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

(11) **EP 2 708 374 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.03.2014 Bulletin 2014/12

(51) Int Cl.:
B44C 5/04 *(2006.01)*

(21) Application number: **12184511.9**

(22) Date of filing: **14.09.2012**

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

(71) Applicant: **Spanolux N.V.**
Div. Balterio
8710 Sint-Baafs-Vijve (BE)

(72) Inventor: **Vermeulen, Bruno Paul Louis**
3680 Aldeneik-Maaseik (BE)

(74) Representative: **De Vries & Metman**
Overschiestraat 180
1062 XK Amsterdam (NL)

(54) **A method of manufacturing a panel**

(57) A method of manufacturing a panel (1) comprises the steps of supplying a substrate (4, 9), applying a sublimable agent (7) on at least one side of substrate (4, 9), supplying a receptive layer (3) for receiving the sublimable agent (7) upon subliming, attaching the substrate (4, 9) and the receptive layer (3) to each other, and subliming the sublimable agent (7) towards the receptive layer (3) so as to form a panel (1) which comprises the substrate (4, 9) and the receptive layer (3) including the sublimable agent (7). The sublimable agent (7) is applied as a separate substance directly onto the substrate (4, 9).

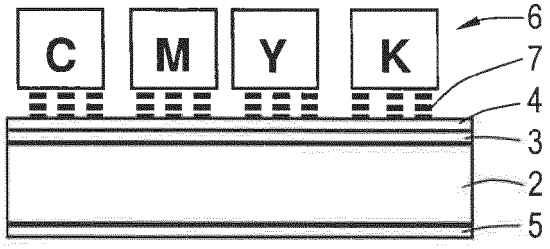

Fig.1

EP 2 708 374 A1

Description

[0001] The present invention pertains to a method of manufacturing a panel comprising the steps of supplying a substrate, applying a sublimable agent on at least one side of the substrate, supplying a receptive layer for receiving the sublimable agent upon subliming, attaching the substrate and the receptive layer to each other, and subliming the sublimable agent towards the receptive layer so as to form a panel which comprises the substrate and the receptive layer including the sublimable agent.

[0002] Such a method is known in the prior art. In the known method the substrate is fixed to the receptive layer before the sublimable agent is applied on the substrate. The sublimable agent is carried by a transfer sheet and applied on the substrate by placing the transfer sheet onto the substrate at the side thereof which is opposite to the side which is fixed to the receptive layer. Then, the transfer sheet is heated such that the sublimable agent sublimes to the receptive layer. This means that the sublimable agent evaporates and penetrates through the substrate into the receptive layer. After the sublimation process the transfer sheet can be removed from the substrate.

[0003] It is an object of the invention to provide an efficient method of manufacturing a panel.

[0004] This is achieved by the method according to the invention, wherein the sublimable agent is applied as a separate substance directly onto the substrate.

[0005] An advantage of the method according to the invention is that a transfer sheet can be omitted. It is noted that the steps of the method according to the invention are not necessarily performed chronologically. Certain steps may be performed in reverse order with respect to the sequence as described hereinbefore. Furthermore, certain steps may be performed at the same time, or additional steps or intermediate steps may be performed.

[0006] The sublimable agent can be applied in the form of a decoration pattern. During the step of subliming, the sublimable agent pattern is transferred towards the receptive layer. Numerous patterns are conceivable, for example wood patterns, stone patterns, or the like, possibly having varying colours. A subliming process appears to result in attractive decoration patterns in the resulting panel, since any non-regular pattern in the sublimable agent on the substrate, for example due to a failure in the process of applying the sublimable agent, will be smoothened during the step of subliming. This is caused by the fact that the sublimable agent slightly diverges during travelling upon the step of subliming. If the sublimable agent is applied by means of a controlled nozzle, a failing nozzle may create a disturbed pattern of the sublimable agent on the substrate, but the disturbance may be eliminated after subliming.

[0007] The sublimable agent may be a water-based, solvent-based or a material comprising a UV curable agent. The water-based agent is advantageous in terms of costs of the agent as well as required technology for applying it to the substrate. The solvent-based agent is beneficial for adhering to certain materials of the substrate, for example substrates made of polymer, for example acrylate, PVC, or the like. The sublimable agent may be a sublimable colouring agent (ink or dye) comprising a resin binder and a dyestuff which is generally referred to as a disperse dye. The disperse dye can be an organic dyestuff such as disazo dyes, anthraquinone dyes and methine dyestuffs.

[0008] The resulting panel may be rigid or flexible and can be an end product or an intermediate product. For example, the resulting panel can be a foil which should still be fixed to a rigid layer by means of laminating, gluing or the like. The foil may be rolled-up and transported or stored, for example. In case when the substrate and the receptive layer are already attached to each other prior to applying the sublimable agent, the resulting panel may be a large board which has to be cut into separate pieces after the step of subliming. In such a case the supplied substrate and receptive layer may already be fixed to one or more layers so as to form a rigid board before applying the sublimable agent. The separate pieces may be provided with locking means such as tongue and grooves so as to be able to fix the pieces to each other, such as known from prior art floor panels. Alternatively, the resulting panels are already provided with locking means and are ready for use after the step of subliming. In such a case the supplied substrate and the receptive layer may already be fixed to one or more layers, and provided with locking means before applying the sublimable agent; the substrate may then be smaller than the board as mentioned hereinbefore.

[0009] The resulting panel may be a floor panel, a wall panel, a ceiling panel, a panel for furniture, packaging, skirting or the like and be suitable for interior and/or exterior use. It may be made of wood-based material like MDF, HDF, WPC, or vinyl, metal, glass, stone, ceramic, polymeric composite or the like.

[0010] The resulting panel comprises at least the substrate and the receptive layer, but it may also comprise one or more additional layers, for example a core, wherein the receptive layer is sandwiched between the substrate and the core. Hence, the supplied substrate may already be fixed to other layers before applying the sublimable agent.

[0011] The receptive layer may comprise a foil or film, a resin impregnated sheet, for example a resin impregnated paper or non-woven sheet or web, a UV laquer layer, a water-based or solvent-based laquer layer. The receptive layer can have absorbance properties for absorbing sublimable agent. However, it is also possible that the sublimed agent penetrates through the substrate and stops at the surface of the receptive layer such that the sublimed agent partly or entirely will be present on the receptive layer. Preferably, the properties are such that spread of sublimable agent in lateral direction of the travelling path towards and/or into the receptive layer is

minimized. The receptive layer may form a white background before applying the sublimable agent. Since the receptive layer can be applied for manufacturing panels with different decoration patterns it can be used in large amounts thereby reducing costs.

[0012] The receptive layer may be attached to a core which is substantially impermeable to the sublimable agent. This means that the sublimed agent does not penetrate into the core after the step of subliming, for example in case of a receptive layer that absorbs the sublimed agent.

