primary web all of the properties of the web are kept as constant as is possible in practise.

[0024] Typically the final product, which is obtained through overlapping of two primary fiber webs arranged on top of each other, is such that has a low or inexistent ability to absorb water. It can in practice be considered to be non-water-absorbent. Water absorption is an undesired property for an insulating material for buildings or constructions, since water absorption ability in the insulating material could easily lead to a mildew problem with such a use.

[0025] A typical primary fiber web has a width, which is usually determined by the width of the collecting surface of the used collecting member. The width of the primary web is usually 1.5 - 4.8, typically 1.8 - 3.6 m. The longitudinal direction of the primary fiber web, i.e. the basic direction usually coincides with the processing direction and is transverse to the lateral or cross direction of the primary web. Typically the fibers of the primary web are mainly aligned in the longitudinal direction of the web. In an embodiment the mineral fibers are essentially evenly aligned in all directions in the plane of the primary web.

[0026] According to the invention at least two primary fiber webs are thus arranged at least partly on top of each other in order to form a combined primary fiber web, which is transported in the first direction. The first direction can coincide with the basic direction, or differ from it. The combined primary web has a first and second edge part and a middle part between them. Depending on how the primary fiber webs have been arranged on top of each other, the edge parts of the combined web can comprise a sheet of both the first and the second primary fiber web or only one of the primary fiber webs. The middle part of the combined primary web usually comprises a sheet of both the first and the second primary fiber web. Sometimes the edge parts of the combined web can comprise a sheet both of the first and the second primary web, whereby the middle part comprises only a sheet of either the first or the second primary web.

[0027] A typical secondary fiber web is obtained by overlapping the combined primary fiber web. When overlapping, the transport direction of the web is changed from the first direction to a second direction, which is transverse in relation to the first direction, and the web is arranged to partly overlap itself. The width of the secondary fiber web is defined as the perpendicular distance between two successive foldings in the combined primary web, which forms the secondary web. When overlapping, a number of layers are formed, which are built up by the overlapped primary web and which form the secondary web. Layers in the secondary web and finally in the resulting product thus comprise the scope of the combined web, which during a pendulum motion, where the pendulum performs the movement from the first extreme position to the second extreme position, is placed on a receiving transporter. The overlapped individual layer will extend over the secondary web between two successive foldings. The layers do not need to be perpendicular in relation to the second direction, but can be in an angle in relation to the second direction, i.e. the transport direction of the secondary web. When two or more primary webs have been placed on top of each other before overlapping, a corresponding number of layers will be supplied to the secondary web during a pendulous motion.

[0028] The secondary web has two large surfaces, which are parallel with each other and which will form the large surfaces of the final product. The distance of the large surfaces from each other after overlapping defines the height of the secondary web and they are at least partly made up of the edge parts of the combined primary web.

[0029] According to an embodiment of the present invention two primary fiber webs are placed on top of each other, whereafter the obtained combined web is overlapped in order to form a secondary fiber web. In this case the different layers will form a repetitive section or sequence -(-B-A-A-B)n-, where A indicates a layer originating from the first primary mat and B a layer originating from the second primary mat.

[0030] According to another embodiment any of the selected properties can be varied in the width direction of the first or the second primary web, so that after overlapping of the combined web a corresponding variation is obtained in the height direction of the secondary fiber web. Then one of the primary webs comprises at least two sections, which extend over the longitudinal direction of the web. The used primary fiber webs can thus be inhomogeneous, so that they comprise in the longitudinal direction of the primary web two or more sections, which differ from each other with relation to one or more properties. The edge parts of the primary web can for example comprise mineral fibers, the mean fiber length of which is lower than the mean fiber length in the middle part of the primary web. In this case the primary fiber web comprises three sections in the longitudinal direction of the web. All these sections can be of the same width or they can be symmetrically or asymmetrically of different width. For example the sections near edge parts can be of the same width, but at the same time substantially narrower than the middle section. By varying the properties of the first and/or second primary fiber web also within an individual primary web it is possible to increase the variation in the final product. Sections in the longitudinal direction of the primary web result, after overlapping, in carefully defined layers in the height direction of the secondary web. For example if the binder content varies in the width direction of the primary web a secondary web with a varying binder content in the height direction can be obtained. According to an embodiment the binder content in the secondary fiber web is at the large surfaces 25 % by weight higher than in the middle of the web.

[0031] According to an embodiment the mean fiber diameter and/or mean fiber length in the first primary fiber web differs at least 10 %, but at the most 50 % from the mean fiber diameter in the second primary fiber web. It is then possible to manufacture products where every other layer imparts good insulating properties and every other layer imparts mechanical strength. In this way it is possible to combine for example these properties, which are favoured by different kinds of fibers, in one single product in a new and surprising way. Usually the mean fiber diameter in the first primary fiber web is 3.0 - 4.5 μm, typically 3.3 - 4.0 μm. Usually the mean fiber length in the first primary fiber web is 1.0 - 4.0 mm, typically 1.2 - 3.0 mm.

[0032] The mean fiber diameter can be obtained by measuring in a microscope with e.g. a 500-fold enlargement. The measurings are performed on the sieved fiber fraction, where the fiber size is <32 μm. The fiber material to be measured is suitably placed between two thin test glasses. The length-based arithmetic mean fiber diameter is used as a reference value for the fiber diameter. A method for obtaining this is to measure the diameter of such fibers that cross one or more drawn lines on a computer screen, which is connected to the microscope, and count the mean diameter of these fibers. Altogether at least 200 fibers are usually measured with an accuracy of 0.1 μm.

[0033] The mean fiber length can be obtained in the following way. The sample is taken from fiber material wherefrom the binder has been removed. The sample is carefully taken from the fiber material with a pair of tweezers, in order to avoid breaking the individual fibers, and placed in a glass container with approx. 300 ml of glycerine. The fibers are separated from each other by careful stirring with a glass rod without touching them. The glycerine/fiber mixture is poured into a small number of, e.g. 5 to 10, Petri dishes with a diameter of approx. 50 mm. The fibers are allowed to sediment to the bottom before the measuring is begun. One Petri dish at a time is projected with a 25 - 50 -fold enlargement onto a white surface or else the image is enlarged and transferred to a computer screen. All the fibers in a Petri dish are measured with an accuracy of 0.1 mm, and the procedure continues with the next dish until at least 300 fibers have been measured. The mean fiber length is the arithmetic mean value of all the measured fibers.

[0034] According to another embodiment of the present invention the fiber amount in the first primary fiber web differs at least 2 - 20 % by weight, typically 3 - 10 % by weight from the fiber amount in the second primary fiber web. This gives the obtained mineral fiber product a good insulating ability and improved handling properties. The fiber amount is here defined as the amount of fibers which are smaller than 32 μm. The fiber amount in the product can be determined by sieving the fiber material through a number of sieves, which have been stacked on top of each other, out of which the smallest one has an aperture size of 32 μm. The material is sieved until all the fibers or sufficiently small particles have passed through the smallest sieve. The mass of fibers, which has passed through the 32 μm sieve, in relation to the combined amount of fiber < 32μm and shot > 32 μm, depicts the fiber amount of the product. Binder is removed from the fiber material before sieving, usually through treatment in approx. 650 °C for 20 minutes.

