

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
8 November 2007 (08.11.2007)

PCT

(10) International Publication Number  
**WO 2007/124550 A2**

(51) International Patent Classification: Not classified

(21) International Application Number:  
PCT/BE2007/000038

(22) International Filing Date: 27 April 2007 (27.04.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
PCT/BE2006/000044 2 May 2006 (02.05.2006) BE

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: PRODUCT COATED WITH THIN PHOSPHATE BINDER CONTAINING LAYER

(57) Abstract: Product having at least one face provided with at least a coating layer comprising at least one inorganic binder comprising calcium silicate sites, in which the coating layer has a first face directed towards the product and a second face opposite to said first face, whereby the coating layer has a controlled average thickness of less than 3mm, while the second layer has less than 20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>.



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**Product coated with thin phosphate binder containing layer****Field of the invention**

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The present invention relates to a product coated with at least a coating layer comprising at least one inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds with a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$  comprised between 0.6:1 and 6:1.

10

**The state of the art**

Inorganic phosphate binder of this type is disclosed in WO03/031366 and WO2005/003056, the content of which is incorporated herein by reference.

15

Other phosphate binders are also known.

For example in a previous patent application WO9903797 in the name of Metal Chemical and Haji Anas, a polymeric matrix is disclosed, said matrix comprising a binder formed by mixing an alkali metal silicate aqueous solution with a powder comprising silico-aluminous reactive raw materials. A polymerization time of more than one hour is however necessary for reaching a sufficient hardening of the matrix.

25 It has also been proposed in US 6,139,619 to form a binder by mixing a water soluble silicate with a water soluble amorphous inorganic phosphate glass in an aqueous medium. The hardening of the binder requires the removal of water by a heat treatment.

30 In US 4,375,551, an acid solution is prepared by mixing  $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$  with phosphoric acid, said acid solution being then mixed with calcium silicate. The so obtained binder has after hardening poor mechanical strength.

In the composition of the invention, the binder used is advantageously the binder as disclosed in WO 03/031366 of Applicant, the content of which is incorporated in the present specification by reference.

- 5 The binder of WO 03/031366 can be sufficiently hardened within a term of less than 10 minutes and which has excellent mechanical properties.

As stated in said document, the binder can be mixed with various fillers.

- 10 WO2005/003056 proposes to use specific filler, especially a combination of specific filler, in order to increase mechanical properties of the mixture binder/filler(s) and/or the final appearance of the composition after its hardening and/or the fire resistance of the composition. For example, it was observed that swelling of the product could be prevented after a water absorption.

- 15 The present invention relates to an improvement of the use of inorganic binder of Applicant previous applications WO 03/031366 and WO 2005/003056, which is characterized by calcium silicate sites which are connected the one with the other by alumina-silica phosphate bonds.

- 20 A problem of the use of inorganic binder as disclosed in WO 03/031366 and WO 2005/003056 is that when making a thin coating layer on a surface of a product, it was difficult to make easily with industrial means coating layer having a quite uniform thickness, especially quite uniform properties.

- 25 It has now been discovered that by spraying specific liquid reacting composition on a face of a product, it was possible to achieve a very thin coating layer with very uniform mechanical and fire resistance properties, although the presence in the liquid reacting composition of solid particles or solid grains. The thin coating layer achieved by said spraying of said specific liquid reacting composition had a  
30 to face with a reduced number of cavities with a depth of more than 0.1 the average thickness and with a volume of more than 2mm<sup>3</sup>, preferably a reduced

number of cavities with a depth of more than 0.1 the average thickness and with a volume of more than 1mm<sup>3</sup>.

The process of the invention was thus suitable for preventing large unevenness' on the top face of the coating, whereby improving the appearance of the product, as well as the mechanical and fire resistance properties of the product.

### **Brief description of the invention**

The invention relates to a product having at least one face provided on at least a surface of 100cm<sup>2</sup> with at least a coating layer comprising at least one inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds with a weight ratio Al<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> comprised between 0.6:1 and 6:1, in which the coating layer has a first face directed towards the product and a second face opposite to said first face, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer has a controlled average thickness of less than 3mm, while the second face of said portion has less than 20 cavities, advantageously less than 10 cavities, preferably less than 5 cavities having a depth of more than 0.2 times, advantageously more than 0.1 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>, advantageously with a cavity volume of more than 1mm<sup>3</sup>.

When applied on a surfaces with cavities or pores, the coating layer can act as means for filling the cavities or closing the pores, whereby flattening the top surface of the product.

The alumina-silica phosphate bounds connecting the calcium silicate sites are advantageously characterized with a SiO<sub>2</sub>/P<sub>2</sub>O<sub>5</sub> molar ratio comprised between 0.1 and 2, preferably 0.2 and 1.5, most preferably between 0.3 and 1.2.

Advantageously, the coating layer has a substantially uniform thickness, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at

least 1000cm<sup>2</sup>, of the coating layer has a maximum variation of thickness with respect to the average thickness of less than 10% of the average thickness, preferably of less than 5% of the average thickness, most preferably of less than 3% of the average thickness of said portion, and/or

- 5 whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a substantially flat top face, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of said top face has unevenness' of less than 10%, advantageously less than 5%, preferably less than 3% of the average thickness of  
10 said portion..

According to a specific embodiment, the calcium silicate containing coating layer has a thickness of less than 2mm, preferably less than 1mm, most preferably comprised between 50µm and 500µm.

15

According to an advantageous detail, the calcium silicate containing coating layer coats a phosphoric acid resistant layer, advantageously a silicon containing layer, preferably a hydrophobic silicon containing layer.

- 20 Advantageously, the phosphoric acid resistant layer forms a substantially uniform layer with a weight of less than 100g/m<sup>2</sup>, preferably less than 50g/m<sup>2</sup>.

According to an advantageous detail of the product of the invention, the calcium silicate containing layer comprises inert fibres with an average (in weight) length  
25 of less than 200µm, preferably less than 100µm, most preferably comprised between 20 and 50µm. For example, the calcium silicate containing layer comprises less than 50% by weight inert fibres, preferably less than 30% by weight, most preferably comprised between 1 and 25% by weight.

- 30 Preferably, the fibres are homogeneously dispersed in the calcium silicate containing coating layer.

For example, the fibre dispersion in the calcium silicate containing coating layer is characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 50cm<sup>2</sup>, advantageously of 100cm<sup>2</sup>, preferably of 250cm<sup>2</sup>, most preferably of 500cm<sup>2</sup> or even more, and by a fibre weight content variation per square centimetre for said surface (for which the average weight content has been determined) of less than 10% of the average fibre content, preferably less than 5% of the average fibre weight content.

10 According to a preferred embodiment, so as to have a good balance between fire resistance properties and weight of the coating, the calcium silicate containing coating layer has a weight of less than 2000g/m<sup>2</sup>, advantageously less than 1000g/m<sup>2</sup>, preferably comprised between 100g/m<sup>2</sup> and 750g/m<sup>2</sup>.

15 According to an advantageous embodiment, the product provided with the coating is a flexible support with a thickness of less than 5mm, preferably less than 4mm, most preferably less than 3mm, especially less than about 2mm, such as a total thickness comprised between 750µm and 1750µm.

20 According to a preferred embodiment, the flexible support comprises a flexible mat of fibres and/or a flexible fibres containing fabric, said mat or fabric having a weight of less than 3000g/m<sup>2</sup>, advantageously less than 2000g/m<sup>2</sup>, preferably less than 1000g/m<sup>2</sup>. The weight of said mat or fabric is for example comprised between 10g/m<sup>2</sup> and 750g/m<sup>2</sup>, such as 20g/m<sup>2</sup>, 40g/m<sup>2</sup>, 50g/m<sup>2</sup>, 100g/m<sup>2</sup>, 200g/m<sup>2</sup>, 250g/m<sup>2</sup> and 500g/m<sup>2</sup>. The flexible support can also comprises several flexible mat(s) and/or fabric(s), the several mat(s) and/or fabric(s) being advantageously attached the one to the other by the phosphate binder containing layer.

Advantageously, the flexible mat or fabric comprises glass fibres. Other fibres can also be used, provided they are resistant to phosphoric acid and/or provided they are provided with a primer which gives sufficient resistance against phosphoric acid.

According to an advantageous embodiment, both faces of the flexible support are provided with a calcium silicate containing coating layer.

- 5 According to a further embodiment, the product comprises a first flexible support, a second flexible support, and an intermediate calcium silicate containing layer situated between the first and second flexible layer. Advantageously, the first flexible layer is a mat of fibres, while the second flexible layer is a fabric, preferably a woven fabric. Preferably, the mat of fibres has a weight of less than  
10 100g/m<sup>2</sup>, advantageously of less than 50g/m<sup>2</sup>, preferably comprised between 10g/m<sup>2</sup> and 40g/m<sup>2</sup>. The use of such a mat gives to the product a soft touch.

- The product of the invention can also be combined with one or more different elements. For example, the product of the invention can be used as support for a  
15 foaming element or composition, such as a foaming PUR element or composition. After foaming, the foamed element is rigid.

- The invention relates also to a combined structure comprising a product of the invention and an element attached to or adhered to said product. The element  
20 comprises advantageously a foamed layer in contact with the product of the invention. The foamed layer is preferably a foamed PUR layer with a thickness of at least 1cm, advantageously of at least 2cm, such as a thickness comprised between 2.5cm and 10cm. When foaming directly a PUR foaming composition on the product, the PUR adheres firmly on the product, especially on a calcium  
25 silicate containing coating.