[0013] The step of subliming can be performed by means of providing heat such that the sublimable agent evaporates. It is conceivable to concentrate the heat to the subimable agent, but alternatively the substrate and/or the receptive layer are heated, as well. During the step of subliming, the substrate including the sublimable agent may be covered by means of a cover member so as to force the sublimable agent to travel away from the cover member towards the receptive layer. The cover member may be a sheet or a plate which can be heated. Besides, the cover member may exert a pressure onto the substrate during the step of subliming. The cover member may comprise a heated press plate having a textured surface or a heated engraved press cylinder or a relatively thin textured release layer on a flat heated press plate such that the step of subliming is combined with a step of embossing the substrate, possibly in register with the pattern of the sublimable agent, for example a wood nerve pattern. Embossing-in-register in this case can be performed more accurately than in conventional laminating processes in which a resin-impregnated paper sheet is provided with a decoration pattern, since the position of the pattern on the paper sheet varies due to the impregnation in practice. Furthermore, the step of subliming may be combined with a step of laminating by using a hot press plate, and possibly also combined with embossing.

[0014] Heat can be concentrated to the sublimable agent, for example by means of applying laser technology. Furthermore, it is conceivable to use the laser technology for creating a textured surface of the panel, as well. The substrate may have a textured surface before applying the sublimable agent. In that case the sublimable agent can be printed in register with the textured surface such that the resulting panel obtains embossment in register with the sublimed agent.

[0015] It is noted that in case of hot pressing during the step of subliming it is possible to apply a release layer between a press plate and the substrate including the sublimable agent in order to facilitate releasing the press plate and the resulting product with respect to each other after hot pressing.

[0016] The method according to the invention is also advantageous in cases in which a substrate surface has limited adherence properties for inks or dyes, for example substrates made of certain polymers. Conventionally, such surfaces must be pre-treated by means of a primer, corona treatment, plasma treatment or the like before printing an ink or dye on it in order to fix the ink or dye sufficiently to the substrate. Since the method according to the invention transfers the sublimable agent away from the substrate surface the requirements of the adherence properties are limited. Therefore, pre-treatments of the substrate surface may be minimized. It is known, for example, that directly applying a certain sublimable agent onto a surface of a polypropylene sheet may be difficult. In such a case a top layer may be applied onto the polypropylene sheet after which the sublimable agent is applied onto the top layer. During the step of subliming the sublimable agent is transferred towards the polypropylene sheet and may be such that the sublimed agent is caught between the polypropylene sheet and the top layer. In this case the substrate is formed by the top layer, and the receptive layer is formed by the polypropylene sheet. Upon the step of subliming the sublimed agent penetrates into the substrate and travels towards the receptive layer. In this case, but also in general, the receptive layer may receive the sublimed agent without absorbing the sublimed agent in the receptive layer. Besides, the sublimed agent may partly remain in the substrate after the step of subliming. In the example above the method according to the invention provides the opportunity to apply a decoration pattern onto the polypropylene sheet without the typical printing and conventional adherence problems of inks or the like to the polypropylene sheet.

[0017] The substrate may be provided with a fixing material to fix the sublimable agent to the substrate temporarily, i.e. in the period between the step of applying the sublimable agent on the substrate and the step of subliming. In practice the sublimable agent and the substrate will be selected on the basis of their mutual compatibility. The substrate preferably comprises a print receptive coating, for example an inkjet receptive coating, which is suitable for receiving a sublimable agent, for example a water-based or solvent-based ink or a material comprising UV curable ink. The sublimable agent may have viscosity and drying properties such that flow of the sublimable agent on the substrate is limited and that it dries soon after being applied on the substrate.

[0018] Furthermore, conventional processing steps such as printing a decoration pattern on a paper sheet, impregnating the paper sheet with a resin and laminating the impregnated paper sheet to a core can be omitted.

[0019] Another advantage of the method according to the invention is that a balancing layer may be omitted. Conventional laminates which have a resin impregnated paper sheet as a decoration layer on top of a core require a balancing layer at the bottom of the core. Leaving out a resin impregnated decoration sheet means that a balancing layer may be eliminated or made relatively thin.

[0020] In a preferred embodiment the sublimable agent is printed onto the substrate by a digital printer. Using a digital printer provides a great flexibility in the pattern to be printed. This makes production of relatively

small product batches with different decoration patterns efficient. Production series can be made unique and/or client-specific and obsolete stocks can be avoided. Alternative embodiments of contact printing or non-contact printing of the sublimable agent are conceivable, for example by means of roller coating. When the sublimable agent is printed onto the substrate it may have a velocity of 5-10 m/s, but a higher or lower velocity is conceivable.

[0021] The side of the substrate on which the sublimable agent is applied may have a textured surface, or for example grooves, bevelled edges, or the like. It is possible that the substrate was already provided with a textured surface before attaching the substrate and the receptive layer to each other.

[0022] The substrate and the receptive layer may be attached to each other before applying the sublimable agent. In this case the substrate and the receptive layer are supplied as an integral unit after which the sublimable agent is applied on the substrate. The unit may be an intermediate panel comprising a plurality of layers, for example the substrate, the receptive layer and a core wherein the receptive layer is sandwiched between the substrate and the core. The core may be substantially impermeable to the sublimable agent. This means that during the step of subliming the sublimable agent penetrates the substrate and possibly the receptive layer, if it absorbs the sublimed agent, but the sublimed agent is not transferred further than the receptive layer. The core may be rigid or flexible such that the resulting panel is rigid or flexible, respectively. It may be made of wood-based material like MDF, HDF, WPC, or vinyl, metal, glass, stone, ceramic, textile, non-woven fabric, polymeric composite or the like. As described hereinbefore, the resulting panel may be ready for use or require further treatment, for example cutting into pieces, providing locking means and the like, and possible other post treatments such as applying additional layers or the like.

[0023] The substrate may comprise a protective layer including anti-wear particles. This means that the unit of the substrate and the receptive layer can be prepared as an intermediate panel which is already provided with anti-wear properties, but which still lacks a decoration pattern. For example, the receptive layer is a white layer or comprises a background colour. During the step of subliming, the sublimable agent can be transferred through the protective layer and penetrate into the receptive layer or remain substantially between the protective layer and the receptive layer. The anti-wear particles may be corundum particles, glass beads, silica or the like. The size of the particles may be selected such that the influence thereof on the process of sublimation is minimized. Alternatively, the protective layer does not include particles, for example the protective layer comprises an ionomer such as abcite or Surlyn™. A combination of an ionomer and particles is also conceivable.