[0035] According to an embodiment the first and the second primary fiber web are manufactured by using one single fiberising apparatus and two collecting members. The collecting members have typically been arranged on top of each other in the height direction in front of the fiberising apparatus, and their width can differ from each other, but they can also be of the same width. Then the first primary fiber web can be collected on the upper collecting member and the second primary fiber web on the lower collecting member. It is also possible to arrange three or more collecting members on top of each other, if the fiber manufacturing capacity allows for or requires it, whereby a corresponding number of primary fiber webs can be obtained. The collecting members can naturally be arranged beside each other.

[0036] According to a preferred embodiment the first and the second primary fiber webs are manufactured by using one single fiberising apparatus and two collecting members, and the first and the second primary fiber web contain mineral fibers with the same chemical composition, but the webs have different physical properties, such as fiber length, fiber amount, fiber structure, surface weight and/or mean fiber diameter. Then a mineral fiber product is obtained, where the different layers have the same chemical composition, but different physical properties, such as strength and/or thermal insulation capacity.

[0037] Typical apparatuses which can be used in the manufacture of primary fiber webs have been described in the patent applications FI 20011561, FI 20041699 and FI 20041670. With these arrangements mineral fibers with specific properties and produced at a specific spinning rotor and a specific rotor sector can be steered towards a certain point on the collecting surface of the collecting member. In this way two primary mineral fiber webs, in which one or more properties differ from each other, can be collected at the same time. The properties can differ from each other also within one collected web. It is for example possible to manufacture a primary web where a property shows variation in the width direction of the web, as described above, i.e. a property changes transversely to the transportation or basic direction of the web. This procedure makes possible among others the manufacture of primary webs, where the binder content varies in the width direction of the primary web.

[0038] If the chemical composition of the fibers varies in the width direction of at least one primary web, a secondary web is obtained, which comprises layers where the chemical composition of the fibers varies in the height direction of the product. According to an embodiment the chemical composition of the fibers varies in the height direction of the secondary web or the product with at least 1.5 % by weight regarding one of the components included in the chemical composition. This means that the chemical composition of the fibers at least in one layer changes from the first large surface of the product to its second large surface.

[0039] According to an embodiment the first and the second primary fiber web are produced with different fiberising apparatuses, whereby the production conditions can be optimized freely for the two primary webs. In this way primary webs can be manufactured, the fibers of which have a different chemical composition, by using two different mineral melts at the manufacture of the respective first and second web. This procedure is also advantageous in the manufacture of primary webs, which contain chemically different binders or different binder contents. When these are then combined into a combined primary web, which is overlapped, a secondary web is obtained, where the binder content is different in the different layers. The difference between the layers originating from the first primary fiber web and originating from the second primary fiber web is typically 0.1 - 3 % by weight, typically 0.3 - 1.5 % by weight.

[0040] Typically the total binder content in the product is 0.5 - 5 % by weight.

[0041] According to an embodiment of the present invention layers originating from the first primary fiber web have at least one property, which differs at least 10 %, advantageously at least 15 %, even more advantageously at least 20 % from the corresponding value in layer originating from the second primary fiber web. The property has in that case been selected from the group, which comprises mean fiber diameter, mean fiber length, surface weight, fiber amount, chemical composition, binder content or binder composition.

[0042] Typically the mean fiber diameter of the two used primary fiber webs differs at the most 5 μm, typically at the most 2 μm, more typically at the most 1 μm, often at the most 0.5 μm from each other if the webs originate from different fiberising apparatuses. If both webs originate from one and the same fiberising apparatus the deviation in the mean fiber diameter between the two webs is typically at the most 2 μm, more typically at the most 0.5 μm, often 0.3 μm. If the mean fiber diameter in the first primary web is 3 μm and 5 μm in the second primary web, then the deviation in mean fiber diameter between the first and second primary fiber web is 60 %.

[0043] In a corresponding way the deviation in mean fiber length is typically at the most 2 mm, more typically at the most 1 mm, often at the most 0.5 mm when the primary webs originate from different fiberising apparatuses, and at the most 1 mm, typically at the most 0.5 mm, more typically at the most 0.3 mm when they originate from one fiberising apparatus.

[0044] Typically the surface weight differs with at the most 1000 g/m2, more typically 300 g/m2, often at the most 200 g/m2 between the two used primary fiber webs, if the webs originate from different fiberising apparatuses. If both webs originate from one and the same fiberising apparatus the deviation in the surface weight between the two webs is typically at the most 500 g/m2, more typically at the most 300 g/m2, often at the most 200 g/m2.

[0045] Typically the fiber amount differs with at the most 30 %, more typically 20 %, often at the most 10 % between the two used primary fiber webs, if the webs originate from different fiberising apparatuses. If both webs originate from one and the same fiberising apparatus the deviation in the fiber amount between the two webs is typically at the most 20 %, more typically at the most 15 %, often at the most 10 %.

[0046] Typically the chemical composition differs between the two used primary fiber webs by at the most 10 percentage units for each individual oxide, which is included in the mineral melt, more typically by at the most 5 percentage units for each oxide. According to one embodiment of the present invention it is possible to have approximately the same chemical composition in both of the mats, whereby the deviation typically is at the most 0.5 % for each oxide.

[0047] It is possible to use completely different binders in the first and the second primary fiber web. The binder content in the first and the second primary fiber web typically differs with at the most 4.5 percentage units, more typically with at the most 3 percentage units. Typically the highest binder content in a primary web to be used in the present invention is 5.0 % by weight. A deviation of 4.5 percentage units between the first and the second primary fiber web means that the first web has a binder content of for example 0.5 % by weight, whereby the second web has a binder content of at the most 5.0 % by weight.

[0048] According to an embodiment of the present invention three, four or more primary fiber webs can be used, which webs are arranged at least partly on top of each other to achieve the combined primary web, which is overlapped. If more than two primary webs are used, a number of these can have identical properties, nonetheless so that at least two of the used webs have at least one property, which differs from the other webs. According to an embodiment all the primary fiber mats, which have been arranged on top of each other and overlapped together, can be different from each other regarding at least one said specific property.

[0049] The primary webs used to obtain the combined primary web can be either of the same width or their width can differ from each other. The first primary fiber mat or web can for example be at least 25 %, sometimes 35 %, also 43 % or sometimes 50 % narrower than the second primary fiber web. If the width of the second web is for example 100 units of measurement, the width of the first web is 75, 65, 57 or 50 units of measurement.

