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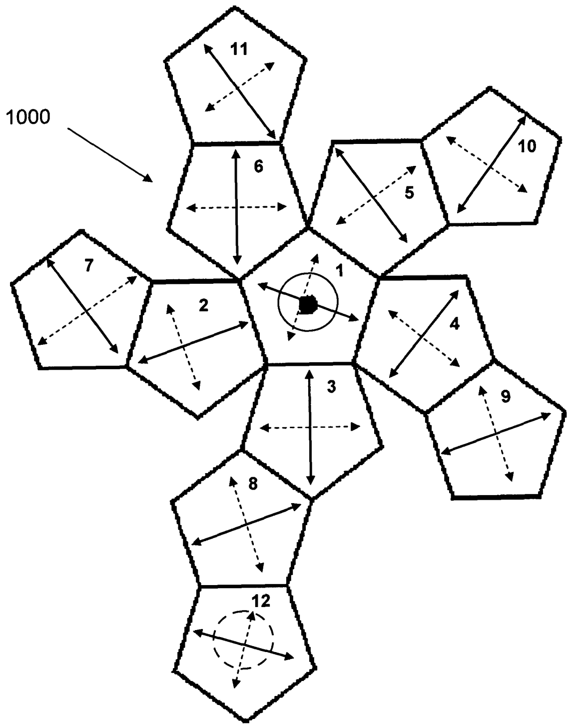
(54) Carcass for a ball

(57) The invention relates to a carcass (1000) for a ball, in particular a ball for ball games. The carcass (1000) comprises several panels (100) which are connected to each other, wherein each panel (100) comprises at least one preferred strain direction (200, 300), wherein the elasticity modulus of a panel (100) is greater in the preferred strain direction (200, 300) than in other directions. The panels (100) of the carcass (1000) are arranged relative to each other so as to exclude an orientation of a pair of adjacent panels (100) where each panel (100) of this pair has a preferred strain direction (200, 300) which is perpendicular to the connection line (400) between the two adjacent panels (100).

Fig. 6

(a)



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Description

1. Technical field

[0001] The present invention relates to a carcass, in particular to a carcass for a ball.

2. The prior art

[0002] There are essentially two types of inflatable balls for ball games, stitched balls and laminated balls. In addition to an inflatable bladder and an outer layer of the ball, a carcass is often provided as a reinforcing layer in between the bladder and the outer layer. In the case of stitched balls (either hand stitched or machine stitched), where the outer layer panels are sewn together, there is typically a substantial variation in the seams between the panels and therefore in the recesses between adjacent panels. This may lead to deviations from the required spherical shape and can negatively impact the behavior of the ball during a game. Additionally, the inhomogeneity of the stitching of the panels often reduces the long-term stability of the ball.

[0003] For laminated balls, the outer panels (made of leather or synthetic leather) are attached to the carcass using a lamination process. Due to the automated manufacturing process, the shape of laminated balls is very close to a spherical shape. Furthermore, size, weight, and deformation characteristics of laminated balls can be easily adjusted. As a result, these balls typically have good long term form stability.

[0004] Regardless of the specific manufacturing process for the ball (stitched or laminated), it is the general objective of the carcass to maintain the quality of a ball (weight, size, spherical shape, durability, form stability, etc.) over a long lifetime.

[0005] A reinforcing carcass may be manufactured from a nylon thread having a length of several kilometers by random winding of the fibre around the bladder of the ball. As described in the US 4,333,648, rubber fibers or fibers from elastic materials may also be used. Balls containing such a carcass have a significantly longer lifetime. However, the manufacturing of such a wound layer is complex and the form stability for longer time periods is limited due to the inhomogeneity of the random winding of the fiber.

[0006] Figures 4a and 7 (left part) show a two-dimensional (2D) representation of a different type of carcass according to the prior art, which is composed of twelve pentagonal two-layered fabric pieces. Further, the US 2006/0084536 describes a manufacturing process for a carcass which is composed of twelve regular pentagons and wherein a single panel comprises two layers of woven material. The application discloses a method for manufacturing a carcass, wherein the marginal edges of all seams are inwardly directed to the bladder.

[0007] In the article "*The dependency of hollow ball deformation on material properties*", published in the proceedings of the ABAQUS User's Conference 2006, detailed investigations of the deformation and the rebound characteristics of a ball having such a carcass made from panels of woven material are described. It is described that under certain conditions the ball shows inhomogeneous rebound characteristics despite its nearly perfect spherical form. The article suggests that this is caused by an anisotropic strain characteristic of the carcass' woven material. However, no solutions are presented as to how the inhomogeneous rebound characteristics could be improved.

[0008] The present invention is based on the problem to obtain an improved reaction performance of the ball under all usage conditions, even if the material from which the carcass is formed has different numerical values for the elasticity modulus or Young's modulus (the relationship between the tensile force and the elongation at the deformation of a solid state body within its linear elastic region) along different directions.

3. Summary of the invention

[0009] According to a first aspect of the invention, this problem is solved by a carcass of claim 1. In one embodiment, the carcass comprises several panels which are connected to each other. Each panel comprises at least one preferred strain direction, wherein the elasticity modulus of the panel is greater in the preferred strain direction than in other directions. The panels of the carcass are arranged relative to each other so as to exclude an orientation of a pair of adjacent panels where each panel of this pair has at least one preferred strain direction which is perpendicular to the connection line between the two adjacent panels.

[0010] The preferred embodiment of the invention shows an improved homogeneous strain characteristic in the region of the connection lines of the panels compared to a carcass having panels with randomly distributed orientations. In particular, the disclosed embodiment avoids the very stiff areas which can occur in a case where each panel in an adjacent pair has at least one preferred strain direction which is perpendicular to the connection line between the two adjacent panels. Therefore, for a given set of preferred strain directions of the individual panels, the homogeneity of the carcass strain characteristics is optimized over the whole surface of the ball. Inserting a carcass manufactured according to a preferred embodiment into a ball improves the reaction characteristics of the ball compared to a ball having a conventional carcass. This improvement is based on the invention and is realized without any negative influence on other ball parameters.

[0011] In a preferred embodiment, the panels of the carcass have two preferred strain directions, for example if the panels comprise a woven material. Natural fibers, plastic fibers or a combination of both can be used as starting materials. The strain characteristics of the woven material, e.g. the elasticity modulus, can be adjusted by choosing suitable starting materials.

[0012] In a further preferred embodiment, the preferred strain directions of the woven materials are parallel to the directions of the warp and the weft. The elasticity modulus in the warp and the weft directions can be adjusted to be substantially equal by appropriate selection of the fibers for the warp and the weft.

[0013] In a particularly preferred alternative embodiment, the panels of the carcass comprise two layers of woven material, an upper layer and a lower layer. The two layers of the woven material are arranged so that the warp direction of the upper layer is substantially perpendicular to the warp direction of the lower layer. This leads to a substantially equal elasticity modulus for both preferred strain directions.

[0014] The inventive principle can be applied to panels of various forms. It is not necessary that all panels forming the carcass have the same form. Furthermore, it is also not necessary that the panels have a form of regular or irregular polygons. Preferably, at least one of the panels has a form of a regular pentagon. In a preferred embodiment, all panels have a regular pentagonal form and 12 panels are connected to each other to form a carcass for a ball. In an alternative embodiment, the panels of the carcass comprise regular pentagons and hexagons similar to the panels of the outer layer of the ball. In this embodiment, the carcass comprises 12 pentagons and 20 hexagons.

[0015] Further useful modifications of the invention are defined in further dependent claims.

4. Short description of the drawings

[0016] In the following, a preferred embodiment of the present invention will be explained with reference to the following drawings:

Fig. 1: a schematic representation of the design of a panel for a carcass which comprises two layers of woven material, wherein the two layers are rotated substantially by 90°;

Fig. 2: a schematic representation of the definition of the angular sum with reference to the connection line between adjacent panels;

Fig. 3a-o: a schematic representation of arrangements of adjacent panels as they may occur in a carcass;

Fig. 4 (a) a schematic two-dimensional representation of the panel arrangement of a carcass according to the prior art, (b) definition of the determination of the angle and the frequency of occurrence of adjacent panel arrangements, and (c) corresponding normalized numerical values of the elasticity modulus of a panel configuration of a carcass of the prior art;

Fig. 5a, a': a schematic representation of arrangements of adjacent panels which are excluded in preferred embodiments of the invention;

Fig. 6: a schematic two-dimensional representation of the panel arrangement of a carcass according to a particularly preferred embodiment of the invention;

Fig. 6b: a schematic representation of arrangements of adjacent panels which can occur in a preferred embodiment including the indication of the angular sum α_S relative to a perpendicular line on the connection line;

Fig. 6c: normalized numerical values of the elasticity modulus for a panel arrangement of a carcass according to a particularly preferred embodiment of the invention;

Fig. 7: Table for the arrangements of adjacent panels and the corresponding angle sum α_S according to angle definition given in Fig. 2; on the left for a carcass according to the prior art and on the right for a carcass according to a preferred embodiment of the invention;

Fig. 8: (a) numerical values (second column) and normalized values (third column) of the elasticity modulus of the arrangements of adjacent panels of Figs. 5 and 6b respectively and (b) representation of the normalized elasticity modulus of arrangements of adjacent panels of Figs. 5 and 6b respectively; and

Fig. 9: frequency distribution for a panel configuration of a carcass (a) according to the prior art and (b) for a preferred embodiment of the invention.

