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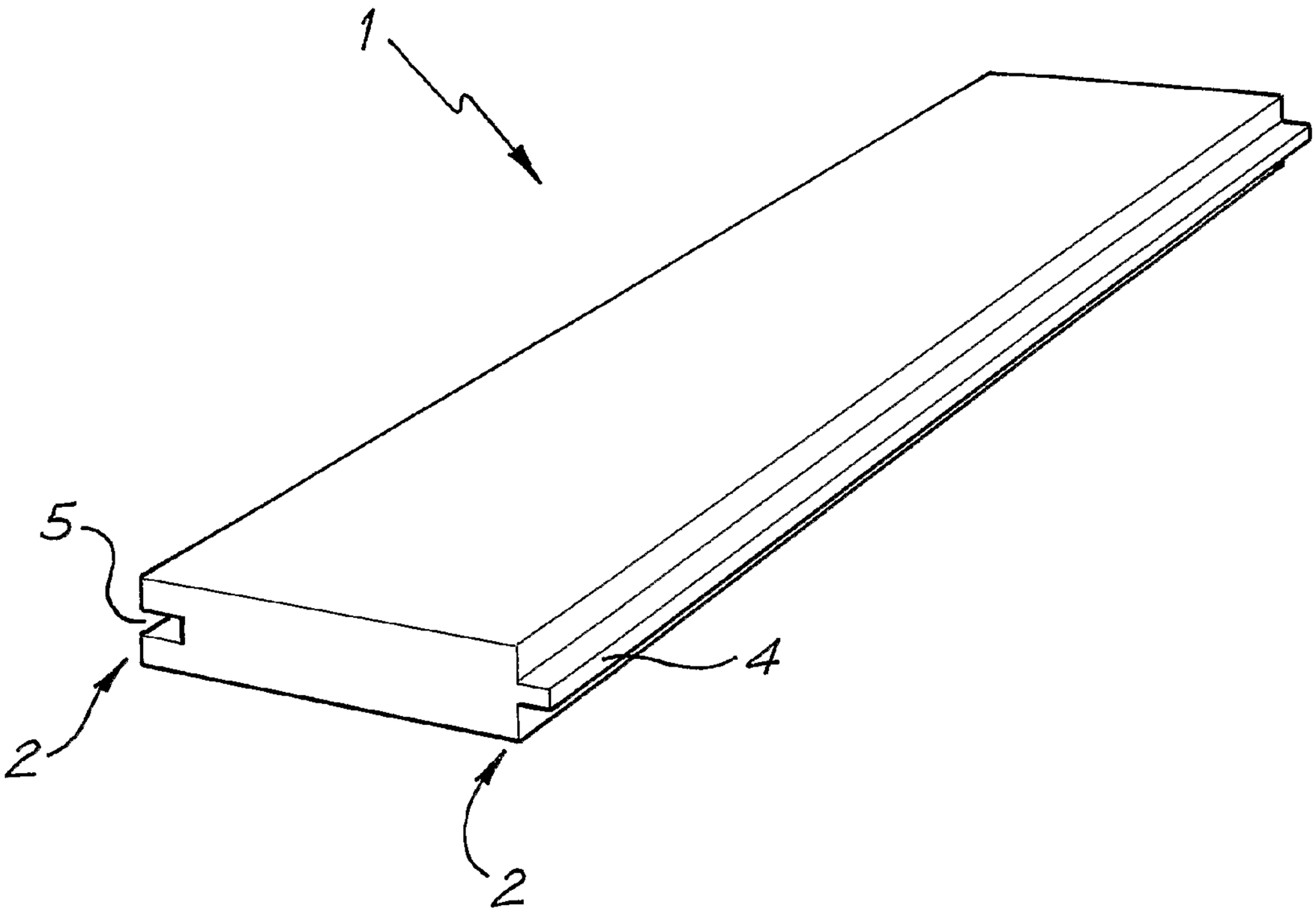

(57) Abrégé/Abstract:
A fibre reinforced cement flooring sheet (1) that is suitable for use in wet area flooring, is lower in density than conventional compressed fibre cement wet area flooring, and is nailable. The flooring sheet (1) includes connecting means (2) on longitudinal edges permitting the sheet to be interlockingly engaged with adjacent sheets to form a substantially coplanar support surface, suitable for use in wet areas.

