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(54) **Embossed sheet having a repetitive pattern, and engraved cylinder for manufacturing embossed sheets**

(57) An embossed sheet with a repetitive pattern has a plurality of pattern units. Each pattern unit comprises one or more raised elongated reliefs, an elongated relief having a length along a major axis and a width smaller than the length along a minor axis perpendicular to the major axis. The pattern units include first pattern units (PU1) having first elongated reliefs (R1) having the major axis parallel to a first direction (D1), and second pattern

units (PU2) having second elongated reliefs (R2) having the major axis parallel to a second direction (D2) oriented traverse to the first direction, wherein a first pattern unit is surrounded by an even number of identical second pattern units. An angle between the first direction (D1) and the second direction (D2) is between 50° and 75°. The embossed sheets have excellent anti-slippage properties combined with low noise generation in use, good wear resistance and relatively low weight.

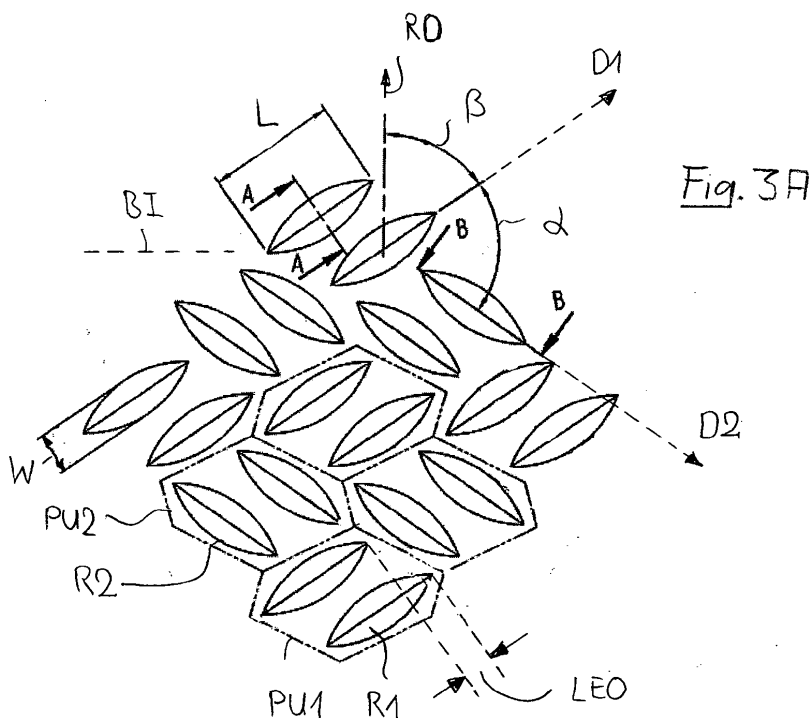


Fig. 3A

Description

BACKGROUND OF THE INVENTION

Technical Field

[0001] The invention relates to an embossed sheet with a repetitive pattern comprising a plurality of pattern units, according to the preamble of claim 1. The invention further relates to an engraved cylinder for embossing sheets, the cylinder comprising a cylinder surface having a repetitive pattern comprising a plurality of pattern units, according to the preamble of claim 13.

[0002] Embossed sheets with repetitive patterns are typically obtained by a final rolling pass performed on a metal sheet employing an engraved embossing cylinder having a cylinder surface which comprises the negative shapes of the reliefs desired for the embossed sheet. Embossed sheets with repetitive patterns formed by raised reliefs projecting over an otherwise flat surface of a sheet may be used in a variety of applications. Industrial applications include using the sheets as flooring material in buildings, ships, or for commercial vehicles. Stairs for accessing air planes are often built using embossed sheets having enhanced slip-resistant surfaces. Scaffolding is another field of application where potential slip-and-fall hazard should be avoided. Embossed sheets may also be used for decoration purposes.

Prior Art

[0003] Numerous models of embossed sheets with a repetitive pattern are commercially available. The most common patterns and their standard designations are shown in standard EN:1386:2007, or earlier versions, such as standard EN:1386:1996. Those common patterns include the Diamond pattern, the Almond pattern, the Two bar (or Duett) pattern, the Five bar (or Quintett) pattern, the Barleyseed (or Barleycorn) pattern, and the Rice Grain pattern. An example of a Rice Grain pattern is shown in international trademark no. 697 200. Those patterns have in common a repetitive pattern comprising a plurality of pattern units, each pattern unit comprising one or more raised elongated reliefs, the pattern units including first pattern units having one or more first elongated reliefs having the major axis parallel to a first direction, and second pattern units having one or more second elongated reliefs having the major axis parallel to a second direction oriented traverse to the first direction, wherein a first pattern unit is surrounded by an even number of identical second pattern units. The first and second directions are oriented perpendicular to each other, or the relative orientation deviates slightly from an exact orthogonal orientation.

[0004] The patent GB 2 312 693 B describes embossed sheets with a repetitive pattern, where each pattern unit comprises two or more reliefs of semi-ovoidal shape arranged in parallel, each pattern unit being sur-

rounded by four identical pattern units oriented perpendicular to the central pattern. The length and width of the reliefs as well as the pitch of the pattern and the proportion of engraved surface obey certain conditions. A comparison with embossed sheets having a Barleycorn pattern with different dimensions indicate that the pattern with semi-ovoidal reliefs requires less force applied to the embossing cylinder during manufacturing, as well as improved flatness and a noise reduction determined in a noise test carried out by rolling a wheeled truck over the sheets.

SUMMARY OF THE INVENTION

[0005] It is one objective of the present invention to provide an embossed sheet having a structured surface with a repetitive pattern providing improved slip resistance. Preferably, when used as flooring material, e.g. in commercial vehicles, such as refrigerated trucks, the embossed sheets shall generate only little noise when run over by fork lifts and other transportation devices, and the embossed sheets should be easy to clean. It is another objective to provide an embossed sheet which is relatively easy to manufacture by rolling using an engraved cylinder with a complementary pattern of dishes on the cylinder surface.

[0006] As a solution to these and other objects the invention provides an embossed sheet comprising the features of claim 1. Further, the invention provides an engraved cylinder having the features of claim 13. Preferred embodiments are given in the dependent claims. The wording of all the claims is incorporated into the description by reference.

[0007] According to the present invention, the angle between the first direction and the second direction - which may also be referred to as "pattern angle" - deviates significantly, i.e. by at least 15°, from the exact orthogonal orientation (90° pattern angle) used in many prior art patterns. Also, where prior art patterns show a deviation of the relative orientations of first and second directions from an orthogonal orientation, these deviations are relatively small such that those patterns may be characterized as having a near-perpendicular relative orientation. In contrast, the patterns according to the present invention have pattern angles clearly differing from a perpendicular or near-perpendicular orientation. Surprisingly, a number of advantageous physical properties of embossed sheets may be obtained, particularly with respect to anti-slippage properties and noise generation under dynamic load conditions.

[0008] In some embodiments the angle between the first direction and the second direction (pattern angle) is between 66° and 74°, particularly at about 70°. In these embodiments, the pattern units frequently have two or more elongated reliefs arranged in parallel. In other embodiments the angle between the first direction and the second direction (pattern angle) is between 59° and 61°, particularly at about 60°. Those embodiments include,

but are not restricted to, special embodiments with pattern units having exactly one elongated relief.

[0009] A first class of embodiments is characterized by the fact that each pattern unit comprises two or more raised elongated reliefs arranged in parallel, and a first pattern unit is surrounded by four identical second pattern units. Considering the number of raised elongated reliefs per pattern unit these embodiments may be considered as "relatives" to the conventional Two Bar or Barleyseed or Five bar patterns, for example.

[0010] Such patterns may have three or four or five or more elongated reliefs arranged in parallel in a pattern unit. In preferred embodiment a pattern unit has exactly two identical elongated reliefs, providing both an attractive appearance and desirable physical properties, such as improved slip resistance and low noise level.