[0024] In an alternative embodiment a further layer is applied to the substrate after applying the sublimable agent. The substrate may comprise an intermediate protective layer, which is primarily intended to protect the intermediate panel during storage between the step of attaching the substrate and the receptive layer and the step of applying the sublimable agent. Additionally, after applying the further layer to the substrate and after the step of subliming, the sublimed agent will be present at a greater distance from the outer surface of the resulting panel than in case of omitting the further layer. It is noted that more than one further layer may be applied. Each further layer may have different properties, for example having anti-scratch properties, UV resistance, colour stability, and the like.

[0025] The substrate may comprise an intermediate protective layer and the further layer may comprise a protective layer including anti-wear particles. The intermediate protective layer may also have anti-wear particles. In this case the size of the particles in the protective layer may deviate from the size of the particles in the intermediate protective layer. For example, the particles in the intermediate protective layer are smaller than the particles in the protective layer. The intermediate protective layer is a transparent layer so as to keep the receptive layer visible.

[0026] The protective layer and/or the intermediate protective layer may be made of resins such as melamine, melamine blends, phenol, polyester, ionomers, polyurethane, acrylate, or the like. In more general terms the substrate and/or the receptive layer and/or any further layers may comprise resins such as melamine, melamine blends, phenol, polyester, ionomers, polyurethane, acrylate, or the like. The resins may be impregnated in a sheet, such as a paper sheet or the like. Particularly, a polyester comprising layer appears to be advantageous, since it has good sublimation characteristics and is suitable for a lamination process. Of course, the polyester comprising layer may be a blend of polyester and other acrylates or resins.

[0027] It is noted in general that resin layers through which a sublimed agent should travel may be partly cured, since a fully cured resin layer may hinder travelling of the sublimed agent towards the receptive layer. During or after subliming, the curing process may be completed in order to fix the sublimed agent to the resin containing layer.

[0028] The substrate and the further layer may be attached to each other synchronously to the step of subliming. For example, the further layer may comprise a resin impregnated overlay sheet which is attached to the substrate by hot pressing, under which conditions the step of subliming occurs, as well. In fact, this is a combination of a laminating process and a subliming process. Additionally, more than one further layer may be laminated during this process. It is also possible to combine lamination and sublimation with embossing of the further layer, for example by using a heated press plate with a textured surface or a heated engraved press cylinder. Possibly, embossing is performed in register with the pattern of the sublimable agent, for example a wood nerve pat-

tern or the like.

[0029] It is also possible to combine the laminating and embossing process whereas the step of subliming is performed afterwards. Alternatively, it is possible to combine the step of applying the sublimable agent on the substrate and the step of embossing, whereas the step of subliming is performed afterwards. In the latter case, the substrate may be textured by means of a textured roller, for example, which roller applies the sublimable ink on the surface at the same time.

[0030] In an alternative embodiment the substrate and the receptive layer are attached to each other after applying the sublimable agent. In this case the sublimable agent is first applied to the substrate and then the substrate including the sublimable agent is fixed to the receptive layer. In fact, the substrate including the sublimable agent can be compared to a conventional transfer sheet including a sublimable agent, but in this case the substrate is fixed to the receptive layer, whereas the conventional transfer sheet is removed after the step of subliming. It is noted, that the receptive layer may be part of an intermediate panel comprising a receptive layer, a core and possibly a balancing layer and/or further layers. Depending on the side of the substrate onto which the sublimable agent is printed and the side of the substrate which faces the receptive layer, the sublimable agent may travel through the substrate upon travelling towards the receptive layer.

[0031] It is advantageous to perform the step of attaching the substrate and the receptive layer and the step of subliming synchronously, since this provides a rapid manufacturing process.

[0032] The steps of attaching and subliming may be performed in a lamination process under elevated temperature and pressure, i.e. by means of hot pressing. For example, the substrate comprises a resin impregnated sheet of paper or non-woven, for example, to which a sublimable agent is printed. The resin impregnated sheet may be dry but the resin is not fully cured yet; the sheet may be in the so-called b-stage. The sheet is positioned onto a receptive layer and the stack of the receptive layer and the impregnated sheet are placed in a heated press. During hot pressing the resin will melt and flow to the receptive layer, whereas the sublimable agent will evaporate and travel towards the receptive layer and possibly penetrate into the receptive layer. Printing onto a resin impregnated sheet, for example a paper sheet impregnated with polyester, or a resin mix of melamine and polyester, or the like, is advantageous since the absorbance speed is limited and a resin is suitable for receiving numerous sublimable inks or dyes. In an alternative embodiment the substrate comprises a sheet onto which the sublimable agent is printed prior to impregnating the sheet with resin. In the latter case the substrate may be partly cured, for example by means of near infrared radiation in order to avoid premature sublimation of the sublimable agent and to create a smoother surface than using conventional drying processes, which creates a better printable surface. During impregnation the curing process is controlled such that the sheet is not fully cured in the impregnation process. In a similar way as described hereinbefore, the step of subliming may be performed at the same time as attaching the resin impregnated sheet to the receptive layer.

[0033] Furthermore, the substrate may be provided with anti-wear particles. For example in case of a resin impregnated sheet, the resin may contain anti-wear particles.

[0034] Additionally, in the same lamination process one or more layers may be laminated to the substrate and the receptive layer such as in conventional laminating techniques, for example in the field of laminated floor panels.

[0035] Furthermore, the protective layer or any further layer positioned on top of the resulting panel may be provided with a textured surface during the lamination process. In case of embossment in register it may be advantageous if the resin impregnated sheet to which the sublimable agent is printed, is impregnated before the printing step since expansion of the sheet due to impregnation has already been occurred in that case such that a better alignment is possible between the sublimed pattern and the textured press member.

[0036] Preferably, the side of the substrate on which the sublimable agent is applied faces the receptive layer, since during the step of subliming the sublimable agent can penetrate directly into the receptive layer instead of first travelling through the substrate. In case of a lamination process the sublimable agent is applied on the substrate and the substrate may then be turned upside down and positioned onto the receptive layer. The lamination process and the sublimation process may be adjusted in such a way that the sublimation process is faster in order to avoid that the resin flow adversely affects the sublimation process.

[0037] It is also possible to provide anti-wear particles at the side of the substrate which is facing the receptive layer in order to minimize the risk of damaging the press member during the lamination process. On the other hand the anti-wear particles may be provided at the opposite side of the substrate in order to avoid that the sublimable agent is hindered by the particles during subliming. It is also possible to apply the anti-wear particles at opposite sides of the substrate.

[0038] When the substrate or any further layer comprises a resin impregnated sheet a relatively thin balancing sheet may be used. It is even possible to omit the balancing sheet or replace it by a lacquer coating or the like.

[0039] In an alternative embodiment the substrate is able to receive and hold sublimed agent. In this case the sublimable agent that is printed as a separate substance directly onto the substrate will be sublimed into the substrate and travel towards the receptive layer, but will not or partially reach the receptive layer. Depending on the subliming process the sublimable agent may penetrate

into the receptive layer that is attached to the substrate, as well. In this case the substrate and the receptive layer together may form an integrated receptive layer.