- The invention relates also to a process for the preparation of a product according to the invention, in which a liquid reacting composition is sprayed on at least one surface of the product so as to form a coating layer comprising at least one  
30 inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds with a weight ratio Al<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> comprised between 0.6:1 and 6:1, in which the coating layer has a first face directed towards

the product and a second face opposite to said first face, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer has a controlled average thickness of less than 3mm, said portion having a second face with less than 20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>,

whereby said composition comprises :

- an aqueous alumina-silica phosphate solution with an Al<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> weight ratio comprised between 0.6 and 6 and a SiO<sub>2</sub>/P<sub>2</sub>O<sub>5</sub> molar ratio comprised between 0.1 and 2, preferably 0.2 and 1.5, most preferably between 0.3 and 1.2;
- calcium silicate solid powder with an weight average particle size of less than 100 μm, said solid powder being adapted to react with the aqueous alumina-silica phosphate solution,
- possibly one or more inert fillers with a size of less than 250μm

whereby the pH of the composition is less than 1, while the solid content of the composition is less than 30% by weight, with the proviso that the weight ratio water/calcium silicate particles is comprised between 0.9 and 2.

By using these parameters, it was possible to achieve a thin coating layer, the top face of which is very uniform, without or substantially without cavities or cracks, while having excellent balance between mechanical properties and fire resistance.

Advantageously, the calcium silicate solid powder of the liquid reacting composition has a weight average particle size lower than 50μm, preferably lower than 25μm.

The pH of the composition is preferably less than about 0.5. The pH is measured at 20°C.



Advantageously, for the liquid reacting composition or for the liquid fraction of the composition, the weight ratio water/alumino silica from the alumino silica phosphate is greater than 2.

5

According to a preferred embodiment, the liquid reacting composition comprises inert fibres with an average (in weight) length of less than 200 $\mu$ m, preferably less than 100 $\mu$ m, most preferably comprised between 20 and 50 $\mu$ m.

Advantageously, the inert fibres of the liquid reacting composition have an  
10 average length greater than 1.5 times the weight average particle size of the calcium silicate solid powder.

Preferably, the liquid reacting composition comprises less than 20% by weight inert fibres, preferably from 5% to 15%.

15 According to an embodiment, the fibres are homogeneously dispersed in the liquid reacting composition before spraying.

According to specific embodiments of the process,

- the spraying of the liquid reacting composition is controlled so as to form a  
20 coating with a fibre dispersion characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 50cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content, and/or
- the spraying of the liquid reacting composition is controlled so as to form a  
25 coating with a fibre dispersion characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 100cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content, and/or
- the spraying of the liquid reacting composition is controlled so as to form a  
30 coating with a fibre dispersion characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a

surface of 250cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content, and/or

- the spraying of the liquid reacting composition is controlled so as to form a coating with a fibre dispersion characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 500cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 5% of the average fibre content, and/or
- the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the second face of the coating layer with a controlled average thickness of less than 3mm, has less than 20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>, and/or
- the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the second face of the coating layer with a controlled average thickness of less than 3mm, has less than 10 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>, and/or
- the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the second face of the coating layer with a controlled average thickness of less than 3mm, has less than 10 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>, and/or
- the spraying of the composition is controlled so that the coating layer has a substantially uniform thickness, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a maximum variation of thickness with respect to the average thickness of less than 10% of the average thickness, and/or
- the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer has a controlled average thickness of less than 3mm, said portion having a maximum variation of thickness with respect to the average thickness of less than

5% of the average thickness, preferably of less than 3% of the average thickness of said portion, and/or

- the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a substantially flat top face having unevenness' of less than 10%, advantageously less than 5%, preferably less than 3% of the average thickness of said portion.

Advantageously, the surface to be sprayed is treated so as to render it substantially not reactive to phosphoric acid, so as to avoid any excessive foaming due to a reaction between the support and the phosphoric acid of the composition.

Preferably, the surface to be coated is precoated with a phosphoric acid resistant layer, such as a hydrophobic phosphoric acid resistant silicon containing layer, preferably a silicon layer, a chloro and/or fluoro silicone layer. Such a layer can be very thin, such as a layer of less than 10µm. The presence of silicon atom in the layer is also advantageous for making chemical bounds between the calcium silicate containing layer and the protection layer against phosphoric acid.

- According to a detail of the process,
- after spraying the calcium silicate containing coating composition onto the support, the coating composition is cured and/or dried at a temperature comprised between 10°C and 75°C for at least 30seconds, preferably for a time period comprised between 1 and 5minutes, and/or
  - at least before spraying the composition, the composition to be sprayed or the portion thereof to be sprayed is heated at a temperature comprised between 30°C and 70°C, and/or
  - the liquid composition is sprayed on a face of the product having a temperature comprised between 10°C and 100°C, advantageously comprised between 20°C and 85°C, preferably comprised between 30°C and 75°C.

As the coating layer is very thin, the drying or curing of the composition is rapid.

It has also been observed that the successive spraying of the liquid coating composition was advantageous, so as to apply liquid reactive composition on an already applied coating layer. The successive spraying of the composition is advantageously carried out when the curing or drying of the prior applied composition is not yet finished. On this manner, the newly applied composition is contacting very reactive coating or a coating still in curing reaction, whereby the further curing or hardening of the newly sprayed composition is favorized.

According to a detail of a preferred process, the calcium silicate containing coating composition is sprayed on a first flexible support resistant to phosphoric acid and/or provided with a phosphoric acid resistant layer, and in which a second flexible support resistant to phosphoric acid and/or provided with a phosphoric acid resistant layer is deposited on the calcium silicate containing coating composition while not being completely cured.

According to a most preferred embodiment, the coating is applied in at least two successive spraying steps. The number of spraying steps will depend of various factors, such as thickness, fibre content, solid content of the liquid composition, etc. The number of spraying steps is advantageously at least three, but can be 4, 5, 6, or even more.

When using successive spraying steps, it is advantageous to use different coating compositions for one or more different spraying steps. For example, the first and the latest spraying steps are carried out with a composition with a low inert fibre content, advantageously without or substantially without fibres, while the intermediate spraying step(s) is/are carried out with coating composition(s) having a higher inert fibre content.

The invention further relates to a liquid reacting composition suitable to be sprayed, said composition comprising :

- an aqueous alumina-silica phosphate solution with an  $\text{Al}_2\text{O}_3/\text{SiO}_2$  weight ratio comprised between 0.6 and 6 and a  $\text{SiO}_2/\text{P}_2\text{O}_5$  molar comprised between 0.1 and 2, preferably 0.2 and 1.5, most preferably between 0.3 and 1.2,

5

- calcium silicate solid powder with an weight average particle size of less than 100  $\mu\text{m}$ , said solid powder being adapted to react with the aqueous alumina-silica phosphate solution,

10

- possibly one or more inert fillers with a size of less than 250  $\mu\text{m}$

whereby the pH of the composition is less than 1, preferably less than 0.5, while the solid content of the composition is less than 30% by weight, with the proviso that the weight ratio water/calcium silicate particles is comprised between 0.9 and 2.

15

Advantageously, the weight average particle size of the calcium silicate solid powder is lower than 50  $\mu\text{m}$ , preferably lower than 25  $\mu\text{m}$ .

20

According to a detail, the weight ratio water/alumino silica from the alumino silica phosphate is greater than 2.

25

According to a preferred embodiment, the composition comprises inert fibres (i.e. inert fibres means fibres not soluble in the acid composition, namely in the phosphoric acid composition during the hardening or curing of the coating composition) with an average (in weight) length of less than 200  $\mu\text{m}$ , preferably less than 100  $\mu\text{m}$ , most preferably comprised between 20 and 50  $\mu\text{m}$ .

Advantageously, the inert fibres have an average length greater than 1.5 times the weight average particle size of the calcium silicate solid powder.

30

Preferably, the liquid reacting composition comprises less than 20% by weight inert fibres, most preferably from 1% to 15%, especially from 5 to 15% by weight.

The invention still further relates to a product comprising :

- a support;
  - a mat of fibres, and
  - an intermediate layer between the support and the mat of fibres, whereby the
- 5 intermediate layer comprises at least one inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds with a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$  comprised between 0.6:1 and 6:1.

The alumina-silica phosphate bounds connecting the calcium silicate sites are

10 advantageously characterized with a  $\text{SiO}_2/\text{P}_2\text{O}_5$  molar ratio comprised between 0.1 and 2, preferably 0.2 and 1.5, most preferably between 0.3 and 1.2.

Advantageously, the support is a flexible support.

- 15 Preferably, the intermediate layer forms bounds between support and the mat of fibres.

According to a detail of embodiment, the support is resistant to phosphoric acid or provided with a phosphoric acid resistant layer, and in which the mat of fibres is

20 resistant to phosphoric acid or provided with a phosphoric acid resistant layer.

According to a preferred embodiment, the support is a flexible fabric, preferably a woven flexible fabric, said fabric having advantageously a weight of less than  $1000\text{g/m}^2$ , preferably less than  $500\text{g/m}^2$ .

25

According to another detail of preferred embodiment, the mat of fibres has a weight of less than  $100\text{g/m}^2$ , advantageously of less than  $50\text{g/m}^2$ , preferably comprised between  $10\text{g/m}^2$  and  $40\text{g/m}^2$ .

- 30 According to a further detail of preferred embodiments, the intermediate layer has a thickness of less than 3mm, advantageously less than 2mm, especially less than 1mm, most specifically between  $50\mu\text{m}$  and  $750\mu\text{m}$ .

The intermediate layer is advantageously made by using a composition of the invention, especially by spraying the composition on the support, and then by covering the sprayed coating layer with the mat of fibres.

