US 20100041488A1

(19) United States
(12) Patent Application Publication
Foxon et al.
(10) Pub. No.: US 2010/0041488 A1
(43) Pub. Date: Feb. 18, 2010

(54) PLAYING SURFACE AND METHOD OF MANUFACTURING A PLAYING SURFACE

(75) Inventors: **Steve Foxon**, Broughton Astley (GB); **Nicholas James McLaren**, South Wigston (GB)

Correspondence Address:
MCDONNELL BOEHNEN HULBERT & BERGHOFF LLP
300 S. WACKER DRIVE, 32ND FLOOR
CHICAGO, IL 60606 (US)

(73) Assignee: **NOTTS SPORT LIMITED**, Oadby (GB)

(21) Appl. No.: **12/191,828**

(22) Filed: **Aug. 14, 2008**

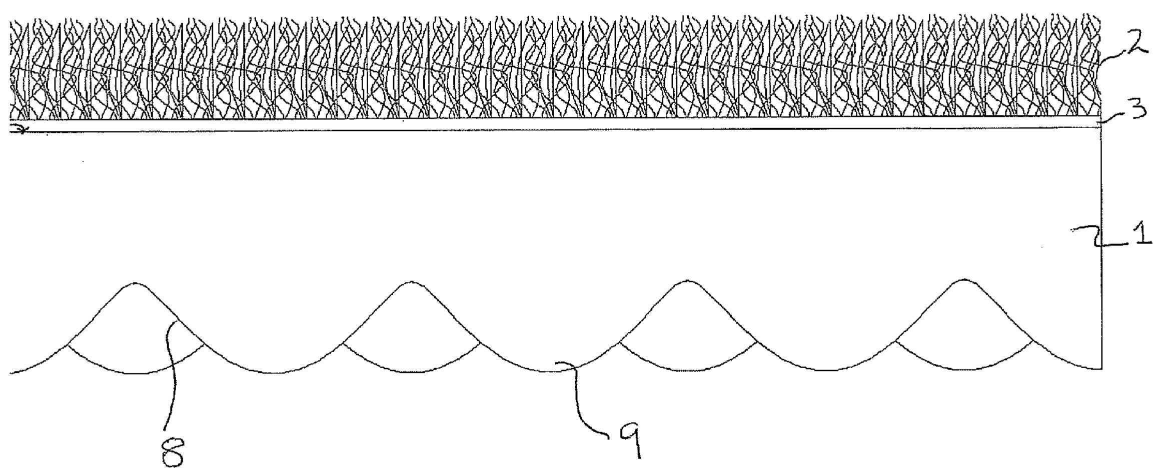
Publication Classification

(51) **Int. Cl.**
E01C 13/00 (2006.01)

(52) **U.S. Cl.** **472/92**; 29/428

(57) **ABSTRACT**

A playing surface comprising a foam layer (**1**) having a top surface and a plurality of downwardly extending energy dissipating projections (**9**) and a fibrous carpet layer (**2**) overlying the top surface of the foam layer (**1**). The plurality of the energy dissipating projections (**9**) are arranged to dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface. The invention also comprises methods of manufacturing the playing surface.