[0011] In some of these embodiments it has been found beneficial with respect to slip resistance and other properties if mutually adjacent elongated reliefs of a pattern unit (having two or more elongated reliefs arranged in parallel) are relatively offset parallel to the major axis by a length offset which is at least 10% of the length of an elongated relief. The length offset may be 15% or more, or 20% or more of the length of an elongated relief. In this arrangement, if viewed in a direction perpendicular to the major axes of the reliefs, the reliefs are not arranged directly in a row, but laterally offset relative to each other such that a barrier formed by the mutually adjacent reliefs is wider than a barrier formed by a single relief. A slip resistance in a direction perpendicular to the length direction may thereby be improved relative to prior art patterns without length offset between mutually adjacent elongated reliefs.

[0012] In some embodiments having two or more elongated reliefs arranged in parallel in a pattern unit mutually parallel major axes of elongated reliefs of second pattern units on opposite sides of a first pattern in the first direction are laterally offset parallel to the minor axes by a lateral offset which is at least 10% of the width of an elongated relief. The lateral offset may be more than 10%, for example at least 15% or at least 20% or at least 30% or at least 50% of the width of an elongated relief. This relative arrangement may contribute to providing improved slip resistance of the pattern particularly in directions parallel to or at a small angle with respect to the first and/or the second direction.

[0013] The significant deviation of the relative orientation of the first and second directions from an orthogonal relative orientation enables the relief structure on the embossed sheets to have a large variety of periodicity lengths in differing directions, which has been found to contribute to improve the anti-slipping properties of the structured surface and to lower the noise level generated e.g. when a wheeled vehicle, such as a fork lift, runs over the sheets.

[0014] In some embodiments the periodicity length of the repetitive pattern in the first or in the second direction is substantially greater than twice the length of the major

axis of the elongated reliefs in the respective directions. The periodicity length may be more than three or more than four or more than five times the length of the large axes, for example.

[0015] On the other hand, a periodicity length of the repetitive pattern along a bisecting line between the first and the second direction may be less than twice the length of the large axes.

[0016] A second class of embodiments is characterized by the fact that the pattern units further include third pattern units having third elongated reliefs having the major axis parallel to a third direction traverse to the first direction and the second direction, wherein a first pattern unit is surrounded by two identical second pattern units and two identical third pattern units. Preferably each pattern unit in these embodiments has exactly one raised elongated relief.

[0017] The third direction may be oriented at a 60° angle relative to both the first and the second direction such that the three directions are evenly distributed in angular space. Highly symmetric patterns with 3-fold or 6-fold rotational symmetry with respect to a rotation center may be obtained. Those patterns are highly aesthetic and have good physical properties

[0018] In preferred embodiments the elongated reliefs have a lenticular shape, i.e. a shape corresponding to a cross-section through a biconvex lens. A lenticular shape provides two pointed tips on both ends of the major axes. A relatively sharp or slightly rounded arcuate ridge may be formed along the major axis, providing improved slip resistance in directions parallel to or at a small angle to the minor axis. In terms of manufacturing the embossing cylinders, a lenticular shape of the relief or of a corresponding dish on the cylinder surface may be easier to manufacture by mechanical engraving than other shapes, such a semi-ovoidal shapes. However, shapes other than lenticular are possible. The shapes may include a semi-ovoidal shape, a diamond or lozenge shape, an almond shape and others.

[0019] The absolute dimensions of the pattern elements (reliefs on a sheet, dishes on an engraved embossing cylinder) may vary. In many applications it has been found useful if the length of the reliefs along the major axis is between 8 mm and 10 mm. The width along the minor axis may be varied, for example between 2.5 mm and 3.5 mm. Those patterns are found to be sufficiently coarse to provide good slip resistance, low noise and good cleanability, and sufficiently fine to be manufactured in high quality. Reliefs may be shorter than 8 mm or longer than 10 mm, and/or reliefs may be wider than 3.5 mm or narrower than 2.5 mm in special fields of application.

[0020] Embossed sheets may be manufactured with a variety of values for the relief height, which is defined here as the height of the vertex (highest point) of the relief relative to a top surface of the sheet adjacent to a relief. In other words: the relief height may be defined as the difference between the maximum thickness of a sheet

measured at a location on top of a relief and the thickness of an adjacent non-raised area. Preferably, the relief height is 0.3 mm or more. A minimum relief height in this order provides sufficient material in the raised portions even under prolonged wear conditions. On the other hand, provided a given base thickness of a sheet, the overall weight of an embossed sheet tends to increase as the maximum relief height increases. Therefore, it has been found useful if the relief height does not exceed 1.2 mm. Useful relief heights giving a good compromise between weight and wear resistance may be in the range from about 0.4 mm to about 0.6 mm, for example, particularly if a relative hard aluminium alloy, such as an Al-Mg alloy, is used as sheet material. In softer materials the maximum relief height is sometimes greater. For example, the relief height may be up to 1.6 mm or 1.7 mm or 1.8 mm or more.

[0021] Another parameter which may be varied to provide desired properties of the sheets is the proportion of embossed surface, which is defined here as the ratio between the area of the sheet covered by raised reliefs and the overall area of the surface covered with embossed reliefs.

[0022] In general it may be advantageous if the proportion of embossed surface is between 25% and 50%. Some physical properties, such as slip resistance, weight etc. may be relatively adjusted by the appropriate proportion of embossed surface.

[0023] In some embodiments, the proportion of embossed surface is more than 44%, for example between 45% and 50%. Those embodiments having relatively large proportion of engraved surface tend to have excellent anti-slipping properties and may therefore be used in applications where slip-and-fall hazard is particularly critical.

[0024] In other embodiments the proportion of engraved surface is between 35% and 44%. It has been found that these embodiments show a very good compromise between very good anti-slipping function of the structured surface, the weight of the sheet and the noise generated by the sheet under certain test conditions. Further, those sheets may be manufactured at great width (e.g. more than 2 m or more than 2.5 m), with only little or no formation of surface cracks during rolling.

[0025] In other embodiments the proportion of engraved surface is less than 35% and/or less than 30%, for example between 25% and 29%. Those embodiments feature a relatively small weight and noise, and a tendency to exhibit small cracks in the material due to the rolling process is further reduced. Anti-slippage properties may be less pronounced than in embodiments with higher proportion of engraved surface.

[0026] The previous and other properties can be seen not only in the claims but also in the description and the drawings, wherein individual characteristics may be used either alone or in sub-combinations as an embodiment of the invention and in other areas and may individually represent advantageous and patentable embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

- | | | |
|----|---------|--|
| 5 | Fig. 1 | shows a schematic plan view on an approximately quadratic portion of a first embodiment of an embossed sheet; |
| 10 | Fig. 2 | shows a schematic cross-section through an embossed sheet perpendicular to the sheet surfaces along a plane including a major axis of an elongated relief; |
| 15 | Fig. 3 | shows in 3A schematically a portion of an engraved surface of an embossing cylinder with a repetitive pattern and some characteristic dimensions thereof, in 3B a section through the cylinder surface along line A-A in Fig. 3A, and in 3C a schematic section along line B-B in Fig. 3A; |
| 20 | Fig. 4 | shows a plan view of an embossed sheet with a prior art Barley-corn pattern as a reference pattern; |
| 25 | Fig. 5 | shows a plan view of a representative portion of an embossed sheet according to a second embodiment of the invention; |
| 30 | Fig. 6 | shows a schematic plan view on an approximately quadratic portion of a third embodiment of an embossed sheet; |
| 35 | Fig. 7 | shows a schematic plan view on an approximately quadratic portion of a fourth embodiment of an embossed sheet. |
| 40 | Fig. 8 | shows a schematic plan view on an approximately quadratic portion of a fifth embodiment of an embossed sheet with pattern units having three reliefs; |
| 45 | Fig. 9 | shows a schematic plan view on an approximately quadratic portion of a sixth embodiment of an embossed sheet with pattern units having three reliefs; and |
| 50 | Fig. 10 | shows a schematic plan view on an approximately quadratic portion of a seventh embodiment of an embossed sheet with pattern units having only one relief, arranged in a pattern with 3-fold rotational symmetry. |

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0028] Fig. 1 shows a schematic plan view on an approximately quadratic portion of an embossed sheet S

according to a first embodiment having a proportion of embossed surface at about 40%. Fig. 2 shows a vertical section through the sheet along a plane including a major axis of a lenticular raised relief. The repetitive pattern of the sheet comprises a plurality of pattern units PU1 and PU2, where each pattern unit consists of exactly two identical raised elongated reliefs arranged in parallel, i.e. with parallel major axes. Each relief has a length L along a major axis and a width W smaller than the length along a minor axis perpendicular to the major axis (see Fig. 3A). Each of the single reliefs has a lenticular shape. The term "lenticular shape" refers to the shape of a cross-section through a biconvex lens. A lenticular shape is bound by two circular arcs joined their end points to form a pointed tip. In the embodiment, the arcs have equal radii, thereby forming a lenticular shape mirror symmetric to the major axis.

