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(54) DECORATIVE PANEL

(57) A decorative panel is disclosed comprising a substrate (20) and a top layer (22) affixed to the substrate. The top layer (22) comprises a wear layer (26), the wear layer having an upper surface (28) and a chamfer (30) having a surface contour (32) extending from said upper surface (28) to an edge (12-14; 16-18) of the decorative panel (10). The surface contour (32) of the chamfer has a first surface contour region (34) extending from the upper surface (28) and a second surface contour region (36) extending from the first surface contour region (32) towards the edge (12-14; 16-18) of the decorative panel. The first surface contour region (32) has a first angle of inclination (A1) with respect to the upper surface (28) and the second surface contour region (36) has a second angle of inclination (A2) with respect to the upper surface (28). The first angle of inclination (A1) is greater than said second angle of inclination (A2).

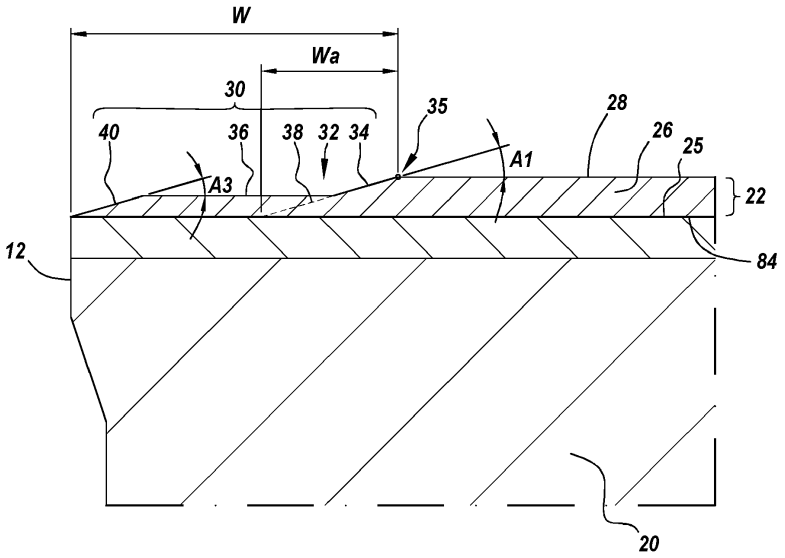

Fig. 4

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Description

[0001] The present invention relates to a decorative panel according to the preamble of claim 1. The invention further relates to a floor covering comprising a plurality of such decorative panels and to a method of manufacturing a decorative panel having coupling means.

[0002] In particular, the invention relates to decorative panels with a substrate and a decorative top layer, wherein the decorative top layer comprises a print and a transparent top layer applied thereon. Such panels are widely known, for example from WO 97/47834, WO 2006/066776, WO 2010/023042 and WO 2012/004701 and may for example imitate parquet panels or stone or ceramic tiles. It is known from WO 97/47834 to provide such panels with coupling means, so that a floating floor covering may be assembled on the basis of such panels.

[0003] In order to mimic a real wood floor panel, it is known to provide decorative panels with a lowered edge region in the form of a chamfer. When two such panels are connected to each other, the chamfers create a substantially V-shaped groove extending along the connected edges of the two panels. Not only is the V-shaped groove perceived by many as being aesthetically pleasing, it can also disguise an imperfect panel edge cut.

[0004] It is known from WO 2012/004701 to use a thermoplastic layer, for example of PVC, as a wear layer. It is also known from this document to remove a portion of the top layer on the edge of the panel for forming a lowered edge region in the form of a chamfer that extends up to the level of the print. Said chamfer may then be provided with a separate decorative covering.

[0005] It is known from WO 2006/066776 to produce a chamfer by deforming the substrate, wherein the print and the wearing layer, in this case for example a thermosetting wearing layer, extend continuously from the central upper surface of the panels over the aforementioned chamfer.

[0006] A decorative panel having a substrate and a decorative top layer is known from WO 2022/013645. The top layer comprises a print and a transparent wear layer applied thereon. The wear layer has a thickness of 0.3 mm or more, but preferably less than 0.75 mm. A lowered edge region in the form of a chamfer is milled into the wear layer, with the chamfer making an angle with the upper surface of the panel which is less than 25° and preferably about 11°. Depending on the thickness of the wear layer, the angle of inclination of the chamfer and the desired maximum depth of the chamfer, the chamfer may a width extending up to about 2.5 mm from the edge of the panel. When two such panels are connected to each other, the chamfers create a substantially V-shaped groove extending along the connected edges of the two panels, the V-shaped groove having a width of up to about 5 mm. A groove of this width is easy to wipe clean and the angle of inclination of the chamfer is sufficient to create a prominent demarcation line between the planar upper surface of the wear layer and the chamfer. Furthermore, the depth of the chamfer at the edge of the panel is sufficient to disguise possible imperfections, such as small chipped areas, which may be created during milling of the chamfer.

[0007] To reduce material costs, it would be desirable to make use of a thinner wear layer, for example of about 0.20 mm thickness. However, difficulties arise in providing such a thin wear layer with a chamfer having an adequate width. For example, compared to a chamfer having an angle of inclination of 11° in a wear layer of 0.55 mm thickness, a chamfer of the same width in a layer of 0.20 mm would have a corresponding angle of inclination of only 4°. Such a shallow angle of inclination may be difficult to impart into the wear layer and would not necessarily provide a sufficiently prominent demarcation line between the planar upper surface of the wear layer and the chamfer.

[0008] The present invention relates in the first place to an alternative decorative panel, wherein according to various preferred embodiments, a solution is offered for the problems with the decorative panels from the prior art. For this purpose, the present invention provides a decorative panel comprising a substrate and a top layer affixed to the substrate. The top layer comprises a wear layer. The wear layer has a, preferably planar, upper surface and a chamfer having a surface contour extending from the upper surface to an edge of the decorative panel. The surface contour of the chamfer has a first surface contour region extending from the planar upper surface and a second surface contour region extending from the first surface contour region towards the edge of the decorative panel. The first surface contour region has a first angle of inclination with respect to the planar upper surface and said second surface contour region having a second angle of inclination with respect to the, preferablyplanar, upper surface. The first angle of inclination is greater than the second angle of inclination. In this manner, the first angle of inclination of the first surface contour region can still be made as steep as that of a chamfer in a wear layer of, say 0.55 mm, even though the chamfer of the invention may have a similar width to that of the prior art.