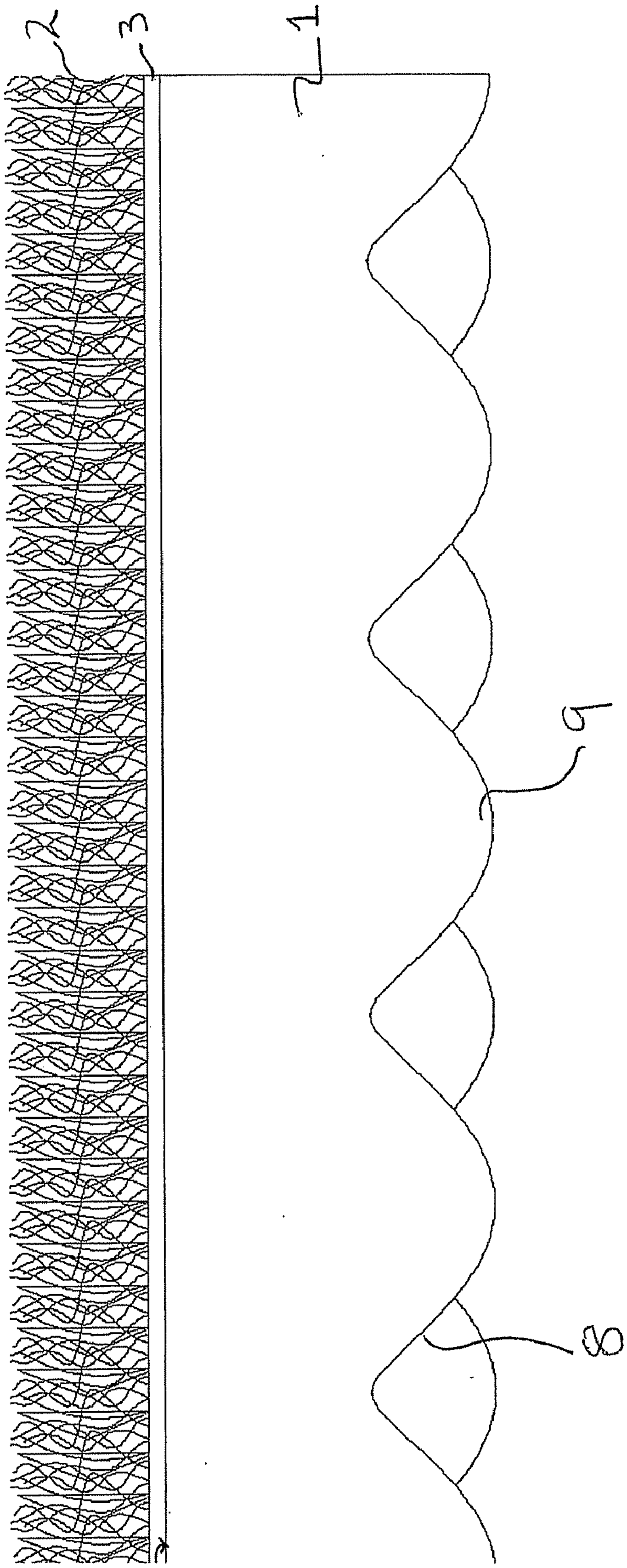


Fig. 1

Fig. 2

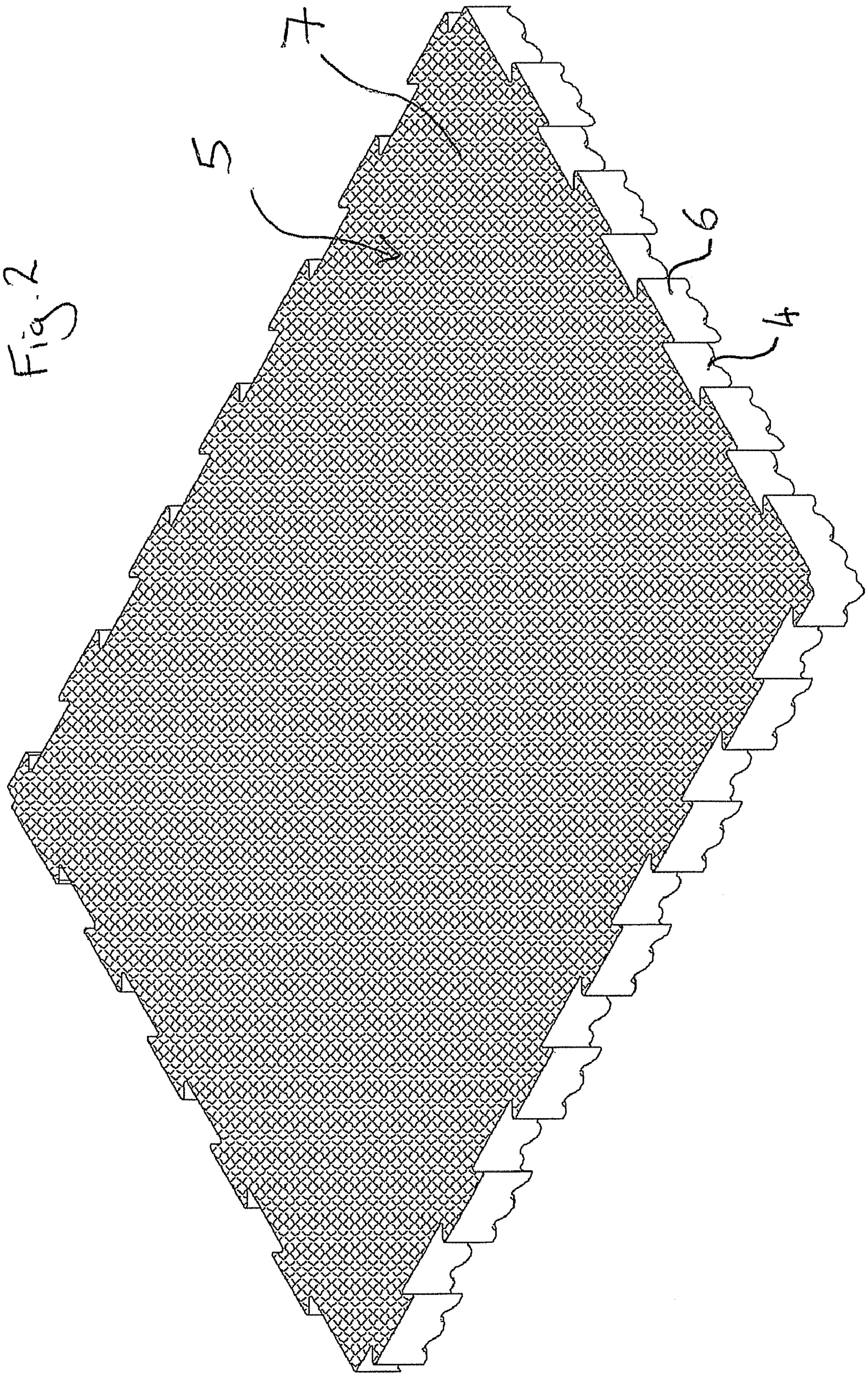
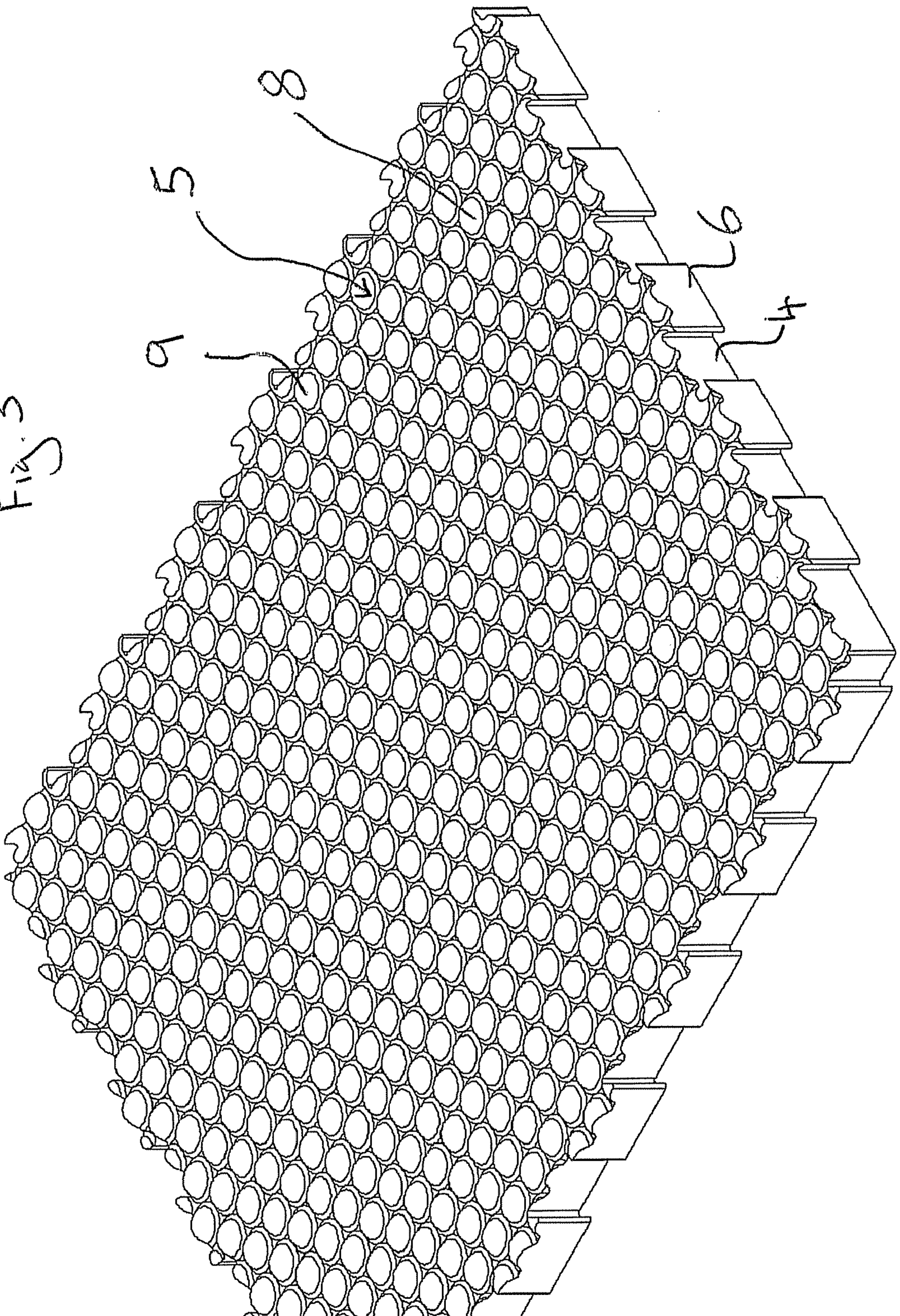