[0029] The pattern is composed by exactly two types of pattern units, namely first pattern units, PU1, and second pattern units, PU2. The shapes of the pattern units may be described as oblique hexagonal tiles with point symmetry relative to a center of a tile, but without mirror symmetry, as indicated by the dash-dotted lines. The tiles fill the area of the sheet without gaps. The first pattern units have first elongated reliefs R1 having their major axis parallel to a first direction D1, and the second pattern units have second elongated reliefs R2 having their major axis parallel to a second direction D2 oriented transverse to the first direction. With the exception of areas at the outer edge of a sheet, each first pattern unit is surrounded by four identical second pattern units, and vice versa. An acute angle α (pattern angle) included between the first direction and the second direction is about 70° in this embodiment. Both the first and second directions are oriented at an angle $\beta = 55^\circ$ relative to the rolling direction RD of the sheet.

[0030] The sheet is formed by a single metallic body formed by repeated rolling of a metal blank. The sheet is preferably formed from aluminum or an aluminum alloy, such as a relatively hard Al-Mg alloy. As seen in Fig. 2, the sheet S has a top surface TS and a bottom surface BS substantially parallel to the top surface in regions outside the raised reliefs R. A base thickness T defined as the distance between top surface TS and bottom surface BS is about 1.5 mm in the embodiment. The base thickness may vary depending on the purpose for which the sheet is used. In sheets used for heavy duty flooring applications the base thickness may range from about 1 mm to about 3 mm, for example.

[0031] The raised reliefs R are formed integral with the sheet during a final rolling pass and protrude over the top surface up to a pattern height H defined as the difference between the maximum thickness of the sheet in the area of the vertex V of a raised portion, and the thickness of an adjacent non-raised area, i.e. the base thickness T of the sheet. The three-dimensional shape of the raised relief is characterized by an U-shaped or arcuate cross-section along the major axis (as seen in Fig. 2) and

a substantially V-shaped cross-section along the minor axis perpendicular thereto.

[0032] The size and shape of the raised reliefs are generally determined by the size and shape of engraved dishes of the engraved embossing cylinder used to roll the sheet metal. Figure 3B shows a cross-section through a concave dish DI on the corresponding embossing cylinder. The cross-section in the width direction (minor axis) may be characterized by an angle A_V included between the flanks of the dish in the middle along the major axis. This angle is about 61° to 62° in the embodiment of Fig. 3B and may range, for example, between 55° and 70° . The bottom of the dish may be rounded in the width direction as a result of the manufacturing process. A radius of curvature, R_V , may be in the order between 0.3 mm and 1.0 mm for example, with $R_V = 0.8$ mm in the embodiment. The depth H' of the dish is about 1.75 mm.

[0033] The length L of the reliefs (corresponding to length L' of the dishes) is about 9 mm in the embodiments. The length may vary, for example between 8 mm and 10 mm depending on the desired use of the sheet. The width W of the reliefs (corresponding to width W' of the dishes) is about 3 mm in the embodiment. The width may vary, for example between about 2 mm and 4 mm. A relief may be characterized by a length ratio L/W, which is about 3.1 in the embodiment. The length ratio may vary, for example between about 5 for relatively "slim" reliefs (see Fig. 7) and about 2 to 3 for relatively "thick" reliefs (see e.g. Fig. 5). The proportion of embossed surface may be adjusted by setting appropriate dimensions for length L, width W, length ratio L/W, the shape of the reliefs and their density per unit area. The proportion of embossed surface is about 43.3% in a structured sheet embossed with a pattern according to Fig. 3A.

[0034] If the material of the sheet metal is relatively soft prior to rolling, such as in low alloy Aluminum, the ductile material may fill the dish more or less completely during rolling such that the shape of the raised relief corresponds closely to the negative of the shape of the dish. Harder materials, such as Al-Mg alloys used for heavy duty flooring materials, generally do not fill the entire dish during rolling. This is schematically indicated in Fig. 3B by the sheet S, which forms a raised relief R during rolling. The outline of the relief is lenticular, having the same dimensions L and W as the dish. However, the relief height H is smaller than the height (or maximum depth) H' of the dish, and a relatively sharp ridge may form on the relief despite the radius R_V at the bottom of the dish. While H' = 1.75 mm in the embodiment, the relief height H of the raised relief is about 0.4 mm to 0.5 mm only. These dimensions have been found beneficial for the desired anti-slippage properties of the sheets. Further, the overall weight of the sheets is moderate, and cleaning of the sheets is relatively easy as the raised reliefs are not too high. Further, the relatively shallow structure of the reliefs shows good resistance against mechanical wear.

[0035] A shape of the dishes generally in accordance with this description has proven to be particularly easy

to manufacture by mechanical carving of the embossing cylinder surface, which reduces overall cost of the manufacturing process.

[0036] Some remarkable features of the repetitive pattern are now explained in connection with Fig. 4 and 5. Fig. 5 shows a portion of a pattern of a second embodiment similar to that of Fig. 1, having the same length $L=9$ mm but a smaller length ratio $W/L=3$. The proportion of embossed surface is about 47%. Fig. 4 shows a photographic representation of a prior art Barleyseed pattern taken from standard EN 1386:1994, page 4, Fig. 4. Both patterns are repetitive patterns comprising a plurality of pattern units, where each pattern unit has exactly two identical elongated reliefs arranged in parallel. There are first and second pattern units, wherein the first pattern units extend with their major axis in a first direction, and the second units extend with their major axis in the second direction transverse to the first direction. Each first pattern unit is surrounded by four identical second pattern units, and vice versa.

[0037] A first evident difference is the pattern angle α included between the first and second directions. The pattern angle is about 80° for the Barleycorn pattern (Fig. 4), whereas the pattern angle is substantially smaller in the embodiment of Fig. 5, the pattern angle α being about 70° .

[0038] The Barleycorn pattern resembles in appearance a double-threaded weaving pattern or basket work because, starting from a central pattern (encircled) the surrounding patterns in one direction appear to follow straight parallel lines, as indicated by the parallel lines in Fig. 4. The single elongated reliefs in every other pair of two parallel reliefs are arranged on the same straight line, similar to a thread in a weaving pattern or to a single strand of a wicker twig in a basket work.

[0039] In contrast, the pattern of the embodiment shown in Fig. 5 does not have this characteristic feature. Instead, starting from a central pattern (circle), which can be arbitrarily chosen, the patterns lying at an oblique (70°) angle relative to the reliefs orientation of the central pattern, do not lie on common straight lines. Instead, if parallel straight lines are drawn lengthwise through the single reliefs forming a pair of parallel reliefs lying on the upper left-hand side of the central pattern, the corresponding pair of lenticular reliefs on the lower right-hand side is laterally offset with respect to the parallel lines drawn through the reliefs positioned at the upper left side of the central pattern. The arrows in Fig. 5 indicate the amount of lateral offset LAO. In other words: mutually parallel major axes of elongated reliefs of second pattern units on opposite sides of a first pattern unit in a first direction are laterally offset parallel to the minor axis by a lateral offset LAO, which is more than 50% larger than the width of the elongated reliefs. In the embodiment, the lateral offset LAO is in the order of the width W of the lenticular reliefs.

[0040] In the Barleyseed pattern (Fig. 4) the pairs of lenticular reliefs in every other pair of two parallel reliefs

in a certain direction may be considered as forming something like a track along which an object pressed onto the structured surface may slide in the direction of the major axes. No such tracks are formed on the structured surface of Fig. 5. It is believed that the absence of tracks of this type contributes to an increased slip resistance provided by sheets structured with a lateral offset as explained above.