[0040] In general terms, the invention is also related to a method of manufacturing a panel comprising the steps of supplying a substrate comprising a receptive layer for receiving a sublimable agent, applying a sublimable agent on at least one side of the substrate, subliming the sublimable agent into the receptive layer so as to form a panel, wherein the sublimable agent is applied as a separate substance directly onto the substrate. The resulting panel may be flexible or rigid panel, but may be provided with additional layers to support or cover the substrate. For example, the substrate comprises a PET foil, for example having a thickness of 300 μm or smaller or larger; upon subliming the sublimable agent penetrates into the substrate, which substrate may be attached to a background layer.

[0041] Furthermore, other features as described in relation to the embodiments hereinbefore are also applicable to this embodiment, such as a textured surface on the substrate, synchronously embossing and/or subliming and/or laminating etc.

[0042] For example, the substrate forms a top layer of a core which is made of engineered polymer, such as WPC or the like. The substrate or top layer comprises a receptive layer and the sublimable agent is applied on the side of the substrate directed away from the core. Upon the step of subliming, the sublimed agent will penetrate into the top layer. Between the core and the top layer there may be a layer which has a contrast colour, for example white.

[0043] The lamination processes as mentioned in this document may be performed by means of a continuous press or a non-continuous press. Besides, the press may be provided with a textured press member in order to combine embossing with laminating and/or subliming as well.

[0044] The invention will hereafter be elucidated with reference to drawings showing embodiments of the invention very schematically.

Figs. 1-6 are illustrative views of consecutive steps of an embodiment of the method of manufacturing a panel according to the invention.

Figs. 7-12 are similar views as Figs. 1-6, showing an alternative embodiment.

Figs. 13-16 are similar views as Figs. 1-6, showing another alternative embodiment.

Figs. 17-19 are similar views as Figs. 1-6, showing still another alternative embodiment.

Fig. 21 is an illustrative view of consecutive steps of an embodiment of the method according to the invention.

[0045] Figs. 1-6 show consecutive steps of an embodiment of a method of manufacturing a panel according to the invention. Fig. 1 shows an intermediate panel comprising the following layers: a core 2, a base coat 3, a protective layer 4 and a balancing layer 5. The layers 2-5 are fixed to each other, for example by means of continuous or non-continuous pressing, laminating, calandering, coating, extruding or the like. In the embodiment as shown the substrate according to the invention is formed by the protective layer 4 and includes anti-wear particles, for example corundum, glass beads, silica or the like. The substrate or protective layer 4 is the upper layer of the intermediate panel. Fig. 1 also shows a digital printer 6 including a plurality of print heads. The digital printer 6 is able to print a sublimable agent 7 on an upper side of the protective layer 4. The sublimable agent 7 may be printed according to any desired decoration pattern. The resulting condition of the layers 2-5 after printing is illustrated in Fig. 2. It is noted that the balancing layer 5 may be omitted if the core 2 is sufficiently rigid, since the intermediate panel does not comprise a resin impregnated decoration paper like prior art laminates. The material of the core 2 may be a wood-based material like MDF, HDF, MFC, or vinyl, metal, glass, stone, ceramic, polymeric composite or the like.

[0046] Figs. 3 and 4 illustrate processing steps in which a heating plate 8 is moved towards and contacts the upper side of the protective layer 4. The heating plate 8 may be pressed onto the intermediate panel in order to improve a proper contact between the heating plate 8 and the protective layer 4. Fig. 5 shows a condition in which the heating plate 8 heats and vaporizes the sublimable agent 7. The base coat 3 comprises a receptive layer for receiving the sublimable agent 7 upon subliming. Due to the material properties of the sublimable agent 7 and the base coat 3 the vaporized agent 7 permeates through the protective layer 4 into the base coat 3. A resulting panel 1, which comprises the protective layer 4, the base coat 3 including the sublimed agent 7, the core 2 and the balancing layer 5, is shown in Fig. 6. The surface of the sublimed agent may be larger than the surface of the sublimable agent since the sublimable agent slightly diverges during the step of subliming.

[0047] In the embodiment of the intermediate panel as shown in Figs. 1-5 the protective layer 4 allows the sublimable agent 7 to pass through it, and the core 2 avoids penetration of the sublimable agent 7. As a consequence, the sublimable agent 7 that is sublimed towards the core 2 remains in the base coat 3. Alternatively, the base coat 3 may be impermeable to the sublimable agent 7 such that the sublimed agent 7 does not penetrate into the base coat but remains on its surface, substantially between the base coat 3 and the substrate 4. In such a case the sublimable agent travels towards the base coat 3 but is not absorbed by it.

[0048] There may be a significant time difference between the moment of manufacturing the unit of layers 2-5, i.e. the intermediate panel, as shown in Fig. 1 and the step of printing the sublimable agent 7 as illustrated in Fig. 1. The unit of layers 2-5 may be stored before applying the sublimable agent 7 onto the protective layer

4. This means that stored intermediate panels may be ready for use, but they still lack a decoration pattern. During the step of subliming, the decoration pattern is applied without substantially affecting other properties of the panel 1. In other words, the protective layer 4 keeps its protective properties upon decorating the intermediate panel.

[0049] An advantage of the method as illustrated in Figs. 1-6 is that the sublimable agent 7 is printed as a separate substance directly onto the intermediate panel. This means that additional steps of printing the sublimable agent first onto a transfer sheet and removing the transfer sheet from the resulting panel 1 after the step of subliming, such as performed in prior art, are omitted.

[0050] The protective layer 4 may have several functions like wear resistance, acoustic properties, anti-static characteristics, creating light stability, etc. The material is also selected on the basis of its receptive characteristics in terms of temporarily fixing the sublimable agent after the printing step.

[0051] Furthermore, the protective layer 4 may have a textured surface before the printing step or it may be embossed afterwards, for example during the step of subliming. In the latter case the protective layer 4 may comprise a hot melting resin and the heating plate 8 may comprise a textured surface such that during hot pressing the surface of the protective layer 4 is embossed and the sublimable agent 7 is evaporated and transferred towards the base coat 3. It is, however, conceivable that in an alternative embodiment the step of subliming is performed after hot pressing for laminating and possible embossing.

[0052] Figs. 7-12 show consecutive steps of an alternative embodiment of the method of manufacturing the panel 1. In this case the substrate comprises an intermediate protective layer 9, which is fixed to the base coat 3 before applying the sublimable agent 7. The substrate according to the invention is formed by the intermediate protective layer 9 in this case, and is supported by the base coat 3, the core 2 and the balancing layer 5, respectively. Fig. 7 illustrates that the digital printer 6 prints the sublimable agent 7 directly onto the intermediate protective layer 9. The intermediate protective layer 9 is a transparent layer. Although in this embodiment the intermediate layer 9 is defined as a protective layer, it is noted that it may be any other layer that functions as the substrate according to the invention, but which is not intended for intermediate protection.