[0009] With a planar upper surface, an upper surface is meant which generally extends planarly, i.e. without taking into account possible rather local embossments or other relief features, for example imitation wood pores or the rugosity of a stone surface.

[0010] The present inventors have surprisingly found that a chamfer having at least two surface contour regions of different inclination may be perceived as a chamfer having a single surface contour region with the steeper angle of inclination. This means that the benefits provided by a chamfer having a relatively steep surface contour region can be essentially retained even in a relatively thin wear layer.

[0011] Preferably, the second angle of inclination is 80% or less of said first angle of inclination.

[0012] In an embodiment the surface contour of the

chamfer has a third surface contour region extending from the edge of said decorative panel towards the second surface contour region, the third surface contour region having a third angle of inclination, the third angle of inclination being greater than the second angle of inclination. In this manner, the third surface contour region adjacent the edge of the panel may have a relatively steep angle of inclination, something which can effectively disguise edge imperfections.

[0013] In an alternative embodiment the second surface contour region extends with a preferably uniform inclination, or without inclination, up until said edge of said decorative panel.

[0014] To mimic chamfers of the prior art having a single surface contour region, the first angle of inclination may be within 20 %, preferably within 10 %, more preferably within 5 %, of the third angle of inclination.

[0015] The first angle of inclination may be between 8° and 14°, preferably between 9° and 13°, more preferably between 10° and 12°, most preferably about 11°. Particularly when the chamfer has three surface contour regions, the second surface contour region may be essentially parallel to the planar upper surface of the wear layer, i.e. the second angle of inclination may be approximately zero.

[0016] The present invention is particularly useful for decorative panels with wear layers having a maximum thickness of 0.30 mm, preferably up to 0.25 mm and more preferably up to about 0.20 mm.

[0017] The wear layer may be a transparent layer of polymeric material such as a thermoplastic material, preferably of PVC, polypropylene, polyurethane or polyethylene. In an embodiment, the wear layer may be made from acrylic and preferably contains wear resistance-promoting additives, such as ceramic particles.

[0018] In various embodiments, the top layer may further comprise a print with the print being located between said substrate and said wear layer. The print can be applied on a thermoplastic carrier film, for example a printed PVC film, PU film, PP film or PET film. In a particular embodiment, the wear layer has an underside and the print is applied to the underside of the wear layer.

[0019] Alternatively, the print may be formed directly on the substrate. In such case, the substrate can be provided with one or more priming coatings on which the print is formed.

[0020] For increased versatility, the print may be digitally printed, preferably by means of an inkjet printing process. Furthermore, the print may comprise a pigment-containing ink, preferably a solvent or water-based ink.

[0021] The print may imitate a wood-grain pattern, one or more types of stone or ceramic tiles. Alternatively, the print may replicate a fancy pattern or logo.

[0022] To provide a surface covering with a continuous appearance, it may be advantageous to allow the print to extend up to the edge of the panel. To ensure that the print remains protected by the wear layer, the chamfer can then terminate at or above the print at the edge of the panel.

[0023] The decorative panel of the present invention may have a substrate of any suitable material. Preferably, the substrate consists mainly of a plastic composite material, for example plastic containing fillers, such as PVC and a filler, such as calcium carbonate. To increase the stability of the panel, the substrate may include at least one embedded fibre reinforcing layer, such as a glass fibre reinforcing layer. Alternatively, the substrate substantially consists of a wood-based material, such as MDF or HDF. Irrespective of the material of the substrate, the panel may comprise a sound damping layer, for example of a foamed material, on the underside of the panel.

[0024] In preferred embodiments, the decorative panel is provided on at least two opposite edges with coupling means that allow two such panels to be coupled together at the respective edges, wherein locking is attained both in a vertical direction perpendicular to the plane of the coupled panels, and in a horizontal direction perpendicular to the respective edges in the plane of the coupled panels. The coupling means may be configured substantially as a male coupling part, for example a tongue, and a female coupling part, for example a groove, wherein in the coupled state horizontally acting locking surfaces are formed, which counteract moving apart of the coupled floor panels. Such decorative panel preferably has a total thickness and/or a substrate thickness of 3.2 mm or more, e.g. up to 15 mm in the case of wood-based substrate and e.g. up to 6 mm in the case of plastic substrates.

[0025] The presence of a chamfer in accordance with the invention is of special advantage when used on panels having coupling parts. The coupling parts may show one or a combination of two or more of the following properties:

- the property that the panel is at least at one pair of opposite edges provided with coupling parts allowing to couple two of such panels at the respective edges by means of a downward motion of one panel to the other. In such case, the ability to lock in said vertical direction may be somewhat limited, in order not to unduly restrict the coupling in the downward direction;
- the above property and the property that the coupling parts, or at least the locking parts responsible for said locking in said vertical direction, are made in one piece from the material of the panel. With such coupling parts, the ability to lock in said vertical direction may be restricted even further;
- the property that the coupling parts comprise a male coupling part at one of said opposite edges, and a female coupling part at the side opposite thereto, wherein, in a coupled condition, vertically active contact surfaces are formed obstructing the moving apart of the male coupling part out of the female coupling part in said vertical direction, wherein said vertically active contact surfaces are inclined 5° or more

against the plane of coupled panels. The male and female coupling part may basically be shaped as a tongue and a groove, or comprise a hook-shaped portion as further elucidated below;

- the property that
  - the coupling parts are basically shaped as a tongue and a groove substantially providing said locking in said vertical direction, wherein said tongue and groove comprise horizontally active locking surfaces which counteract the moving apart of the tongue and the groove in said horizontal direction; or
  - the coupling parts are configured as a male coupling part comprising a hook-shaped portion that projects on the upper side of the panel, and the female coupling part comprises a hook-shaped portion that projects on the underside of the panel, wherein the hook-shaped portion of the male coupling part comprises a downward projecting locking element that can interact with a recess in the hook-shaped portion of the female coupling part, wherein the interaction of the downward projecting locking element and the recess is mainly responsible for the locking in said horizontal direction, and wherein said hook-shaped portions are further provided with one or more snap portions and undercuts interacting therewith, which provide the locking in said vertical direction; and
  - that both pairs of opposite edges are provided with coupling parts, either basically shaped as a tongue and a groove, as described above, at both pairs of opposite edges, or basically shaped as a tongue and a groove, as described above, at one pair of opposite edges, and configured as a male coupling part and a female coupling part with hook-shaped portions, as described above, at the other pair of opposite edges.