[0050] The first and the second primary webs are placed on top of each other to obtain the combined primary web. The webs can be placed symmetrically: if the webs are of the same width they can be arranged on top of each other so that they completely overlap each other or if they are of different width, so that the narrower web is placed in the middle of the wider web, whereby the wider web reaches the same amount over both of the narrower web's edges. It is also possible to place the webs asymmetrically: the webs can be placed so that they overlap each other only partly. In that case the first edge part of the combined web is made up of the first primary web and the second edge part of the second primary web. If one of the webs is wider, the overreaching edges do not need to be of the same width on both sides.

[0051] According to an embodiment the overlapping of two primary webs of the same width is arranged in such a way that the width of the edge part becomes half of the distance between two identical layers on the large surface of the overlapped secondary web, measured in the longitudinal direction of the web.

[0052] If the first and the second primary fiber web are placed asymmetrically on top of each other before overlapping, then one of the primary fiber webs will at overlapping primarily make up one or both of the large surfaces of the secondary fiber web. It can then be noted that one of the large surfaces of the secondary web is mainly made up of fiber material, which originates from either the first or the second primary fiber web. In this way secondary fiber webs can easily be manufactured, which at the large surfaces show horizontal layers with one or more differing properties, compared to the middle part of the secondary web. It is also possible with this method to produce secondary webs with relatively thin differing horizontal layers. Usually the surface layer of the secondary web can be 4 - 50, typically 5 - 25 mm in the height direction of the web.

[0053] According to an embodiment of the present invention the density at one or both of the large surfaces of the secondary web is at least 10 %, typically 15 % higher than in the middle of the product. If one of the large surfaces of the product has a higher density that the rest of the product, the high density area usually extends to a depth, which comprises 10 - 50 %, typically 10 - 30 % of the height of the product. If both of the large surfaces of the product have a higher density that the rest of the product, the individual high density areas usually extend to a depth, which comprises 10 - 30 %, typically 10 - 20 % of the height of the product. In this way products can be manufactured, which show a strong and resistant surface, but which are relatively light.

[0054] Usually the large surfaces of the collected primary web differ from each other with regard to evenness and "porosity". The one of the large surfaces of the primary web which lies against the surface of the collecting member and which here is called the collector side, is typically more even that the other opposite surface, which is here called the "free" side. Also the fibers tend to be more oriented on the collecting side and it often also has less binder. The first and second primary fiber web can be placed on top of each other so that the collector side of the first web comes against the "free" side of the second mat. In some cases the primary fiber webs can be placed on top of each other so that the collector sides or the "free sides" of the webs will lay against each other.

[0055] The secondary fiber web can be treated in various ways before hardening. It can for example be exposed to longitudinal or height compression. A surface coating can also be added to one or both of the large surfaces.

[0056] The obtained secondary fiber web is hardened in a hardening furnace. At hardening the binder, which is present already in the original first and/or second primary web, is hardened. After the hardening the hardened secondary web is cut or broken in the cross direction and longitudinal direction of the web. Usually the web is cut in its longitudinal direction in 1 - 10, typically 2 - 5 cutting places.

[0057] Some embodiments of the present invention are described in more detail below with reference to the following figures, in which

Figure 1A - 1 D	show schematically different ways to place the first and the second primary fiber web on top of each other in order to obtain the combined primary web,
Figure 2	shows schematically how the overlapping is performed according to an embodiment of the present invention,
Figure 3	shows schematically a secondary fiber web according to an embodiment of the present invention,
Figure 4	shows schematically a cross section of a mineral fiber product according to an embodiment of the present invention seen towards the width direction of the web, and
Figure 5	shows schematically a cross section of a mineral fiber product according to another embodiment of the present invention seen towards the width direction of the web.

[0058] In figures 1A - 1 D are shown schematically different ways to place the first and the second primary fiber web on top of each other in order to obtain the combined primary web.

[0059] In figure 1A the first primary fiber web A has the same width as the second primary fiber web. The primary webs A, B have been placed on top of each other so that they wholly overlap each other without sideways displacement. Thereby a combined primary web has been obtained. The edge parts of the combined web comprise the edge parts A', A" of the web A and the edge parts B', B" of the web B. The edge parts of the combined web have been identified with dashed lines in the figure. The longitudinal direction of the combined web has been identified with an arrow and this longitudinal direction usually coincides with the main fiber direction of the webs A, B. The width of this combined primary web has been identified with the letter "w" in the figure and its height with the letter "d".

[0060] In figure 1B the first and the second primary fiber webs A, B are still of the same width, but they have been placed on top of each other so that their edge parts are displaced in relation to each other. The combined primary fiber web thus has edge parts, which are substantially thinner than in the case shown in figure 1A. The edge parts of the combined web have been identified with dashed lines in the figure. The thin edges cause the secondary web, which is formed from the combined primary web through overlapping, to be more homogeneous, because this configuration allows the density distribution to be evened out in the longitudinal direction of the secondary web, since the edge parts of the original primary webs can be arranged as evenly spread out as possible on the large surfaces of the secondary web.

[0061] As can be seen in figure 1B the first edge part C' of the combined web comprises mainly fiber material, which originates from the first primary web A, i.e. the first edge part C' is made up mostly of the first primary web A. In the same way the second edge part C" of the combined web is made up mostly of the second primary web B. The first and second edge parts C', C" of the combined web are thus different from each other. After overlapping of the combined web the first large surface of the secondary fiber web can come to be made up of the first edge part of the combined primary web and the second large surface of the second edge part of the combined primary web, depending on the relationship between the overlapping frequency and the speed of the receiving transporter. It is possible that the first large surface of the secondary fiber web comprises mostly fiber material, which originates from the first primary web A, and its second large surface mostly fiber material, which originates from the second primary web B. When the primary webs A, B have different properties, e.g. different mean fiber length, the large surfaces of the secondary web will differ from each other, whereby an integrated mineral fiber product with varying properties in its height direction is obtained.

[0062] In figure 1C the first primary fiber web A is narrower than the second primary fiber web B. The first web A has been placed on the second web B in such a way that the second web B extends symmetrically over the edges A', A" of the first web. The edge parts C', C" of the combined web are then made up mainly of the second primary fiber web. As has been described above, depending on the width v', v" of the edge parts C', C", the overlapping frequency and/or the speed of the receiving transporter, the large surfaces of the secondary fiber web can comprise mostly or wholly fiber material, which originates from the second web B. The large surfaces of the secondary web will then have properties, which differ from properties in the middle part of the secondary web.

[0063] In accordance with figure 1C a low density product can for example be manufactured, which has high demands for ë properties, tensile strength and compressibility. In this context compressibility means that the product has an ability to return to an intended thickness after being compressed during storage and transport. The first primary web A can for example have a width of 3.6 m and the second primary web B can have a width of 4.2 m. The collector side of the first primary web A can be placed against the "free" side of the second primary web B. The first web A can for example have a lower mean fiber diameter that the second web B, which thus contains thicker fibers. The second web B can however be thinner than the first web A, since web B has a stronger structure. When the combined primary web, which has been obtained by placing the first mat A on the second web B as indicated in figure 1C, is overlapped, a secondary fiber mat will be obtained, wherein every other layer throughout the secondary mat is made up of the mechanically stronger primary web B. Moreover the large surfaces of the secondary fiber mat are mostly or wholly made up of the second primary web B. The integrated mineral fiber product thus comprises a number of layers where every other layer originates from the first primary fiber web A and every other from the second primary web B. The web A comprises mostly slender, surface-oriented fibers and web B comprises thick, surface-oriented fibers which provide mechanical strength. In this way the better thermal insulation capacity of the web A can be combined with the mechanical strength of the web B throughout the whole thickness of the product and in many layers.