[0053] Fig. 8 shows that in this embodiment a protective layer 10 is applied as a further layer to the intermediate protective layer 9 after printing the sublimable agent 7. The projective layer 10 may include anti-wear particles, whereas the intermediate protective 9 layer may be free of anti-wear particles. Alternatively, the intermediate protective layer 9 may also comprise anti-wear particles, for example having a different size than those contained in the protective layer 10. Figs. 9-12 show the steps of subliming the sublimable agent 7 to the base coat 3.

[0054] In the embodiment as illustrated in Figs. 7-12 the protective layer 10 is attached to the intermediate protective layer 9 such that the resulting panel 1 includes the protective layer 10, see Fig. 12. This is achieved by applying a protective layer 10 which is made of a material that develops adhering properties upon heating. For example, the protective layer is made of a resin impregnated sheet which adheres to the intermediate protective layer 9 during hot pressing. Hence, the heating plate 8 does not only affect the subliming process, but also fixes the protective layer 10 to the intermediate protective layer 9. In other words, the step of attaching the protective layer 10 to the intermediate protective layer 9 and the step of subliming are performed synchronously.

[0055] In general, the layers to be laminated should not only be compatible in terms of fixing to each other but may also be compatible to each other in relation to wear resistance and sublimation characteristics. For example, the intermediate protective layer 9 may comprise a resin mix of melamine and polyester for good properties for receiving sublimable agent but less wear resistance, whereas the protective layer 10 may comprise a melamine for optimal wear resistance.

[0056] Similar to the embodiment as shown in Figs. 1-6 and described hereinbefore, a textured surface can be applied to the protective layer 10 before, during or after the step of subliming.

[0057] The intermediate panel as shown in Fig. 7 and comprising an intermediate protective layer 9, base coat 3, core 2 and balancing layer 5 may be stored before applying the sublimable agent 7. The intermediate protective layer 9 functions as a temporary protection during storage. Therefore, the protective layer 9 may be free of anti-wear particles. The intermediate protective layer 9 and the protective layer 10 may be made of different materials, depending on desired functionalities.

[0058] Figs. 13-16 show consecutive steps of another alternative embodiment of the method of manufacturing the panel 1. In this case the sublimable agent 7 is printed directly onto the protective layer 4 before the protective layer 4 is attached to the base coat 3. The substrate according to the invention is formed by the separate protective layer 4 in this case. After the step of printing, the protective layer 4 including the sublimable agent 7 is turned upside down as illustrated in Fig. 14. Then, the protective layer 4 is laid onto the base coat 3 such that its side to which the sublimable agent 7 is printed faces the base coat 3. Fig. 15 shows that the base coat 3 is supported by the core 2 and that the balancing layer 5 is located below the core 2. The layers 2-5 are still separate in this situation as illustrated in Fig. 15. The stack of separate layers 2-5 is pressed under elevated heat such that the layers 2-5 are laminated to each other and the sublimable agent 7 is sublimed to the base coat 3 at the same time. For this reason one or more of the layers to be laminated may comprise a hot melting resin, for example comprising melamine formaldehyde, urea formaldehyde, phenol formaldehyde, or the like. During the step of sub-

liming the sublimed agent 7 can directly travel towards, and in this case, into the base coat 3 without travelling through the protective layer 4. If in an alternative embodiment the protective layer 4 is not turned upside down, the sublimed agent 7 also travels through the protective layer 4.

[0059] If the protective layer 4 comprises a resin impregnated sheet of paper or non-woven web, for example, the sublimable agent 7 may be applied onto the protective layer 4 before or after the impregnation process. The resin impregnated sheet may be partially dried and partially cured to the so-called b-stage before the lamination process during which final curing takes place, as illustrated in Fig. 16, or already before applying the sublimable agent 7, as illustrated in Fig. 13. If the protective layer 4 is partially dried and cured after applying the sublimable agent 7 the drying/curing process should be such that subliming is not initiated yet. This can be achieved by using near infrared irradiation of the resin impregnated sheet. An advantage of applying the sublimable agent 7 to the protective layer 4 when this is in a b-stage is that a better alignment of the pattern of the sublimed agent 7 and a textured press plate can be achieved in case of desired embossment in register, since the pattern of sublimable agent is applied on the protective layer 4 after expansion of the sheet during the impregnation process. Furthermore, a layer 4 having a b-stage has a relatively smooth surface having good characteristics for being printed.

[0060] In the embodiment as illustrated in Figs. 13-16 the protective layer 4 and the base coat 3 are fixed to each other after printing the sublimable agent 7. It is also possible that the layers 2, 3, 5 are already fixed to each other in the situation as shown in Fig. 15, and that in the hot pressing step only the protective layer 4 has to be fixed to the base coat 3, whereas the sublimable agent 7 is sublimed to the base coat 3 at the same time.

[0061] Although not shown in Figs. 13-16, it is possible to provide anti-wear particles to the protective layer 4. For example the anti-wear particles may be applied at the side of the substrate which is facing the base coat 3 in order to minimize the risk of damaging a press member during the lamination process, which press member contacts the protective layer 4. It is also possible to apply the anti-wear particles at the opposite side of the protective layer 4 which is directed away from the core 2 in order to avoid that the sublimable agent 7 is hindered by the particles during subliming.

[0062] The protective layer 4 may comprise a resin impregnated sheet, for example a paper sheet or non-woven web. The protective layer 4 itself may comprise a plurality of sheets or foils. It may also be provided with a coating for improving its receptive properties for receiving the sublimable agent 7. Furthermore, the protective layer 4 may be provided with a textured surface, before or after applying the sublimable agent 7. If the protective layer 4 is embossed after applying the sublimable agent, it may be embossed before, during or after the step of subliming. As described hereinbefore, it is advantageous to emboss the protective layer 4, to laminate the protective layer 4 to the base coat 3 and sublime the sublimable agent 7 synchronously.

[0063] Figs. 17-20 show consecutive steps of still another alternative embodiment of the method of manufacturing the panel 1. In this case the sublimable agent 7 is printed directly onto the intermediate protective layer 9. The substrate according to the invention is formed by the intermediate protective layer 9 in this case. Then the intermediate protective layer 9 including the sublimable agent 7 is turned upside down as illustrated in Fig. 18. In a next step a stack of separate layers 5, 2, 3, 9, 10 is made, as seen from bottom to top: balancing layer 5, core 2, base coat 3, intermediate protective layer 9 including the printed sublimable agent 7 and the protective layer 10. This is illustrated in Fig. 19. The stack of layers 5, 2, 3, 9, 10 is pressed under elevated heat such that they are laminated to each other and the sublimable agent 7 is sublimed to the base coat 3 at the same time. The intermediate protective layer 9 and/or the protective layer 10 may comprise resin impregnated sheets. In the resulting panel 1, the decoration pattern of sublimed agent 7 lies deeper in the panel 1 than in the previous embodiment as shown in Fig. 16.