5. Detailed description of preferred embodiments

[0017] In the following, a presently preferred embodiment of the carcass according to the invention is explained in detail. This is preferably a carcass for a soccer ball. However, the invention can also be used for other kind of inflatable balls like volley balls, handballs, rugby balls, etc.

[0018] Fig. 1 shows a particularly preferred embodiment of a panel 100 which comprises two layers of a woven material, an upper layer 50 and a lower layer 60.

For each of the two layers 50 and 60, the solid arrow in Fig. 1 is parallel to the warp direction 200 and the dashed arrow is parallel to the weft direction 300. The two directions 200 and 300 are perpendicular to each other. Due to the structural set-up of the woven material, the individual layers 50 and 60 have an anisotropic strain characteristic. This means that the numerical values of the elasticity modulus in the warp direction 200 and the weft direction 300 are larger than in other directions. In other words, when applying the same tensile force, the relative length variation of a layer 50 or 60 parallel to the warp direction 200 and parallel to the weft direction 300 is smaller than in other directions. The warp direction 200 and the weft direction 300 are the two preferred strain directions 200 and 300 of a layer 50 or 60 of woven material.

[0019] For weaving of the material, fibers of natural fibers/fabrics or of plastic materials can be used. Additionally, the materials for the warp and weft can be chosen so that the numerical values of the elasticity modulus for the two preferred strain directions 200, 300 are equal or unequal. Furthermore, the woven material may comprise a texture supporting the adhesive bonding of the outer panels. In addition, the material of the carcass can also be immersed or laminated to adjust properties like stiffness or the like according to the requirements of the ball.

[0020] In a preferred embodiment, the upper layer 50 and the lower layer 60 of woven material are rotated by an angle of substantially 90° relative to each other and are subsequently connected to each other, preferably by adhesive bonding. The panel 100 shown in Fig. 1 forms the basic element of the carcass. Due to the construction of the panel 100, the two preferred strain directions 200 and 300 show substantially the same strain characteristics, i.e. the numerical values of the elasticity modulus are almost identical for the preferred directions 200 and 300. As a result, tough and long term stable panels 100 for carcasses are achieved. By interchanging the upper layer 50 with the lower layer 60 before cutting the panel 100 from the two-layer material, the preferred strain directions 200 and 300 can be exchanged.

[0021] In the preferred embodiment represented in Fig. 1, a panel 100 is generated by adhesive bonding of the woven materials of the upper layer 50 and lower layer 60 wherein the latter is rotated by substantially 90° relative to the upper layer 50. In an alternative embodiment an individual layer 50 or 60 of the woven material forms the panel 100. In a further alternative embodiment, the panel 100 comprises a material having only a single preferred strain direction.

[0022] In the panel 100 presented in Fig. 1, the warp direction 200 and the weft direction 300 form an angle of 90° and therefore generate two preferred strain directions 200 and 300, which are perpendicular to each other. However, such a special configuration is not necessary for a preferred realization of the invention. Any anisotropic, elastic, two-dimensional material can be used instead of the woven material for a panel 100 to produce a preferred embodiment of a carcass in accordance with the invention. Use of the two-layer set-up represented in Fig. 1, means that the elasticity modulus of any elastic anisotropic material selected for the manufacture of the panel 100 can be made symmetric. However, it is also possible to use more than two layers and / or to arrange the layers with other relative orientations.

[0023] According to a particularly preferred embodiment, the panels 100 in Fig. 1 comprise a regular pentagonal form. The inventive principle can also be applied to other panels having a form of regular or irregular polygons. In an alternative embodiment (not shown), the carcass comprises regular pentagons and hexagons. The panels 100 of the carcass can be congruent with the outer panels of a ball. An arrangement with an offset is also conceivable.

[0024] As can be seen from the preferred embodiment of Fig. 1, the preferred strain directions 200 and 300 of the panel 100 have a substantially fixed orientation relative to the pentagonal shape of the panel 100. However, the invention does not require such a defined orientation. In the context of the present description, the term "substantially" reflects manufacturing tolerances which may or may not occur at different production steps.

[0025] Fig. 2 shows two regular pentagonal panels 100. The two panels 100 may be connected along a connection line 400 by various techniques, like stitching, gluing and welding. Both panels 100 have preferred strain directions 200 and 300 which are again perpendicular to each other.

[0026] Furthermore, Fig. 2 illustrates the definition of the angle determination for the preferred strain directions 200, 300 of an arrangement of adjacent panels 100 in relation to the connection line 400. A perpendicular line 500 relative to the connection line 400 serves as a reference direction. Perpendicular line 500 intersects both preferred strain directions 200, 300 and forms with each of them an angle $0 \leq \alpha_{200}, \alpha_{300} \leq 90°$ for each panel 100. The smaller angle of the two angles α_{200}, α_{300} serves as the reference angle for that panel in distinguishing the various arrangements. If the intersection point of the two preferred strain directions 200, 300 coincides with the central point of the pentagonal panel 100, the preferred strain direction 200, 300, which is used for the determination of the angle, intersects the connection line 400. The other preferred strain direction 200, 300, which forms the larger angle, does not intersect the connection line 400.

[0027] The preferred strain direction 200 of the left panel 100 in Fig. 2 has an angle $\alpha_{200} = 0°$ and the preferred strain direction 300 has an angle $\alpha_{300} = 90°$ according to the given definition. As a result, the sought-after angle for the left panel 100 is 0°. For the right panel 100, the preferred strain direction 200 has an angle of $\alpha_{200} = 36°$ and intersects the connection line 400. The preferred strain direction 300 forms an angle of $\alpha_{300} = 54°$ and does not intersect the connection line 400. As a result, the sought-after angle for the left panel 100 is 36°.

[0028] When connecting the two panels 100 along the connection line 400, the angles defined above for the individual panels 100 are added, i.e. the angle of the upper panel 100 α_{UP} and the angle of the lower panel 100 α_{LP}. For the example given in Fig. 2, the angle sum α_S is therefore $\alpha_S = \alpha_{UP} + \alpha_{LP} = 0° + 36° = 36°$. The configuration resulting from the connection of both panels 100 in Fig. 2 is shown as arrangement (e) in Fig. 3.

[0029] Fig. 3 shows a schematic presentation of all configurations of adjacent panels 100 which occur in a carcass made from regular pentagonal panels 100. According to the angle definition given in Fig. 2, the configurations show angle sums α_S of 0°, 18°, 36°, 54° and 72°. Each panel combination can be turned upside down so that the upper panel takes the place of the lower panel and the lower panel takes the place of the upper panel. Turning an arrangement upside down does not change its properties. This is the reason why the upside-down combinations are not shown in Fig. 3. Furthermore, some configurations can be obtained by mirroring other configurations along the perpendicular line 500 from other configurations. The mirrored configurations in Fig. 3 are (b)/(c), (d)/(e), (g)/(h), (j)/(o), (k)/(m) and (l)/(n). For the combination (a), the turning of a panel combination upside down or its mirroring does not change its appearance. The turning of the panel combinations (f) or (i) upside down leads to the same arrangement as their mirroring. This is the reason why neither a mirrored combination (a) nor (f) nor (i) is shown.

[0030] Fig. 4a shows a cut, two-dimensional arrangement of the pentagonal panels 100 of a carcass 1000 for a ball which has been manufactured according to the prior art. The carcass 1000 comprises 12 regular pentagonal panels 100 being numbered from 1 to 12. The solid circle in panel 1 indicates a valve of the bladder which passes through the carcass 1000. The dashed circle in panel 12 marks a counter balance, which is attached on the opposite inside of the carcass 1000. The solid arrows 200 and dashed arrows 300 indicate the preferred strain directions 200 and 300 of the individual panels 100.

[0031] Fig. 4b shows again the chosen angle definition. Furthermore, Fig. 4b reflects that the configuration of panels 100 of a carcass 1000 according to the prior art has six times the unfavorable configuration (a) ($\alpha_S = 0°$) and the remaining 24 pairs of adjacent panels 100 have an angle sum of $\alpha_S = 54°$, wherein the configurations (g) and (h) each occur twelve times (see Fig. 7 left table and Fig. 9a).