5

The invention further relates to a metal support or sheet (such as a steel support or sheet) covered at least partly with a resin foam layer, especially with a PUR foam layer, whereby said metal support is provided with a coating layer intermediate at least partly between the metal support or sheet and the resin foam layer, said  
10 intermediate layer, said intermediate layer comprising at least one inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds with a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$  comprised between 0.6:1 and 6:1, whereby said layer has an average thickness of less than 3mm, advantageously of less than 2mm, preferably less than 1mm.

15

Advantageously, the intermediate layer is a coating layer having one or more characteristics of the coating layer of a product of the invention as disclosed here above.

20 The alumina-silica phosphate bounds connecting the calcium silicate sites are advantageously characterized with a  $\text{SiO}_2/\text{P}_2\text{O}_5$  molar ratio comprised between 0.1 and 2, preferably 0.2 and 1.5, most preferably between 0.3 and 1.2.

According to another embodiment, the intermediate layer is a product of the  
25 invention as disclosed here above, said product being provided on its both faces with a coating layer. Such a product comprises advantageously a flexible support, such as a flexible fabric and/or mat.

Details and characteristics of the invention will appear from the following  
30 description of preferred embodiments. In said description, reference is made to the following drawings.

**Brief description of the drawings**

- Figure 1 is a perspective view of foamed support provided with a calcium silicate containing coating of the invention;
- 5 Figure 2 is a partial enlarged view, in cross section, of the coating of the support of Figure 1; while figure 2bis is an enlarged view of a product not of the invention;
- Figure 3 is a perspective view of a flexible product of the invention;
- Figure 4 is an enlarged cross section view of the flexible product of Figure 3;
- Figure 5 is a perspective view of a further flexible product of the invention;
- 10 Figure 6 is an enlarged cross section view of the flexible product of Figure 5;
- Figure 7 is a perspective view of another product of the invention;
- Figure 8 is a partial enlarged cross section view of the product of Figure 7;
- Figure 9 is a partial enlarged cross section view of a product similar to the product of figure 4;
- 15 Figures 10,11,12, 13 and 14 is a partial enlarged cross section view of product respectively similar to the product shown in Figures 2, 4,6 and 8;
- Figure 15 is a schematic view of a plant for the production of a product of the invention.

**Description of preferred embodiments**

Figure 1 is a schematic view of a product of the invention.

The product comprise a foamed support 1, for example a PUR foam with closed  
25 cells, and a top coating layer 2.

The top coating layer 2 comprises :

- an inorganic binder comprising calcium silicate sites connected the one to the other by alumina-silica phosphate bounds having a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$   
30 comprised between 0.6:1 and 6:1, and
- glass fibres.



The coating layer was prepared by spraying in one or preferably successive steps a liquid reactive composition comprising :

- an aqueous alumina-silica phosphate solution with an  $\text{Al}_2\text{O}_3/\text{SiO}_2$  weight ratio comprised between 0.6 and 6 and a  $\text{SiO}_2/\text{P}_2\text{O}_5$  molar comprised between 0.1 and 2,
- 5 - calcium silicate solid powder with an weight average particle size of less than 25  $\mu\text{m}$ , said solid powder being adapted to react with the aqueous alumina-silica phosphate solution, and
- possibly glass fibres (not soluble in the phosphate solution) with an weight average length comprised between 20 and 50 $\mu\text{m}$ , the average length of the fibres
- 10 being at least 2 times the average maximum length of the calcium silicate solid powder,

whereby the pH of the composition is less than about 0.5, while the solid content of the composition is less than 30% by weight, with the proviso that the weight ratio water/calcium silicate particles is comprised between 0.9 and 2.

15

The sprayed composition comprises less than 20% by weight inert fibres, preferably from 5% to 15%.

The liquid reactive composition was sprayed so as to achieve after hardening and drying of the composition a coating layer 2 having a thickness E of less than 2mm, such as 1.5mm, 1mm, 750 $\mu\text{m}$ , 500 $\mu\text{m}$  and 250 $\mu\text{m}$ .

20

The upper face 20 of the coating layer 2, i.e. the face opposite to the face 21 facing the support 1, has substantially no cavities, while the fibres are quite

25 homogeneously distributed with respect to the surface of the coating.

25

It was possible to achieve a top coating face 20 having less than 5 cavities with a depth greater than 0.1 times the thickness of the coating 2 and with a cavity volume of more than 2 $\text{mm}^3$ , for a top coating surface of 2000  $\text{cm}^2$ .

30

The liquid reactive composition was prepared by using the following products :

WATER W : demineralized water with a very low calcium/magnesium content (less than 20ppm)

SiO<sub>2</sub> : precipitated SiO<sub>2</sub> particles with an average particle size of about 10µm, said  
5 particles having a purity of 99% by weight

Al<sub>2</sub>O<sub>3</sub> : powder with an average particle size of about 10µm and a purity of 99% by weight

10 Phosphoric acid PA: concentrated phosphoric acid, as an aqueous solution containing 75% by weight phosphoric acid

Calcium silicate CS1 : calcium meta silicate powder, water insoluble, acicular nature with a length/breadth or aspect ratio of about 3 to 5, advantageously about  
15 3, with an average weight particle of about 15µm. The calcium silicate comprises more than about 46% (weight) CaO and more than about 51.5% (weight) (calculated after burning).

Calcium silicate CS2 : calcium meta silicate powder, water insoluble, acicular  
20 nature with a length/breadth or aspect ratio of about 3 to 5, advantageously about 3, with an average weight particle of about 10µm. The calcium silicate comprises more than about 46% (weight) CaO and more than about 51.5% (weight) (calculated after burning).

25 Calcium silicate CS3 : calcium meta silicate powder, water insoluble, acicular nature with a length/breadth or aspect ratio of about 3 to 5, advantageously about 3, with an average weight particle of about 5µm. The calcium silicate comprises more than about 46% (weight) CaO and more than about 51.5% (weight) (calculated after burning).

30

Calcium silicate CS4 : calcium meta silicate powder, water insoluble, acicular nature with a length/breadth or aspect ratio of about 3 to 5, advantageously about

3, with an average weight particle of about 2.5 $\mu$ m. The calcium silicate comprises more than about 46% (weight) CaO and more than about 51.5% (weight) (calculated after burning).

- 5 Glass fibre (GF1) : glass fibre with a length of about 50 $\mu$ m, said fibre being treated with a water repellent silane layer (fluoro silane layer)

Glass fibre (GF2) : glass fibre with a length of about 25 $\mu$ m, said fibre being treated with a water repellent silane layer (fluoro silane layer)

10

Silica fume (Sf) : average particle size (in weight) below 1 $\mu$ m.

- The binder composition have been prepared by adding SiO<sub>2</sub> particles to phosphoric acid. After dissolution of the SiO<sub>2</sub> particles, Al<sub>2</sub>O<sub>3</sub> particles were  
15 added. An acid alumina silica phosphate aqueous solution was so achieved. The pH of said acid solution, measured at 20°C was less than about 0.5.

Water was then added to the solution, while keeping the pH of the solution below 1.

20

Calcium silicate particles was then added. The pH of the composition suitable to be sprayed was below 1.

- Advantageously to said composition, some "inert" fillers were added, namely glass  
25 fibres and/or silica fume.

- Water can be further be added, but the pH is preferably maintained below 1. It has been observed that when keeping the pH below 1, the fluidity of the composition can be ensured even if the composition has a solid content of about 30% by  
30 weight, whereby ensuring an efficient spraying of the composition with normal industrial spraying system.

It was also observed that the mixing of the suspension was more easy at such a low pH, and that the composition could be easily kept sufficiently homogeneous, even without mixing or shaking for a time sufficient for the spraying.

- 5 The following compositions have been prepared :

TABLE 1

| Composition                                                                     | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    |
|---------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|
| binder                                                                          |      |      |      |      |      |      |      |      |
| SiO <sub>2</sub> (g)                                                            | 20   | 25   | 30   | 30   | 40   | 25   | 30   | 35   |
| Al <sub>2</sub> O <sub>3</sub> (g)                                              | 30   | 25   | 20   | 20   | 20   | 35   | 30   | 25   |
| PA (g)                                                                          | 150  | 150  | 150  | 150  | 150  | 150  | 140  | 150  |
| Molar ratio<br>SiO <sub>2</sub> /P <sub>2</sub> O <sub>5</sub> of<br>the binder | 0.58 | 0.73 | 0.87 | 0.87 | 1.16 | 0.73 | 0.93 | 1.02 |
| pH                                                                              | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  |
| Added water/calcium silicate and possible fillers                               |      |      |      |      |      |      |      |      |
| Water (g)                                                                       | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| CS1 (g)                                                                         | 100  | 100  | 75   | 100  | 50   |      | 50   | 100  |
| CS2 (g)                                                                         |      |      |      |      |      | 50   | 50   |      |
| CS3 (g)                                                                         |      |      |      |      | 50   | 50   |      |      |
| CS4 (g)                                                                         |      |      |      |      |      |      |      |      |
| GF1 (g)                                                                         |      |      |      |      |      |      |      |      |
| GF2 (g)                                                                         |      |      |      |      |      |      |      |      |
| Sf (g)                                                                          |      |      |      |      |      |      |      |      |
| Characteristic of the composition                                               |      |      |      |      |      |      |      |      |
| pH                                                                              | < 1  | < 1  | < 1  | < 1  | < 1  | < 1  | < 1  | < 1  |