[0026] It is especially with coupling parts having one or more of the above properties that inaccuracies in the milling process for the coupling parts may lead to height differences or open seams between adjacent panels in a covering assembled from a plurality of such panels, even more so when it concerns panels, the substrate of which consists mainly of plastic and/or fillers. Such substrate material may to some extent be prone to compression in the milling process, and spring-back afterwards, leading to a resulting inaccurate geometry of the coupling parts. The particular geometry of the chamfer, especially said third surface region when available, protects the actual edges of the panels from premature wear in the case of height differences, and may hide an open seam to some extent. Also the possibility of limiting the thickness of the wear layer, for example to a maximum of 0.3 mm, while still having a chamfer in accordance with the invention, may lead to a better control of height differences and open seams since the coupling parts may be provided with horizontally and/or vertically active surfaces at a location closer to the actual upper surface of the panels. Moreover, when the total thickness of the panel is kept, for example at least 3.2 mm, or at least 4 mm, more substrate material may be available to provide the coupling parts, such that these may be sturdier and more effective.

[0027] In accordance with alternative embodiments, the decorative panel is a so-called gluedown decorative panel. Such decorative panels may also have substrates of plastic and/or fillers, but are free from coupling means that enable a locking in a vertical and horizontal direction. Potentially coupling means are available at one or both pairs of opposite edges that enable locking in only one of said vertical or horizontal direction. Preferably however, one or both pairs of opposite edges of such gluedown panels are substantially vertical, potentially inclining inwardly from the top surface to the bottom surface. Such inward inclination may provide for a seamless adjacent placement of the top surfaces in a covering assembled from gluedown panels. Gluedown panels preferably have a total thickness and/or a substrate thickness of 3.5 mm or below, or 3 mm or below. Gluedown panels are particularly prone to installation with height differences between adjacent panels, since the slightest difference in thickness between adjacent panels may show as a difference in height at the seam.

[0028] The invention is of particular importance with panels having a substrate obtained by extrusion of plastic composite materials or by calendaring several layers of plastic composite materials. Such substrate may show important thickness variations

[0029] The present invention further relates to a floor, wall or ceiling covering comprising a plurality of decorative panels of the type disclosed above. According to a preferred embodiment said the covering comprises at least two decorative panels, wherein the thickness of the substrate layer of said two panels differs at least by 0.1 mm or at least by 0.2 mm, or at least by 0.3 mm.

[0030] For a decorative panel of the type described above, e.g. having coupling means, the chamfer and the coupling means, when available, may be manufactured by milling. Accordingly, the present invention further relates to such a method. It is clear that for milling said chamfer, a method with a special milling tool, with rake angles and clearance angles as disclosed in WO 2022/013645 may be used, e.g. in order to obtain a mat surface on the chamfer. Alternatively, the chamfer may be obtained by a pressing operation or by controlled melting of the wear layer. Preferably, the substrate layer of said decorative panels is obtained by extrusion of a plastic composite material. Preferably the thickness variation of said substrate layer is controlled such that the maximum thickness is 0.3 mm or less, 0.2 mm or less, 0.1 mm or less thicker than the minimum thickness obtained.

[0031] The invention will be described in the following by way of example only and with reference to the attached

drawings, in which:

Fig. 1 is a schematic perspective view of a decorative panel with features of the invention;
Fig. 2 is a cross-sectional view along line II-II of Fig. 1;
Fig. 3 is a cross-sectional view along line III-III of Fig. 1;
Fig. 4 shows, on a larger scale, a view of the region that is marked F4 in Fig. 2;
Fig. 5 shows an alternative chamfer profile;
Fig. 6 shows, on a larger scale, a view of the region that is marked F6 in Fig. 5;
Fig. 7 shows, on a larger scale, a view of the region that is marked F7 in Fig. 5;
Fig. 8 shows an alternative chamfer profile;
Fig. 9 shows yet another alternative chamfer profile; and
Fig. 10 shows how decorative panels according to the invention may be assembled to provide a floating floor covering.

[0032] In the drawings, reference number 10 generally denotes a decorative panel according to the present invention. More particularly, Fig. 1 shows a rectangular, elongated decorative panel 10, in this case a floor panel, with a pair of long opposite edges 12-14 and a pair of short opposite edges 16-18. Typically, a decorative panel may have a length of 1200 mm, a width of 190 mm and a thickness T1 of from 4 mm to 20 mm, preferably about 5 mm to 15 mm.

[0033] Figs. 2 and 3 show that the decorative panel 10 comprises a substrate 20 and a decorative top layer 22. The substrate 20 may consist mainly of plastic and/or fillers, such as PVC and calcium carbonate. To impart additional stability, the substrate 20 may include one or more embedded fibre reinforcing layers 23 such as a glass fibre reinforcing layer. Alternatively, the substrate may substantially consist of a wood-based material, such as MDF or HDF. A, preferably foamed, layer 24, for example based on crosslinked polyethylene, may be applied on the underside of the substrate 20, for the purpose of sound damping and/or accommodation of irregularities of the substrate.

[0034] The decorative top layer 22 comprises a print 25 and a transparent wear layer 26 there-above. The wear layer has a planar upper surface 28. The panel 10 has on at least one edge, and in this case, on both edges of both the pair of short opposite edges 16-18 and the pair of long opposite edges 12-14, a lowered edge region in the form of a chamfer 30. Preferably the chamfer 30 extends along the entire length of the respective edge 12-14; 16-18.

[0035] One embodiment of a chamfer 30 in accordance with the present invention is illustrated in Fig. 4. The chamfer 30 has a chamfer profile with a surface contour 32 which extends over a width w from the planar upper surface 28 to an edge, in this case one 12 of the long edges 12-14, of the decorative panel 10. The surface contour 32 has a first surface contour region 34 extending from the planar upper surface 28 and a second surface contour region 36 extending from the first surface contour region towards the edge 12 of the decorative panel. The first surface contour region 34 has a first angle of inclination A1 with respect to the planar upper surface 28 and the second surface contour region 36 has a second angle of inclination A2 with respect to the planar upper surface 28. Since, in the illustrated embodiment, the second surface contour region 36 is parallel to the planar upper surface 28, the second angle of inclination is zero and so it is not shown in the drawing. In accordance with the invention, the first angle of inclination A1 is greater than the second angle of inclination A2. Preferably, the second angle of inclination A2 is 80% or less of the first angle of inclination.