[0032] Fig 5 shows again the arrangement (a) of Fig. 3. On the left side (Fig. 5a), the same preferred strain direction 200 (solid arrow) of the upper and the lower panel 100 has the same direction. Additionally this preferred strain direction 200 is perpendicular to the connection line 400 of both panels 100. This arrangement is in the following identified by (a) and $\alpha_S = 0°$ according to the angle definition discussed in Fig. 2. The arrangement shown in Fig. 5a occurs in particular, if the individual panels of a carcass 1000 are not pentagonal, but have a shape comprising two contiguous pentagons of woven material which have been cut or stamped out from the same piece of material.

[0033] On the right side (Fig. 5a'), the first preferred strain direction 200 (solid arrow) of the lower panel 100 is parallel to the second preferred strain direction 300 (dashed arrow) of the upper panel 100 and the corresponding preferred strain directions 200, 300 are perpendicular to each other. This is the reasons why this arrangement is identified by (a') and $\alpha_S = 0°$, again in accordance with the angle definition of Fig. 2. Furthermore, the second preferred strain direction 300 of the upper panel 100 and the first preferred strain direction 200 of the lower panel 100 are perpendicular to the connection line 400 of both panels 100.

[0034] Applicant has found out by experiments that for the two arrangements shown in Figs. 5a and 5a' having both an angle sum of $\alpha_S = 0°$ the connection lines 400 of the two adjacent panels 100 are very stiff. This excessive stiffness should be avoided. An embodiment of a carcass 1000 according to the invention therefore excludes the two arrangements of adjacent panels 100 which are represented in Fig. 5a and Fig. 5a'. The resulting carcass 1000 has a more homogeneous stiffness across its surface.

[0035] Fig. 8a summarizes in the table the measured numerical values of the elasticity modulus of the different combinations of adjacent panels 100 of Figs. 5 and 6b. The second column lists the measured numerical values of the elasticity modulus of the combinations of adjacent panels 100 given in the first column. The third column represents normalized numerical values, wherein the configuration (f) is chosen as a reference. The diagram in Fig. 8b represents the relative ratios of the numerical values of the elasticity modulus of the different arrangements of Figs. 5 and 6b.

[0036] In this diagram, in particular the size of the elasticity modulus of arrangement (a) is prominent. It is more than twice the second largest numerical value of the arrangements (b) and (c). As already discussed in the context of Fig. 5 the arrangements (a) and (a') should be avoided to provide a carcass 1000 with an essentially homogeneous strain behavior across its surface. As also already indicated when discussing Fig. 3, mirrored arrangements have identical numerical values of the elasticity modulus. The numerical value of the elasticity modulus varies nearly tenfold among the configurations (a) and (a') ($\alpha_S = 0°$) on the one hand and (i) ($\alpha_S = 72°$) on the other hand.

[0037] Fig. 4c shows the normalized numerical values of the elasticity modulus of a carcass 1000 according to the prior art. As already mentioned when discussing Fig. 5 in a carcass 1000 according to the prior art the arrangement (a) ($\alpha_S = 0°$) occurs six times and all of the remaining 24 configurations of adjacent panels 100 have an angle sum of $\alpha_S = 54°$. These 24 configurations are exclusively arrangements (g) and (h) (see Fig. 7 left table and Fig.

9a). All other arrangements do not occur in a carcass 1000 according to the prior art.

[0038] Fig. 8 shows under (b) relative ratios of the numerical values of the elasticity modulus of adjacent panels 100 for the standard carcass 1000 of Fig. 8a (see Figs. 5 and 6b). The arrangement (a) is correlated to the highest elasticity modulus. The combinations (g) and (h) have the second lowest numerical value of the elasticity modulus. The two numerical values differ by a factor of seven. This difference in combination with the asymmetrical frequency distribution results in an inhomogeneous strain behavior across the surface of a carcass 1000. This means that the behavior of a ball containing such a carcass 1000 is negatively impacted.

[0039] Figs. 5, 6b and 8 illustrate the following relation: the larger the angle sum α_S the smaller the numerical values of the elasticity modulus. The configurations (d), (e) and (f) have all an angle sum of α_S = 36°. Here the numerical value of the elasticity modulus of the arrangement (f) is larger than that of the configurations (d) and (e) (see Fig. 8). This could be related to the fact that for each arrangement (d), (e) and (f) the angle sum α_S has the same value, but the contributions from the individual panel 100 of the panel pair to the angle sum α_S is different for the arrangement (f) and (d) and (e).

[0040] Fig. 6a shows a cut, two-dimensional representation of an arrangement of a particularly preferred embodiment of a carcass 1000. In accordance with Fig. 4a the carcass 1000 comprises again 12 regular pentagonal panels 100. They are numbered from 1 to 12. Again, the solid arrows 200 and dashed arrows 300 indicate the preferred strain directions 200 and 300 of the individual panels 100.

[0041] Fig. 6b shows the arrangements of adjacent panels 100 which are used in a particularly preferred embodiment. In contrast to the carcass 1000 according to the prior art as shown in Fig. 4, the arrangements (a) - as well as (a') - do not occur in a preferred embodiment. The angle sums of adjacent panels 100 which occur in preferred embodiments are 18°, 36°, 54° and 72°. All the other five configurations discussed in Fig. 8 occur with an identical frequency, six times each, (see Fig. 7 right table and Fig. 9b). Fig. 6c depicts the numerical values of the elasticity modulus of the frequency distribution of the arrangements of adjacent panels 100 (see Fig. 8). The largest numerical value of the elasticity modulus which is linked to the arrangements (a) and (a') do not occur in preferred embodiments. The remaining five different numerical values of the elasticity modulus have a significantly smaller variation (4.3 compared to 7.0 in Fig. 4c). The smaller variation of the numerical values of the elasticity modulus of adjacent panels 100 (see Fig. 9b) and the homogeneous frequency distribution leads to a carcass 1000 with an essentially homogeneous strain behavior across its surface. Therefore, despite the anisotropy of the individual panels 100, the panel arrangement shown in Fig. 6a leads to a largely uniform carcass 1000. This means that the behavior of a ball containing such a carcass 1000 is not negatively influenced.

[0042] The left table of Fig. 7 lists in the third column all 30 angle sums α_S of adjacent panels 100 which can occur in a carcass 1000 according to the prior art. The center column indicates the arrangements according to the terminology introduced in Figs. 3, 5 and 6b. The right table of Fig. 7 summarizes the angle sums α_S of adjacent panels 100 of the arrangements occurring in preferred embodiments of the invention. It can immediately be seen that the especially stiff arrangements (a) and (a') respectively with α_S = 0°, which occur six times in the left table, do not occur in the right table.

[0043] Fig. 9 shows under (a) the frequency distribution of the arrangements of adjacent panels 100 of a carcass 1000 according to the prior art. As already mentioned when discussing Fig. 4, the angle sum α_S = 0° (configuration (a)) occurs six times and the angle sum α_S = 54° (configurations (g) and (h)) occurs 24 times. Fig. 9 shows under (b) the frequency distribution of arrangements of adjacent panels 100 of a carcass 1000 according to a preferred embodiment. In contrast to a carcass 1000 according to the prior art shown in Fig. 4a the configurations (a) - as well as (a') - do not occur (see Fig. 5). All the other five arrangements discussed in Fig. 6b having different numerical values of the elasticity modulus (see Fig. 8) occur with an identical frequency distribution - six times each (see Fig. 7 right table).

Claims

1. A carcass (1000) for reinforcing a ball, comprising:

    a. a plurality of panels (100) connected to each other;
    b. wherein each panel (100) comprises at least one preferred strain direction (200, 300), wherein the elasticity modulus of a panel (100) is greater in the at least one preferred strain direction (200, 300) than in other directions; and
    c. wherein the panels (100) of the carcass (1000) are arranged relative to each other so as to avoid an orientation of a pair of adjacent panels (100) where each panel (100) of this pair has at least one preferred strain direction (200, 300) which is perpendicular to at least one connection line (400) between the two adjacent panels (100).

2. The carcass of claim 1, wherein at least one panel (100) comprises two preferred strain directions (200, 300).

3. The carcass of one of claims 1 or 2, wherein at least one panel (100) comprises a woven material.

4. The carcass of claim 3, wherein the two preferred strain directions (200, 300) are parallel with the warp direction (200) and the weft direction (300), respec-

tively, of the woven material.

5. The carcass of one of the claims 3 or 4, wherein at least one panel (100) comprises an upper layer (50) and a lower layer (60) of the woven material, said layers being arranged such that the warp direction (200) of the upper layer (50) is perpendicular to the warp direction (200) of the lower layer (60).