Fig 3



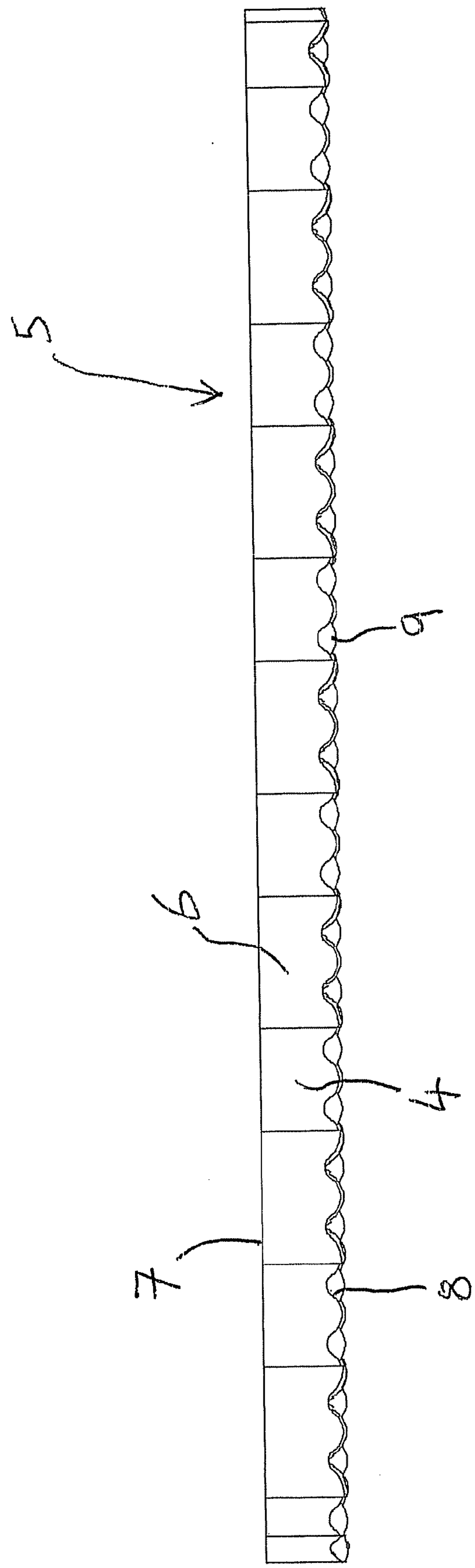


Fig. 4

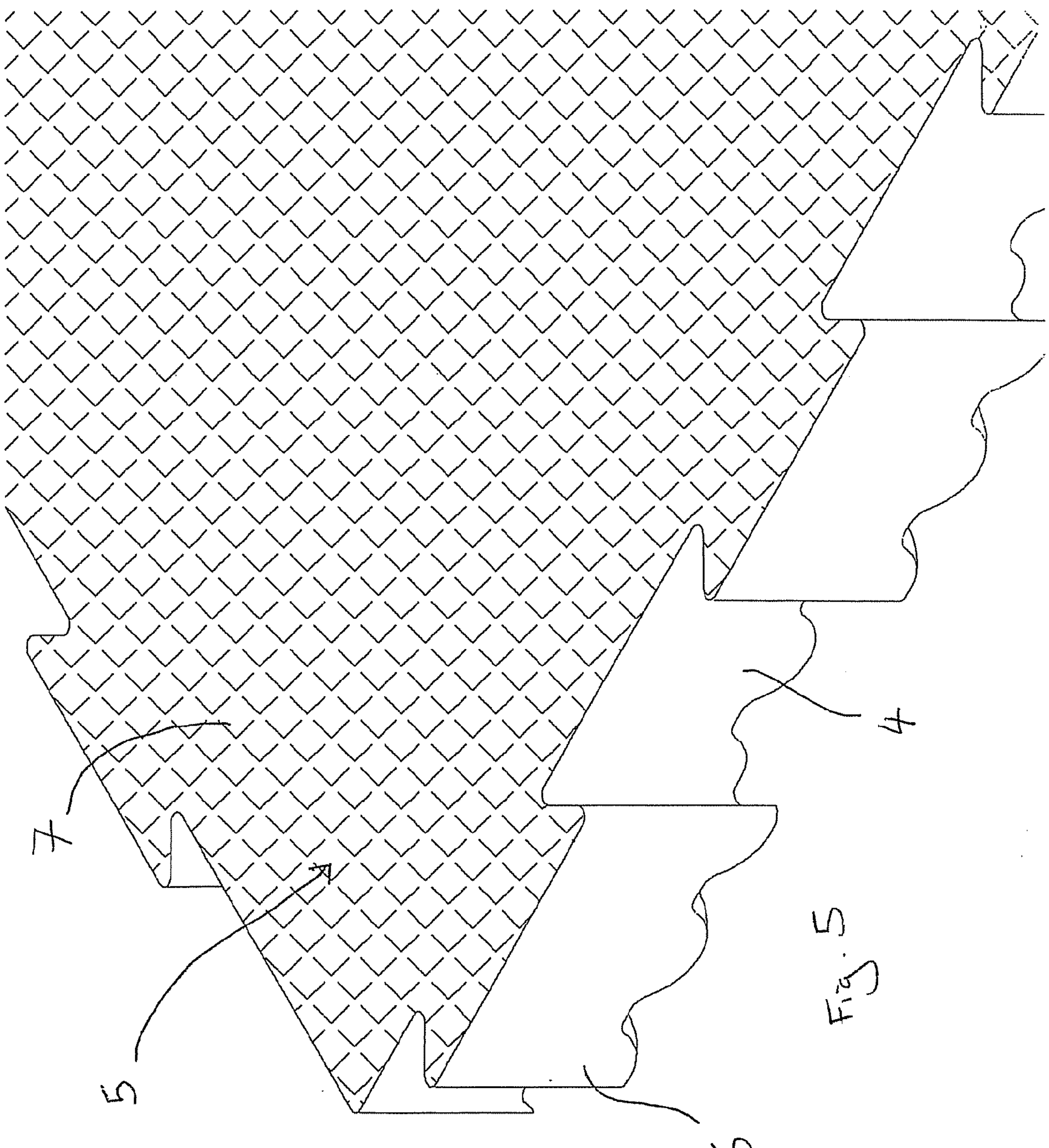


Fig. 5

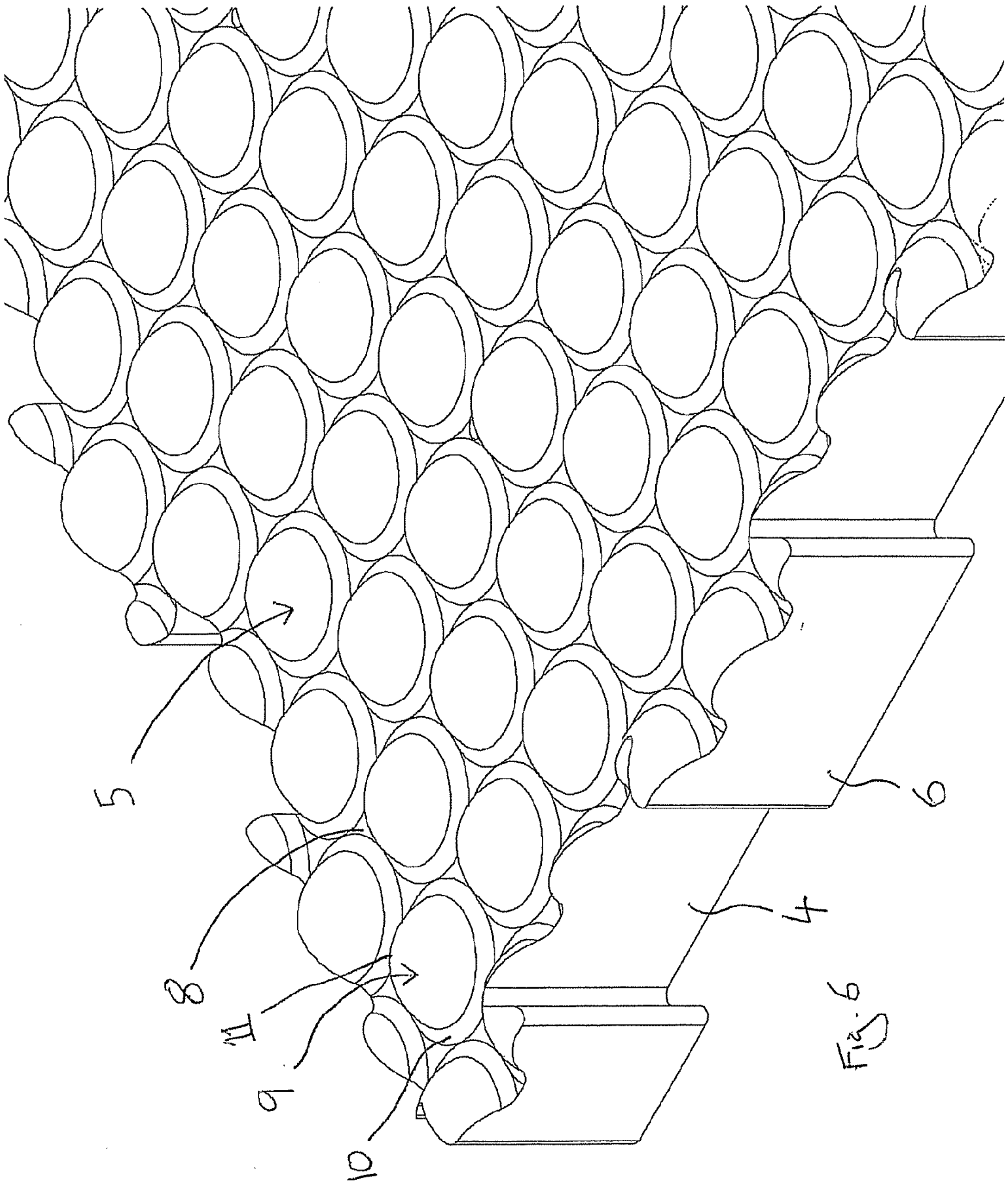


Fig. 6

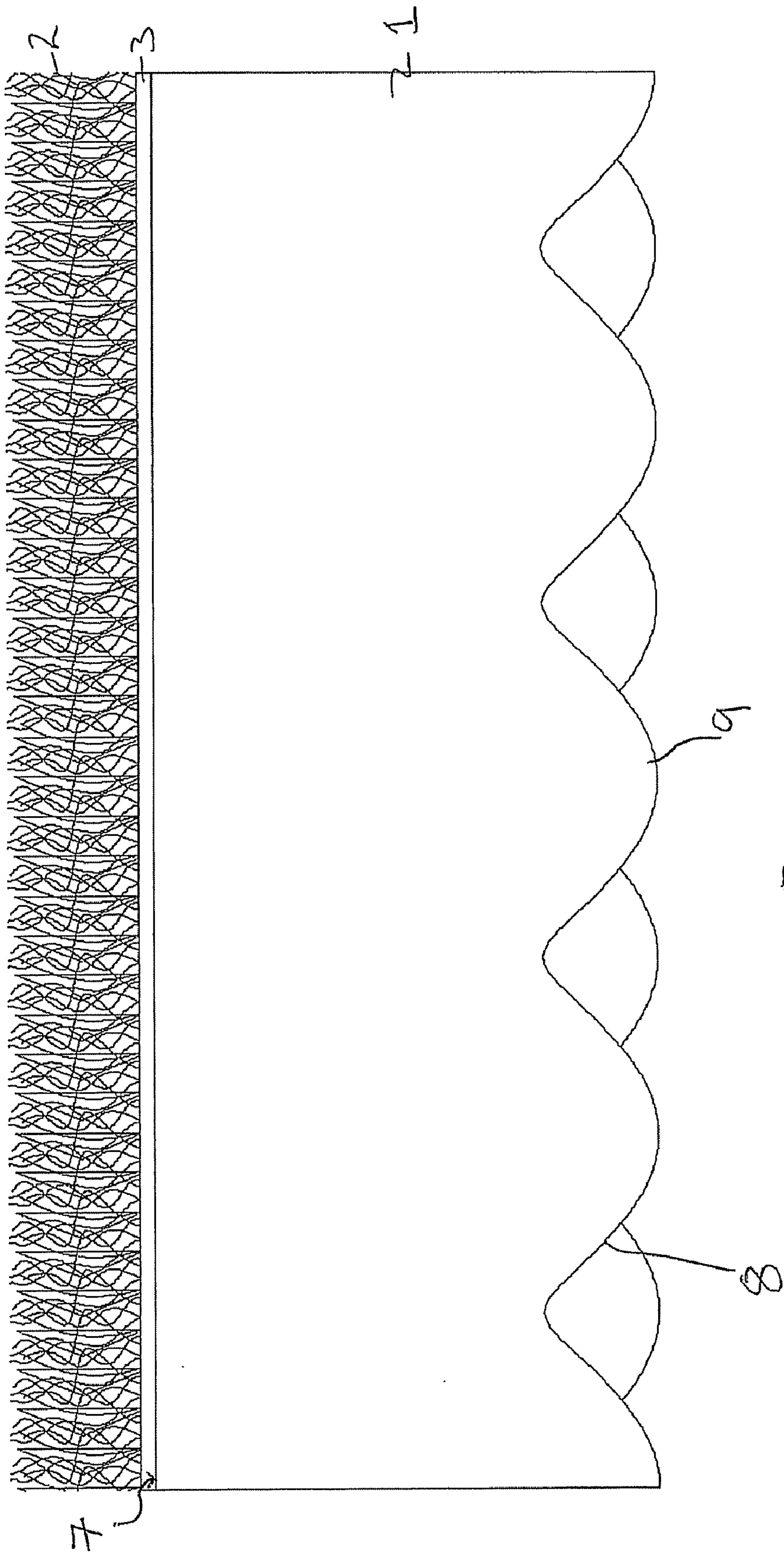


Fig. 7

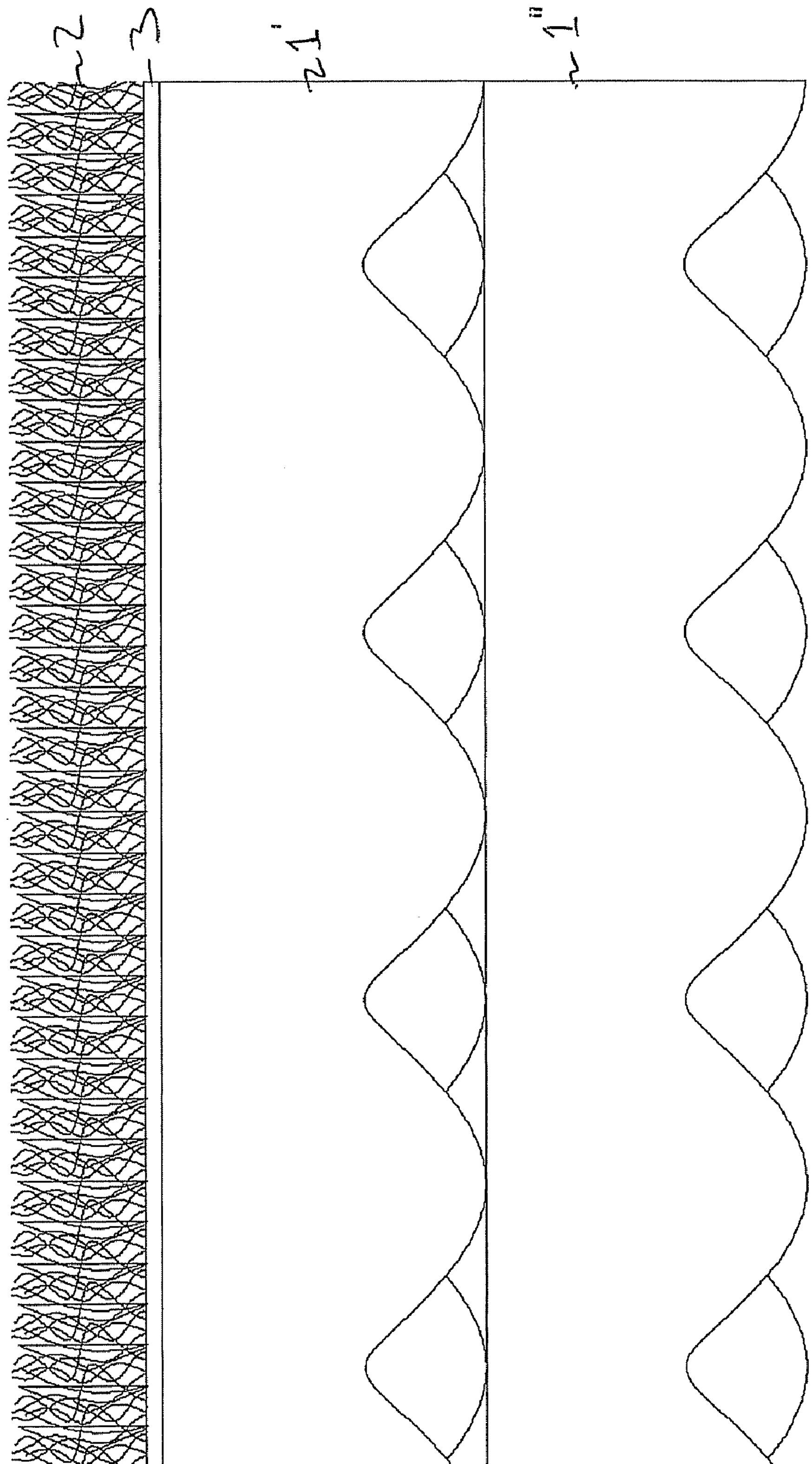


Fig. 8

PLAYING SURFACE AND METHOD OF MANUFACTURING A PLAYING SURFACE

TECHNICAL FIELD

[0001] This invention concerns a playing surface and a method of manufacturing a playing surface. The invention has particular, but not exclusive, application to playing surfaces for use in children's playgrounds or other situations wherein a user could fall from a significant height, such as situations wherein the Critical Fall Height is required to be 2.4 metres or more.