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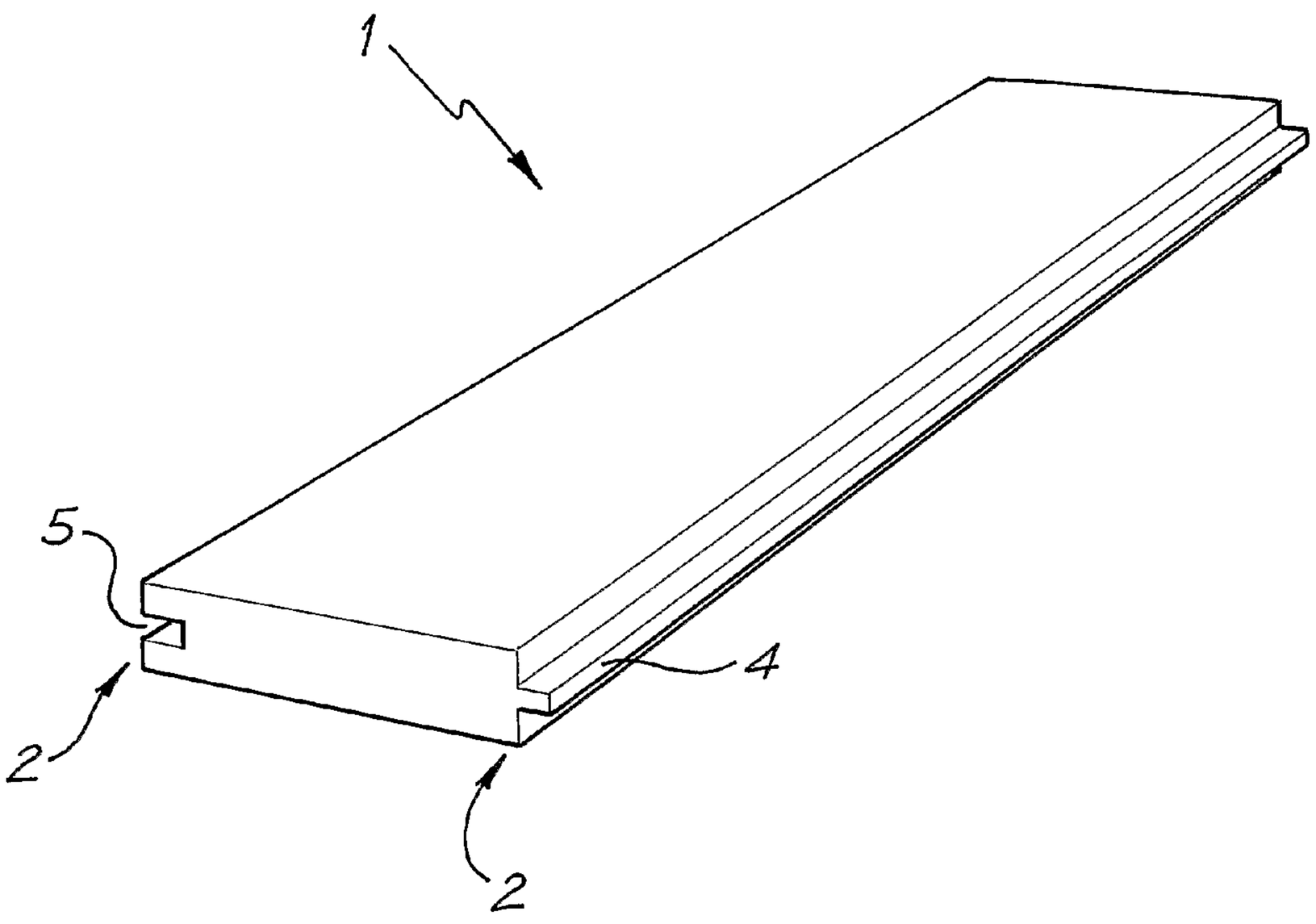
(54) Title: FLOORING SHEET AND MODULAR FLOORING SYSTEM