TABLE 2

| Composition                                                                     | 9    | 10   | 11   | 12   | 13   | 14   | 15   | 16   |
|---------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|
| binder                                                                          |      |      |      |      |      |      |      |      |
| SiO <sub>2</sub> (g)                                                            | 20   | 25   | 30   | 30   | 40   | 25   | 30   | 35   |
| Al <sub>2</sub> O <sub>3</sub> (g)                                              | 30   | 25   | 20   | 20   | 20   | 35   | 30   | 25   |
| PA (g)                                                                          | 150  | 150  | 150  | 150  | 150  | 150  | 140  | 150  |
| Molar ratio<br>SiO <sub>2</sub> /P <sub>2</sub> O <sub>5</sub> of<br>the binder | 0.58 | 0.73 | 0.87 | 0.87 | 1.16 | 0.73 | 0.93 | 1.02 |
| pH                                                                              | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  |
| Added water/calcium silicate and possible fillers                               |      |      |      |      |      |      |      |      |
| Water (g)                                                                       | 100  | 100  | 100  | 100  | 100  | 100  | 100  | 100  |
| CS1 (g)                                                                         |      | 50   | 40   | 60   | 25   |      | 25   | 75   |
| CS2 (g)                                                                         |      |      |      |      |      | 25   | 25   |      |
| CS3 (g)                                                                         | 25   |      |      |      | 50   | 25   |      |      |
| CS4 (g)                                                                         | 25   |      |      |      |      |      |      |      |
| GF1 (g)                                                                         | 50   |      | 30   |      |      | 40   | 35   | 25   |
| GF2 (g)                                                                         |      | 20   |      | 40   |      |      |      |      |
| Sf (g)                                                                          |      | 30   | 10   |      |      | 10   | 15   |      |
| Characteristic of the composition                                               |      |      |      |      |      |      |      |      |
| pH                                                                              | < 1  | < 1  | < 1  | < 1  | < 1  | < 1  | < 1  | < 1  |

5

The compositions 1 to 16 were sprayed on a foamed support (PUR) in several spraying steps for achieving different coating layers, namely coating layers having different thickness, namely 2mm, 1mm, 750µm, 500µm and 250µm. The variation of thickness was very low, namely a variation of less than 2% with

respect to the average thickness. The fibres were well distributed, due to the easiness to keep the suspension homogeneous and due to the possibility to apply the suspension by spraying. For the layer having substantially a constant thickness, the variation of fibre content per  $\text{cm}^2$  is less than 3% of the average (weight) fibre content determined for a coating surface of  $1000\text{cm}^2$ . It was even  
5 observed that it was possible to have fibres directed in substantially all the planar directions, whereby ensuring good mechanical properties for the coating as such in any planar direction.

10 After the spaying of the composition, the support provided with a wet coating was placed in a oven at  $50^\circ\text{C}$  for 1 minute. After said drying, the coating 2 was hardened and well attached to the support.  
The coating composition 2 of the invention has properties which are quite constant.

15

In a comparative test, the liquid suspension binder compositions 1, 2, 6 and 7 of WO 2005/003056 were used for coating a support. The coating of the support could not be achieved by spraying. In order to keep sufficient homogeneousness for the composition, it was necessary to ensure a sufficient mixing. After drying  
20 and hardening of the composition, the top face (see figure 2 bis) had cavities 201 and/or asperities or projections. Some cracks were apparent. The coating had thus many cavities (more than 20 cavities with a depth "d" greater than 0.2 times the thickness of the coating 200). For preventing the formation of cracks, WO 2005/003056 suggests the addition of silicon containing fibres with a length  
25 advantageously comprised between  $25\mu\text{m}$  and  $300\mu\text{m}$ . Such a composition can still no be sprayed with efficient spraying industrial system. Very thin layer without asperities and/or cavities and/or grooves can not be achieved. Figure 2 bis shows schematically a coating layer 200 prepared from a liquid binder composition with fibres. The coating layer had some variation of properties due to  
30 variation of thickness, as well as variation in the fibre density. Moreover, still some cavities were present along the top surface of the coating 200.

Figure 3 shows a fabric which was coated with compositions of Tables 1 and 2. The fabric 30 is for example a glass fabric with a weight comprised between 200g/m<sup>2</sup> and 500g/m<sup>2</sup>.

- 5 The woven glass fabric was coated by several successive spraying steps, so that the top face was substantially flat.

As the composition was enough liquid, some liquid reactive composition was able to flow between the glass fibres of the fabric, whereby increasing the adhesion of the coating 2 on the fabric 30. Advantageously, compositions 1 to 16 as disclosed for the embodiment of figure 1 are used for the coating.

The coating was carried out only on one face of the fabric.

- 15 The thickness of the coating 2 was advantageously less than 750µm, such as 500µm, 300µm, 200µm, 100µm, or even lower, so as to keep the coated woven glass fabric still sufficiently flexible.

- In order to harden the coating, the coated fabric passes advantageously at least 15 seconds (for example between 20 and 50 seconds) in an oven at a temperature comprised between 40 and 80°C. Possibly, a flash drying can be operated at a higher temperature.

- When coating a fabric or another band, the coating can be carried out substantially continuously. For example, the fabric from a roll is unrolled, before passing in front of one or more spraying stations or ramps. After being coated, the fabric passes through an oven so as to ensure a sufficient hardening of the coating. The dried coated fabric is then rolled back into a roll.

- The so coated fabric is still sufficient flexible for being rolled back. For preventing any damage of the coating during the rolling up of the coated fabric, as well during the unrolling of the coated fabric, it is advantageous to use a mandrel having a minimum diameter of 20cm (preferably at least 25cm, such as 30cm) for the rolling up of the coated fabric.

The so rolled coated fabric can then be protected by a plastic or paper film or sheet.

- 5 The fabric is advantageously a glass woven fabric, having a weight comprised between  $100\text{g/m}^2$  and  $1500\text{g/m}^2$ , preferably between  $100\text{g/m}^2$  and  $750\text{g/m}^2$ .

Figure 5 is a schematic view of a coated fabric similar to the coated fabric of figure 3, except that both faces of the fabric have been coated with a coating layer  
10 2A and 2B. The thickness of the coating layers 2A, 2B can be identical or different, but advantageously lower than 2mm, preferably lower than 1.5mm. Preferably the total thickness of the coated fabric is less than about 2mm, such as less than about 1.5mm. Advantageously, the outer coating layer or the layer intended to be directed outwardly is thicker than the inner layer. The inner layer  
15 can possibly be very thin, such as less than  $100\mu\text{m}$ .

The method for manufacturing such a coated fabric is for example as follows :

The fabric 30 from a roll is unrolled, before passing in front of one or more  
20 spraying stations or ramps, so as to coat one face of the fabric. After said face being coated, the fabric passes through an oven so as to ensure a sufficient hardening of the coating layer. Advantageously, compositions 1 to 16 as disclosed for the embodiment of figure 1 are used for the coating.

- 25 The fabric is advantageously a glass woven fabric, having a weight comprised between  $100\text{g/m}^2$  and  $1500\text{g/m}^2$ , preferably between  $100\text{g/m}^2$  and  $750\text{g/m}^2$ .

By means, for example of one or more return rollers (having advantageously a diameter of at least 20cm), the downwards face is now the upwards face of the  
30 fabric. The now upwards face passes in front of one or more spraying station or ramps, so as to coat said face. Said coated face passes then in an oven for ensuring



a sufficient hardening of the coating. The dried coated fabric is then rolled back into a roll.

The so coated fabric is still sufficient flexible for being rolled back. For preventing any damage of the coating during the rolling up of the coated fabric, as well during the unrolling of the coated fabric, it is advantageous to use a mandrel having a minimum diameter of 20cm (preferably at least 25cm, such as 30cm) for the rolling up of the coated fabric.

The so rolled coated fabric can then be protected by a plastic or paper film or sheet.

Figure 7 is a schematic view of a further product of the invention.

Said product comprises a fabric 30 which is coated with a coating layer 2, which is covered by a mat of fibres 32. The coating forms here at least an intermediate layer extending between the fabric and the mat. A portion of the coating extend within the fabric and within the mat. Advantageously, compositions 1 to 16 as disclosed for the embodiment of figure 1 are used for the coating.

The mat 32 is deposited on the coating layer before it hardening, and is advantageously pressed in the coating. Thereafter, the product passes in an oven (for example having a temperature of 60°C) for less than 1 minute, so as to harden very quickly the coating composition.

The fabric is advantageously a glass woven fabric, having a weight comprised between 100g/m<sup>2</sup> and 1500g/m<sup>2</sup>, preferably between 100g/m<sup>2</sup> and 750g/m<sup>2</sup>. The mat 32 is advantageously a mat with a weight of less than 200g/m<sup>2</sup>, preferably between 10g/m<sup>2</sup> and 150g/m<sup>2</sup>, especially between 20g/m<sup>2</sup> and 50g/m<sup>2</sup>.

30

Such a product can be manufactured as follows.

The fabric 30 is unrolled from a roll and is moved towards a spray station or spray ramp(s). A mat is unrolled from a roll and is moved towards the coated fabric. The mat is then pressed towards the coated fabric, whereby coating enters at least partly in the openings of the mat. The coated fabric provided with the mat is then  
5 heat dried so as to ensure a quick hardening of the coating.

The product, after its hardening is rolled back on a mandrel.

For the hardening of the coating the structure formed by the fabric, the coating and  
10 the mat can pass between one or more heated rollers, said rollers being adapted for ensuring a hardening of the coating, as well as a compression of the structure. This enables a better adhesion of the mat with the fabric.

Figure 9 is a view of a product similar to that of figure 4, except that the top face  
15 20 of the coating is provided with a protection film or layer 33, such as a very thin water repellent layer. Such a water repellent layer can be a fluoro silane layer (such as the product Cascada®), Such a water repellent layer can be very thin. Advantageously, compositions 1 to 16 as disclosed for the embodiment of figure 1 are used for the coating.