BACKGROUND

[0002] The surface used for playgrounds and the like must be chosen such that the Critical Fall Height matches or exceeds the maximum height from which a user can fall from the play equipment. BS EN 1177 defines the Critical Fall Height test. A 4.6 kg spherical 'headform' representing a child's head is dropped from various heights onto a test surface, and the time the headform is in contact with the surface and its peak deceleration is measured. A stiffer surface reduces the time a head is in contact with the surface but this has to be balanced with the peak deceleration, which increases with increases in stiffness.

[0003] The Critical Fall Height is the height at which the Head Injury Criterion (HIC) is 1000. HIC is a measure of the likelihood of head injury arising from an impact. The HIC is calculated using:

$$HIC = \left\{ (t_2 - t_1) \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} a(t) \cdot dt \right]^{2.5} \right\}_{max},$$

wherein t_1 and t_2 are the initial and final times (t) of the interval during which the HIC attains a maximum value, usually a 15 ms interval, and a(t) is the instantaneous acceleration over this interval in units of gravitational force (g). At a HIC of 1000, one in six people suffer a life threatening injury.

[0004] It is known to increase the thickness of a foam layer of a playing surface in order to increase the Critical Fall Height achieved by the playing surface. However, it has been found that increasing the thickness of the foam layer only increases the Critical Fall Height up to a specified limit. For a polypropylene foam tile having a foam density of 30 grams per litre, the limit for the Critical fall Height that can be achieved through increasing the thickness of the foam is approximately 2.4 metres. Further increases in the thickness of the foam layer do not significantly increase the Critical Fall Height of the playing surface.

[0005] Furthermore, to keep the time and cost of installation down, the playing surface should be kept as shallow as possible to reduce the amount of excavating work that needs to be done to lay the playing surface.

SUMMARY

[0006] According to a first aspect of the invention there is provided a playing surface comprising a foam layer having a top surface and a plurality of downwardly extending energy dissipating projections and a fibrous carpet layer overlying the top surface of the foam layer, wherein the plurality of the energy dissipating projections are arranged to dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface.

[0007] It has been found that providing appropriately arranged projections on the bottom of the foam layer may increase the Critical Fall Height of the playing surface without having to increase the thickness of the foam layer, allowing a shallower playing surface to be used. Furthermore, Critical Fall Heights above 2.4 metres can be achieved. The projections deform into the spaces between the projections during an impact to dissipate the energy of the impact. Appropriately arranged projections can change the profile of how energy is dissipated by the foam layer to increase the Critical Fall Height of the playing surface.

[0008] The arrangement of the plurality of the projections may result in the playing surface having a Critical Fall Height significantly greater, for example 10 cm, 20 cm or 1 m greater, than a Critical Fall Height that would be achieved with a foam layer of the same material and foam density having a flat bottom surface.

[0009] It has been found that the size and shape of the projections can affect the Critical Fall Height of the playing surface. In particular, for the typical foam densities that are appropriate for a foam layer of a playing surface, the projections should have a height of at least 10 mm and preferably, between 10 mm and 20 mm. It has been found that the size of the projections can affect the performance of the playing surface at different fall heights and it is believed that projections having a height of between 10 mm and 20 mm give a good balance between the performance at the lower and higher fall heights.

[0010] In one embodiment, the foam layer is expanded polypropylene. The foam density may be at least 25 grams per litre and preferably, between 30 grams per litre and 40 grams per litre. Foam densities below 25 grams per litre have a tendency to come apart, in use. Foam densities above 40 grams per litre may be too stiff resulting in a Critical Fall Height of the playing surface of less than 2.4 metres or requiring thicker projections to achieve a 2.4 metre Critical Fall Height, if this is possible at all, resulting in a playing surface having a thickness that is impractical to use.

[0011] In one embodiment, the foam layer has a thickness (excluding the projections) of between 40 mm and 65 mm. The base needs to be stiff enough to avoid "bottoming out" on the hard supporting surface, such as a concrete surface, when a person falls onto the surface but kept as shallow as possible to reduce the amount of excavating that needs to be done to lay the surface. A foam layer having a thickness of less than 40 mm may be too weak at the typical foam densities used for playing surfaces, which may result in the foam layer breaking up in use. A foam layer having a thickness of more than 65 mm may be too stiff at the typical foam densities used for playing surfaces, the impact of the headform not penetrating much further than 65 mm and therefore, not being dissipated by the projections.

[0012] Each projection may have a free end that, in use, contacts a surface supporting the playing surface, the projection having a shape that narrows towards the free-end. The shape of the projection can affect the profile of how energy is dissipated by the projections during an impact and it is believed that narrowing projections provide a profile that reduces peak deceleration and therefore, the HIC value. For example, the projections may be dome shaped. Dome shaped projections perform particular well in use, however, other shaped projections may be used such as pyramid, tetrahedron, cone, wedge shaped, a frustum of these shapes or any other suitable shape. The disadvantage of projections that end in points (such as pyramids, tetrahedrons and cones) that contact the supporting surface is that the point can break off in use.

[0013] In one embodiment, the foam layer may comprise one or more holes extending from the top surface to the bottom surface of the foam layer. The holes may allow water to drain from the top surface of the playing surface. In addition to dissipating energy, the projections provide channels below the foam layer for water to drain from the area covered by the playing surface.

[0014] The playing surface may comprise a geotextile layer between the foam layer and the carpet layer. The geotextile layer may protect the foam layer during laying of the carpet, in particular, the carpet layer may be formed from rolls/strips of carpet connected together using a hot melt adhesive and the geotextile layer protects the foam layer being damaged from the heat. Furthermore, the geotextile layer may increase the load bearing capacity of the playing surface, reducing damage to the foam layer during an impact.

[0015] It has been found that moulding a foam layer with a conventional mould results in a smooth finish to the foam layer that allows the carpet layer and geotextile layer to move relative to the foam layer, in use. In a playground such movement of the surface is undesirable. Accordingly, in this embodiment, the top surface of the foam layer may comprise a rough surface that contacts the geotextile or carpet layer to provide high frictional resistance to relative movement between the layers. The rough top surface may comprise a plurality of upwardly extending projections, for example upwardly extending projections that produce a course top surface. It will be understood that the upwardly extending projections are small relative to the thickness of the foam layer and the height of the energy absorbing projections, for example having a height of less than 0.5 mm, the upwardly extending projections having minimal impact on the energy absorbing capability of the foam layer but increasing the frictional resistance of the top surface. In one embodiment, the projections may be irregular.