[0036] Fig. 4 also shows, by means of a dashed line, a virtual extension 38 of the first surface contour region 34 towards the print 25. If the chamfer 30 had not been provided with the second surface contour region 36, the chamfer would have had an abridged width w_a which is significantly narrower than the width w of a chamfer 30 according to the invention.

[0037] The first surface contour region 34 of the chamfer 30 intersects, or transitions into, the planar upper surface 28 to thereby form a demarcation line 35 dividing the chamfer 30 from the planar upper surface. The demarcation line 35 runs parallel to the respective edge of the panel, preferably along the entire length of the respective edge 12-14; 16-18.

[0038] In accordance with a preferred embodiment, the surface contour 32 of the chamfer 30 has a third surface contour region 40 which extends from the edge 12 of the decorative panel towards the second surface contour region 36. The third surface contour region 40 has a third angle of inclination A3 which is greater than the second angle of inclination A2. In order to emphasize the perception of a chamfer having a single steeper surface contour, the first angle of inclination may be within 20 %, preferably within 10 %, more preferably within 5 %, of the third angle of inclination.

[0039] In absolute terms, the first angle of inclination A1 may be between 8° and 14°, preferably between 9° and 13°, more preferably between 10° and 12°, most preferably about 11°. With a first angle of inclination within these ranges, a distinctive demarcation line 35 is formed.

[0040] An alternative chamfer profile is illustrated in Fig. 5. Rather than being essentially planar, the first and third surface contour regions 34, 40 are shown as being curved. To emphasize the demarcation line 35, it may be advantageous if the first surface contour region 34 has a concave profile. This profile is more clearly shown in Fig. 6. The first angle of inclination A1 of such a profile is defined as the acute angle formed from the horizontal by a first virtual straight line 42 connecting the demarcation line 35 to a first transition point 44 at which the first surface contour region 34 transitions into the second surface contour region 36. To better disguise any manufac-

turing anomalies along the panel edges to thereby allow greater manufacturing tolerances, and with reference to Fig. 7, it may be beneficial if the third surface contour region 40 has a convex profile. The third angle of inclination A3 of such a profile is then defined as the acute angle formed from the horizontal by a second virtual straight line 46 connecting first and second end points 48, 50 of the third surface contour region 40. The first end point 48 is defined as the point on the panel edge 12 from which the third surface contour region 40 extends and the second end point 50 is defined as the point at which the third surface contour region transitions into the second surface contour region 36. In Fig. 7, the second surface contour region 36 is illustrated as being planar and therefore it extends parallel to the planar upper surface 28 of the wear layer 26. Accordingly, the third angle of inclination A3 is the acute angle between the second virtual straight line 46 and the second surface contour region 36.

[0041] Of course, it lies within the scope of the invention that only one of the first to third surface contour regions has a curved profile. For example, the first surface contour region may be curved and the second and/or third surface contour region may be planar, or the third surface contour region may be curved and the second and/or first surface contour region may be planar.

[0042] In the embodiments shown in Figs. 4 to 7, the second surface contour region 36 is shown as being planar and essentially parallel to the planal upper surface 28 of the wear layer 26 such that the second angle of inclination A2 is zero. Nevertheless, it is conceivable that decorative panels of the invention are provided with one or more chamfers 30 having a second surface contour region 36 with a second angle of inclination A2 having a positive or a negative value. Thus, and with reference to Fig. 8, a further embodiment of a chamfer profile is illustrated having first, second and third surface contour regions, 34, 36 and 40, respectively, though in which the second surface contour region 36 extends obliquely with respect to the planar upper surface 28 of the wear layer 26. Accordingly, the second surface contour region has a second angle of inclination A2 with respect to the planar upper surface 28 which has a negative value compared to the first and third angles of inclination A1, A3. Irrespective of whether the value of the second angle of inclination A2 is positive or negative, in accordance with the invention its value is always less than that of the first angle of inclination A1. Although the first and third surface contour regions 34, 40 are depicted as being curved in Fig. 8, it is to be understood that one or both of them may be planar.

[0043] A further chamfer profile is illustrated in Fig. 9. In this embodiment the chamfer profile 32 consists of a first surface contour region 34 and a second surface contour region 36. The first surface contour region 34 has a concave profile, whilst the second surface contour region 36 has a convex profile. The first surface contour region 34 transitions into the second surface contour region 36 at the transition point 44. The second surface contour region extends to an edge point 52 on the edge 12 of the decorative panel 10. The second surface contour region 36 has an angle of inclination A2 which is defined as the acute angle formed from the horizontal by a third virtual straight line 54 extending between the edge point 52 and the transition point 44. As with all the illustrated embodiments, the first angle of inclination A1 is greater than the second angle of inclination A2.

[0044] Reverting to Fig. 5, it will be seen that the transparent wear layer 26 has a thickness T, apart from where the chamfer(s) 30 is/are provided. Thanks to the chamfer profile of the invention, the thickness T may be no more than 0.30 mm, preferably no more than 0.25 mm and more preferably no more than about 0.20 mm, whilst still conveying the impression of being a planar chamfer in a wear layer of over 0.50 mm. The wear layer 26 may be a transparent layer of a polymeric material, such as a thermoplastic material, preferably of PVC, polypropylene, polyurethane or polyethylene. Alternatively, the wear layer is made from acrylic and preferably contains wear resistance-promoting additives, such as ceramic particles.

[0045] Figs. 2 and 3 clearly show that the decorative panel 10 may be provided on both pairs of opposite edges 12-14; 16-18 with coupling means 54 that allow two such panels 10 to be coupled together on the respective edges. In the coupled state, locking is attained both in a vertical direction V1 perpendicular to the plane of the coupled floor panels, and in a horizontal direction H1 perpendicular to the respective edges 12-14; 16-18 and in the plane of the coupled panels. The coupling means 54 are in each case configured as a male coupling part 56 and a female coupling part 58, wherein in the coupled state, horizontally acting locking surfaces 60 are formed, which counteract movement of the coupled decorative panels 10 away from each other in the horizontal direction. On the pair of long opposite edges 12-14, the male coupling part 56 is formed by a sideways projecting tongue 62, and the female coupling part by a groove 64.