[0041] Further, in the prior art a Barleycorn pattern, the reliefs of a pattern unit repeat in every other pair of lenticular reliefs, resulting in a relatively short periodicity length along a first or a second direction. In contrast, the new pattern has relatively large periodicity lengths in the directions parallel to the longer axes of the lenticular reliefs, i.e. in the direction parallel to the first or second direction.

[0042] Further, mutually adjacent elongated reliefs of a pattern unit are relatively offset parallel to the major axis by a length offset LEO best seen as indicated in Fig. 3. In the embodiment, the length offset LEO is about 25% of the length L of a single relief. As a consequence, each pair of single reliefs of a pattern unit when seen in a direction perpendicular to the respective major axis has a larger effective width than in a case where little or no length offset LO exists such that the reliefs are more or less arranged in line. It is believed that this feature contributes to increased slip resistance in directions perpendicular to the first or second direction.

[0043] Further, there is a relatively short periodicity length of the repetitive pattern along a bisecting line BI arranged symmetrically between the first and the second directions, and perpendicular to the rolling direction RD, as indicated in Fig. 3. The periodicity length in this direction is less than twice the length of a single relief. Further, when seen in the direction of the bisecting line, the lenticular reliefs arranged alternately in the first and in the second direction form a pattern resembling a tractor track, which is also believed to improve slip resistance in the respective direction. Further, it is believed that the variety of periodicities present in these patterns is effective against noise generation when a wheeled device, such as a fork lift, runs over the sheet during use.

[0044] The pattern comprising a plurality of raised reliefs on a surface of the sheet is obtained by rolling with an engraved cylinder bearing the concave negative shapes of the lenticular reliefs of the sheet on its cylinder surface. Fig. 3B and 3C show a respective vertical sections through the cylinder surface of the embossing cylinder CY parallel to the minor axis of a lenticular dish (Fig. 3B) and parallel to the major axis of an elongated dish (Fig. 3C). The lenticular shape of the concave dishes is easily generated in a previously undisturbed cylindrical surface by mechanically carving the respective shape in the cylinder surface. Cylinders made of hardened steel to form the cylinder surface may be used, providing a long service life time of an embossing cylinder. It is possible to use embossing cylinders having relatively great widths to engrave large sheets having widths of 2 m or

more, or even 2.5 m or more.

[0045] Embossed sheets according to embodiments of the invention may be manufactured at moderate costs with high quality. The sheets may be used for decorative purposes, if desired. Engraved sheets may also be used in flooring applications. For example, an engraved sheet having a width large enough to cover the entire width of a truck loading room may be used in the manufacture of refrigerated trucks to provide a crack-free wall-to-wall flooring providing excellent slip resistance under all conditions (frozen, wet or dry) and further combining sufficient wear resistance and relatively light weight. Further, those sheets can be cleaned easily by high pressure cleaning fluids and/or by scrubbing. In addition, sheets should be relatively "silent" under use conditions, which may be particularly important for health of workers engaged in loading/unloading activities in closed environments, such as in a cargo bay of a refrigerated truck.

[0046] Embossed sheets according to the general teaching of the invention may be manufactured to meet different sets of requirements depending on the intended use. For example, where excellent slip resistance is desired, it may be desirable to use a pattern with relatively large proportion of engraved surface. In the embodiment of Fig. 5, the proportion of the engraved surface is about 47%, giving good wear resistance and excellent anti-slip properties. In the embodiment of Fig. 6 the lenticular reliefs have the same length as in the previous embodiment, but a smaller width. With the pattern angle between the first and second direction being the same as in the previous embodiment ($\alpha = 70^\circ$), the proportion of engraved surface is reduced to be about 35% in this embodiment. An excellent compromise between wear resistance and weight combined with good anti-slip properties may be obtained. Slip resistance may be improved by increasing the percentage of engraved surface, which is about 40% in the embodiment of Fig. 1. Where weight of the sheet is an issue, even less material can be provided in the raised reliefs, thereby reducing the weight of a unit area of the sheet. In the embodiment of Fig. 7, the proportion of engraved surface is about 28%. While the length of the single reliefs is the same as in the previous embodiments (about 9 mm), the width is further reduced. The figures are drawn to scale, therefore dimensions may be taken from the figures.

[0047] Embodiments with pattern units having a plurality of elongated reliefs arranged in parallel are not restricted to embodiments having exactly two reliefs. Figures 8 and 9 show plan views of embodiments of patterns where each pattern unit PU1 and PU2 has three identical lenticular elongated reliefs arranged in parallel. Similar to the above embodiments having two reliefs in a pattern unit, the identical reliefs in a single pattern unit are offset with respect to each other parallel to the length direction (direction of the major axis) by a length offset LEO, and a variety of periodicities are found in different direction across the surface of the embossed sheets. In the embodiment of Fig. 8, the pattern angle α between the first

direction D1 and the second direction D2 is about 72.5° . The percentage of engraved surface of the cylinder, corresponding to the proportion of raised reliefs in the embossed sheet, is about 41.6%. In the embodiment of Fig. 9, the proportion of raised reliefs is the same as in the embodiment of Fig. 8, but the pattern angle α between the first and second directions D1 and D2 is significantly smaller, the pattern angle being about 54° in the embodiment. It is evident that the length offset LEO becomes larger the smaller the pattern angle becomes. The dimensions of the single lenticular reliefs may be the same as in the other embodiments, or may be different.

[0048] Fig. 10 shows a plan view of a seventh embodiment of an embossed sheet with a highly symmetric pattern of raised reliefs, the pattern having a three-fold or six-fold rotational symmetry depending on the choice of location of the center of rotational symmetry. Like the other embodiments, the pattern units include first pattern units PU1 having first reliefs R1 having the major axis along a first direction D1, and second pattern units PU2 having second reliefs R2 having their major axis parallel to a second direction D2 oriented at a non-perpendicular angle (60°) relative to the first direction D1. Additionally, the pattern has third pattern units PU3 having third elongated reliefs R3 having their major axis parallel to a third direction D3 transverse to the first and second directions D1, D2. As indicated by dashed lines, each pattern unit has the shape of a rhombus with the interior angles in the length direction being 60° and the interior angles in the width direction being 120° . The rhombohedral pattern units fill the entire area in the manner of tiles. Each first pattern unit PU1 is enclosed by two second pattern units PU2 directly adjacent to the first pattern unit on either side in the third direction D3, and by two third pattern units directly adjacent to the first pattern unit on either side in the second direction D2. The angles between the first and second directions D1, D2, and between the second and third directions D2, D3 are exactly 60° . Each pattern unit has only one elongated relief R1 (for the first pattern units), R2 (for the second pattern units) and R3 (for the third pattern units). The pattern has a floral appearance, which is particularly suitable for decoration purposes, for example. Further, the ridges running along the length direction of the elongated reliefs form barriers in three directions, giving very good anti-slip properties of the embossed sheet.

[0049] The above description of the preferred embodiments has been given by way of example. From the disclosure given, those skilled in the art will not only understand the present invention and its attendant advantages, but will also find apparent various changes and modifications to the structures and methods disclosed. It is sought, therefore, to cover all changes and modifications as fall within the spirit and scope of the invention, as defined by the appended claims, and equivalents thereof.

[0050] The content of all the claims is made part of this description by reference.