6. The carcass of one of the claims 1 - 5, wherein at least one panel (100) has a form of a regular pentagon.

7. The carcass of one of the claims 1 - 6, wherein the carcass comprises twelve regular pentagonal panels (100) connected to each other.

8. The carcass of one of the claims 1 - 7, wherein adjacent pairs of panels (100) are arranged such that an angular sum of adjacent panels comprises numerical values of about 18°, 36°, 54° or 72°, wherein the angular sum is the sum total of the angles of the two adjacent panels (100), wherein for each panel (100) always the smaller angle is used, which is calculated by reference to the angle at which the preferred strain directions (200, 300) of a panel (100) intersect a perpendicular (500) on the connection line (400).

9. The carcass of claim 8, wherein the panels are arranged such that six pairs of adjacent panels (100) have an angular sum of substantially 18°, 12 pairs of adjacent panels (100) have an angular sum of 36°, 6 pairs of adjacent panels (100) have an angular sum of 54°, and 6 pairs of adjacent panels (100) have an angular sum of 72°.

10. A ball comprising a carcass (1000) of one of claims 1 - 9.

Fig. 1

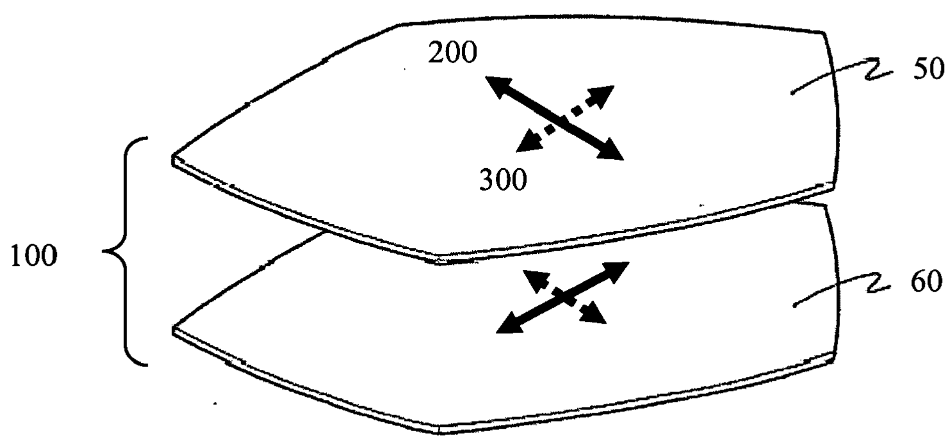

200
50
300
100
60

Fig. 2

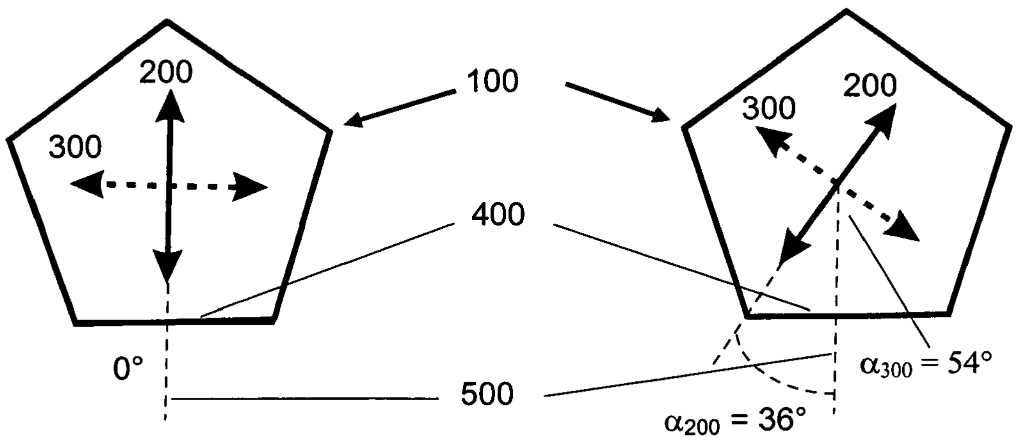
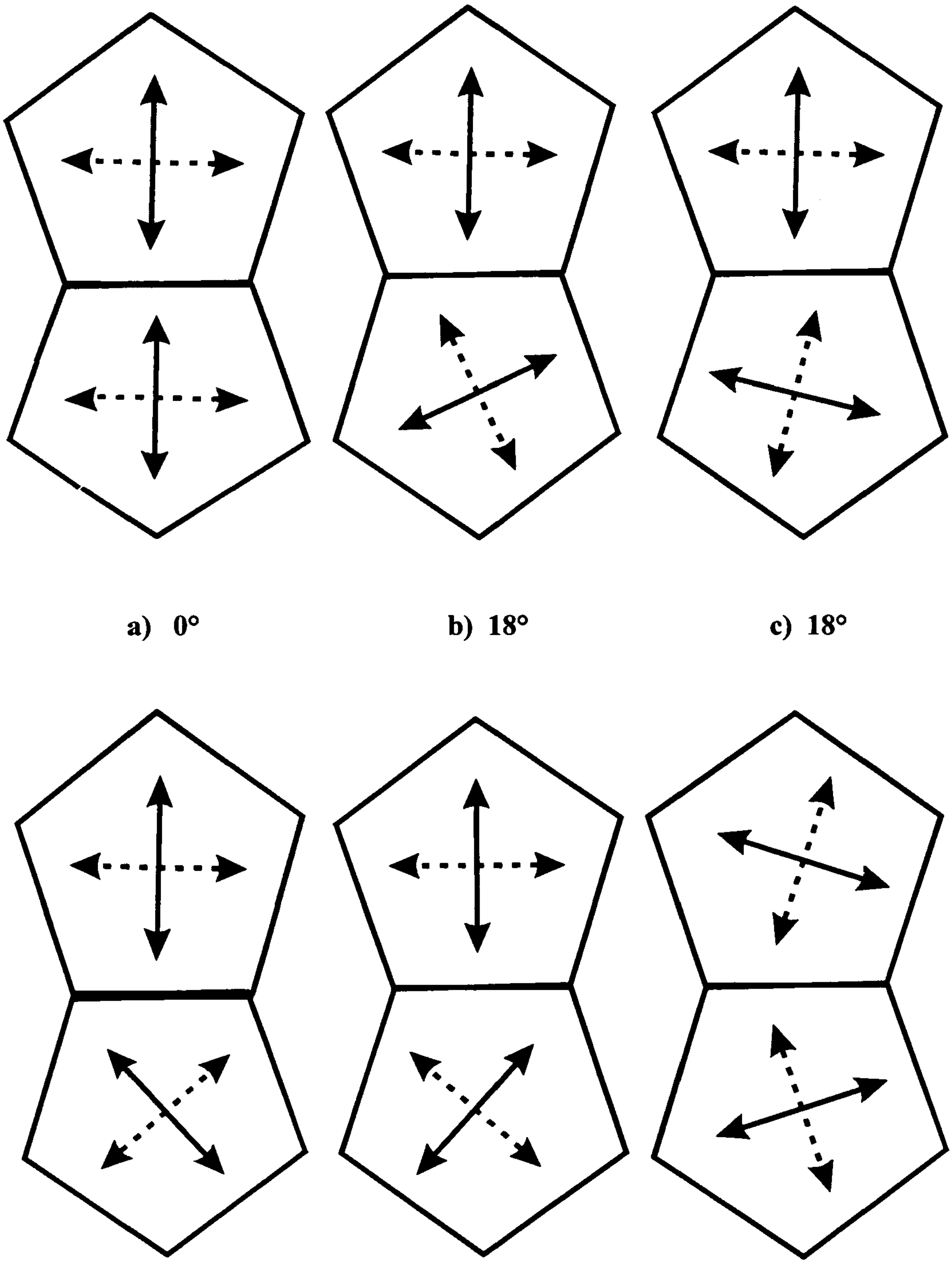
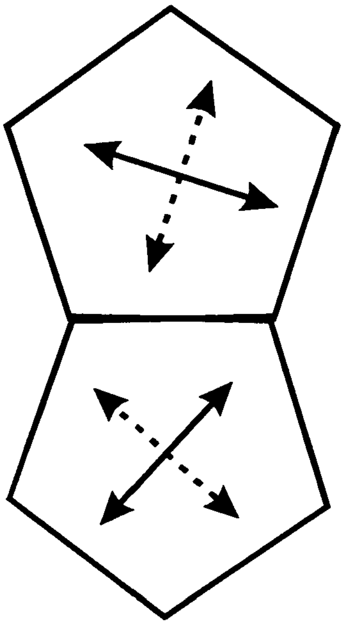