20

Figures 10, 11, 12, 13 and 14 are view of embodiments respectively similar to the embodiments of figure 2, 4, 6, 8 and still 8.

In said embodiment, the support 1 to be coated is protected by an intermediate layer 40 resisting to phosphoric acid, said layer containing advantageously one or  
25 more silicon atoms.

In figure 11, the woven fabric 30 is first coated with a protection layer 40, said layer covering only one face of the fabric. Such a layer 40 can be very thin, such as a layer with a thickness of less than 100µm. Such a protection layer is advantageously a silane layer. On the protection layer 40, a liquid aqueous acid  
30 alumina-silica phosphate composition containing solid calcium silicate is deposited. After the hardening of said composition, for example by gentle heating at a temperature comprised between 45°C and 75°C, for less than 2 minutes, for

example for 15 to 45 seconds, the flexible coated fabric can be rolled up on a mandrel. The inorganic binder containing layer had for example a thickness of 100 $\mu$ m to 2000 $\mu$ m.

- 5 In figure 12, the fabric is provided on its both faces with a protection layer 40A,40B. Both protected faces of the fabric are then provided with an inorganic binder containing layer 2A,2B.

10 In figure 13, the fabric 30 is provided on its both faces with an acid protection layer 40A,40B. An inorganic binder containing layer 2 is deposited on one of the protected face of the fabric. While still not completely hardened, a mat of fibres 32 is placed on the coating layer and pressed thereon. The mat is prepared from fibres resistant to phosphoric acid.

- 15 In figure 14, the woven fabric 30 and the mat 32 are prepared from fibres resistant to phosphoric acid.

Figure 15 is a schematic of an installation for preparing continuously or substantially continuously product provided with an inorganic binder containing  
20 layer.

The installation of figure 15 comprises :

- means for placing the product to be coated in line 100, such means being for  
25 example a means for unrolling a roll 101 of a product, such as a roll of a fabric or mat or combination thereof;
- possibly means 102 for providing at least one face, or both faces of the product with a phosphoric acid resistant layer, such a means 102 is for example a system with one or more spraying means 103 for providing one or both faces with a  
30 protection layer, and a dryer unit 104;
- a coating unit 105 for providing at least one face of the product with a liquid reactive coating composition comprising an aqueous alumina-silica phosphate

solution, calcium silicate and possibly one or more inert fillers, said coating unit 105 comprising advantageously one or more spraying system 106;

- possibly a unit 107 for associating the coating with a further product, film, porous film, fabric, woven fabric or mat, said unit comprising advantageously

5 means 108 (such as compressing rollers) for pressing the further product on the product ;

- a dryer 109 for hardening the composition, for example said dryer being an oven 110 (with heating system for reaching a temperature comprised between 40°C and 90°C) and/or heating roller(s), especially in the case a further product has to be

10 pressed against the product ;

- possibly a rolling system 111 for rolling up the coated product on a mandrel, or a foaming unit 112 in which a foaming composition is deposited on the face of the support not provided with the coating layer or provided with a coating layer, so as to form a foamed layer attached to the coated product.

15

Metal supports, not galvanized, such as steel supports, iron supports, etc. have been spray coated with compositions disclosed for the product of Figure 1.

The metal supports were beams, I-beams, plates with thickness of 1mm, 2mm, 5 mm, and 10mm.

20

After the spray coating in one or more successive steps, the coated supports were air dried with heated air with a temperature of 45°C to 80°C. The coating layer had a thickness of less than 1mm, such as a thickness of 100µm, 200µm, 300µm, 500µm and 750µm.

25

It was observed that the coated face of the products was resistant to corrosion, by the alumino-silicate layer as such, but also by the formation of some phosphate layer forming a kind of intermediate layer between the face of the product and the alumino silicate layer.

30

The so coated metal sheets or supports have then been provided with a resin foam layer, such as a PUR foam layer. It has been observed that the adhesion of the

foam PUR layer on the coating layer was excellent and much better than the simple direct coating of the metal sheet with the foam PUR layer.

**What I claim is :**

1. Product having at least one face provided on at least a surface of 100cm<sup>2</sup> with at least a coating layer comprising at least one inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds  
5 with a weight ratio Al<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> comprised between 0.6:1 and 6:1, in which the coating layer has a first face directed towards the product and a second face opposite to said first face, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer has a controlled  
10 average thickness of less than 3mm, while the second face of said portion has less than 20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>.
2. The product of claim 1, in which the second face of at least a portion of  
15 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer having a controlled average thickness of less than 3mm, has less than 20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>.
- 20 3. The product of claim 1 or 2, in which the second face of at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer having a controlled average thickness of less than 3mm, has less than 10 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>.
- 25 4. The product of anyone of the claims 1 to 3, in which the second face of at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer having a controlled average thickness of less than 3mm, has less than 10 cavities having a depth of more than 0.2 times the  
30 controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>.

5. The product of anyone of the claims 1 to 4, in which the second face of at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer having a controlled average thickness of less than 3mm, has less than 10 cavities having a depth of more than 0.1 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>.

6. The product of anyone of the claims 1 to 5, in which the second face of at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer having a controlled average thickness of less than 3mm, has less than 10 cavities having a depth of more than 0.1 times the controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>.

7. The product of anyone of the claims 1 to 6, in which the coating layer has a substantially uniform thickness, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a maximum variation of thickness with respect to the average thickness of less than 10% of the average thickness of said portion, and/or has a substantially flat top face, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of said top face has unevenness' of less than 10% of the average thickness of said portion.

8. Product of anyone of the claims 1 to 7, in which at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer has a controlled average thickness of less than 3mm, said portion having a maximum variation of thickness with respect to the average thickness of less than 5% of the average thickness, preferably of less than 3% of the average thickness of said portion, and/or has a substantially flat top face, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of said top face has unevenness' of less than 5%, preferably less than 3% of the average thickness of said portion.

9. Product of anyone of the claims 1 to 8, in which the calcium silicate containing coating layer has a thickness of less than 2mm, preferably less than 1mm.
10. Product of claim 9, in which the calcium silicate containing coating layer has a  
5 thickness comprised between 50µm and 500µm.
11. Product of anyone of the claims 1 to 10, in which the calcium silicate containing coating layer coats a phosphoric acid resistant layer.
- 10 12. Product of claim 11, in which the phosphoric acid resistant layer is a silicon containing layer, preferably a hydrophobic silicon containing layer.
13. Product of claim 11 or 12, in which the phosphoric acid resistant layer forms a substantially uniform layer with a weight of less than 100g/m<sup>2</sup>, preferably less than  
15 50g/m<sup>2</sup>.
14. Product of anyone of the claims 1 to 13, in which the calcium silicate containing layer comprises inert fibres with an average (in weight) length of less than 200µm, preferably less than 100µm, most preferably comprised between 20  
20 and 50µm.
15. Product of claim 14, in which the calcium silicate containing layer comprises less than 50% by weight inert fibres, preferably less than 30% by weight, most preferably comprised between 1 and 25% by weight.  
25
16. Product of claim 14 or 15, in which the fibres are homogeneously dispersed in the calcium silicate containing coating layer.
17. Product of anyone of the claims 14 to 16, in which the fibre dispersion in the  
30 calcium silicate containing coating layer is characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being



determined on a surface of 50cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content.

18. Product of anyone of the claims 14 to 17, in which the fibre dispersion in the calcium silicate containing coating layer is characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 100cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content.

19. Product of anyone of the claims 14 to 18, in which the fibre dispersion in the calcium silicate containing coating layer is characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 250cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content.

20. Product of anyone of the claims 14 to 19, in which the fibre dispersion in the calcium silicate containing coating layer is characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 500cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 5% of the average fibre content.

21. Product of anyone of the preceding claims, in which the calcium silicate containing coating layer has a weight of less than 2000g/m<sup>2</sup>, advantageously less than 1000g/m<sup>2</sup>, preferably comprised between 100g/m<sup>2</sup> and 750g/m<sup>2</sup>.

22. Product of anyone of the preceding claims, which is a flexible support with a thickness of less than 5mm.

23. Product of claim 22, in which the flexible support comprises a flexible mat of fibres and/or a flexible fibres containing fabric, said mat or fabric having a weight of less than 3000g/m<sup>2</sup>, advantageously less than 2000g/m<sup>2</sup>, preferably less than 1000g/m<sup>2</sup>.

24. Product of claim 23, in which the flexible mat or fabric comprises glass fibres.

25. Product of any one of the claims 22 to 24, in which both faces of the flexible  
5 support are provided with a calcium silicate containing coating layer.

26. Product of any one of the claims 22 to 25, which comprises a first flexible  
support, a second flexible support, and an intermediate calcium silicate containing  
layer situated between the first and second flexible layer.

10

27. Product of claim 26, in which the first flexible layer is a mat of fibres, while  
the second flexible layer is a fabric, preferably a woven fabric.

28. Product of claim 27, in which the mat of fibres has a weight of less than  
15  $100\text{g/m}^2$ , advantageously of less than  $50\text{g/m}^2$ , preferably comprised between  
 $10\text{g/m}^2$  and  $40\text{g/m}^2$ .

29. Combined structure comprising at least a product of anyone of the preceding  
claims and an element, whereby said element is attached to or adhered to said  
20 product.

30. The structure of claim, in which the element is a foamed layer, advantageously  
a foamed resin layer, preferably a foamed PUR layer.

25 31. A process for the preparation of a structure according to claim 29 or 30, in  
which a resin foaming composition is applied on a product of anyone of the claims  
1 to 28, preferably on a flexible support according to anyone of the claims 22 to  
28.