(57) Abstract: A fibre reinforced cement flooring sheet (1) that is suitable for use in wet area flooring, is lower in density than conventional compressed fibre cement wet area flooring, and is nailable. The flooring sheet (1) includes connecting means (2) on longitudinal edges permitting the sheet to be interlockingly engaged with adjacent sheets to form a substantially coplanar support surface, suitable for use in wet areas.

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TITLE: FLOORING SHEET AND MODULAR FLOORING SYSTEM

FIELD OF THE INVENTION

The present invention relates to flooring and in particular to wet area flooring. The invention has been developed primarily for providing wet area sheet flooring and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

BACKGROUND OF THE INVENTION

The following discussion of the prior art is intended to place the invention in an appropriate technical context and enable the advantages of it to be more fully understood. However, any discussion of prior art throughout the specification should not be considered as an express or implied admission that such art is widely known or forms part of common general knowledge in the field.

One known method of laying a foundation for wet area flooring involves abutting sheets of compressed fibre cement side by side across a desired wet area and subsequently fastening the sheets in place. A disadvantage of compressed fibre cement products currently used for this application is that they are particularly heavy, making transportation, handling and installation difficult. Furthermore, the density of the compressed products prevents effective pneumatic or power nail fastening and in order to screw the sheets in place, the screw holes must be pre-drilled and countersunk which is time-consuming relative to pneumatic or power nailing.

The abutting edges of the sheets are typically fastened to joists wherever possible to minimise relative movement between adjacent sheets. Current practice is also to provide support on trimmers between floor joists to the edges that are not supported continuously on a floor joist, in order to provide adequate support for the edges and reduce the likelihood of relative movement between the abutting edges of adjacent sheets.

Once the floor sheeting is secured and adequately waterproofed, tiles can be laid in conventional manner. In many instances, floor sheeting is installed directly over subflooring. The subflooring may comprise particle-board, press board, OMD, or other such timber-based subflooring products. If the waterproofing is not installed correctly, if it deteriorates over time, or if defects in the waterproofing surface and

connections develop, water may penetrate through to the underlying floor sheeting which, depending on the sheet flooring material, may become damaged due to water effects such as swelling and other mechanisms. This in turn can disrupt the finish of the flooring surface or the integrity of the underlying structure.

In addition to the desirability of avoiding problems related to moisture absorption after installation, it is also highly desirable for a product to resist moisture absorption during transport and storage. For example, although compressed fibre cement is generally resistant to moisture damage, moisture absorption can lead to increased mass during storage prior to installation, thereby increasing transportation costs and making handling more burdensome. A means of resisting moisture absorption during storage prior to installation is therefore desirable for ease of handling, installation and transportation.

It is an object of the present invention to overcome or ameliorate one or more of the disadvantages of the prior art, or at least to provide a useful alternative.

DISCLOSURE OF THE INVENTION

Accordingly, in an aspect, there is provided a fibre reinforced cement bound flooring sheet that is suitable for use in domestic wet area flooring, is lower in density than conventional compressed fibre cement wet area flooring, and is nailable, wherein said flooring sheet has a bending strength sufficient to withstand a uniformly distributed load of at least 5 kPa when supported at 450mm centres along its length, and wherein said sheet includes connecting means at opposed edges, such that the sheet may be interlockingly engaged with an adjacent complementary sheet to form a coplanar support surface, wherein said connecting means include tongue and groove formations disposed respectively on opposite longitudinal edges of each flooring sheet, whereby the tongue on one sheet and the groove on the adjacent sheet

cooperate to provide secure interlocking engagement between adjoining sheets and wherein a longitudinal cavity is formed between the interlocking tongues and grooves, to permit insertion of a sealant or a glue between the adjoining sheets.