200
100
300
200
300
400
0°
500
α_{300} = 54°
α_{200} = 36°

Fig. 3

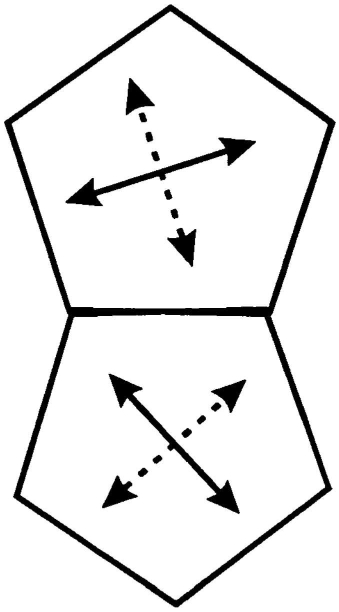


a) 0°   b) 18°   c) 18°

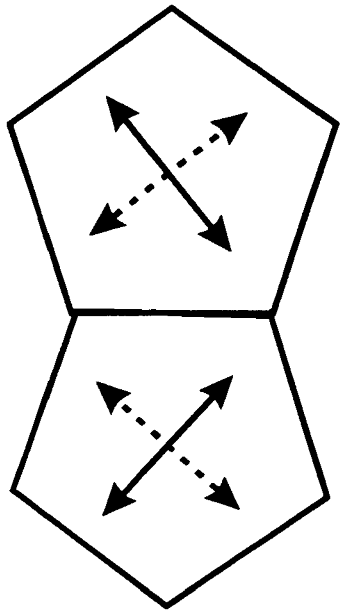
d) 36°   e) 36)   f) 36°



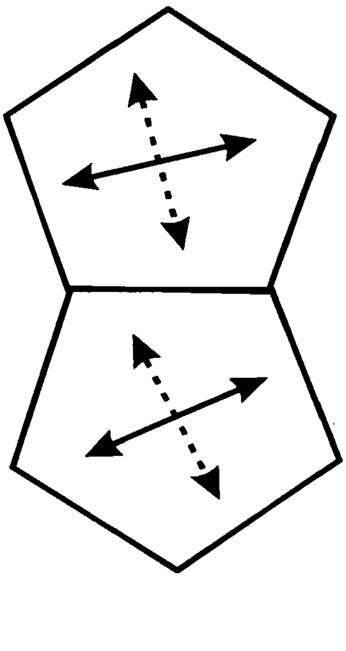
g) 54°



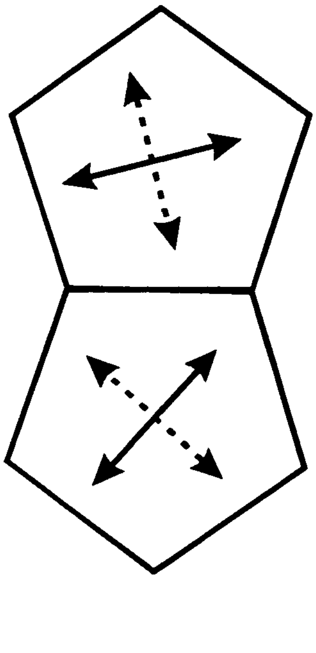
h) 54°



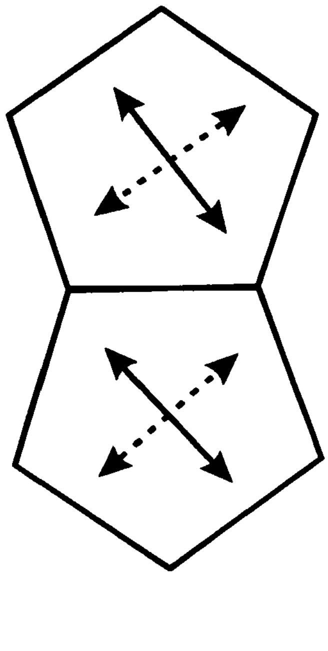
i) 72°



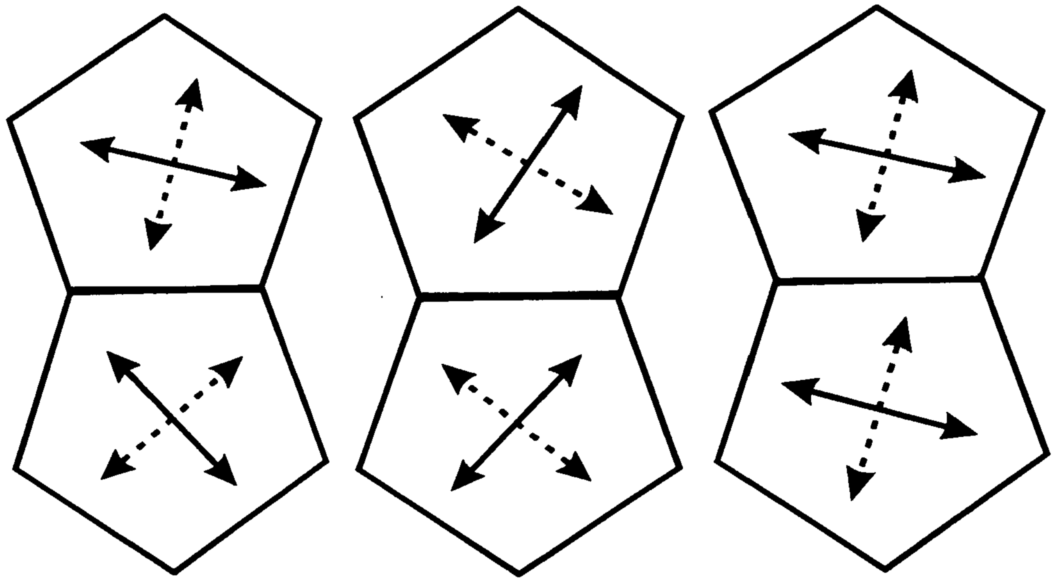
j) 36°



k) 54°



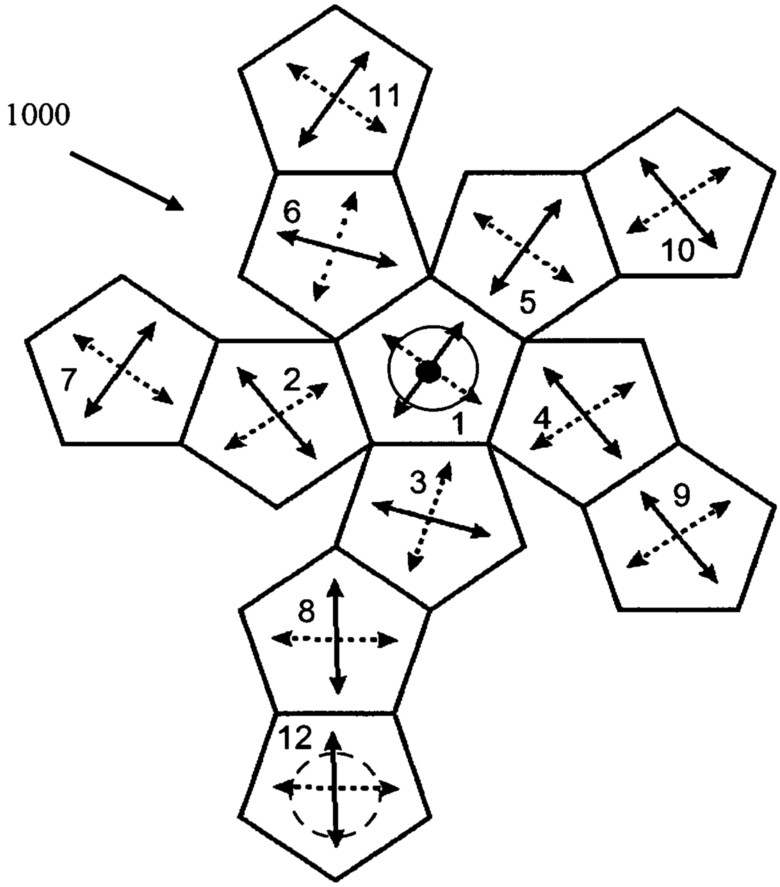
l) 72°



m) 54° n) 72° o) 36°

Fig. 4 (prior art)

(a)



(b)

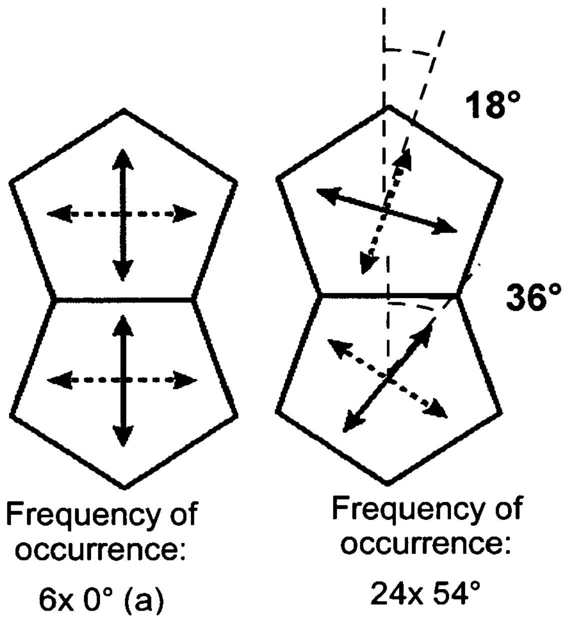


Fig. 4 (prior art)