30 32. Process for the preparation of a product according to anyone of the preceding  
claims, in which a liquid reacting composition is sprayed on at least one surface of  
the product so as to form a coating layer comprising at least one inorganic binder

- comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds with a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$  comprised between 0.6:1 and 6:1, in which the coating layer has a first face directed towards the product and a second face opposite to said first face, whereby at least a portion of  $100\text{cm}^2$ ,  
5 advantageously of at least  $500\text{cm}^2$ , preferably of at least  $1000\text{cm}^2$  of the coating layer has a controlled average thickness of less than 3mm, said portion having a second face with less than 20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than  $2\text{mm}^3$ , whereby said composition comprises :
- 10
- an aqueous alumina-silica phosphate solution with an  $\text{Al}_2\text{O}_3/\text{SiO}_2$  weight ratio comprised between 0.6 and 6 and a  $\text{SiO}_2/\text{P}_2\text{O}_5$  molar comprised between 0.1 and 2
  - calcium silicate solid powder with an weight average particle size of less than  $100\mu\text{m}$ , said solid powder being adapted to react with the aqueous alumina-silica  
15 phosphate solution,
  - possibly one or more inert fillers with a size of less than  $250\mu\text{m}$
- 20 whereby the pH of the composition is less than 1, while the solid content of the composition is less than 30% by weight, with the proviso that the weight ratio water/calcium silicate particles is comprised between 0.9 and 2.
33. The process of claim 32, in which the calcium silicate solid powder of the  
25 liquid reacting composition has a weight average particle size lower than  $50\mu\text{m}$ , preferably lower than  $25\mu\text{m}$ .
34. The process of claim 32 or 33, in which the pH of the composition is less than about 0.5.

35. The process of anyone of the claims 32 to 34, in which for the liquid reacting composition, the weight ratio water/alumino silica from the alumino silica phosphate is greater than 2.
- 5 36. The process of anyone of the claims 32 to 35, in which the liquid reacting composition comprises inert fibres with an average (in weight) length of less than 200µm, preferably less than 100µm, most preferably comprised between 20 and 50µm.
- 10 37. The process of claim 36, in which the inert fibres of the liquid reacting composition have an average length greater than 1.5 times the weight average particle size of the calcium silicate solid powder.
38. The process of claim 36 or 37, in which the liquid reacting composition  
15 comprises less than 20% by weight inert fibres, preferably from 5% to 15%.
39. The process of anyone of the claims 36 to 38, in which the fibres are homogeneously dispersed in the liquid reacting composition before spraying.
- 20 40. The process of anyone of the claims 36 to 39, in which the spraying of the liquid reacting composition is controlled so as to form a coating with a fibre dispersion characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 50cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less  
25 than 10% of the average fibre content.
41. The process of anyone of the claims 36 to 40, in which the spraying of the liquid reacting composition is controlled so as to form a coating with a fibre dispersion characterized by an average fibre weight content of the layer per square  
30 cm, said average fibre weight content being determined on a surface of 100cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content.

42. The process of anyone of the claims 36 to 41, in which the spraying of the liquid reacting composition is controlled so as to form a coating with a fibre dispersion characterized by an average fibre weight content of the layer per square  
5 cm, said average fibre weight content being determined on a surface of 250cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 10% of the average fibre content.

43. The process of anyone of the claims 36 to 42, in which the spraying of the  
10 liquid reacting composition is controlled so as to form a coating with a fibre dispersion characterized by an average fibre weight content of the layer per square cm, said average fibre weight content being determined on a surface of 500cm<sup>2</sup>, and by a fibre weight content variation per square centimeter for said surface of less than 5% of the average fibre content.

15 44. The process of anyone of the claims 32 to 43, in which the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the second face of the coating layer has a controlled average thickness of less than 3mm, as well as less than 20  
20 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>.

45. The process of anyone of the claims 32 to 44, in which the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of  
25 at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the second face of the coating layer has a controlled average thickness of less than 3mm, as well as less than 10 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 2mm<sup>3</sup>.

30 46. The process of anyone of the claims 32 to 45, in which the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the second face of the coating

layer has a controlled average thickness of less than 3mm, as well as less than 10 cavities having a depth of more than 0.2 times the controlled average thickness and with a cavity volume of more than 1mm<sup>3</sup>.

5 47. The process of anyone of the claims 32 to 46, in which the spraying of the composition is controlled so that the coating layer has a substantially uniform thickness, whereby at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a maximum variation of thickness with respect to the average thickness of less than 10% of the  
10 average thickness of said portion, and/or in which the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a substantially flat top face having unevenness' of less than 10% of the average thickness of said portion.

15 48. The process of anyone of the claims 32 to 47, in which the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup> of the coating layer has a controlled average thickness of less than 3mm, said portion having a maximum variation of  
20 thickness with respect to the average thickness of less than 5% of the average thickness, preferably of less than 3% of the average thickness of said portion, and/or in which the spraying of the composition is controlled so that at least a portion of 100cm<sup>2</sup>, advantageously of at least 500cm<sup>2</sup>, preferably of at least 1000cm<sup>2</sup>, of the coating layer has a substantially flat top face having unevenness'  
25 of less than 5%, preferably less than 3% of the average thickness of said portion.

49. The process of anyone of the claims 32 to 48, in which the surface to be sprayed is treated so as to render it substantially not reactive to phosphoric acid.

30 50. The process of anyone of the claims 32 to 49, in which the surface to be coated is precoated with a phosphoric acid resistant layer.

51. The process of claim 50, in which the surface to be coated is precoated with a hydrophobic phosphoric acid resistant silicon containing layer.

52. The process of anyone of the claims 32 to 51, in which after spraying the calcium silicate containing coating composition onto the support, the coating composition is cured and/or dried at a temperature comprised between 10°C and 75°C for at least 30seconds, preferably for a time period comprised between 1 and 5minutes.

53. The process of anyone of the claims 32 to 52, in which at least before spraying the composition, the composition to be sprayed or the portion thereof to be sprayed is heated at a temperature comprised between 30°C and 70°C.

54. The process of anyone of the claims 32 to 53, in which the liquid composition is sprayed on a face of the product having a temperature comprised between 10°C and 100°C, advantageously comprised between 20°C and 85°C, preferably comprised between 30°C and 75°C.

55. The process of anyone of the claims 32 to 54, in which the calcium silicate containing coating composition is sprayed on a first flexible support resistant to phosphoric acid and/or provided with a phosphoric acid resistant layer, and in which a second flexible support resistant to phosphoric acid and/or provided with a phosphoric acid resistant layer is deposited on the calcium silicate containing coating composition while not being completely cured.

25

56. The process of anyone of the claims 32 to 55, in which the coating is applied in at least two successive spraying steps.

57. Liquid reacting composition suitable to be sprayed, said composition comprising :

30

- an aqueous alumina-silica phosphate solution with an  $\text{Al}_2\text{O}_3/\text{SiO}_2$  weight ratio comprised between 0.6 and 6 and a  $\text{SiO}_2/\text{P}_2\text{O}_5$  molar comprised between 0.1 and 2
  - calcium silicate solid powder with an weight average particle size of less than 100  $\mu\text{m}$ , said solid powder being adapted to react with the aqueous alumina-silica phosphate solution,
  - possibly one or more inert fillers with a size of less than 250  $\mu\text{m}$
- 10    whereby the pH of the composition is less than 1, while the solid content of the composition is less than 30% by weight, with the proviso that the weight ratio water/calcium silicate particles is comprised between 0.9 and 2.
58. Liquid reacting composition of claim 57, in which the weight average particle  
15    size of the calcium silicate solid powder is lower than 50  $\mu\text{m}$ , preferably lower than 25  $\mu\text{m}$ .
59. Liquid reacting composition of claim 57 or 58, in which the pH of the composition is less than about 0.5.
- 20    60. Liquid reacting composition of anyone of the claims 57 to 59, in which the weight ratio water/alumino silica from the alumino silica phosphate is greater than 2.
- 25    61. Liquid reacting composition of anyone of the claims 57 to 60, which comprises inert fibres with an average (in weight) length of less than 200  $\mu\text{m}$ , preferably less than 100  $\mu\text{m}$ , most preferably comprised between 20 and 50  $\mu\text{m}$ .
- 30    62. Liquid reacting composition of claim 61, in which the inert fibres have an average length greater than 1.5 times the weight average particle size of the calcium silicate solid powder.



63. Liquid reacting composition of claim 61 or 62, which comprises less than 20% by weight inert fibres, preferably from 5% to 15%.

64. Product comprising :

- 5    - a support;
- a mat of fibres, and
- an intermediate layer between the support and the mat of fibres, whereby the intermediate layer comprises at least one inorganic binder comprising calcium silicate sites connected the one with the other by alumina-silica phosphate bounds
- 10   with a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$  comprised between 0.6:1 and 6:1.

65. The product of claim 64, in which the support is a flexible support.

15   66. The product of claim 64 or 65, in which the intermediate layer forms bounds between support and the mat of fibres.

67. The product of anyone of the claims 64 to 66, in which the support is resistant to phosphoric acid or provided with a phosphoric acid resistant layer, and in which the mat of fibres is resistant to phosphoric acid or provided with a phosphoric acid

20   resistant layer.

68. The product of anyone of the claims 64 to 67, in which the support is a flexible fabric, preferably a woven flexible fabric, said fabric having advantageously a weight of less than  $1000\text{g/m}^2$ , preferably less than  $500\text{g/m}^2$ .