[0046] The coupling means 54 on the pair of short opposite edges 16-18, shown in Fig. 3, are configured as a male coupling part 56 and a female coupling part 58, which can be fitted into each other by means of a downward motion. The male coupling part 56 comprises a hook-shaped portion 66 that projects on the upper side of the panel 10, and the female coupling part 58 comprises a hook-shaped portion 66 that projects on the underside of the panel 10. The hook-shaped portion 66 of the male coupling part 56 comprises a downward projecting locking element 68 that can interact with a recess 70 in the hook-shaped portion 66 of the female coupling part 58. The interaction of the downward projecting locking element 68 and the recess 70 is mainly responsible for the locking in the horizontal direction H1. The hook-shaped portions 66 are further provided with one or more snap portions 72 and undercuts 74 interacting therewith, which provide the locking in the vertical direction VI. Al-

though not shown, it is clear that, in a coupled condition, vertically active locking surfaces will be formed between the upper side of said snap portion 72 and the upper surface of said undercut 74. These vertically active locking surfaces, as shown here, are inclined with respect to the plane of the panels 10.

[0047] The coupling means 54 on the pair of long opposite edges 12-14, shown in Fig. 2, are, as mentioned above, configured as a tongue 62 and a groove 64, delimited by an upper lip 76 and a lower lip 78. The tongue 62 and groove 64 provide per se the locking in the aforementioned vertical direction V1, and are provided with locking elements with locking surfaces 60, mainly responsible for locking in the aforementioned horizontal direction H1. The locking elements comprise, in the example, a projection 80 on the underside of the tongue 62 and a recess 82 in the lower lip 78 of the groove 64. The mechanical coupling means 54 may be made with pretension, obtained on the basis of a lower lip bent outwards in the coupled position, which in an attempt to spring back, presses against the underside of the tongue 62.

[0048] The coupling means 54 shown here also allow coupling based on a horizontal sliding movement of the panels 1 toward each other.

[0049] As previously mentioned, the top layer 22 comprises the print 25 and the transparent wear layer 26 there-above. As is most clearly shown in Figs. 4 and 5, the print 25 may be applied to a carrier film 84, preferably of thermoplastic material, for example a printed PVC film, PU film, PP film or PET film. Alternatively, the print 25 may be applied to an underside of the wear layer 26. In other embodiments, the print may be formed directly on the substrate 20. In such case, the substrate 20 is preferably provided with one or more priming coatings onto which the print 25 is formed. The print 25 itself may be applied by means of any suitable printing method, such as digital printing, flexographic printing or offset printing. Preferably, the print is digitally printed by means of an inkjet printing process. The print 25 comprises a suitable ink, for example a pigment-containing ink which may be a solvent or water-based ink. It is not excluded that a UV-curable ink be used. The print 25 extends essentially continuously over the entire surface of the panel defined as the area within the four edges 12, 14, 16 18, such that it extends up to each of the edges. To protect the print 25, it is preferable that the wear layer 26 also extends to the edges such that the chamfer 30 terminates at or above the print 25 at each edge.

[0050] Fig. 10 shows that the decorative panel 10 of the invention is suitable for assembling a floating floor covering. In this case, the coupling means 54 on the pair of long edges 12-14 may be coupled to each other by means of a rolling or turning motion W, and the coupling means 54 on the pair of short edges 16-18 may be coupled to each other by means of a downward motion N.

[0051] The coupling means 54 and the chamfer 30 are advantageously produced on the basis of a milling operation with rotating milling tools. A suitable milling tool may comprise one or more cutting sections, preferably at least nine cutting sections uniformly distributed over the circumference of a rotating cutting tool. Preferably the cutting sections comprise a face and a flank surface, which are joined to each other by a cutting edge, which is provided as a ridge between the face and the flank surface. The radius of the cutting edge is advantageously between 2 and 200 pm, preferably between 25 and 100 pm. A radius between 2 and 50 pm also offers interesting possibilities. The wedge angle between the rake surface and the flank surface is preferably less than 80°. The rake angle is preferably between -15° and 15°. The rake angle is preferably positive and is between 2° and 15°, or better still between 5 and 12°. The clearance angle is preferably between 0° and 15°, or better still between 0 and 5°.

[0052] The present invention is by no means limited to the embodiments described above, but said decorative panels, methods for the manufacture thereof, and milling tools used therein, may be realized while remaining within the scope of the present invention as defined by the appended claims. For example, it is not excluded that the decorative panel of the invention may be provided with a v-shaped groove in a region of the panel remote from the edges. Each side of such a v-shaped groove may have a profile corresponding to one of the chamfer profiles described above.

Claims

1. A decorative panel comprising a substrate (20) and a top layer (22) affixed to said substrate, said top layer (22) comprising a wear layer (26), said wear layer having an upper surface (28) and a chamfer (30) having a surface contour (32) extending from said upper surface (28) to an edge (12-14; 16-18) of said decorative panel (10), **characterized in that** said surface contour (32) of said chamfer has a first surface contour region (34) extending from said upper surface (28) and a second surface contour region (36) extending from said first surface contour region (32) towards said edge (12-14; 16-18) of said decorative panel, said first surface contour region (32) having a first angle of inclination (A1) with respect to said upper surface (28) and said second surface contour region (36) having a second angle of inclination (A2) with respect to said upper surface (28), said first angle of inclination (A1) being greater than said second angle of inclination (A2).

2. The decorative panel according to claim 1, **characterized in that** said second angle of inclination (A2) is 80% or less of said first angle of inclination (A1).

3. The decorative panel according to claim 1 or 2, **characterized in that** said surface contour (32) of said chamfer (30) has a third surface contour region (40)

extending from said edge (12-14; 16-18) of said decorative panel towards said second surface contour region (36), said third surface contour region (40) having a third angle of inclination (A3), said third angle of inclination (A3) being greater than said second angle of inclination (A2).

4. The decorative panel according to claim 3, **characterized in that** said first angle of inclination (A1) is within 20 %, preferably within 10 %, more preferably within 5 %, of said third angle of inclination (A3).