[0064] In figure 1D the first primary fiber web A is narrower than the second primary fiber web B. The first web A has been placed on the second web B in such a way that the first edges A', B' of the first and second webs A, B make up one of the edge parts of the combined primary web. The second edge part of the combined web is made up only of edge B" of the web B.

[0065] In figure 2 is shown schematically how the overlapping is performed according to an embodiment of the present invention. A combined primary web 1 has been obtained by placing two thin primary webs A, B on top of each other. The narrower primary web A has been placed symmetrically on the second primary web B, so that the edge parts of the combined primary web are made up of the second primary fiber web B. The combined primary web 1 is transported by means of the transporters 2, 2' to the overlapping apparatus 3, which is made up of two transporters 3', 3", the upper end of which is held in its place and the lower end of which performs a pendulous movement over a receiving transporter (not shown).

[0066] A secondary fiber web 4 is formed on the receiving transporter. The direction of motion of the receiving transporter and the longitudinal direction of the secondary web have been indicated with an arrow. The width b of the secondary fiber web is determined by the perpendicular distance between the foldings 5', 5" of the secondary web.

[0067] It can be observed that the relationship in figure 2 between the overlapping frequency and the speed of the receiving transporter is such that the first large surface 4' of the secondary web 4 is not wholly made up of fiber material, which originates from the second primary web B. The first large surface 4' also comprises narrow zones 6', 6", which comprise fiber material from the first primary fiber web A.

[0068] In figure 3 is shown schematically a secondary fiber mat according to an embodiment of the present invention. The secondary fiber mat 31 has been obtained by overlapping a combined primary web. The secondary fiber mat 31 is built up of a number of layers 30, 30', 30" and its width is defined as the perpendicular distance between two successive foldings 32', 32", 32"', 32"", 33', 33", 33"'. The edge 34 of the secondary mat 31 is made up of the first primary fiber web. Typically a part of the edge part of the secondary mat 31 is however cut off before the hardening, whereby the layer structure typical for the invention will extend over the width of the whole secondary mat 31.

[0069] In figure 4 is shown schematically a cross section of a mineral fiber product according to an embodiment of the present invention seen in the width direction of the mat. A mineral fiber product comprises a number of layers 40, 40', 42, 42'. It can be observed that beside a layer 42 there is a layer 40, which originates from the same primary fiber mat as layer 42, and another layer 42', which originates from the second primary fiber mat.

[0070] In figure 4 can also be seen that the layers 40, 42, 43, which originate from the first primary fiber web, contain a section, which has a differing property compared to the rest of the layer.

[0071] In figure 5 is shown schematically a cross section of a mineral fiber product according to another embodiment of the present invention seen towards the width direction of the product. The product 51 comprises a number of layers A, B, which originate from different primary fiber webs. At the forming of the combined primary fiber web the first and the second primary fiber web A, B have been placed on top of each other so that their edge parts are displaced in relation to each other. After overlapping of the combined primary web the first large surface 52 of the secondary web and thereby of the final product 51 will comprise mainly fiber material, which originates from the first primary web A, and the second large surface 52' of the combined web is made up mostly of fiber material originating from the second primary web B. The first and second large surfaces 52, 52' of the final product 51 are then different from each other. In figure 5 has also been marked layer pairs s, s', s", which are formed during a pendulous motion.

Claims

1. A method for the manufacture of an integrated mineral fiber product, wherein

   - a first and a second primary mineral fiber web, which both are of a certain width, are obtained,
   - the first and the second primary mineral fiber web are placed at least partly on top of each other, so that a combined primary web is obtained, which shows a first and second edge part and a middle part between them,
   - the combined primary web is transported in a first direction,
   - a secondary mineral fiber web is obtained by overlapping the combined primary web transversely in relation to the first direction, whereby the combined primary web is arranged to partly overlap itself so that the perpendicular distance between two successive foldings of the combined web defines the width of the secondary fiber web, and the edge parts of the combined web make up at least a part of the large surfaces of the secondary web,
   - the obtained secondary fiber web is hardened in a hardening furnace, and cut into final products of a suitable size,

   characterised in that
   the first and second primary fiber webs are selected or manufactured so that in the first primary fiber web at least one of the following properties:

   - mean fiber diameter,
   - mean fiber length,
   - surface weight,
   - fiber amount,
   - chemical composition,
   - binder content or
   - binder composition

   differs at least 5 % from the corresponding value in the second primary fiber web.

2. Method according to claim 1, **characterised in that** the first and the second primary fiber webs are placed asymmetrically on top of each other before overlapping to form the combined primary web and that during overlapping one of the primary fiber webs will mainly make up one or both of the large surfaces of

the secondary fiber web.

3. Method according to calm 2, **characterised in that** the first primary fiber web is at least 25 % narrower than the second primary fiber web.

4. Method according to any of claims 1 - 3, **characterised in that** the mean fiber diameter and/or the mean fiber length in the first primary fiber web differs at least 10 %, but at the most 50 % from the mean fiber diameter and/or mean fiber length in the second primary fiber web.

5. Method according to any of the preceding claims, **characterised in that** the fiber amount in the first primary fiber web differs at least 2 - 20 % by weight from the fiber amount in the second primary fiber web.

6. Method according to any of the preceding claims, **characterised in that** any one of the mentioned properties is varied in the width direction of the first or the second primary web so that after overlapping a variation is obtained in the secondary fiber web from its first large surface to its second large surface.

7. Method according to any of the preceding claims, **characterised in that** the first and the second primary fiber webs are manufactured by using one single fiberising apparatus and two collecting members.

8. An integrated mineral fiber product, which comprises

- a first and a second large surface, which are parallel with each other, and the perpendicular distance between which defines the height direction of the product,
- a first and a second side surface, which connect the large surfaces, and the perpendicular distance between which defines the width direction of the product, which is transverse in relation to the height direction of the product,
- a number of layers,
- which extend from the first side surface to the second side surface,
- out of which at least a part extend from the first large surface towards the second large surface,
- which originate from a first and a second primary fiber web, and
- which have, in the longitudinal direction of the product, which is transverse in relation to the height direction and width direction of the product, been arranged so that the product comprises a repeating section, which comprises a layer originating from the first primary fiber web, thereafter two adjacent layers, which originate from the second primary fiber web and thereafter an adjacent layer originating from the first primary fiber web,

characterised in that in a layer originating from the first primary fiber web at least one of the following properties

- mean fiber diameter,
- mean fiber length,
- surface weight,
- fiber amount,
- chemical composition,
- binder content or
- binder composition

has been arranged to differ at least 5 % from the corresponding value in layers originating from the second primary fiber web.