25

69. The product of anyone of the claims 64 to 68, in which the mat of fibres has a weight of less than  $100\text{g/m}^2$ , advantageously of less than  $50\text{g/m}^2$ , preferably comprised between  $10\text{g/m}^2$  and  $40\text{g/m}^2$ .

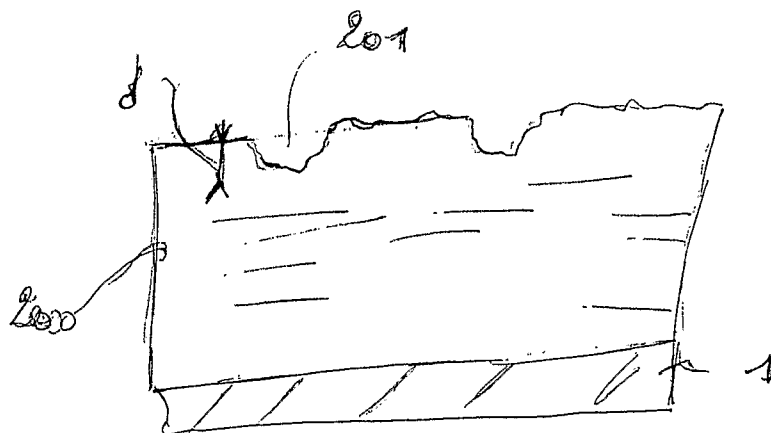
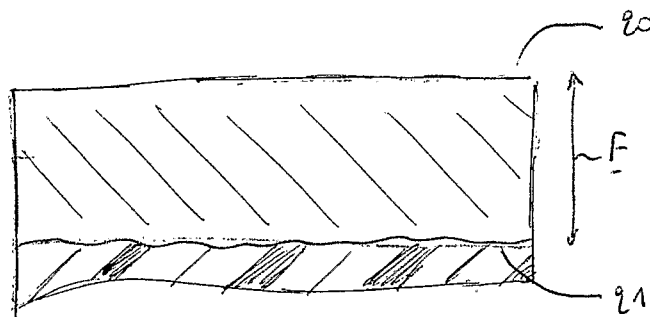
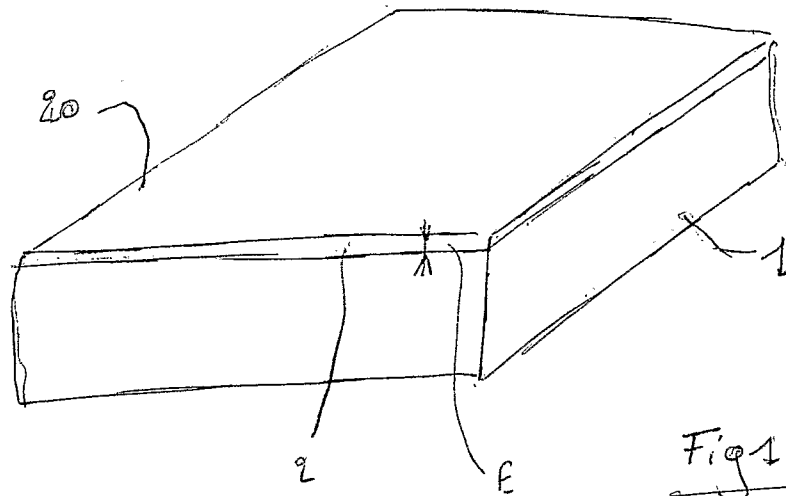
30   70. The product of anyone of the claims 64 to 69, in which the intermediate layer has a thickness of less than 3mm, advantageously less than 2mm, especially less than 1mm, most specifically between  $50\mu\text{m}$  and  $750\mu\text{m}$ .

71. The product of anyone of the claims 64 to 70, in which the intermediate layer is made by using a composition according to anyone of the claims 57 to 63.

5 72. Metal support or sheet covered at least partly with a resin foam layer, especially with a PUR foam layer, whereby said metal support is provided with a coating layer intermediate at least partly between the metal support or sheet and the resin foam layer, said intermediate layer, said intermediate layer comprising at least one inorganic binder comprising calcium silicate sites connected the one with  
10 the other by alumina-silica phosphate bounds with a weight ratio  $\text{Al}_2\text{O}_3/\text{SiO}_2$  comprised between 0.6:1 and 6:1, whereby said layer has an average thickness of less than 3mm, advantageously of less than 2mm, preferably less than 1mm.

73. Metal support or sheet of claim 72, in which the intermediate layer is a coating  
15 layer having one or more characteristics of anyone of the claims 1 to 20.

74. Metal support or sheet of claim 72, in which the intermediate layer is a product according to anyone of the claims 1 to 24, said product being provided on its both faces with a coating layer.



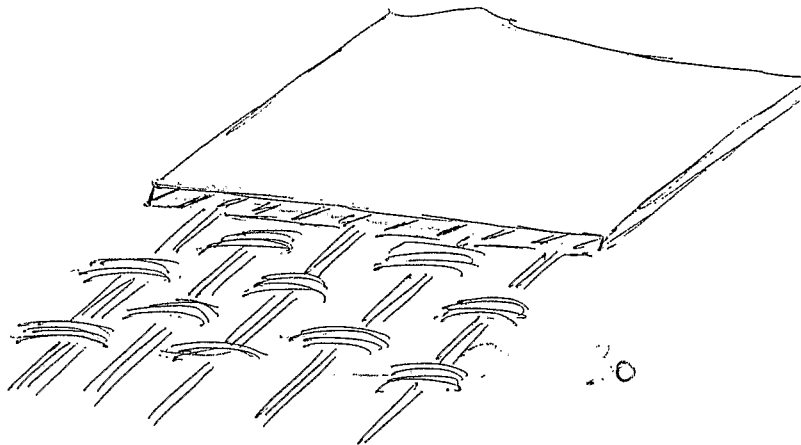


Fig 3

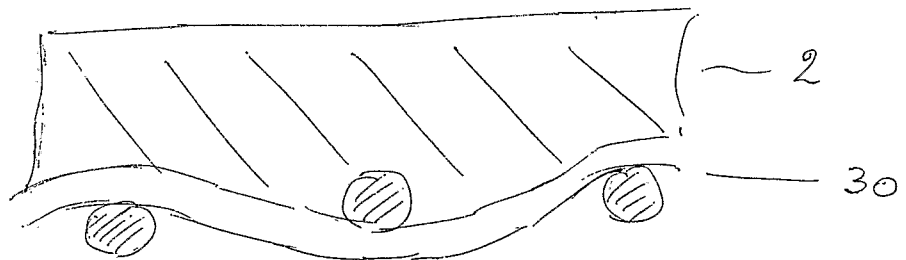


Fig 4

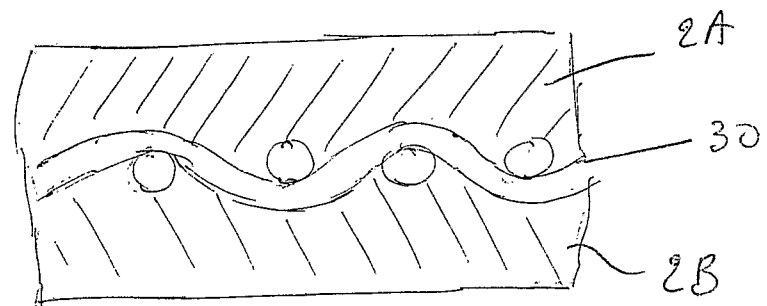
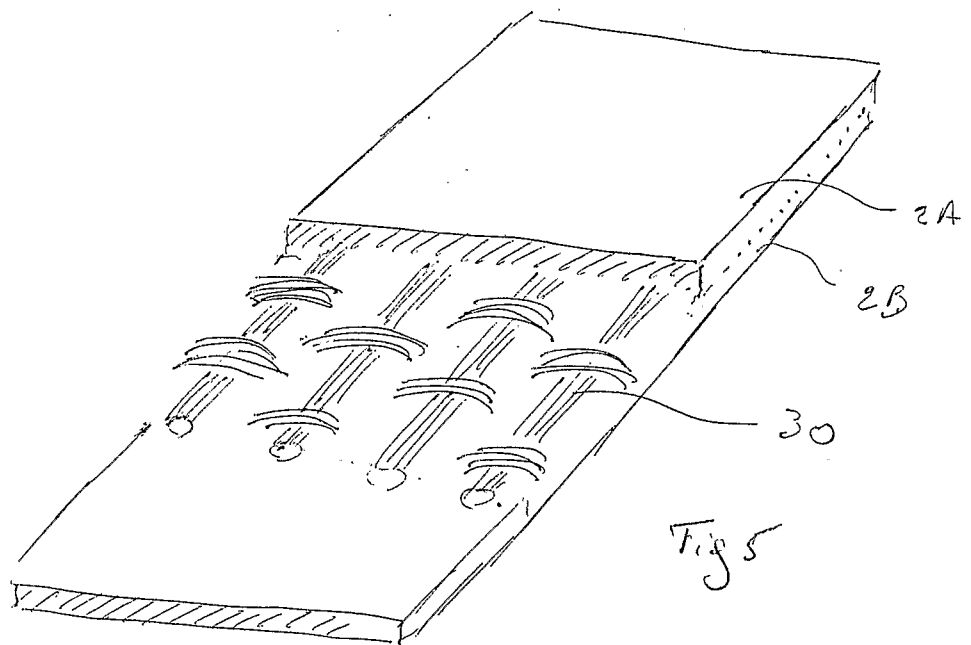