Claims

1. An embossed sheet with a repetitive pattern comprising a plurality of pattern units, each pattern unit comprising one or more raised elongated reliefs, an elongated relief having a length along a major axis and a width smaller than the length along a minor axis perpendicular to the major axis, the pattern units including first pattern units (PU1) having one or more first elongated reliefs (R1) having the major axis parallel to a first direction (D1), and one or more second pattern units (PU2) having second elongated reliefs (R2) having the major axis parallel to a second direction (D2) oriented traverse to the first direction, wherein a first pattern unit is surrounded by an even number of identical second pattern units, **characterized in that** an angle between the first direction (D1) and the second direction (D2) is between 50° and 75°.
2. The embossed sheet according to claim 1, wherein each pattern unit comprises two or more raised elongated reliefs arranged in parallel, and a first pattern unit (PU1) is surrounded by four identical second pattern units (PU2), wherein preferably each pattern unit (PU1, PU2) has exactly two identical elongated reliefs.
3. The embossed sheet according to claim 1 or 2, wherein the angle between the first direction (D1) and the second direction (D2) is between 66° and 74°, particularly at about 70°.
4. The embossed sheet according to claim 2 or 3, wherein mutually adjacent elongated reliefs of a pattern unit are relatively offset parallel to the major axis by a length offset (LEO), which is at least 10% of the length of an elongated relief, wherein preferably the length offset is more than 20% of the length of an elongated relief.
5. The embossed sheet according to one of claims 2 to 4, wherein mutually parallel major axes of elongated reliefs (R2) of second pattern units (PU2) on opposite sides of a first pattern unit (PU1) in the first direction (D1) are laterally offset parallel to the minor axis by a lateral offset (LAO) which is at least 10% of the width of an elongated relief, wherein preferably the lateral offset is at least 50% of the width of an elongated relief.
6. The embossed sheet according to one of claims 2 to 5, wherein a periodicity length of the repetitive pattern in the first direction (D1) or in the second direction (D2) is substantially greater than twice the length (L) of the major axis of the elongated reliefs in the respective direction, and/or wherein a periodicity length of the repetitive pattern along a bisecting line (BI) between the first direction (D1) and the second direction (D2) is less than twice the length (L) of the major axis of an elongated relief.
7. The embossed sheet according to claim 1, wherein the pattern units further include third pattern units (PU3) having third elongated reliefs (R3) having the major axis parallel to a third direction (D3) traverse to the first direction (D1) and the second direction (D2), wherein a first pattern unit (P1) is surrounded by two identical second pattern units (PU2) and two identical third pattern units (PU3), wherein preferably each pattern unit comprises exactly one raised elongated relief (R1, R2, R3).
8. The embossed sheet according to claim 7, wherein the angle between the first direction (D1) and the second direction (D2) is 60°, and the third direction (D3) is oriented at an angle of 60° relative to both the first direction (D1) and the second direction (D2).
9. The embossed sheet according to one of the preceding claims, wherein the elongated reliefs (R1, R2, R3) have a lenticular shape, wherein preferably an elongated relief has a substantially U-shaped cross section along the major axis and a substantially V-shaped cross section along the minor axis.
10. The embossed sheet according to one of the preceding claims, wherein the length of the elongated reliefs (R1, R2, R3) along the major axis is between 8 mm and 10 mm and/or wherein the width of the elongated reliefs (R1, R2, R3) along the minor axis is between 2.5 mm and 3.5 mm.
11. The embossed sheet according to one of the preceding claims, wherein the elongated reliefs (R1, R2, R3) have a relief height (H) smaller than 1.2 mm, wherein preferably the relief height is between 0.4 mm and 0.6 mm.
12. The embossed sheet according to one of the preceding claims, wherein a proportion of embossed surface is between 25% and 50%, wherein preferably the proportion of embossed surface is between 35% and 44%.
13. An engraved cylinder (CY) for embossing sheets, the cylinder comprising a cylinder surface having a repetitive pattern comprising a plurality of pattern units, each pattern unit comprising one or more concave elongated dishes (DI), an elongated dish having a length (L') along a major axis and a width (W') smaller than the length along a minor axis perpendicular to the major axis, the pattern units (PU1) including first pattern units having one or more first elongated dishes having the

major axis parallel to a first direction (D1), and one or more second pattern units (PU2) having second elongated dishes having the major axis parallel to a second direction oriented traverse to the first direction, wherein a first pattern unit is surrounded by an even number of identical second pattern units, **characterized in that** an angle between the first direction (D1) and the second direction (D2) is between 50° and 75°.

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14. The engraved cylinder according to claim 13, wherein the dishes (D1) are formed by mechanically engraving the cylinder surface.

15. The engraved cylinder according to claim 13 or 14, wherein the dishes on the embossing cylinder are dimensioned and distributed to emboss an embossed sheet according to one of claims 1 to 12.

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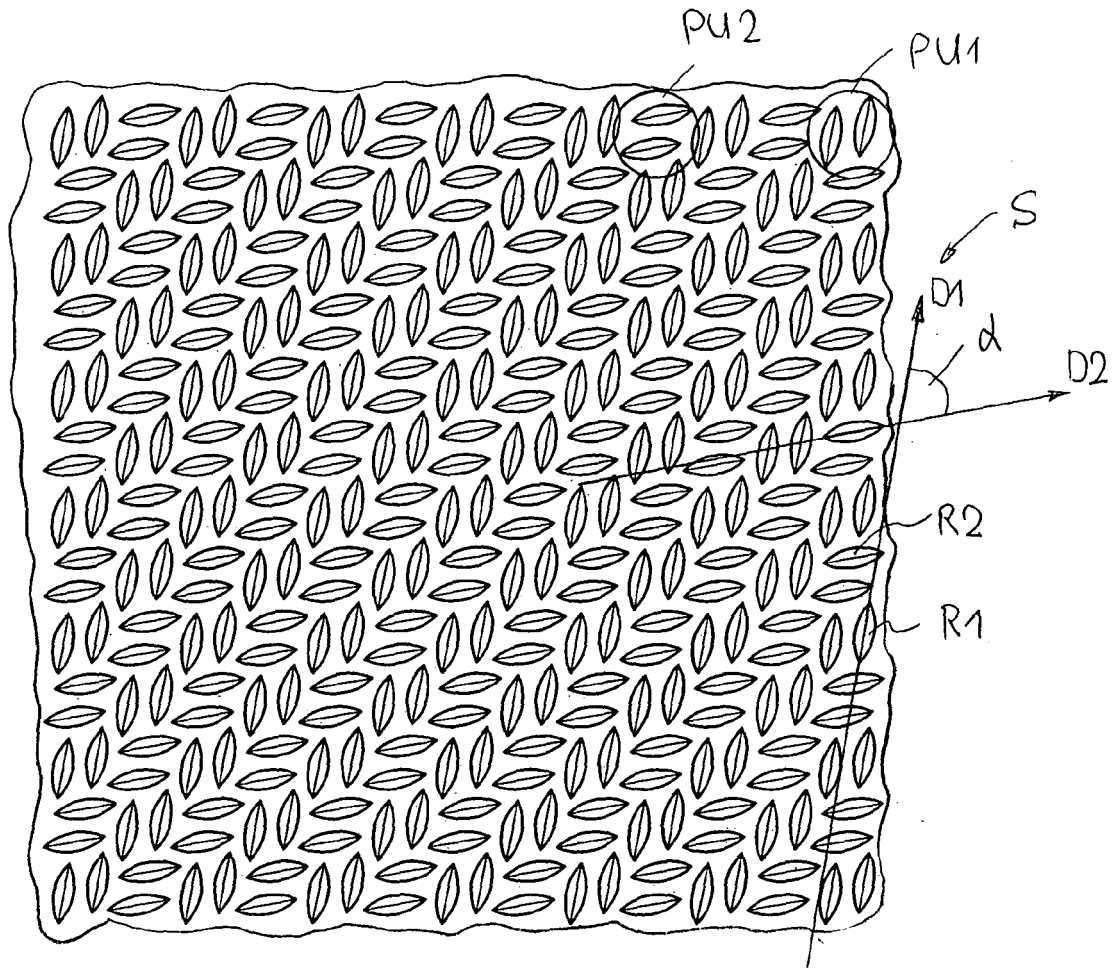