5. The decorative panel according to any one of the preceding claims, **characterized in that** said first angle of inclination (A1) is between 8° and 14°, preferably between 9° and 13°, more preferably between 10° and 12°, most preferably about 11°.

6. The decorative panel according to any one of the preceding claims, **characterized in that** said wear layer (26) has a maximum thickness of 0.30 mm.

7. The decorative panel according to any one of the preceding claims, **characterized in that** said wear layer (26) is a transparent layer of thermoplastic material, preferably of PVC, polypropylene, polyurethane or polyethylene, or, **in that** said wear layer (26) is made from acrylic and preferably contains wear resistance-promoting additives, such as ceramic particles.

8. The decorative panel according to any one of the preceding claims, **characterized in that** said top layer (22) further comprises a print (25), said print being located between said substrate (20) and said wear layer (26).

9. The decorative panel according to claim 8, **characterized in that** said print (25) is applied on a thermoplastic carrier film, for example a printed PVC film, PU film, PP film or PET film.

10. The decorative panel according to claim 8, **characterized in that** said print (25) is formed directly on said substrate (20), said substrate (20) preferably being provided with one or more priming coatings on which said print is formed.

11. The decorative panel according to any one of claims 8 to 10, **characterized in that** said print (25) extends up to said edge (12-14; 16-18) of said panel and said chamfer (30) terminates at or above said print (25) at said edge of said panel.

12. The decorative panel according to any one of the preceding claims, **characterized in that** said substrate (20) consists mainly of plastic and/or fillers, such as PVC and calcium carbonate, and preferably includes at least one embedded fibre reinforcing layer (23), such as a glass fibre reinforcing layer.

13. The decorative panel according to any one of the preceding claims, **characterized in that** the panel is provided on at least one pair of opposite edges (12-14; 16-18) with coupling means (54) that allow two such panels to be coupled together at the respective edges, wherein locking is attained both in a vertical direction perpendicular to the plane of the coupled panels, and in a horizontal direction perpendicular to the respective edges in the plane of the coupled panels.

14. The decorative panel according to claim 13, **characterized in that** said coupling means (54) are configured substantially as a male coupling part (56), for example a tongue (62), and a female coupling part (58), for example a groove (64), wherein in the coupled state horizontally acting locking surfaces (60) are formed, which counteract moving apart of the coupled panels.

15. A method of manufacturing a decorative panel (10) according to any of the preceding claims, **characterized by** forming said chamfer (30) and, when available said coupling means (54), by milling.