Fig 6

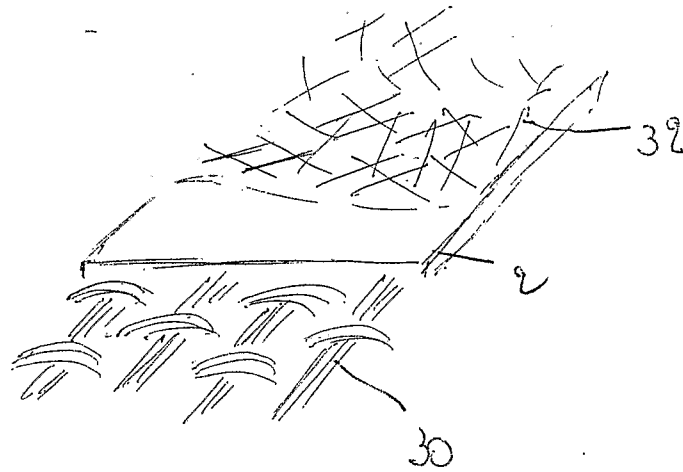


Fig 7

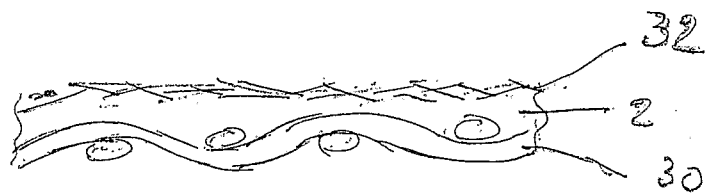


Fig 8

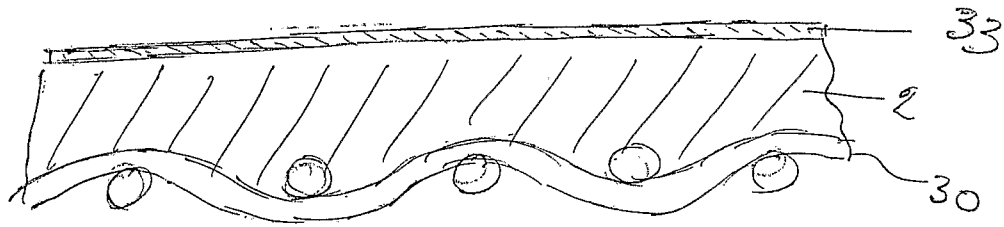


Fig 9

Fig 10

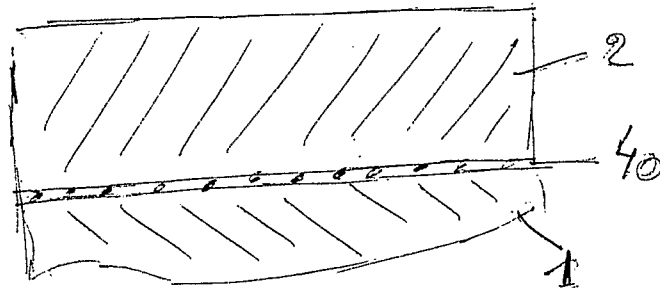


Fig 11

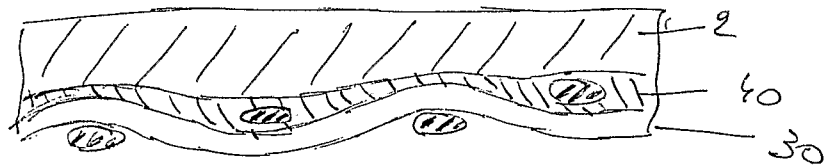


Fig 12

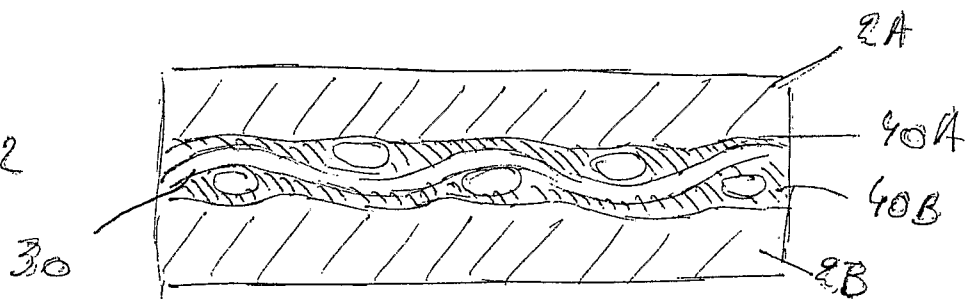


Fig 13

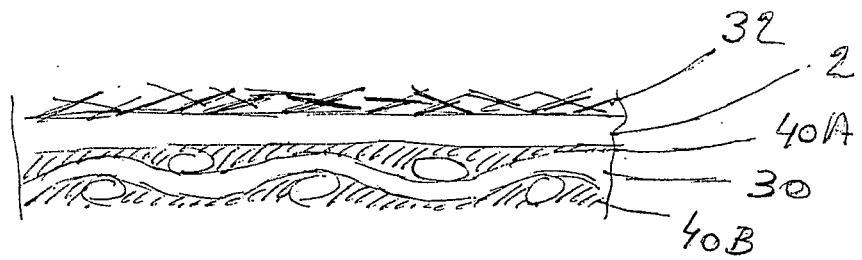
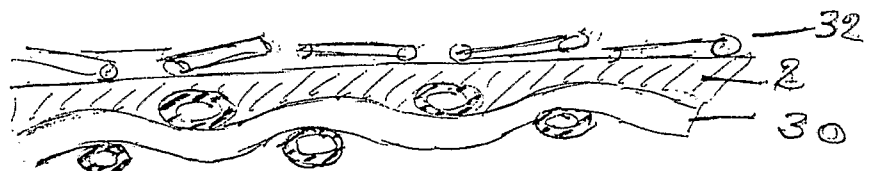


Fig 14





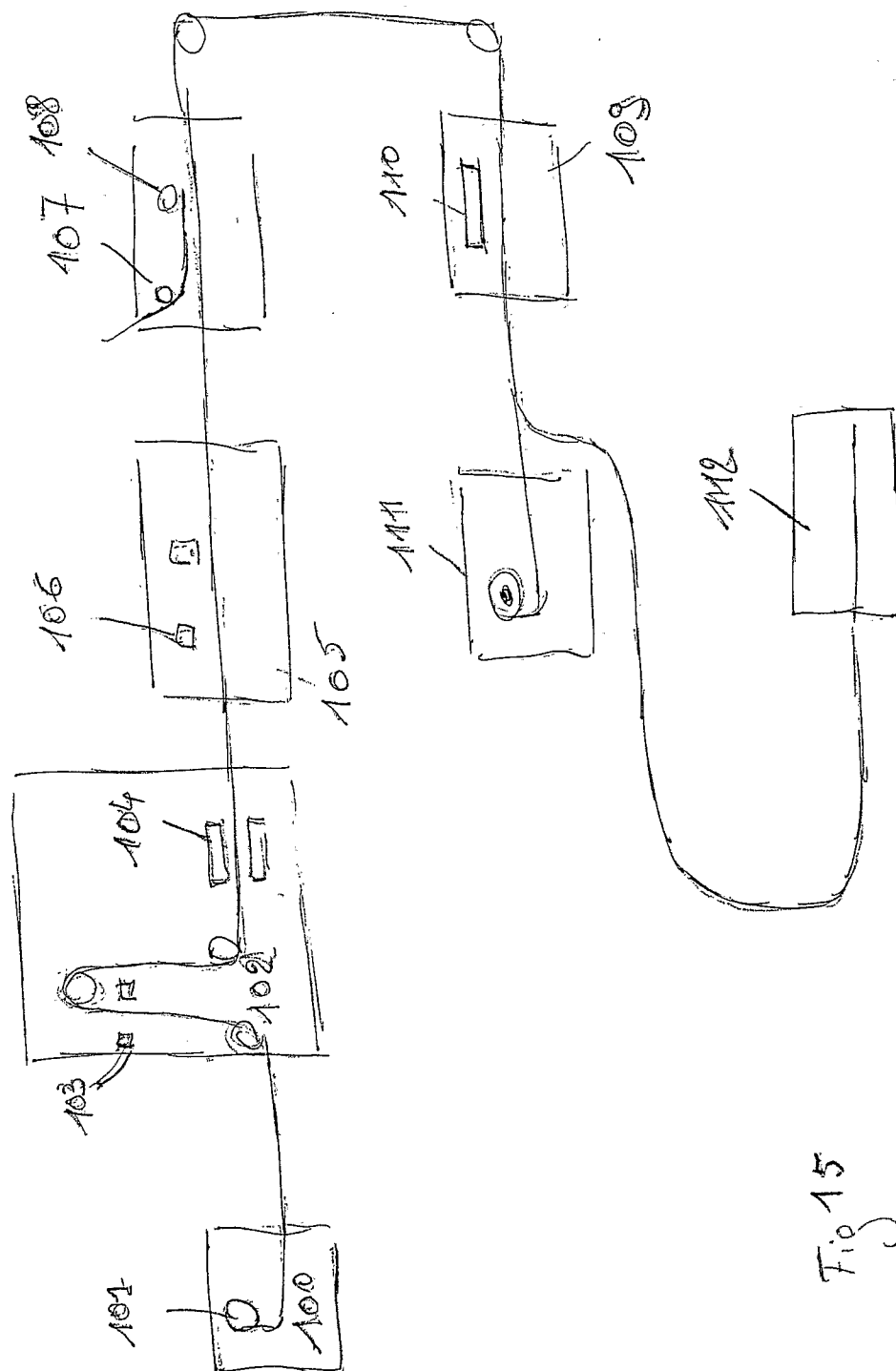


Fig 15