9. Mineral fiber product according to claim 8, **characterised in that** one of the large surfaces is made up mainly of layers, which originate from the first or the second primary fiber mat.

10. Mineral fiber product according to claim 8 or 9, **characterised in that** the difference in mean fiber diameter and/or mean fiber length in the layers originating from the first or second primary fiber web is at least 10 %, but at the most 50 %.

11. Mineral fiber product according to any of the claims 8 - 10, **characterised in that** any one of the mentioned properties moreover varies in the height direction of the product.

12. Mineral fiber product according to claim 11, **characterised in that** the chemical composition of the fibers varies in the height direction of the product with at least 1.5 % by weight for any one of the components included in the chemical composition.

13. Mineral fiber product according to claim 11 or 12, **characterised in that** the binder content at the large surfaces is 25 % higher than in the middle of the product.

14. Mineral fiber product according to any of the preceding claims, **characterised in that** in a layer originating from the first primary fiber web at least one of the following properties: mean fiber diameter, mean fiber length, surface weight, fiber amount, chemical composition, binder content or binder composition, has been arranged to differ at least 10 %, advantageously at least 15 %, even more advantageously at least 20 % from the corresponding value in layers originating from the second primary fiber web.

Patentansprüche

1. Verfahren zum Herstellen eines integrierten Mineralfaserproduktes, wobei

   - ein erstes und ein zweites primäres Mineralfasergewebe, welche beide von einer bestimmten Breite sind, erhalten werden,
   - das erste und das zweite primäre Mineralfasergewebe zumindest teilweise aufeinander platziert werden, so dass ein kombiniertes primäres Gewebe erhalten wird, welches einen ersten und zweiten Randteil und einen Mittelteil zwischen ihnen zeigt,
   - das kombinierte primäre Gewebe in einer ersten Richtung transportiert wird,
   - ein sekundäres Mineralfasergewebe durch Überlappen des kombinierten primären Gewebes quer in Relation zu der ersten Richtung erhalten wird, wodurch das kombinierte primäre Gewebe so angeordnet wird, dass es sich teilweise selbst überlappt, so dass der senkrechte Abstand zwischen zwei aufeinander folgenden Faltungen des kombinierten Gewebes die Breite des sekundären Fasergewebes definiert und die Randteile des kombinierten Gewebes mindestens einen Teil der großen Oberflächen des sekundären Gewebes darstellen,
   - das erhaltene sekundäre Fasergewebe in einem Härtungsofen gehärtet wird und in Endprodukte geeigneter Größe geschnitten wird,

   dadurch gekennzeichnet dass
   das erste und zweite primäre Fasergewebe so ausgewählt oder hergestellt wird, dass sich in dem ersten primären Fasergewebe mindestens eine der folgenden Eigenschaften:

   - mittlerer Faserdurchmesser,
   - mittlere Faserlänge,
   - Flächengewicht,
   - Fasermenge,
   - chemische Zusammensetzung,
   - Bindemittelgehalt oder
   - Bindemittelzusammensetzung,

   um mindestens 5% von dem entsprechenden Wert in dem zweiten primären Fasergewebe unterscheidet.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** das erste und das zweite primäre Fasergewebe asymmetrisch vor dem Überlappen zur Bildung des kombinierten primären Gewebes aufeinander platziert werden und dass während des Überlappens eines der primären Fasergewebe hauptsächlich eine oder beide der großen Oberflächen des sekundären Fasergewebes darstellen wird.

3. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet, dass** das erste primäre Fasergewebe mindestens 25% enger ist als das zweite primäre Fasergewebe.

4. Verfahren gemäß einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der mittlere Faserdurchmesser und/oder die mittlere Faserlänge in dem ersten primären Fasergewebe sich um mindestens 10%, aber höchstens 50%, von dem mittleren Faserdurchmesser und/oder der mittleren Faserlänge in dem zweiten primären Fasergewebe unterscheidet.

5. Verfahren gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Fasermenge in dem ersten primären Fasergewebe sich um mindestens 2-20 Gew.-% von der Fasermenge in dem zweiten primären Fasergewebe unterscheidet.

6. Verfahren gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** eine der genannten Eigenschaften in der Breitenrichtung des ersten oder des zweiten primären Gewebes variiert wird, so dass nach dem Überlappen eine Variation in dem sekundären Fasergewebe von seiner ersten großen Oberfläche zu seiner zweiten großen Oberfläche erhalten wird.

7. Verfahren gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das erste und das zweite primäre Fasergewebe unter Verwendung einer einzelnen Faserbildungsvorrichtung und zweier Sammelelemente hergestellt werden.

8. Integriertes Mineralfaserprodukt, welches umfasst

   - eine erste und eine zweite große Oberfläche, welche parallel zueinander sind, und den senkrechten Abstand dazwischen, der die Höhenrichtung des Produktes definiert,
   - eine erste und eine zweite Seitenoberfläche, welche die großen Oberflächen verbinden, und den senkrechten Abstand dazwischen, welcher die Breitenrichtung des Produktes definiert, welche quer in Relation zu der Höhenrichtung des Produktes ist,
   - eine Anzahl von Schichten,
   - welche sich von der ersten Seitenoberfläche zu der zweiten Seitenoberfläche erstrecken,
   - von welchen sich mindestens ein Teil von der ersten großen Oberfläche in Richtung der zweiten großen Oberfläche erstreckt,
   - welche aus einem ersten und einem zweiten primären Fasergewebe stammen und
   - welche in der Longitudinalrichtung des Produktes, welche quer in Relation zu der Höhenrich-

tung und der Breitenrichtung des Produktes ist, so angeordnet wurden, dass das Produkt einen Wiederholungsabschnitt umfasst, welcher eine Schicht, die aus dem ersten primären Fasergewebe stammt, danach zwei benachbarte Schichten, die aus dem zweiten primären Fasergewebe stammen, und danach eine benachbarte Schicht, die aus dem ersten primären Fasergewebe stammt, umfasst,

dadurch gekennzeichnet, dass in einer Schicht, die aus dem ersten primären Fasergewebe stammt, mindestens eine der folgenden Eigenschaften:

- mittlerer Faserdurchmesser,
- mittlere Faserlänge,
- Flächengewicht,
- Fasermenge,
- chemische Zusammensetzung,
- Bindemittelgehalt oder
- Bindemittelzusammensetzung,

so ausgerichtet wurde, dass sie sich um mindestens 5% von dem entsprechenden Wert in Schichten, die aus dem zweiten primären Fasergewebe stammen, unterscheidet.

9. Mineralfaserprodukt gemäß Anspruch 8, **dadurch gekennzeichnet, dass** eine der großen Oberflächen hauptsächlich durch Schichten dargestellt wird, die aus der ersten oder der zweiten primären Fasermatte stammen.