Fig. 1

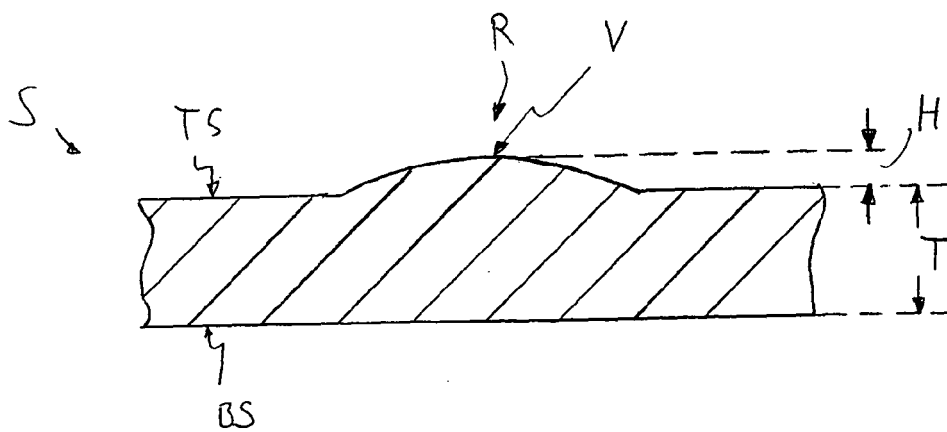
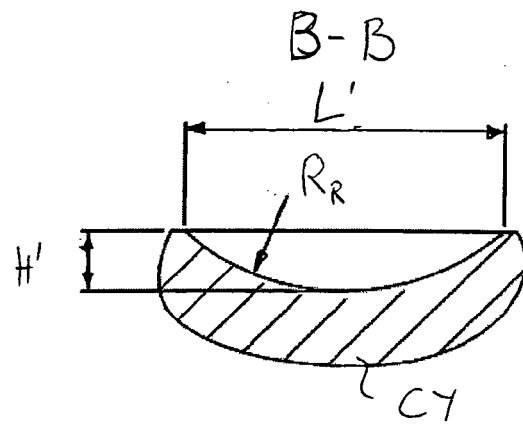
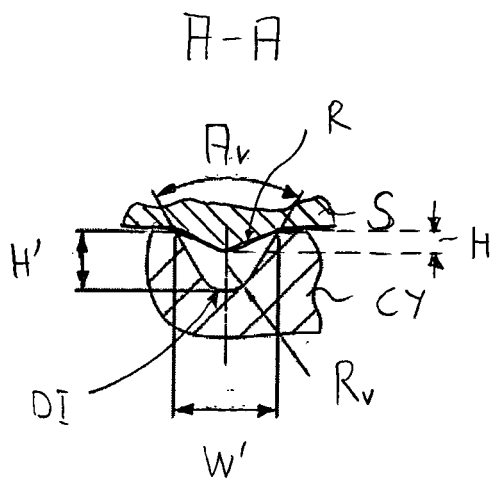
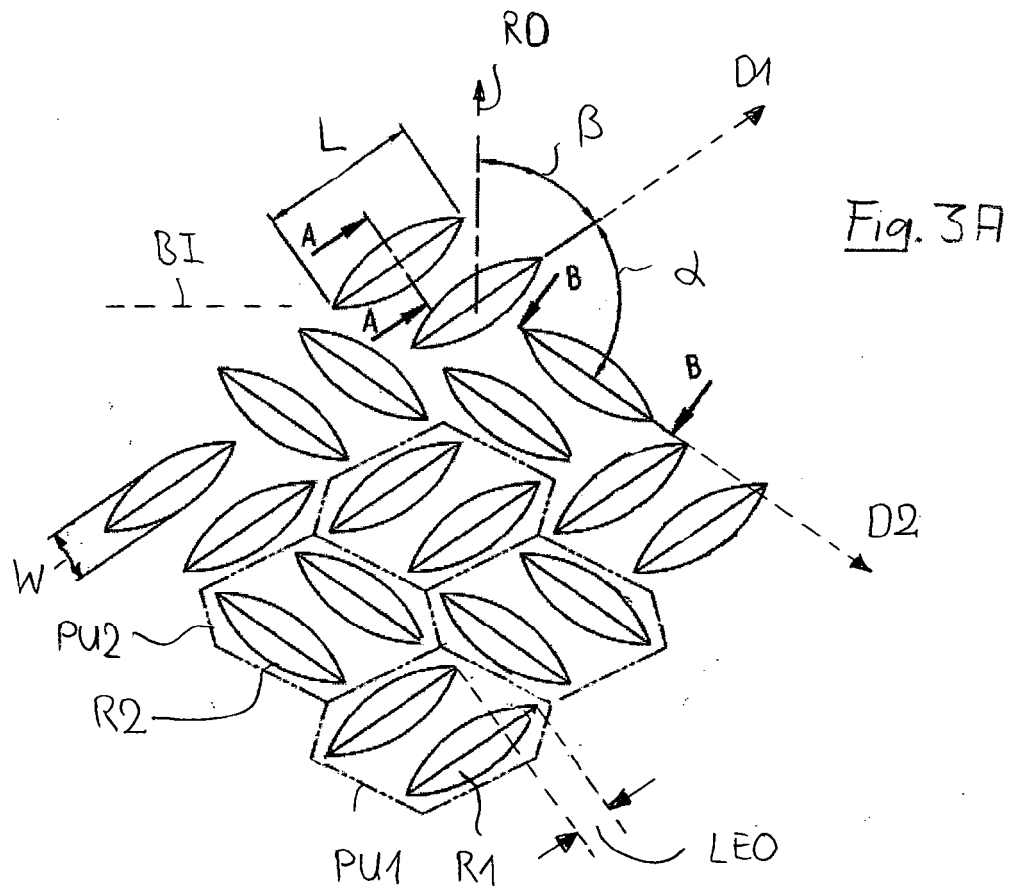


Fig. 2



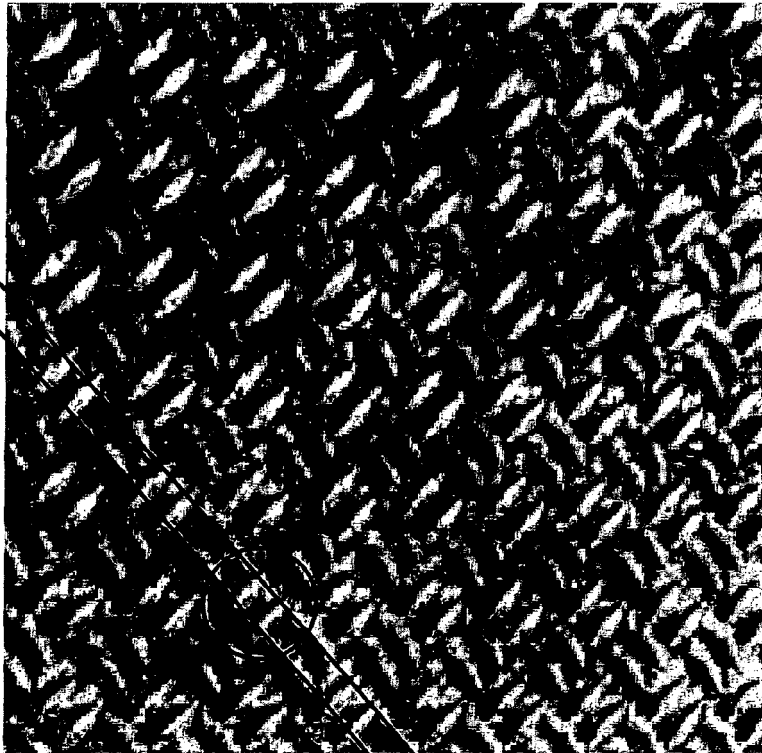
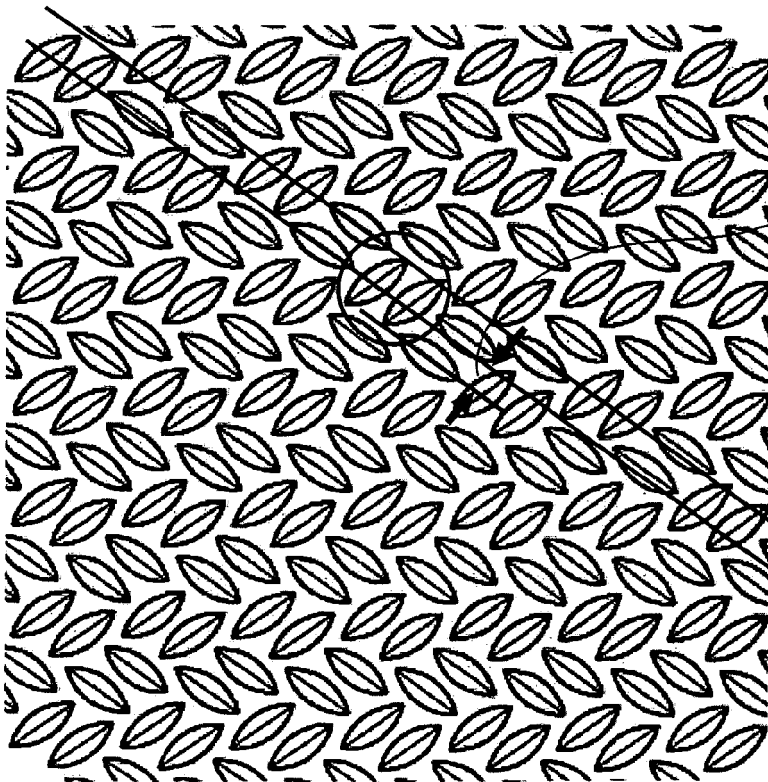