[0064] Similar to the previous embodiment as described hereinbefore, printing of the sublimable agent 7 onto the intermediate protective layer 9 can be performed before or after the impregnation process if the intermediate protective layer 9 comprises a resin impregnated sheet.

[0065] In this embodiment anti-wear particles may be provided to the intermediate protective layer 9 and/or the protective layer 10.

[0066] Fig. 21 illustrates a manufacturing process in which the step of printing a sublimable agent 7 on an intermediate protective layer 9, the step of applying a second intermediate protective layer 11, the step of applying the protective layer 10, and the step of laminating are shown.

[0067] An intermediate panel is supplied to a conveyor belt 12, as shown at the right side of Fig. 21. Similar to the embodiment as shown in Fig. 7, the intermediate panel comprises the intermediate protective layer 9, the base coat 3, the core 2 and the balancing layer 5, as seen from the top to the bottom of the intermediate panel. The sublimable agent 7 is printed on the intermediate protective layer 9 by means of the digital printer 6. Then, the second intermediate protective layer 11 is applied on top of the printed intermediate protective layer 9 by means of applying a protective coating. In a next step a powder mixture of corundum and ionomer is spread on top of the second intermediate protective layer 11 by means of a powdering device 13, hence creating the protective layer 10. The intermediate panel including the added layers are transferred to a heated press 14. During hot pressing the sublimable agent 7 is sublimed to the base coat 3, the second intermediate protective layer 11 is fixed to

the intermediate protective layer 9 and the protective layer 10, and the ionomer powder of the protective layer 10 is melted such that the corundum particles are embedded in the ionomer layer.

[0068] From the foregoing it will be apparent that the invention provides an efficient method of manufacturing a panel.

[0069] The invention is not restricted to the above-described embodiments as shown in the drawings, which can be varied in several ways without departing from the scope of the invention. For example, separate layers that are fixed to each other by means of hot pressing may be pressed by means of a continuous pressing process, for example by means of calandering. Similarly, the step of subliming may be performed by means of a continuous process. The press plate may be provided with a textured surface or a textured release sheet may be present between the press plate and the stack to be laminated.

Claims

1. A method of manufacturing a panel (1) comprising the steps of:

   supplying a substrate (4, 9),
   applying a sublimable agent (7) on at least one side of the substrate (4, 9),
   supplying a receptive layer (3) for receiving the sublimable agent (7) upon subliming,
   attaching the substrate (4, 9) and the receptive layer (3) to each other,
   subliming the sublimable agent (7) towards the receptive layer (3) so as to form a panel (1) which comprises the substrate (4, 9) and the receptive layer (3) including the sublimable agent (7),
   wherein the sublimable agent (7) is applied as a separate substance directly onto the substrate (4, 9).

2. A method according to claim 1, wherein the sublimable agent (7) is printed onto the substrate (4, 9) by a digital printer (6).

3. A method according to claim 1 or 2, wherein the substrate (4, 9) and the receptive layer (3) are attached to each other before applying the sublimable agent (7), hence forming an integral unit before applying the sublimable agent (7).

4. A method according to one of the preceding claims, wherein the substrate comprises a protective layer (4) including anti-wear particles.

5. A method according to claim 3, wherein a further layer (10) is applied to the substrate (9) after applying the sublimable agent (7), wherein the substrate (9) and the further layer (10) may comprise resin impregnated sheets which resins of the substrate (9) and the further layer (10) are compatible to each other.

6. A method according to claim 5, wherein the substrate comprises an intermediate protective layer (9) and the further layer (10) comprises a protective layer including anti-wear particles, wherein preferably the intermediate protective layer (9) is a transparent layer.

7. A method according to claim 5 or 6, wherein the substrate (9) and the further layer (10) are attached to each other synchronously to the step of subliming.

8. A method according to claim 7, wherein the further layer (10) comprises a resin impregnated overlay sheet which is attached to the substrate (9) by hot pressing, under which conditions the step of subliming occurs.

9. A method according to claim 1 or 2, wherein the substrate (4, 9) and the receptive layer (3) are attached to each other after applying the sublimable agent (7).

10. A method according to claim 9, wherein the step of attaching the substrate (4, 9) and the receptive layer (3) and the step of subliming are performed synchronously.

11. A method according to claim 10, wherein the steps of attaching and subliming are performed in a lamination process under elevated temperature and pressure.

12. A method according to claim 11, wherein one or more layers (2, 5, 10) are laminated to the substrate (9) and the receptive layer (3).

13. A method according to one of the claims 9-12, wherein the side of the substrate (4, 9) on which the sublimable agent is applied faces the receptive layer (3) or is directed away from the receptive layer (3).

14. A method according to one of the preceding claims, wherein the receptive layer (3) is attached to a core (2) which is substantially impermeable to the sublimable agent (7).

15. A method of manufacturing a panel (1) comprising the steps of:

   supplying a substrate (4) comprising a receptive layer (3) for receiving a sublimable agent (7),
   applying a sublimable agent (7) on at least one side of the substrate (4),
   subliming the sublimable agent (7) into the receptive layer (3) so as to form a panel (1),

wherein the sublimable agent (7) is applied as a separate substance directly onto the substrate (4).