10. Mineralfaserprodukt gemäß Anspruch 8 oder 9, **dadurch gekennzeichnet, dass** der Unterschied im mittleren Faserdurchmesser und/oder der mittleren Faserlänge in den Schichten, die aus dem ersten oder dem zweiten primären Fasergewebe stammen, mindestens 10%, aber höchstens 50%, beträgt.

11. Mineralfaserprodukt gemäß einem der Ansprüche 8 bis 10,
dadurch gekennzeichnet, dass eine der genannten Eigenschaften darüber hinaus in der Höhenrichtung des Produktes variiert.

12. Mineralfaserprodukt gemäß Anspruch 11, **dadurch gekennzeichnet, dass** die chemische Zusammensetzung der Fasern in der Höhenrichtung des Produktes mit mindestens 1,5 Gew.-% für eine der Komponenten, die in der chemischen Zusammensetzung eingeschlossen ist, variiert.

13. Mineralfaserprodukt gemäß Anspruch 11 oder 12, **dadurch gekennzeichnet, dass** der Bindemittelgehalt an den großen Oberflächen 25% höher ist als in der Mitte des Produktes.

14. Mineralfaserprodukt gemäß einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** in einer Schicht, die aus dem ersten primären Fasergewebe stammt, mindestens eine der folgenden Eigenschaften: mittlerer Faserdurchmesser, mittlere Faserlänge, Flächengewicht, Fasermenge, chemische Zusammensetzung, Bindemittelgehalt oder Bindemittelzusammensetzung, so ausgerichtet wurde, dass sie sich um mindestens 10%, vorteilhafterweise mindestens 15%, sogar noch vorteilhafter mindestens 20%, von dem entsprechenden Wert in Schichten, die aus dem zweiten primären Fasergewebe stammen, unterscheidet.

Revendications

1. Procédé de fabrication d'un produit en fibres minérales intégrées, dans lequel

- une première et une seconde nappes de fibres minérales primaires, qui présentent toutes les deux une certaine largeur, sont obtenues,
- la première et la seconde nappes de fibres minérales primaires sont placées, au moins partiellement l'une par-dessus l'autre, de façon qu'une nappe primaire combinée soit obtenue, laquelle présente une première et une seconde parties de bord et une partie médiane située entre elles
- la nappe primaire combinée est transportée dans une première direction,
- une nappe de fibres minérales secondaire est obtenue en superposant la nappe primaire combinée de façon transversale par rapport à la première direction, de sorte que la nappe primaire combinée est disposée en vue de se chevaucher partiellement à elle-même de sorte que la distance perpendiculaire entre deux pliages successifs de la nappe combinée définisse la largeur de la nappe de fibres secondaire, et que les parties de bord de la nappe combinée constituent au moins une partie des grandes surfaces de la nappe secondaire,
- la nappe de fibres secondaire obtenue est durcie dans un four de durcissement, et découpée en produits finals d'une dimension appropriée,

caractérisé en ce que
la première et seconde nappes de fibres primaires sont sélectionnées ou fabriquées de sorte que dans la première nappe de fibres primaires au moins l'une des propriétés suivantes:

- diamètre moyen de fibre,
- longueur moyenne de fibre,
- poids surfacique,
- quantité de fibres,
- composition chimique,

- teneur en liant ou
- composition du liant,

diffère d'au moins 5% de la valeur correspondante de la seconde nappe de fibres primaire.

2. Procédé selon la revendication 1, **caractérisé en ce que** la première et seconde nappes de fibres primaires sont placées de façon asymétrique l'une pardessus l'autre avant de se chevaucher afin de former la nappe primaire combinée et **en ce que** pendant le chevauchement l'une des nappes de fibres primaires constituera principalement l'une des, ou les deux grandes surfaces de la nappe de fibres secondaire.

3. Procédé selon la revendication 2, **caractérisé en ce que** la première nappe de fibres primaire est plus étroite que la seconde nappe de fibres primaire d'au moins 25%.

4. Procédé selon l'une quelconque des revendications 1 à 3,
caractérisé en ce que le diamètre moyen de fibres et/ou la longueur moyenne des fibres dans la première nappe de fibres primaire diffère d'au moins 10%, mais au plus de 50% du diamètre moyen des fibres et/ou de la longueur moyenne des fibres dans la seconde nappe de fibres primaire.

5. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la quantité de fibres dans la première nappe de fibres primaire diffère d'au moins 2 à 20 % en poids de la quantité de fibres dans la seconde nappe de fibres primaire.

6. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'une quelconque des propriétés mentionnées est modifiée dans la direction de la largeur de la première ou de la seconde nappe primaire de sorte qu'après un chevauchement une modification est obtenue dans la nappe de fibres secondaires de sa première grande surface à sa seconde grande surface.

7. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la première et la seconde nappes de fibres primaires sont fabriquées en utilisant un seul appareil de fibrage et deux éléments collecteurs.

8. Produit en fibres minérales intégrées, lequel comprend:

- une première et une seconde grandes surfaces, lesquelles sont parallèles l'une à l'autre, et la distance perpendiculaire entre elles, définit la direction de hauteur du produit,
- une première et une seconde surfaces latérales, lesquelles raccordent les grandes surfaces, et la distance perpendiculaire entre elles, définit la direction de largeur du produit, laquelle est transversale par rapport à la direction de hauteur du produit,
- un certain nombre de couches,
- qui s'étendent de la première surface latérale à la seconde surface latérale,
- en dehors desquelles au moins une partie s'étende la première grande surface vers la seconde grande surface,
- lesquelles proviennent d'une première et d'une seconde nappes de fibres primaires, et
- lesquelles, dans la direction longitudinale du produit, qui est transversale par rapport à la direction de hauteur et à la direction de largeur du produit, ont été agencées de telle sorte que le produit comporte une section de répétition, laquelle comprend une couche provenant de la première nappe de fibres primaire, après quoi deux couches adjacentes, lesquelles proviennent de la seconde nappe de fibres primaire et ensuite une couche adjacente provenant de la première couche de fibres primaire,

caractérisé en ce que, dans une couche provenant de la première nappe de fibres primaire, au moins l'une des propriétés suivantes:

- diamètre moyen des fibres,
- longueur moyenne des fibres,
- poids surfacique,
- quantité de fibres,
- composition chimique,
- teneur en liant ou
- composition du liant

a été agencée pour différer d'au moins 5% de la valeur correspondante dans des couches provenant de la seconde nappe de fibres primaire.

9. Produit en fibres minérales selon la revendication 8, **caractérisé en ce que** l'une des grandes surfaces est constituée principalement de couches qui proviennent du premier ou du second matelas de fibres primaire.

10. Produit en fibres minérales selon la revendication 8 ou 9, **caractérisé en ce que** la différence de diamètre moyen des fibres et/ou de longueur moyenne des fibres dans les couches provenant de la première ou de la seconde nappe de fibres primaire est d'au moins 10%, mais au maximum de 50 %.