Preferably, the sheet flooring material is nailable with conventional pneumatic or power nailing equipment.

Preferably, the sheets are strong enough to meet loading requirements for domestic construction flooring on supporting members spaced at 450 mm centres. In one preferred embodiment, the fibre reinforced cement sheet has a dry density lower than about 1.25 g/cm^3. It is preferable that a fibre reinforced cement bound sheet having a nominal thickness of 19mm exhibits a bending strength sufficient to withstand a uniform load of 5 to 9 kPa when supported at 450 mm centres along its length, whether the cement bound sheet is dry or saturated with water.

Typically, the sheets have a front or outer surface, a back surface, and a thickness therebetween. In addition, the sheets have edges of substantially uniform depth corresponding to the thickness between the front and back surfaces. In one preferred form, the described sheets have at least one surface sealed with a polymeric surface coating to give at least one surface of the sheet resistance to moisture

absorption. Typically, the outer surface of the sheet is sealed with the polymeric coating. However, additional or alternative surfaces may be coated as well, and the entire sheet is coated in some preferred embodiments. The polymeric coating is preferably specifically formulated to achieve and maintain a strong bond to tile adhesives and bedding materials. On the bottom surface of the sheet the surface coating is preferably adapted to bond to typical adhesives used to bond sheet flooring. On the edges of the sheet the surface coating is preferably adapted to bond to sealants or glues used in the connection of such sheets.

In another preferred form, the sheet is reinforced with a substantially continuous layer of reinforcing material such as sheets or fibres of metals, inorganic fibres, polymeric fibres, carbon fibres or a combination or the above. The reinforcing material can be added in a plane of the sheet in any position throughout the sheet thickness and is preferably positioned at or towards at least one of the outer surfaces. The reinforcing material may be uni-directional or multi-directional, spaced, matt or woven. The reinforcing material is preferably embedded into the sheet material during green forming of the sheet, pressed into the surface of the green sheet article in a green state, or bonded to the surface in a cured or green state. Where glass fibre reinforcement is used, the fibre is preferably resistant to alkali attack. Alkali resistant glass or polymer coated glass fibre are examples of suitable materials.

Another aspect of the invention provides a modular flooring system for a wet area, said flooring system including at least one flooring sheet as previously defined, and complementary connecting means permitting said flooring sheet to be interlockingly engaged with an adjacent sheet to form a substantially coplanar support surface.

In one preferred form, the adjacent complementary sheet is also formed from fibre cement, more preferably a density modified fibre cement sheet having a dry density lower than about 1.25g/cm^3. In another preferred form, the adjacent complementary sheet is formed from particle board.

Preferably, the fibre cement sheet is generally rectangular and the connecting means run along a longitudinal edge. More preferably, the connecting means run along both longitudinal edges. In one preferred form, the connecting means take the form of tongue and groove formations respectively defined on opposite longitudinal edges of the sheet. In this embodiment, the tongue on one sheet and the

complementary groove on the adjacent sheet are preferably formed to cooperate with one another to allow a secure connection between the sheets. Various types of tongue and groove geometries are contemplated, including a lock system wherein the tongue is configured with a slight protrusion along its length and the groove is further configured with a corresponding recess along its length to accept the protrusion.

Preferably, the tongue and groove are configured such that when a tongue and groove on adjoining sheets are interlocked, a cavity is created between the tongue and the groove along their lengths to allow glue to be inserted. The glue in this case preferably acts either to bond the connection and/or seal the connection to moisture as required for waterproofing wet areas such as bathroom floors.