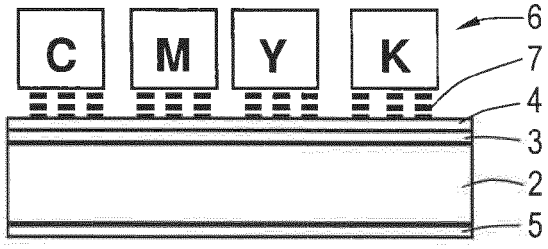

Fig.1

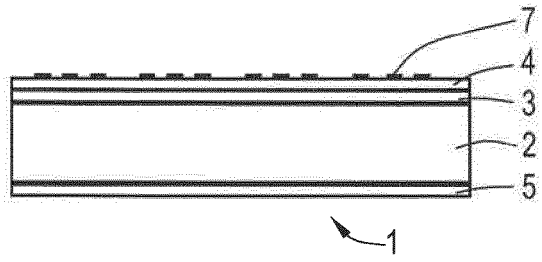

Fig.2

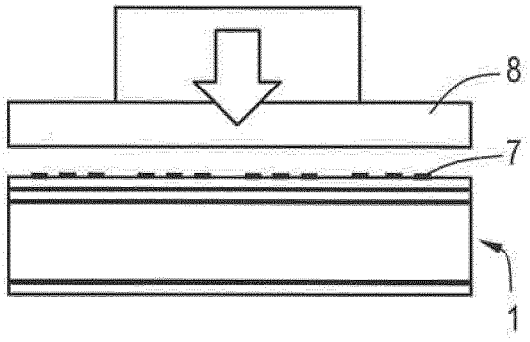

Fig.3

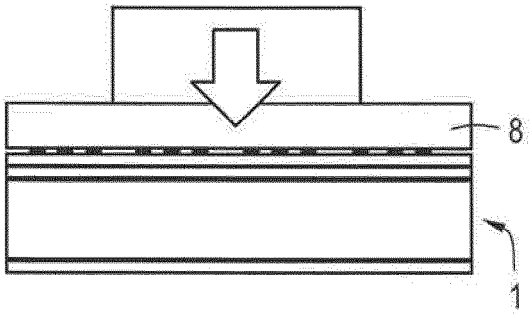

Fig.4

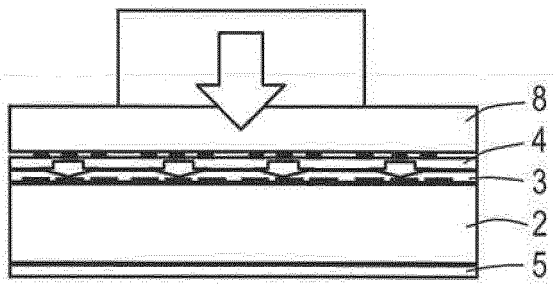

Fig.5

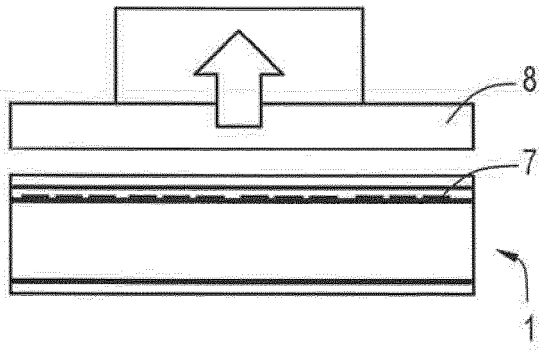

Fig.6

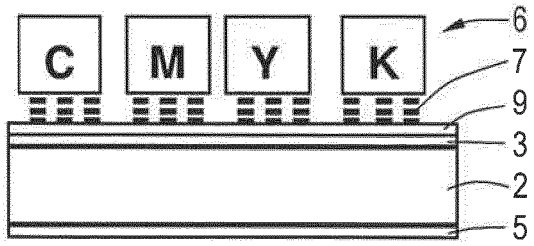

Fig.7

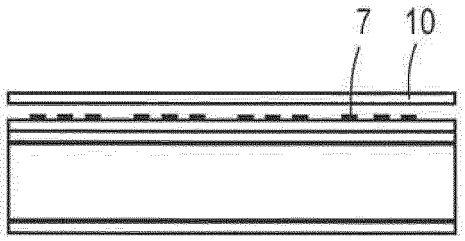

Fig.8

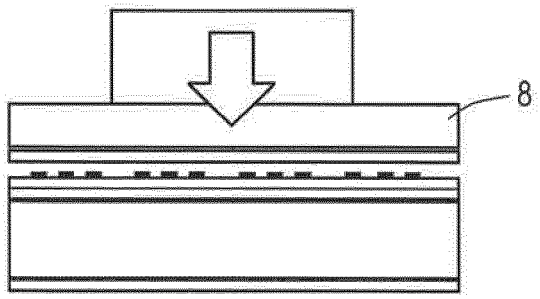

Fig.9

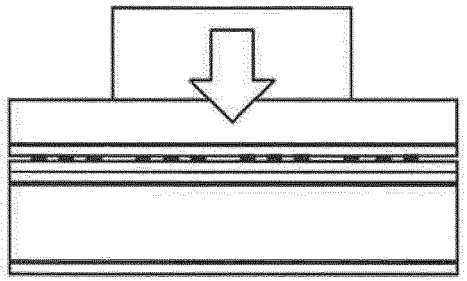

Fig.10

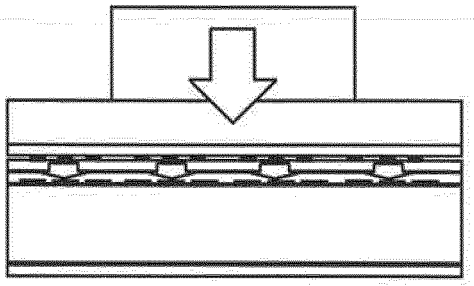

Fig.11

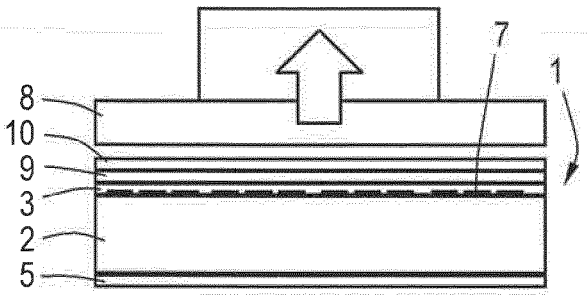

Fig.12

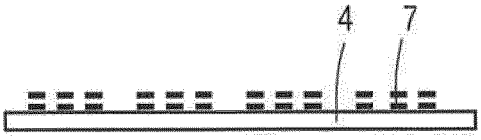

Fig.13

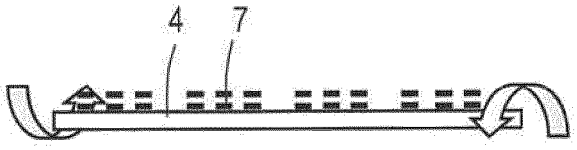

Fig.14

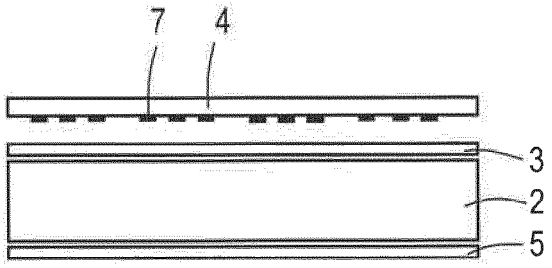

Fig.15

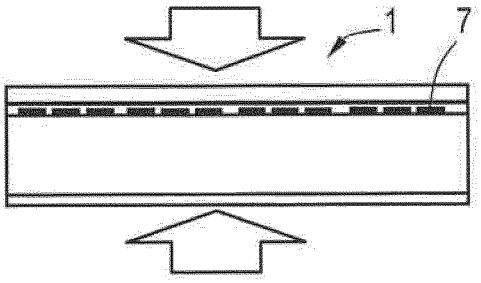

Fig.16

Fig.17

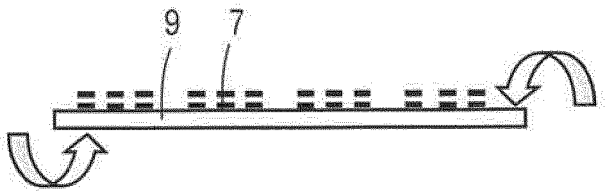

Fig.18

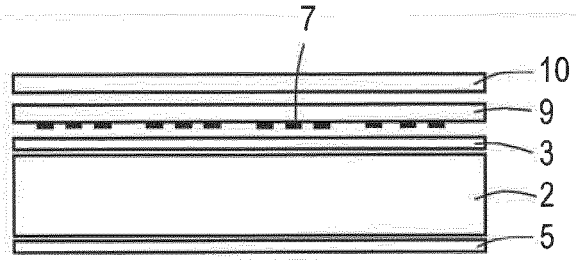

Fig.19

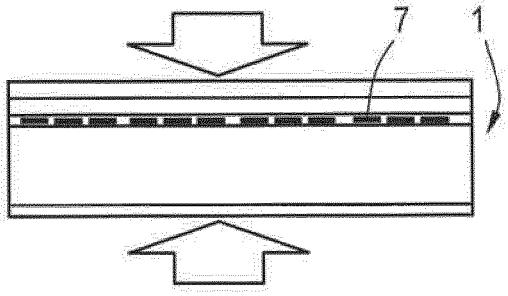

Fig.20

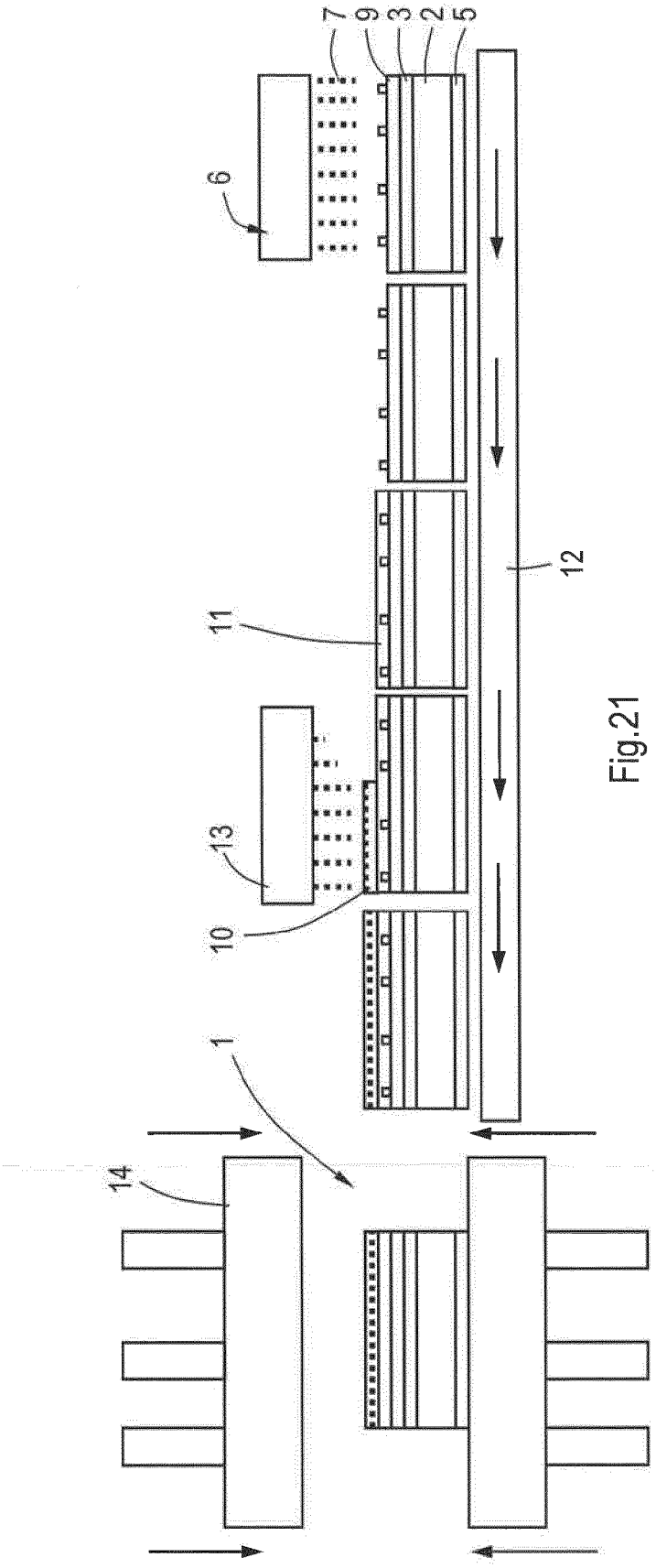

Fig.21

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 18 4511

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2005/106153 A1 (TRIO IND GROUP INC [US]; GYEMANT ROBERT E [US]; DANIELS EVAN R [US]) 10 November 2005 (2005-11-10) * paragraph [0015] - paragraph [0020] * * paragraph [0079] - paragraph [0083]; figures 10a-10c *	1-15	INV. B44C5/04