Fig. 4
(PRIOR ART)



LAO

Fig. 5

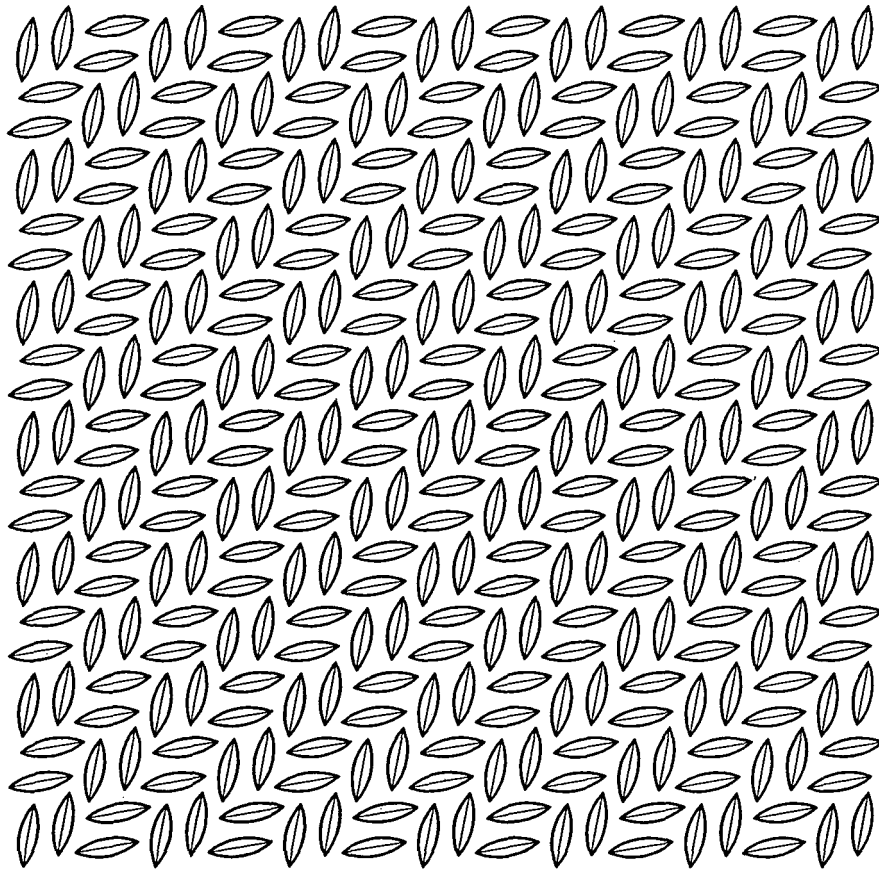


Fig. 6

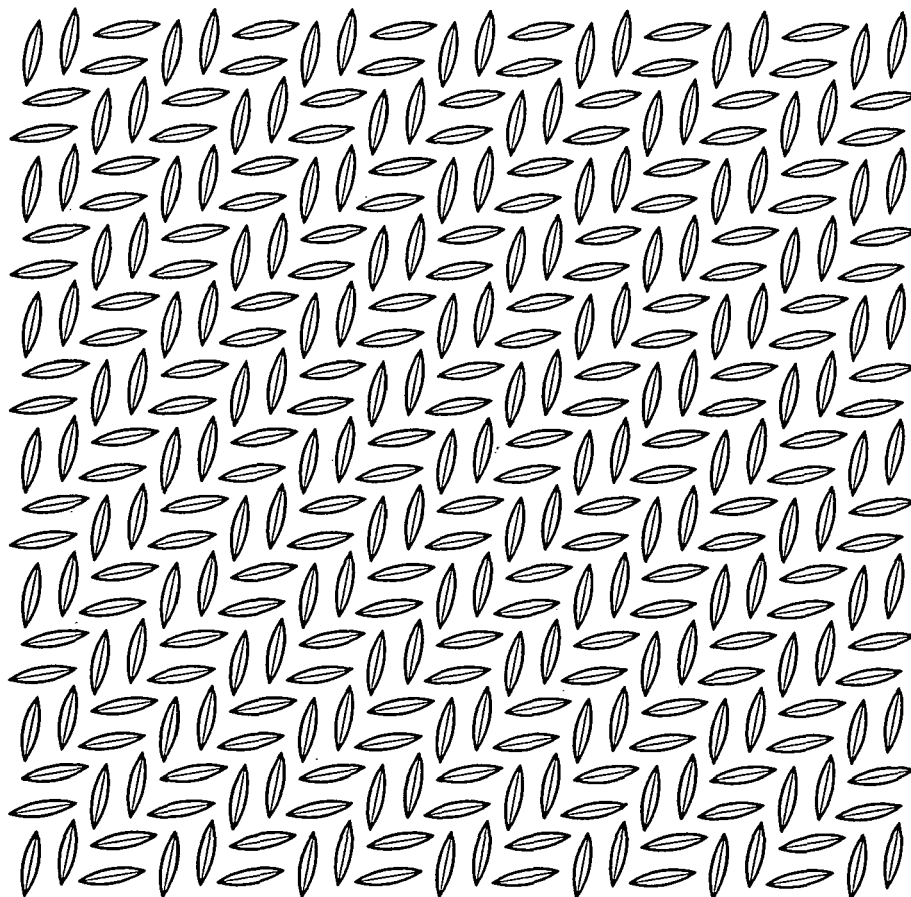
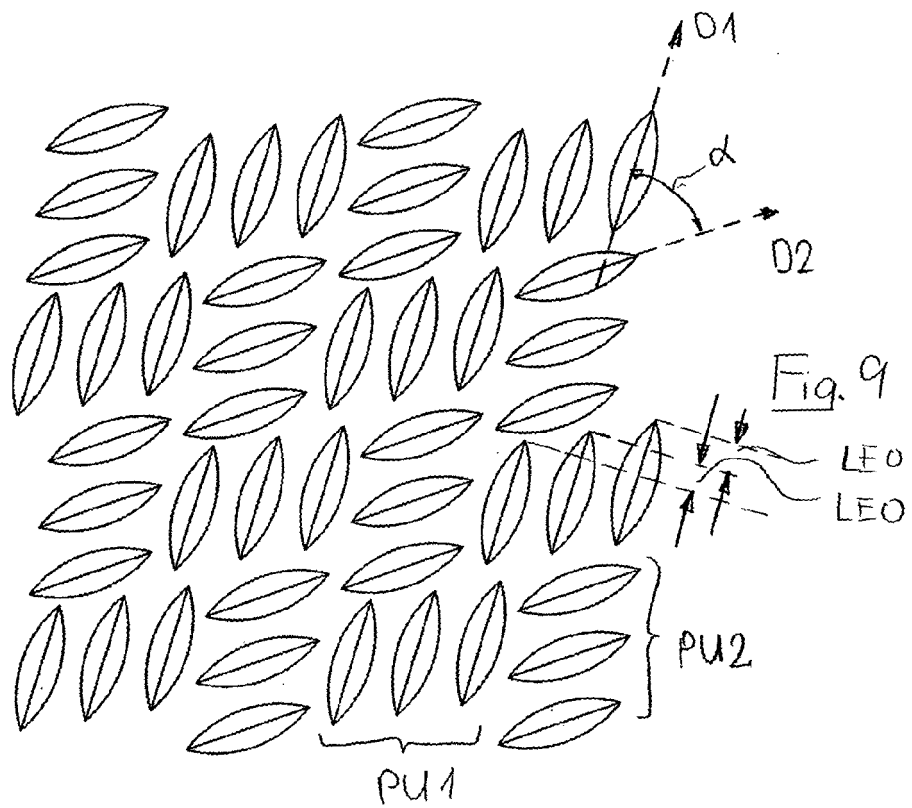
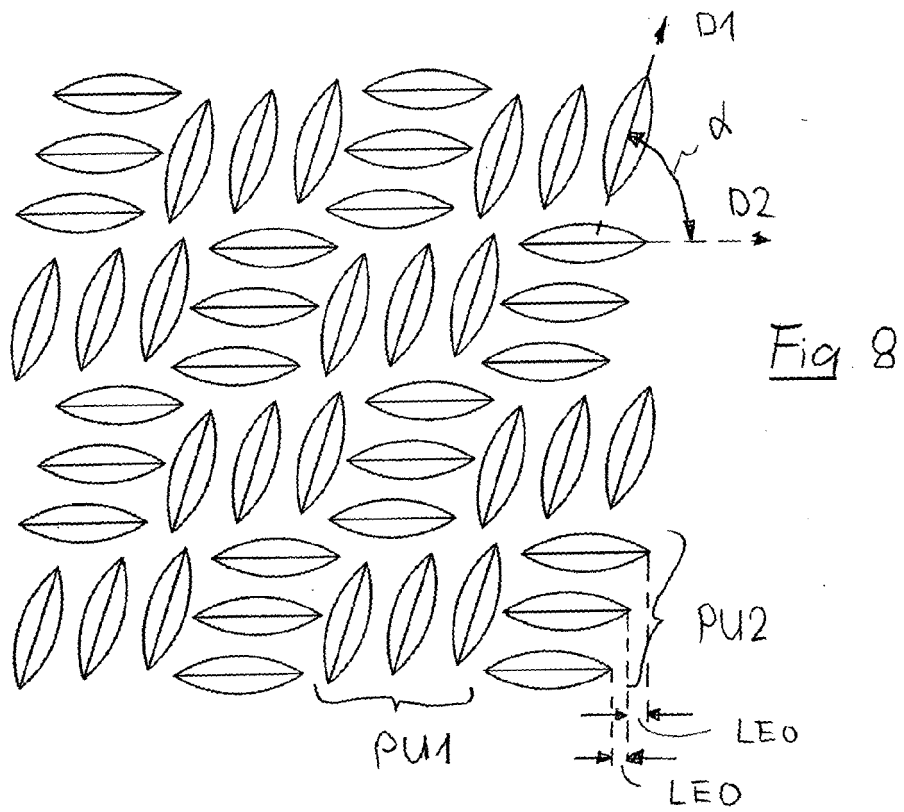