In another preferred form, the connecting means take the form of grooves formed in opposite longitudinal edges of each sheet and a complementary elongate joining member adapted for simultaneous engagement with the respective adjacent grooves of adjoining sheets.

Preferably, embodiments of the fibre cement sheet disclosed herein have a dry density of less than about 1.5 g/cm^3. More preferably, the fibre cement sheet has a dry density of less than about 1.25 g/cm^3.

Preferred embodiments of the fibre cement sheet include elements such as microspheres, pearlite and volcanic ash.

In a particularly preferred form, embodiments of the fibre cement sheet composition include those disclosed in United States Patent No. 6,572,697, entitled "Fiber Cement Building Materials with Low Density Additives". In addition, the preferred fibre cement sheets may be

formulated according to embodiments disclosed in United States Patent No. 6,346,146 entitled "Building Products" and also according to embodiments disclosed in Australian Patent No. AU 515151, entitled "Fibre Reinforced Cementitious Articles".

In some preferred embodiments, the average thickness of the fibre cement sheets is preferably between about 10 mm and 30 mm, and more preferably between 16 to 22 mm. However, in certain embodiments, the thickness may be greater than or

less than the disclosed thicknesses yet still provide the advantageous characteristics contemplated by the disclosed embodiments.

According to a further aspect of the invention, there is provided a method of installing a modular flooring system as defined above, including the steps of aligning two or more of the flooring sheets on a support platform and engaging the connecting means on the adjoining sheets so as to form a coplanar support surface.

Preferably, the sheets are fastened to a support surface platform formed by framing members disposed in spaced apart relationship. Various materials may be used to form the support surface platform such as timber, steel or concrete.

The sheets are preferably nailed to the support surface platform. However, other fastening techniques such as screwing or gluing may also be used to secure the sheets in place.

The connecting means on opposed edges are preferably formed by machining. However, this may also be achieved by other methods such as casting, extruding, or fastening.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a first embodiment of a modular flooring sheet according to the invention, shown with tongue and groove connecting means;

Figure 2 is a side view of a series of interconnected modular flooring sheets of the type shown in Figure 1;

Figure 3 is a perspective view of an alternative embodiment of a modular flooring sheet according to the invention, shown with connecting means in the form of grooves and joining member;

Figure 4 is a side view of a series of interconnected modular flooring sheets of the type shown in Figure 3;

Figure 5 is a plan view of a uniform distributed load testing apparatus and a sample of flooring sheets installed in the testing apparatus; and

Figure 6 is a front view of a portion of the testing apparatus of Figure 5 showing the spaced apart support members supporting the flooring sheet sample.

PREFERRED EMBODIMENT OF THE INVENTION

Referring to the drawings, the invention provides a modular flooring system including at least one generally rectangular fibre cement sheet 1 having connecting means 2 on longitudinal opposed edges such that the sheet 1 may be interlockingly engaged with an adjacent complementary sheet to form a coplanar support surface 3, as seen in Figures 2 and 4. The adjacent complementary sheet may be formed from any material having complementary connecting means, such as a further fibre cement sheet or a sheet of particle board.

The connecting means 2 serves to resist relative movement, and in particular co-planar misalignment, between abutting sheets along the joins. It will be appreciated by those skilled in the art that the connecting means may take many different forms. In Figures 1 and 2, the connecting means take the form of tongue and groove formations 4 and 5 respectively defined on opposite longitudinal edges of the sheets. Preferably, when a tongue and groove of adjoining sheets are interlocked, a cavity 6 is created to allow for glue to be inserted.

In another preferred form, as shown in Figures 3 and 4, the connecting means take the form of grooves 7 formed in opposite longitudinal edges of each sheet and a complementary elongate joining member 8 adapted for simultaneous engagement with the respective grooves of adjoining sheets, as shown in Figure 4.