(c)

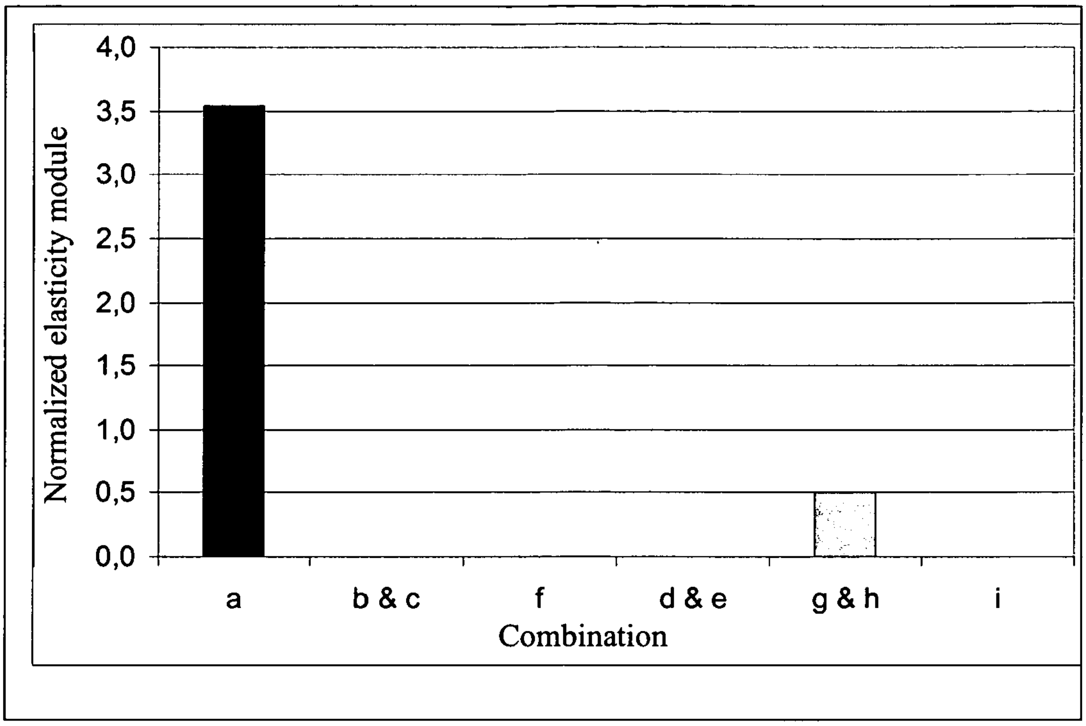
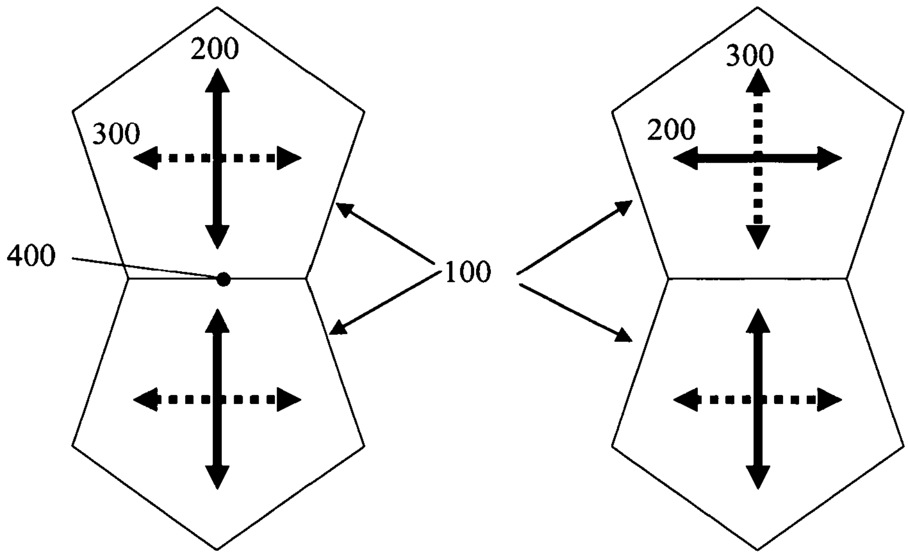


Fig. 5



a) 0° **a') 0°**

Fig. 6

(a)