Fig. 7



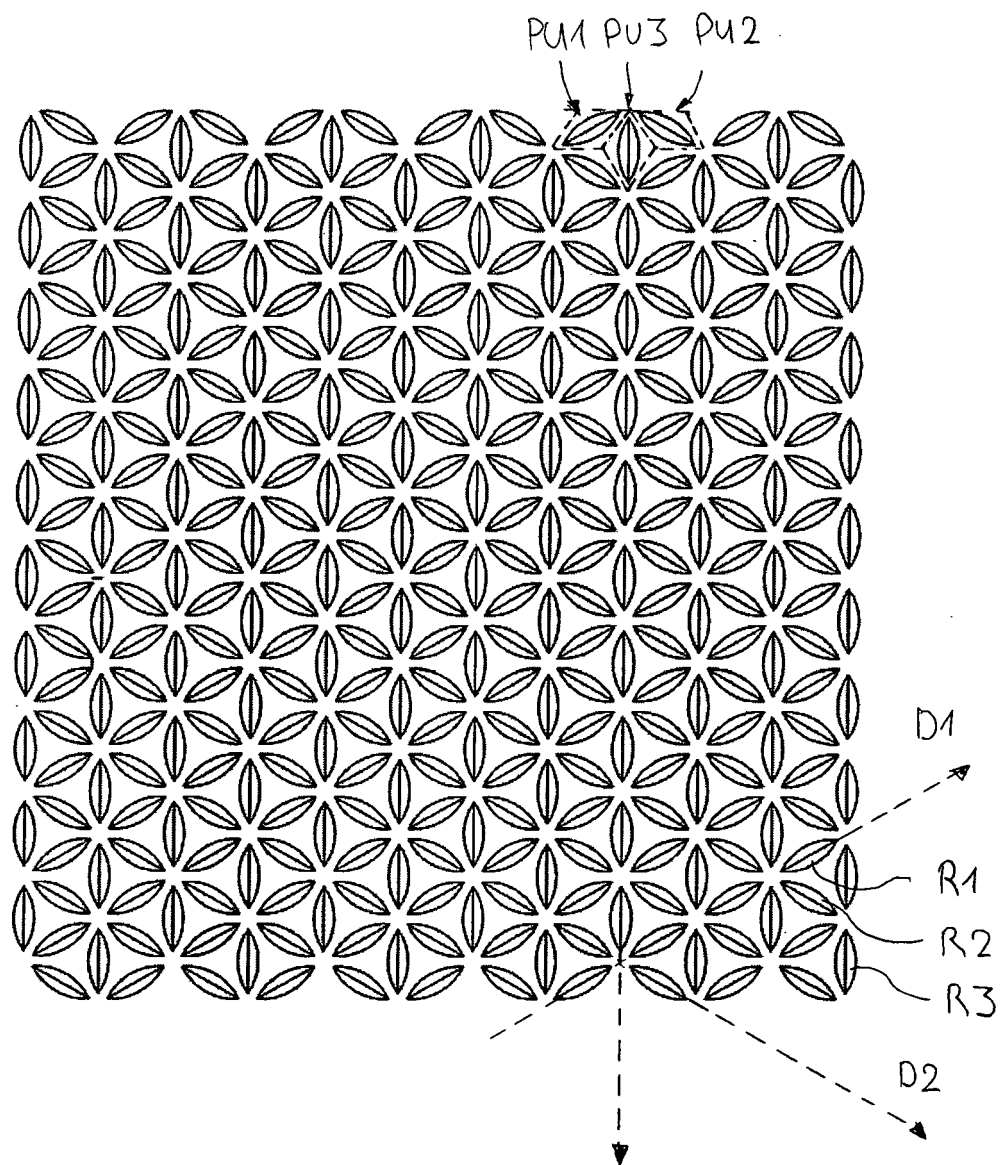


Fig. 10



EUROPEAN SEARCH REPORT

Application Number
EP 09 01 3567

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	DE 94 11 626 U1 (VIESSMANN GMBH & CO [DE]) 27 October 1994 (1994-10-27)	1,3-6, 11,12	INV. B21H7/00
Y	* the whole document *	13-15	B21H8/00
	-----		B21B1/22
Y	DE 297 06 241 U1 (PECHINEY RHENALU [FR]) 22 May 1997 (1997-05-22)	13-15	B21B27/00
A	* the whole document *	1,2,6,9, 10,12	E04F15/06

A	US 3 627 502 A (REES WILLIAM H ET AL) 14 December 1971 (1971-12-14) * column 2, line 37 - column 4, line 72; figures 1-8 *	1,13-15	

A	WO 2006/029429 A1 (AMAG ROLLING GMBH [AT]; PRENNER MICHAEL [AT]; STECKENBAUER HERMANN [AT]) 23 March 2006 (2006-03-23) * page 1, paragraph 1 - page 2, paragraph 1 *	1,13	

			TECHNICAL FIELDS SEARCHED (IPC)
			B21H B21B E04F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 30 March 2010	Examiner Ritter, Florian
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			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 01 3567

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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30-03-2010

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 9411626	U1	27-10-1994	NONE	

DE 29706241	U1	22-05-1997	FR 2747948 A1	31-10-1997
			GB 2312693 A	05-11-1997
			IT MI970298 U1	26-10-1998

US 3627502	A	14-12-1971	NONE	

WO 2006029429	A1	23-03-2006	AT 389473 T	15-04-2008
			AT 501464 A4	15-09-2006
			EP 1789214 A1	30-05-2007
			ES 2303686 T3	16-08-2008
			SI 1789214 T1	31-08-2008

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 2312693 B [0004]