[0016] In one embodiment, the playing surface may comprise two or more foam layers, each foam layer having a top surface and a plurality of downwardly extending energy dissipating projections. The foam layers may be stacked consecutively on top of each other. It is believed that the provision of multiple foam layers will further increase the Critical Fall Height of the playing surface. Furthermore, in an embodiment in which holes are provided in each foam layer from the top surface to the bottom surface, the projections provide channels from the holes in one foam layer to the holes in another foam layer for water to drain. Without the channel between the projections, the drainage holes of consecutive layers would have to be aligned, increasing the costs of installation.

[0017] The foam layer may comprise a plurality of interlocked tiles, each tile having formations for cooperating with formations on the other tiles for interlocking the tiles together. Forming the foam layer from a plurality of tiles simplifies laying of the carpet layer. The interlocking of the tiles reduces relative movement between the tiles, in use.

[0018] According to a second aspect of the invention there is provided a method of manufacturing a playing surface comprising forming a foam layer having a top surface and a plurality of downwardly extending energy dissipating projections, wherein the plurality of the energy dissipating projections are arranged such that, when the foam layer is used as part of a playing surface with a fibrous carpet layer overlaying the foam layer, the plurality of projections dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface.

[0019] According to a third aspect of the invention there is provided a method of laying a playing surface comprising laying a foam layer having a top surface and a plurality of downwardly extending energy dissipating projections and overlaying the foam layer with a fibrous carpet layer, wherein the plurality of the energy dissipating projections are arranged such that, when the foam layer is used as part of a playing surface with a fibrous carpet layer overlaying the foam layer, the plurality of projections dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface.

[0020] The plurality of the projections may be arranged such that the playing surface has a Critical Fall Height of at least 2.4 metres.

[0021] The method may comprise providing laying a geotextile layer over the foam layer and laying the carpet layer over the geotextile layer, the carpet layer comprising a series of carpet strips connected together by a hot melt adhesive, the geotextile layer arranged to protect the foam layer form heat used in applying the hot melt adhesive.

DESCRIPTION OF THE DRAWINGS

[0022] Embodiments of the invention will now be described, by example only, with reference to the following drawings, in which:

[0023] FIG. **1** is a cross-section of a playing surface according to an embodiment of the invention;

[0024] FIG. **2** is a perspective view of a tile of the foam layer of the playing surface shown in FIG. **1** from above;

[0025] FIG. **3** is a perspective view of a tile of the foam layer of a playing surface shown in FIGS. **1** and **2** from below;

[0026] FIG. **4** is a side view of a tile of the foam layer of the playing surface shown in FIGS. **1** to **3**;

[0027] FIG. **5** is a blown-up perspective view of a tile of the foam layer of a playing surface shown in FIGS. **1** to **4** from above;

[0028] FIG. **6** is a blown-up perspective view of a tile of the foam layer of a playing surface shown in FIGS. **1** to **5** from below;

[0029] FIG. **7** is a cross-section of a playing surface according to another embodiment of the invention; and

[0030] FIG. **8** is a cross-section of a playing surface according to yet another embodiment of the invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0031] Referring to FIG. **1**, a playing surface comprises a foam layer **1** and a fibrous carpet layer **2** overlying the top surface of the foam layer **1**. Located between the foam layer **1** and the carpet layer **2** is a geotextile layer **3**.

[0032] The fibrous carpet layer **1** comprises a pile (e.g. a yarn that stands up from the backing), which may be considered synthetic grass. For example, the pile of the carpet layer may be polypropylene needle punched surface having a 12 to 14 mm pile (14 to 16 mm total thickness including the backing). The pile may have an open fibrous structure having randomly oriented fibres, as described in European Patent No: 0174755.

[0033] The geotextile layer **3** may be 2 mm thick needle punched polyester material.

[0034] The foam layer **2** comprises a plurality of interlocked tiles **5** (one of which is shown in FIGS. **2** to **6**), each tile having connecting formations, in this embodiment trapezoidal recesses **4** for cooperating with corresponding trapezoidal protrusion **6** on the other tiles, for interlocking the tiles **5** together. Each tile **5** has a top surface **7** and a bottom surface **8**.

[0035] The top surface **8** has a rough texture that contacts the geotextile layer **3** to provide high frictional resistance to relative movement between the foam layer **1** and the geotextile layer **3**. The high frictional resistance may prevent movement of the geotextile layer **3** or carpet layer **2** relative to the foam layer **1** when subjected to lateral forces.

[0036] The foam layer **1** further comprises a plurality of downwardly extending energy dissipating projections **9**. The projections **9** are of a shape, in this embodiment dome shaped, such that the projections **9** narrow towards a free end **11** (in this embodiment an apex **11** of the dome) that contacts a surface supporting the playing surface. It will be understood that in other embodiments, other shapes may be used for the projections **9**. The projections **9** have a height (the vertical distance from a valley between the projections to the apex **11** of the projections **9**) of approximately 15 mm and, in this embodiment in which the projections **9** have a dome shape a diameter of approximately 30 mm. The projections **9** are arranged in a pseudo-hexagonal packing arrangement with each projection **9** being close to but being spaced from adjacent projections **9** by a predetermined distance, as indicated by rings **11** around each projection **9**. It will be understood that rings **11** are included in the drawings to illustrate that the projections **9** do not meet and these regions are flat and are part of the valley between the projections **9**.

[0037] In this embodiment, the foam layer **1** is expanded polypropylene having a foam density of 30 grams per litre and the thickness of the foam layer from the top surface to a valley of the bottom surface is 40 mm.

[0038] In one embodiment, the foam layer **1** may comprise one or more holes (not shown) extending from the top surface **7** to the bottom surface **8** that allow water to drain from the playing surface. The projections **9** provide channels below the foam layer **1** for water to drain from the area covered by the playing surface.

[0039] A combination of foam density of the foam layer **1** and an arrangement of the plurality of the projections **9** significantly affects a Critical Fall Height of the playing surface. In particular, the projections **9** are arranged to deform into the spaces to dissipate energy during an impact. It has been found that the combination of features of the foam layer **1** of the above-described embodiment results in the playing surface having a Critical Fall Height of up to 1.4 metres.