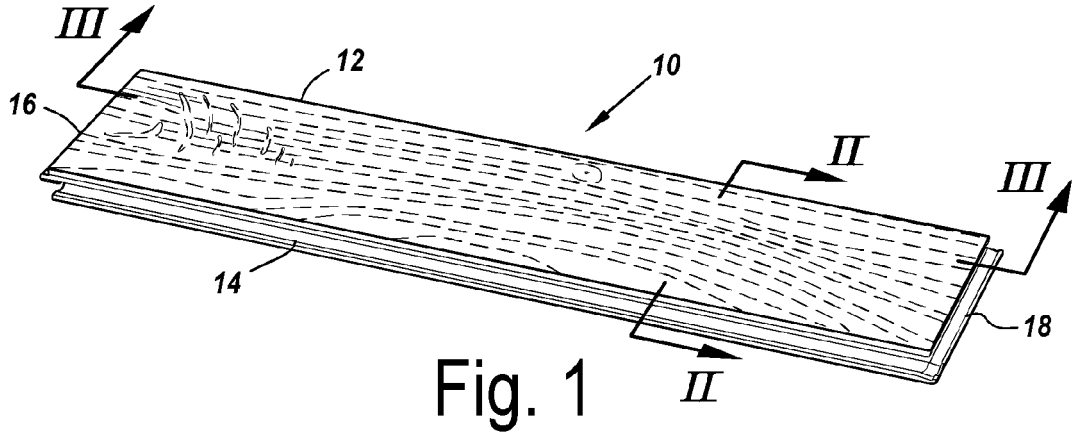

Fig. 1

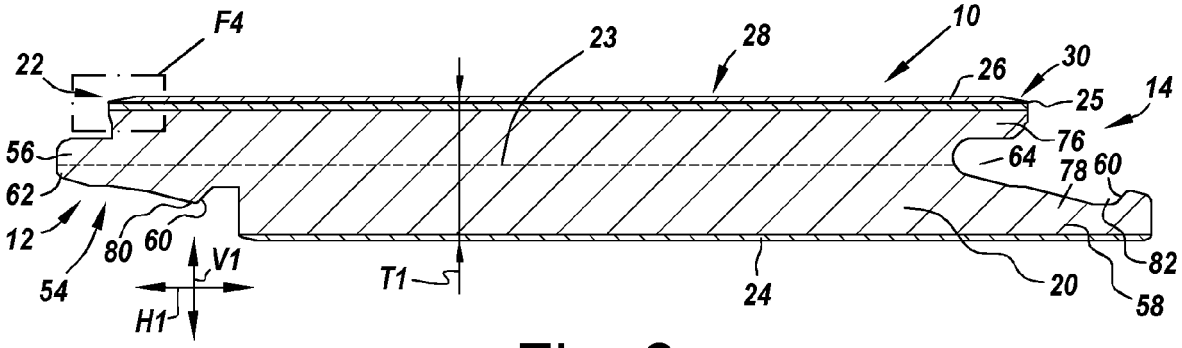

Fig. 2

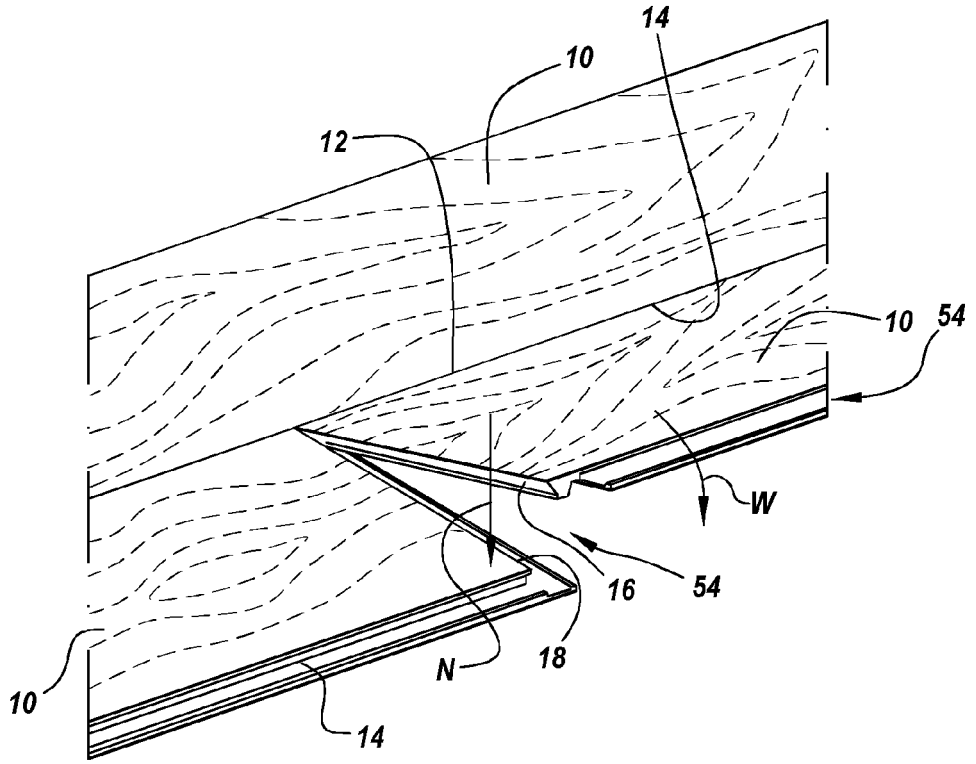

Fig. 10

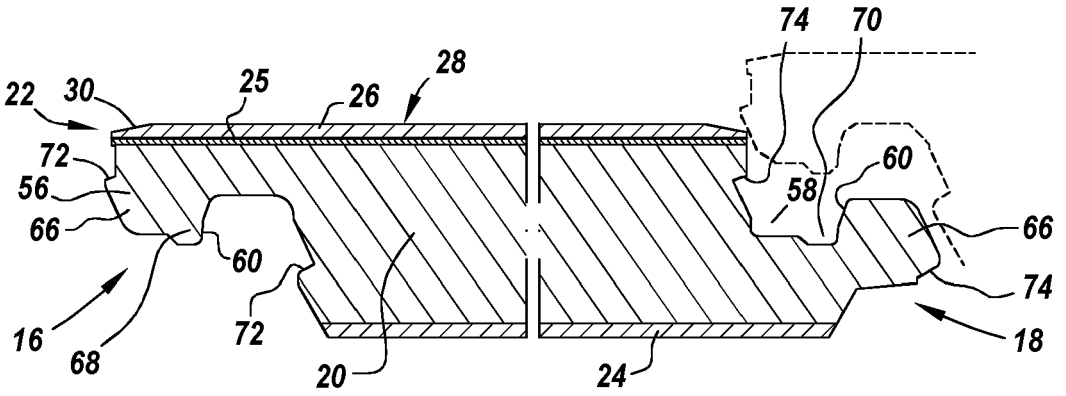
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Fig. 3

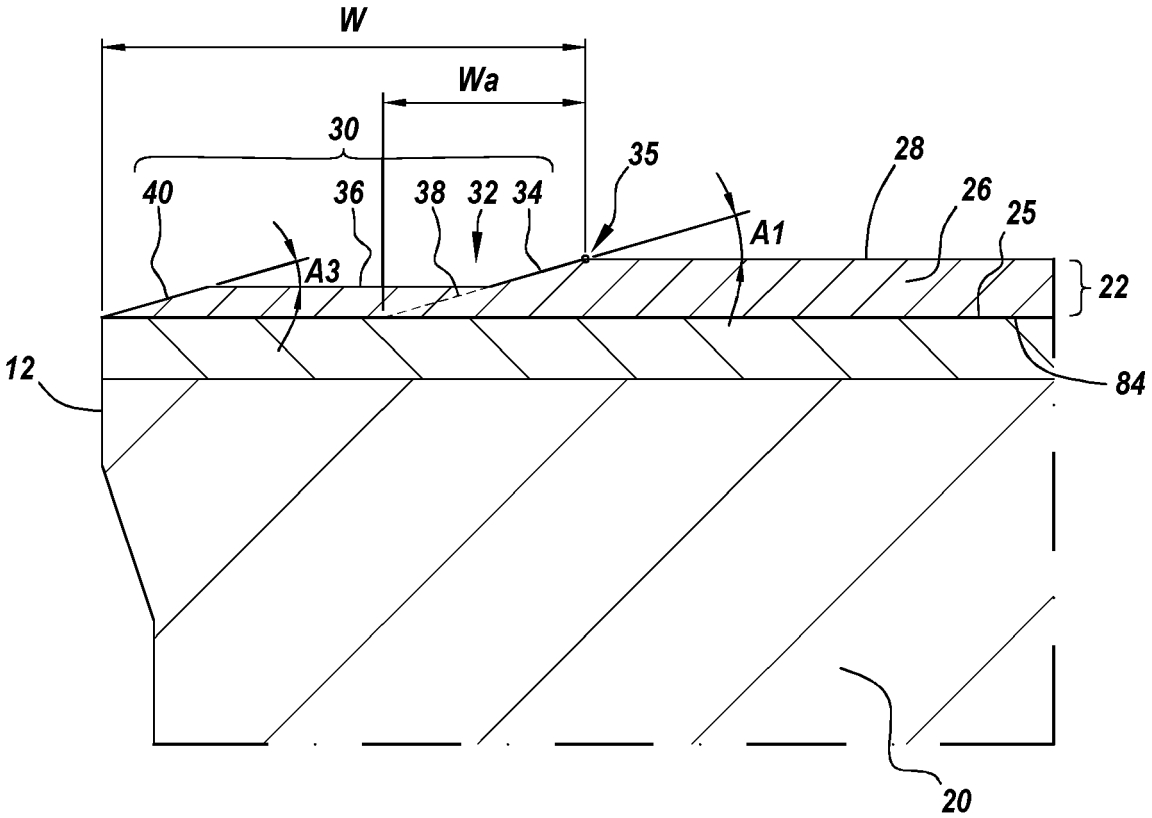
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Fig. 4