11. Produit en fibres minérales selon l'une des revendications 8 à 10, **caractérisé en ce que** l'une quelconque des propriétés mentionnées varie par ailleurs dans la direction de la hauteur du produit.

12. Produit en fibres minérales selon la revendication 11, **caractérisé en ce que** la composition chimique des fibres varie dans la direction de la hauteur du produit d'au moins 1,5 % en poids pour l'un quelconque des composants inclus dans la composition chimique.

13. Produit en fibres minérales selon la revendication 11 ou 12, **caractérisé en ce que** la teneur en liant au niveau des grandes surfaces est de 25% plus grande que dans la partie centrale du produit.

14. Produit en fibres minérales selon l'une quelconque des revendications précédentes, **caractérisé en ce que** dans une couche provenant de la première nappe de fibres primaire, au moins l'une des propriétés suivantes: diamètre moyen des fibres, longueur moyenne des fibres, poids surfacique, quantité de fibres, composition chimique, teneur en liant ou composition du liant, a été agencée en vue de différer d'au moins 10%, de façon avantageuse d'au moins 15%, de façon encore plus avantageuse d'au moins 20%, de la valeur correspondante dans les couches provenant de la seconde nappe de fibres primaire.

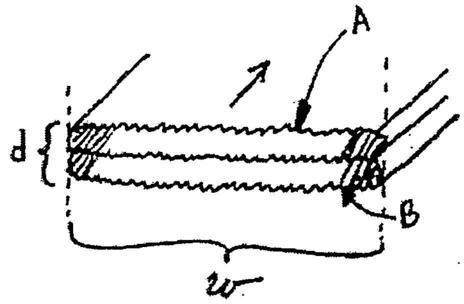

FIG 1A

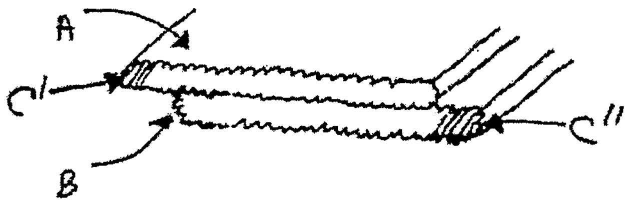

FIG 1B

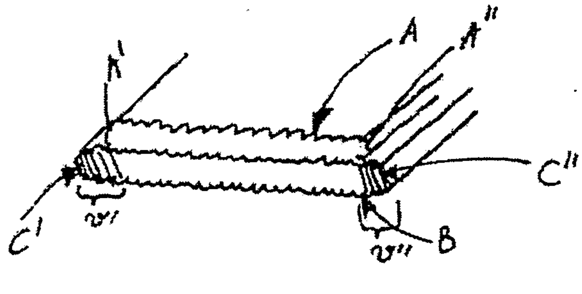

FIG 1C

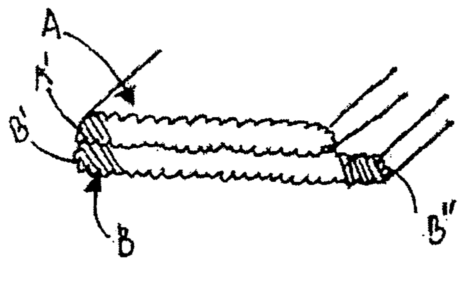

FIG 1D

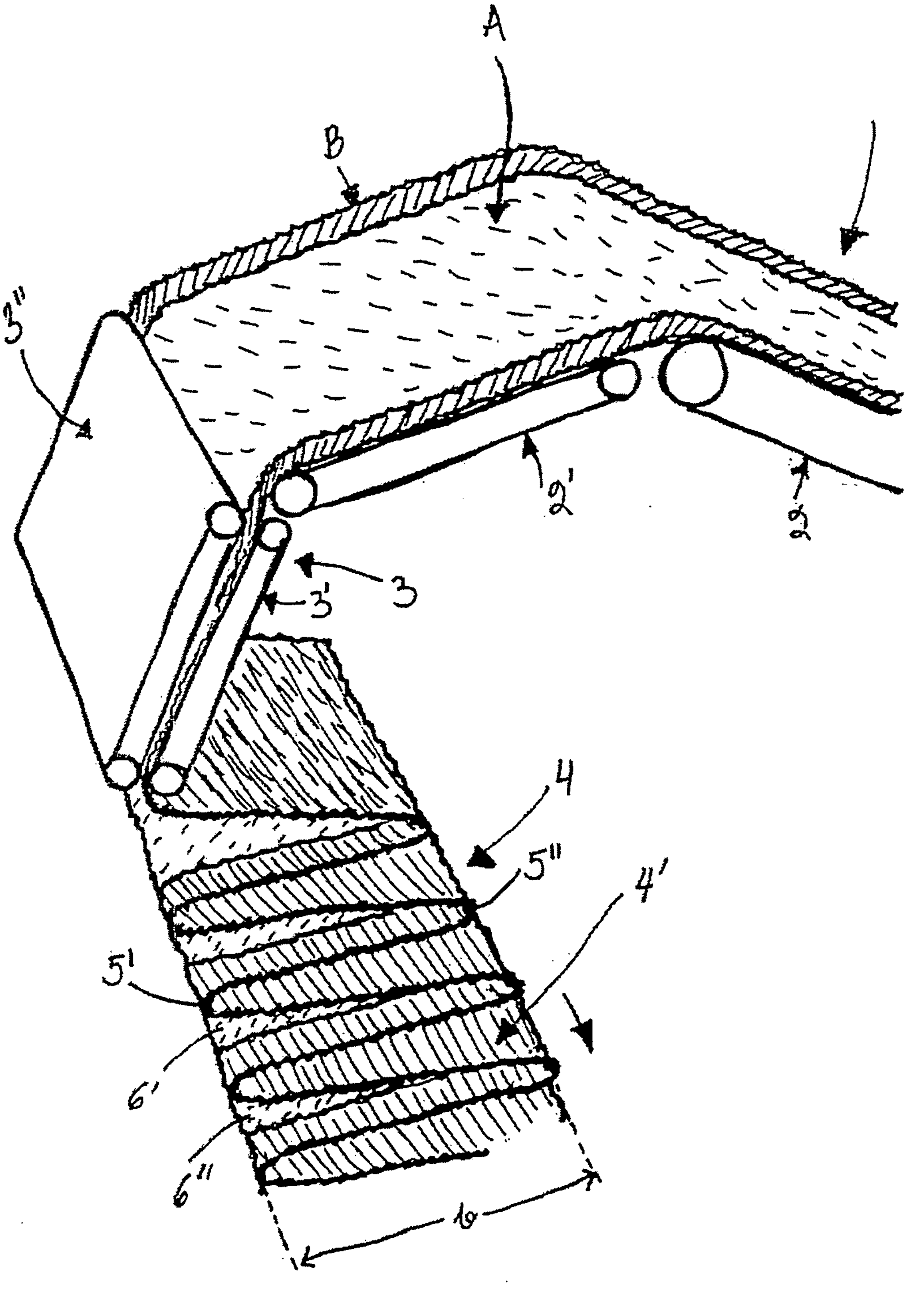

FIG 2

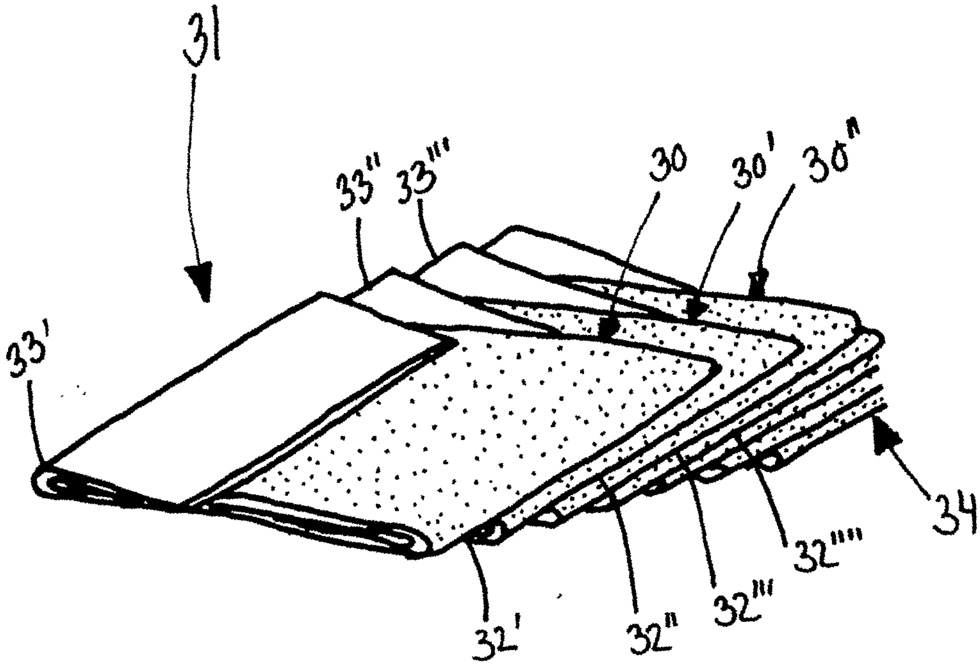

FIG 3

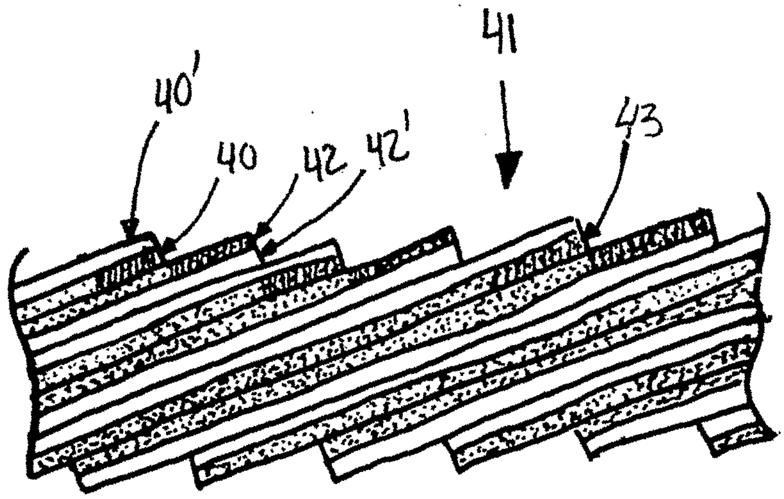

FIG 4

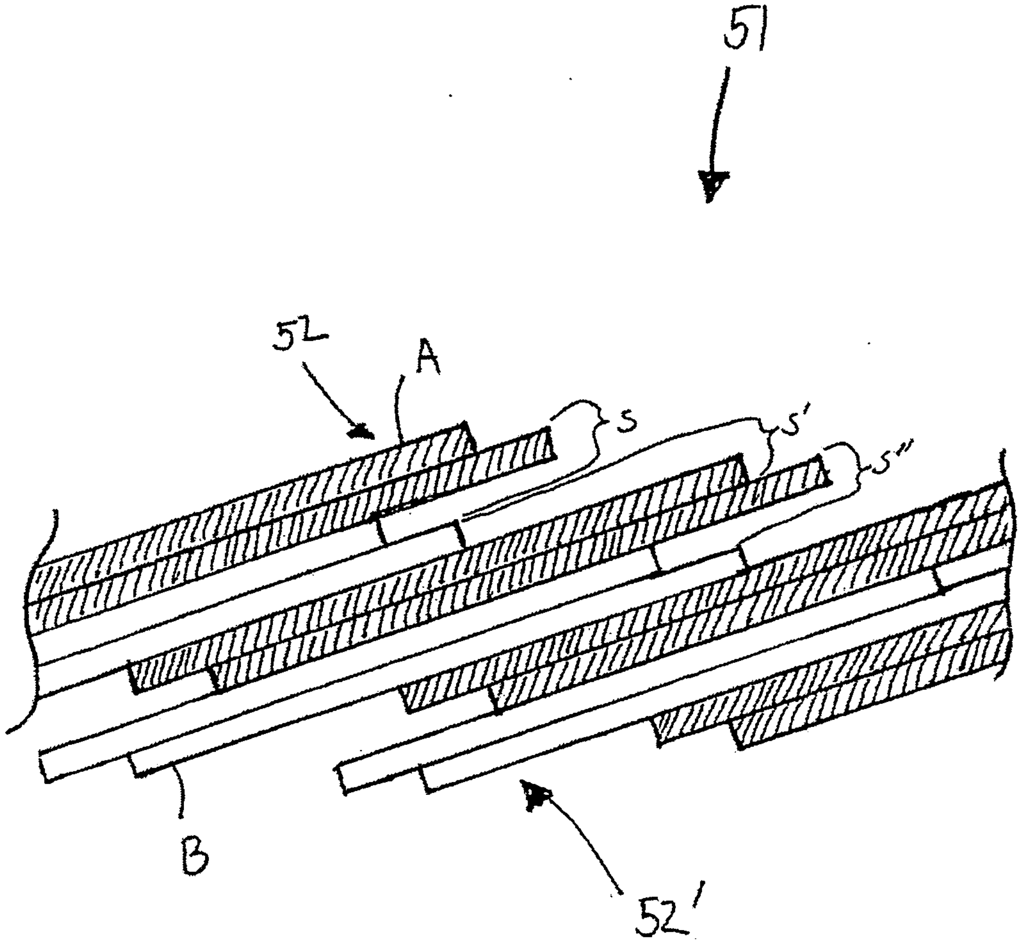

FIG 5

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

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- EP 0280338 B1 **[0007]**
- EP 0280339 A **[0020]**
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