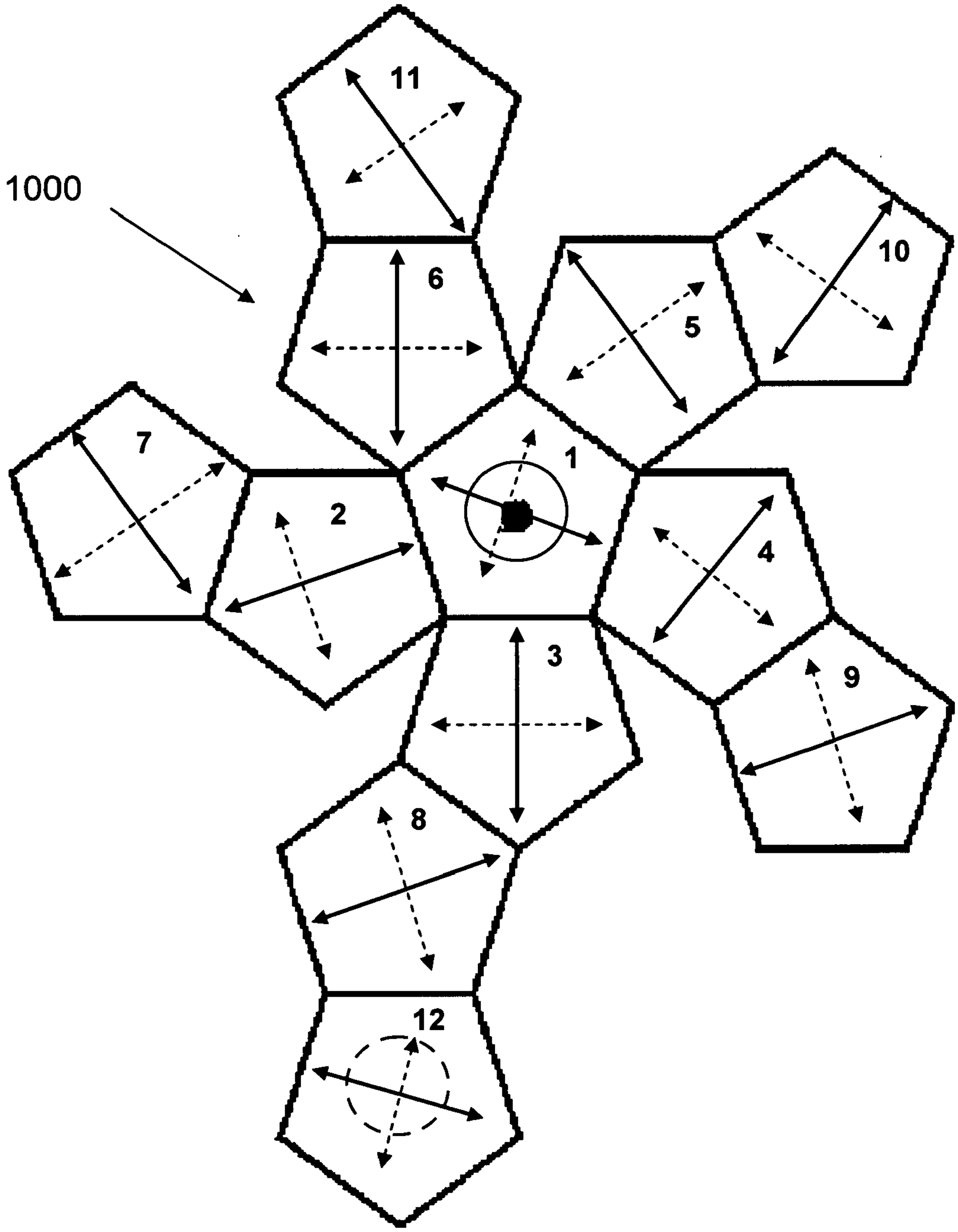
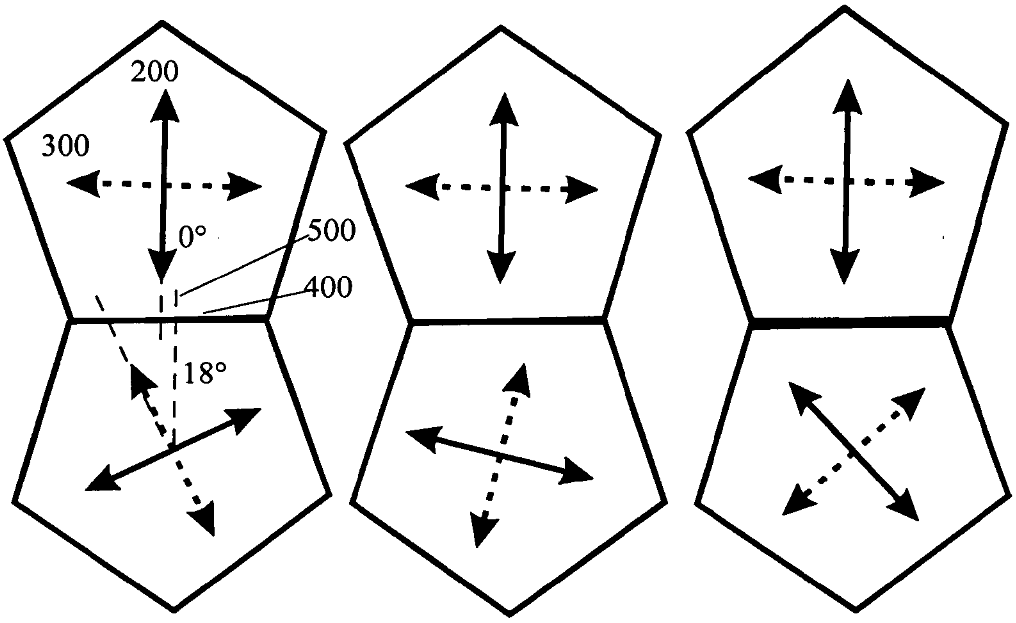
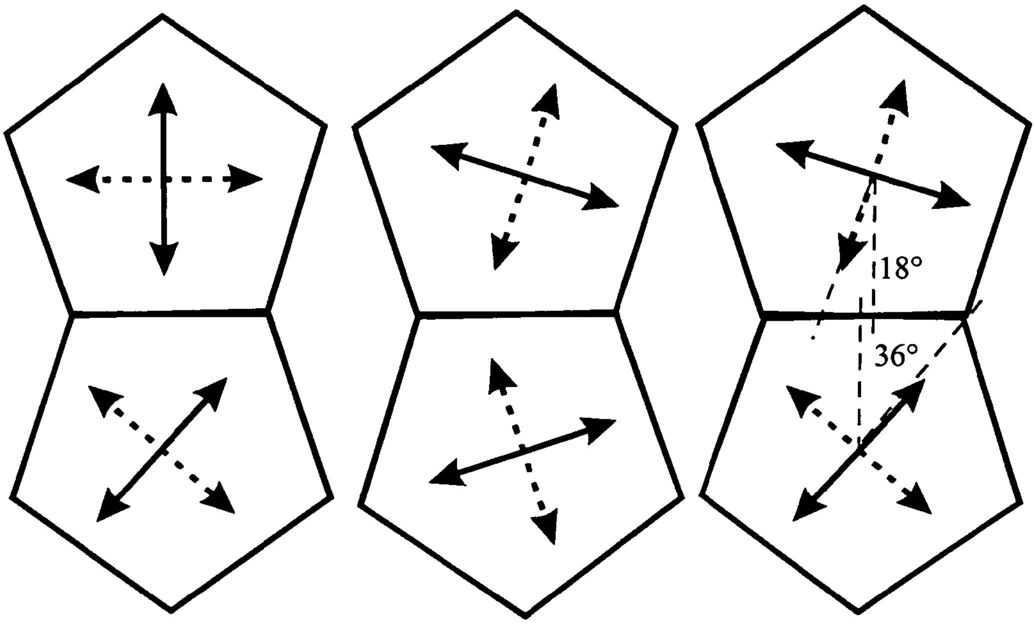


Fig. 6

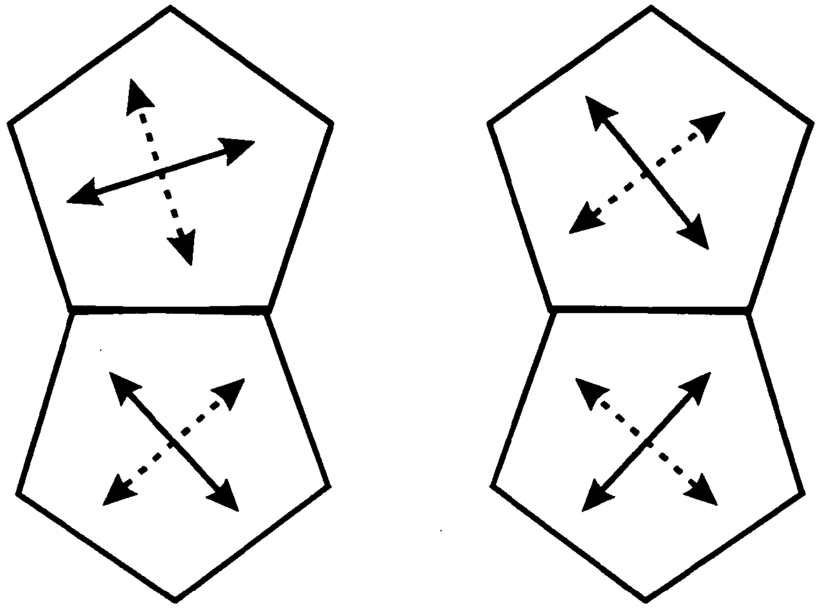
(b)



b) 18° (0° + 18°) **c) 18°** **d) 36°**



e) 36° **f) 36)** **g) 54° (18° + 36°)**



h) 54° i) 72°

Fig. 6

(c)

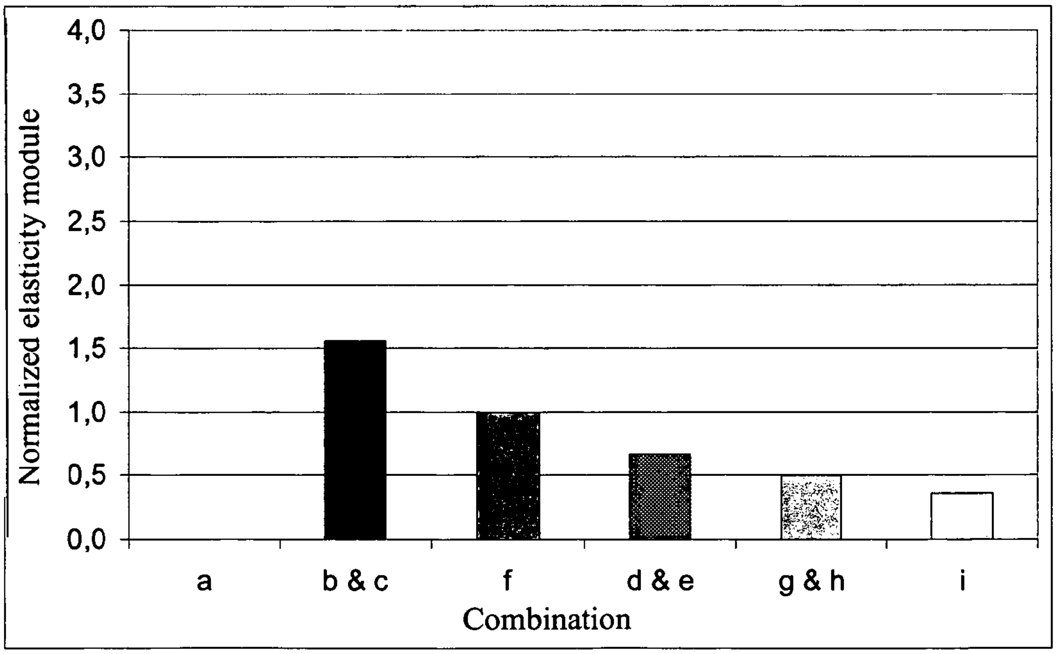


Fig. 7

Connection	Combination	α_S
1 2	h	54°
1 3	g	54°
1 4	g	54°
1 5	a	0°
1 6	h	54°
2 3	a	0°
3 4	g	54°
4 5	h	54°
5 6	g	54°
6 2	h	54°
7 8	g	54°
8 9	h	54°
9 10	g	54°
10 11	a	0°
11 7	h	54°
2 7	g	54°
2 8	g	54°
3 8	h	54°
3 9	h	54°
4 9	a	0°
4 10	h	54°
5 10	h	54°
5 11	g	54°
6 11	g	54°
6 7	a	0°
12 7	h	54°
12 8	a	0°
12 9	g	54°
12 10	g	54°
12 11	h	54°