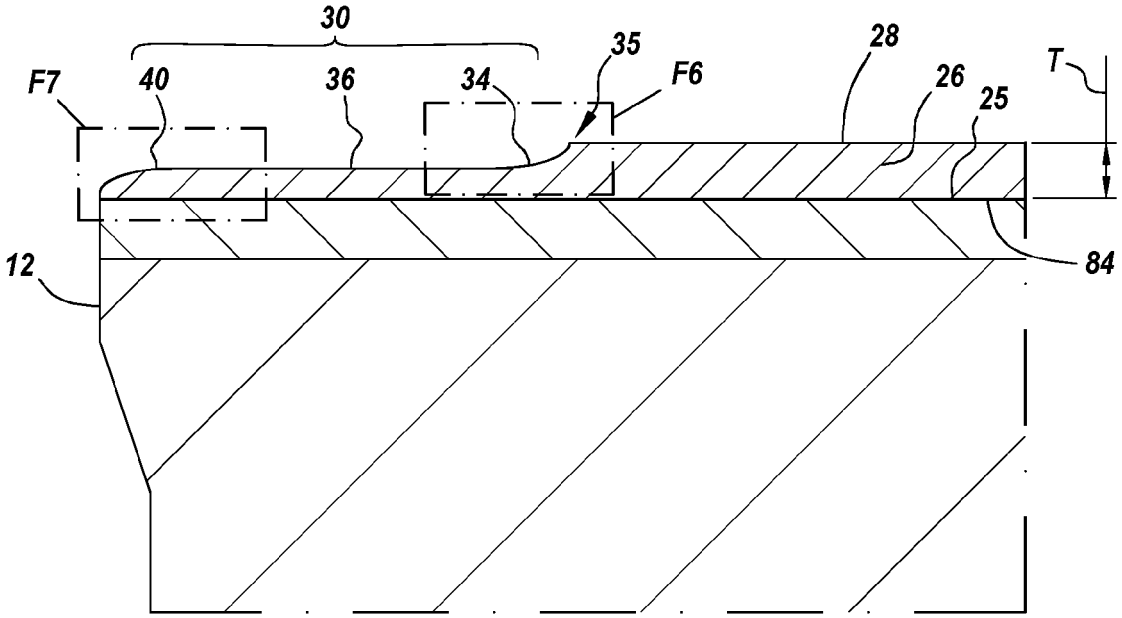

Fig. 5

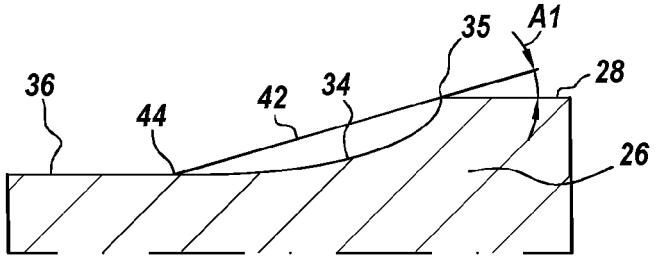

Fig. 6

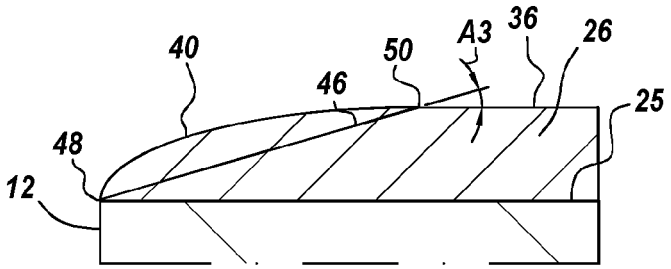

Fig. 7

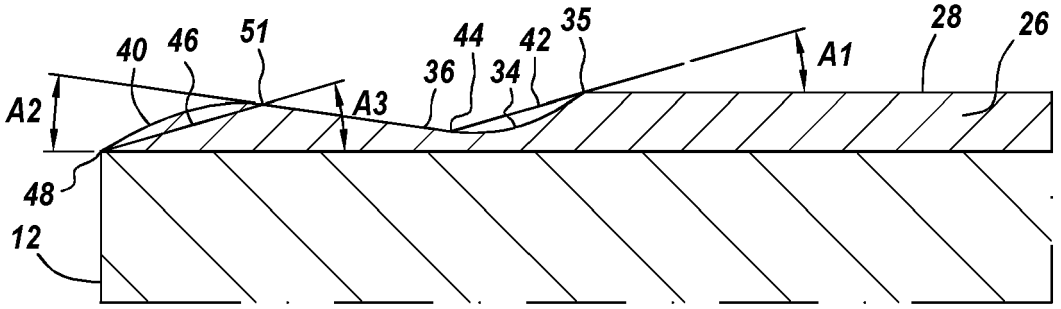
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Fig. 8

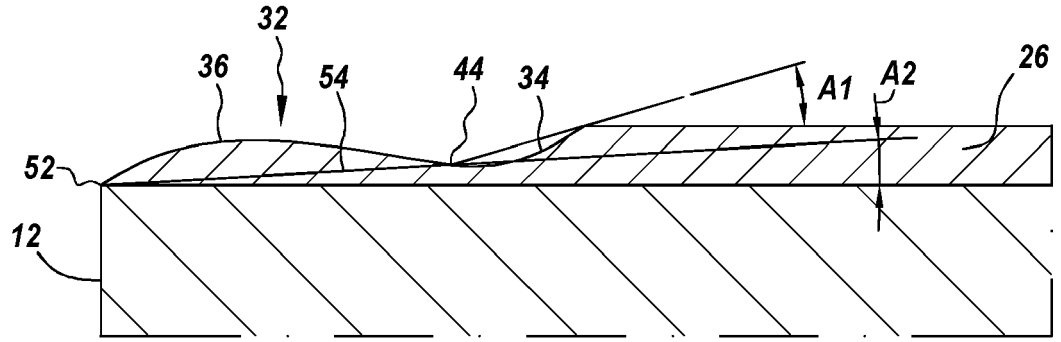
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Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 23 15 9726

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E04F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 September 2023	Fournier, Thomas

CATEGORY OF CITED DOCUMENTS

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