[0040] Referring to FIG. **7**, there is shown another embodiment of a playing surface according to an embodiment of the invention. In this embodiment, the foam layer **1** has a thickness of 65 mm. The Critical Fall height of this playing surface may be at least 2.4 metres.

[0041] FIG. **8** shows another embodiment of a playing surface according to the invention. In this embodiment, the playing surface comprises two foam layers **1'** and **1"** stacked consecutively on top of each other. It is believed that the provision of multiple foam layers further increases the Critical Fall Height of the playing surface.

[0042] To manufacture the playing surface, the carpet layer **2** and the geotextile layer **3** may be manufactured in a conventional manner. The foam layer **1** is manufactured by moulding the foam layer **1** in a suitably shaped mould, for example by injection moulding. During the moulding process, the top surface **7** is formed with a rough texture of relatively small projections.

[0043] Laying of the playing surface is typically carried out by digging out a recess in the ground and, optionally, lining the ground with stone, the stone providing a level supporting surface. The tiles forming the foam layer **1** are then placed on the stone surface, the tiles being interlocked together by recesses **4** and protrusions **6**, such that at least the apexes (free ends) of the projections **9** contact the stone. Sheets forming the geotextile layer **3** are placed over the foam layer **1** and rolls of carpet layer **2** are placed over the geotextile layer **3**. The rolls of carpet may be secured together at the joints by introducing using a hot-melt adhesive at the seams. It has been found that the geotextile layer **3** advantageously protects the foam layer **1** from the heat used in this process.

[0044] The playing surface of this embodiment is suitable for external use, such as on children's playgrounds.

[0045] The table below shows the results of measurements of HIC for a playing surface according to the invention having 15 mm energy absorbing projections and a playing surface having a foam tile with no energy absorbing projections.

Type of Foam Tile	Fall Height	HIC
50 mm tile with no energy absorbing projections	2.10 m	897
50 mm tile with 15 mm energy absorbing projections	2.3 m	801
Two 50 mm tiles with no energy absorbing projections placed one on top of the other	2.45 m	949
Two 50 mm tiles with 15 mm energy absorbing projections placed one on top of the other	3.6 m	767

[0046] As can be seen from the table, the playing surfaces with foam tiles having the 15 mm projections can achieve a lower HIC value for higher fall heights. Accordingly, these measurements show that the energy absorbing projections affect the Critical Fall Height of the playing surface.

[0047] It will be understood that the invention is not limited to the above-described embodiments, but modifications and alterations can be made thereto without departing from the aspects of the invention as defined herein.

[0048] For example, the foam layer may be made of other suitable materials, such as polyurethane, expanded polyethylene and expanded polystyrene.

[0049] Rather than forming the foam layer **1** with an integral rough top surface **7**, a separate additional layer may be adhered to the top surface of the foam layer, this additional layer having an upper surface that provides a high frictional resistance to movement of the geotextile layer **3**.

1. A playing surface comprising a foam layer having a top surface and a plurality of downwardly extending energy dissipating projections and a fibrous carpet layer overlying the top surface of the foam layer, wherein the plurality of the energy dissipating projections are arranged to dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface.

2. A playing surface according to claim **1**, wherein at least two of the plurality of projections have a height of at least 10 mm.

3. A playing surface according to claim **2**, wherein the majority, if not all, of the plurality of projections have a height of at least 10 mm.

4. A playing surface according to claim **2**, wherein the plurality of projections have a height of between 10 mm and 20 mm.

5. A playing surface according to claim **1**, wherein the arrangement of the plurality of the projections results in the playing surface having a Critical Fall Height significantly greater than a Critical Fall Height that would be achieved with a foam layer of the same material and foam density having a flat bottom surface.

6. A playing surface according to claim **1**, wherein the foam layer is expanded polypropylene.

7. A playing surface according to claim **1**, wherein the foam density is at least 25 grams per litre.

8. A playing surface according to claim **7**, wherein the foam density is between 30 grams per litre and 40 grams per litre.

9. A playing surface according to claim **1**, wherein the foam layer has a thickness of between 40 mm and 65 mm.

10. A playing surface according to claim **1**, wherein each projection has a free end that, in use, contacts a surface supporting the playing surface, the projection having a shape that narrows towards the free-end.

11. A playing surface according to claim **10**, wherein the projections are dome shaped.

12. A playing surface according to claim **1**, wherein the foam layer comprises one or more holes extending from the top surface to the bottom surface of the foam layer.

13. A playing surface according to claim **1** comprising a geotextile layer between the foam layer and the carpet layer.

14. A playing surface according to claim **1**, wherein the top surface of the foam layer comprises a rough surface that contacts the geotextile or carpet layer to provide high frictional resistance to relative movement between the layers.

15. A playing surface according to claim **14**, wherein the top surface of the foam layer comprises upwardly extending projections having a height of less than 0.5 mm.

16. A playing surface according to claim **1**, comprising two or more foam layers, each foam layer having a top surface and a plurality of downwardly extending energy dissipating projections.

17. A playing surface according to claim **16**, wherein the foam layers are stacked consecutively on top of each other.

18. A playing surface according to claim **1**, wherein the foam layer comprises a plurality of interlocked tiles, each tile having formations for cooperating with formations on the other tiles for interlocking the tiles together.

19. A method of manufacturing a playing surface comprising forming a foam layer having a top surface and a plurality of downwardly extending energy dissipating projections, wherein the plurality of the energy dissipating projections are arranged such that, when the foam layer is used as part of a playing surface with a fibrous carpet layer overlaying the foam layer, the plurality of projections dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface.

20. A method of laying a playing surface comprising laying a foam layer having a top surface and a plurality of downwardly extending energy dissipating projections and overlaying the foam layer with a fibrous carpet layer, wherein the plurality of the energy dissipating projections are arranged such that, when the foam layer is used as part of a playing surface with a fibrous carpet layer overlaying the foam layer, the plurality of projections dissipate energy of an impact through deformation to significantly affect a Critical Fall Height of the playing surface.

21. A method according to claim **19** or claim **20**, wherein the plurality of the projections are arranged such that the playing surface has a Critical Fall Height of at least 2.4 metres.

22. A method according to claim **20**, comprises laying a geotextile layer over the foam layer and laying the carpet layer over the geotextile layer, the carpet layer comprising a series of carpet strips connected together by a hot melt adhesive, the geotextile layer arranged to protect the foam layer from heat used in applying the hot melt adhesive.

* * * * *