X	US 2011/056617 A1 (CAGLE JONATHAN HAILE [US]) 10 March 2011 (2011-03-10) * the whole document *	1-15	
X	US 2004/026017 A1 (TAYLOR DENE H [US] ET AL) 12 February 2004 (2004-02-12) * paragraph [0033] - paragraph [0047]; figure 1 *	1-15	
X	EP 0 914 972 A1 (CIMER CREATION IND MEUBLE DU R [FR]) 12 May 1999 (1999-05-12) * paragraph [0014] - paragraph [0020]; figures 1,2 *	1-15	
X	US 6 686 315 B1 (CREED DOUGLAS C [US]) 3 February 2004 (2004-02-03) * page 3, line 38 - page 4, line 10; figures 4-8 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) B44C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 March 2013	Sartor, Michele

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 18 4511

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

12-03-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005106153 A1	10-11-2005	NONE	
US 2011056617 A1	10-03-2011	NONE	
US 2004026017 A1	12-02-2004	AU 2003231301 A1	25-02-2004
		US 2004026017 A1	12-02-2004
		WO 2004014649 A1	19-02-2004
EP 0914972 A1	12-05-1999	DE 69804282 D1	25-04-2002
		EP 0914972 A1	12-05-1999
		FR 2770454 A1	07-05-1999
US 6686315 B1	03-02-2004	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82