Connection	Combination	α_S
1 2	e	36°
1 3	c	18°
1 4	c	18°
1 5	f	36°
1 6	i	72°
2 3	f	36°
3 4	c	18°
4 5	e	36°
5 6	g	54°
6 2	h	54°
7 8	d	36°
8 9	h	54°
9 10	g	54°
10 11	f	36°
11 7	b	18°
2 7	i	72°
2 8	g	54°
3 8	i	72°
3 9	e	36°
4 9	f	36°
4 10	i	72°
5 10	h	54°
5 11	i	72°
6 11	d	36°
6 7	f	36°
12 7	b	18°
12 8	f	36°
12 9	i	72°
12 10	d	36°
12 11	b	18°

Fig. 8

(a)

Combination	Elasticity module [GPa]	Norm. elasticity module	Grey level
a & a'	39,0	3,5	
b & c	17,2	1,6	
f	11,0	1,0	
d & e	7,3	0,7	
g & h	5,6	0,5	
i	4,0	0,4	

(b)

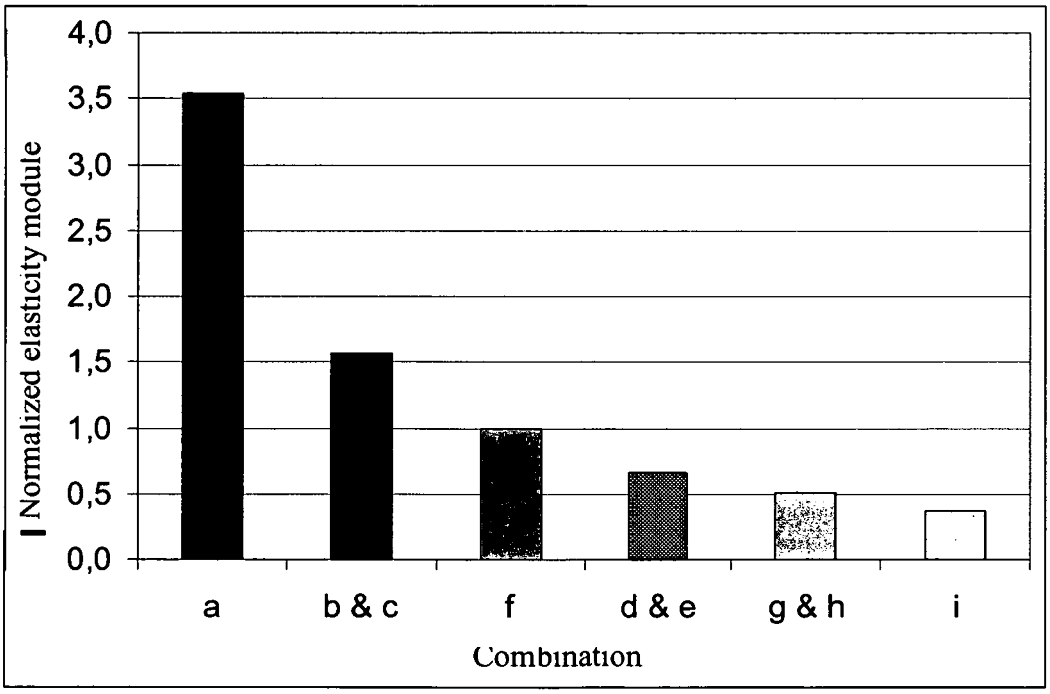
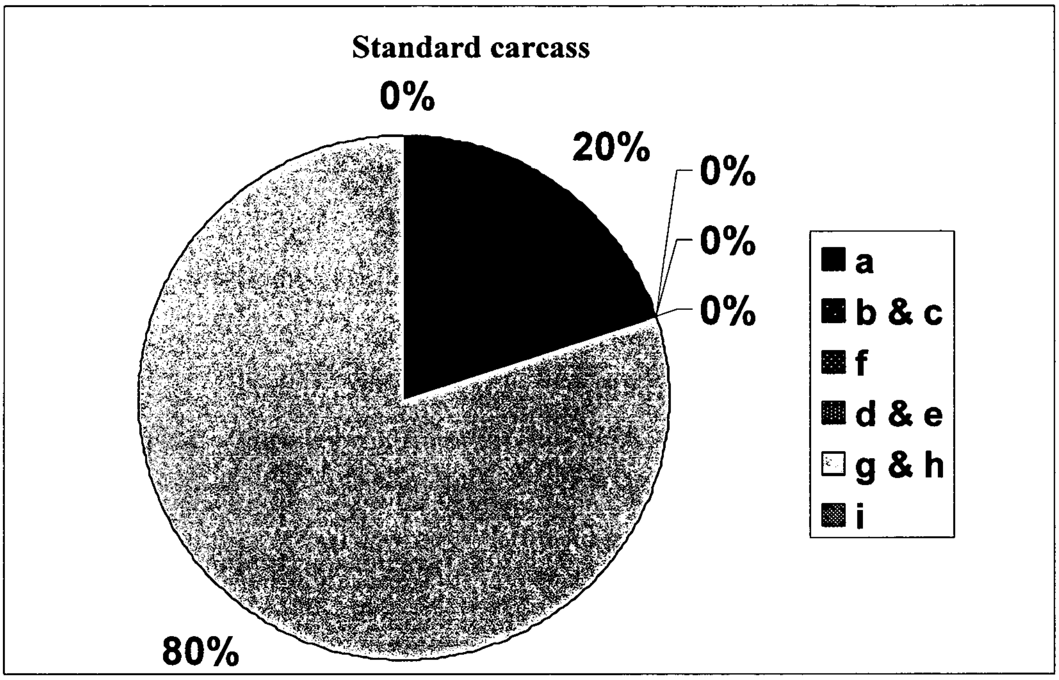
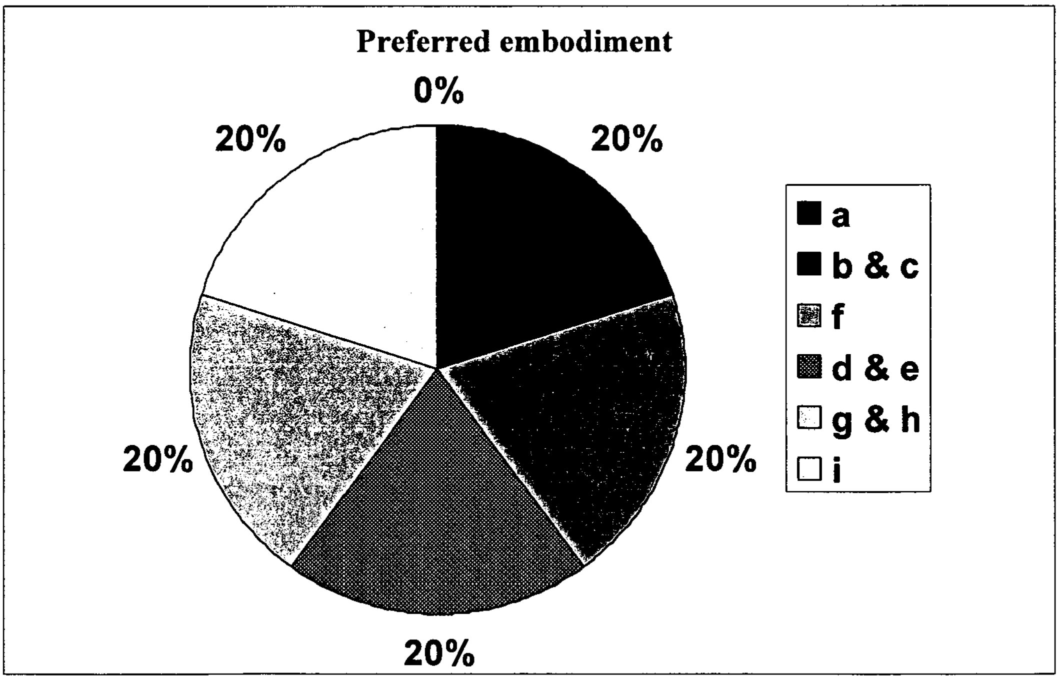


Fig. 9

(a)


Standard carcass
0%
20%
0%
0%
0%
80%
a
b & c
f
d & e
g & h
i

(b)


Preferred embodiment
0%
20%
20%
20%
20%
20%
a
b & c
f
d & e
g & h
i

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EUROPEAN SEARCH REPORT

Application Number
EP 08 02 1367

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 March 2009	Teissier,Sara

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The members are as contained in the European Patent Office EDP file on
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18-03-2009

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