While the embodiments shown in the accompanying figures illustrate connecting means having square or rectangular geometries, it will be appreciated that the cooperating tongues and grooves can take any desired shape, and are not limited to the exemplary geometries given. The connecting means may be formed on the board by any suitable means, such as by extrusion during the sheet formation process, or by machining once sufficient curing has taken place. Other suitable methods of forming the connecting means will be readily apparent to those skilled in the art.

The fibre cement sheet preferably has a dry density of less than about 1.5 g/cm^3 and more preferably less than about 1.25 g/cm^3, while retaining strength properties that meet relevant building standards for sheet flooring designed to span spaced apart floor

joists. Many different additives and materials, such as density modifiers and strength enhancers, may be utilised in the fibre cement sheets to achieve these desirable characteristics such as microspheres, pearlite, volcanic ash or combinations thereof.

These features provide a sheet with the strength properties needed for a wet area floor. However, transportation and installation time and costs are decreased due to the lightweight characteristics of the material in comparison with currently available products. Furthermore, using this type of product removes the need to countersink screw holes required with higher density materials, as nails can be used to secure the sheets to the underlying joists, thereby significantly decreasing installation time and cost.

In use the fibre cement sheets are applied pre or post autoclave curing with a sealant or sealant combination of a polymer emulsion or solution and/or a water repellent, such as, for example, silanes, siloxanes , waxes or stearates, to decrease the boards' water absorption in order to strengthen the boards and promote water resistant properties. The coating system can encompass air drying, multiple component systems, reactive chemical curing, forced curing (eg heat, steam, accelerates) or radiation cured coatings (eg electron beam, ultra-violet, infra-red, near-infra-red, microwave radiation) or combinations thereof, utilising any curing/drying techniques for water based, solvent based or 100% solids (wet or powder) coating systems. In one preferred embodiment, the edges of the sheets are subsequently machined to form the connecting formations. However, in other embodiments, the edges of the sheets are machined or otherwise formed prior to the coating system being applied so that the edges will exhibit the same low water absorption properties as the surface of the sheet.

Turning now to the method of installation of the system, initially a structural support platform is constructed from timber framing materials, steel framing materials, a concrete base or other suitable means to define a wet area, such as a bathroom floor. In the embodiment of the invention shown in figures 5 and 6, timber framing members 10 are used to support joists 11, the upper surfaces of which collectively form a flooring support platform 12.

The sheets are then interlocked via the connecting means 2 and laid across the wet area. The sheets may be connected to one another prior to laying over the support platform. However, in preferred embodiments, the sheets are laid in succession, each

being secured in turn to the previous sheet and to the underlying support platform. In some preferred embodiments, glue is used between the connecting formations to secure the sheets together. There is no need to countersink screw holes in the sheets as the density of the board allows the sheets to be secured in place with nails 14, ideally by pneumatic or power nailing. However, screws can be used to secure the sheets to the supporting subfloor or underlying framework if desired. Once the sheets have been secured in place, a suitable waterproofing material is placed over the support surface in the conventional manner. Tiles or other finishing products are then laid.

Example 1

One embodiment of the flooring sheets described herein was prepared according to the formulation given below in Table 1. It should be understood that the given formulation represents only one exemplary formulation within the scope of United States Patent No. 6,572,697, entitled "Fiber Cement Building Materials with Low Density Additives" and does not constitute all embodiments of the flooring sheets contemplated and disclosed herein.

Formulation %	*Portland Cement*	*Silica*	*Wood Pulp*	*Metal hydroxide*	*Microspheres*
A	**36.9**	**24.6**	**10**	**3.5**	**25**

Table 1

Tests were conducted to ascertain the strength of the described board in response to a uniformly distributed load (UDL), according to AS 1170.1, "AS/NZS Structural design actions – Permanent, imposed and other actions" by forming a timber frame having dimensions of 2410 mm × 1210 mm constructed of 90mm × 45mm thicknessed radiata pine framing timber, at 450mm stud centres.

The frame was sheeted with tongue and groove wet area flooring fibre cement sheets as described herein. The sheets used in this example were nominally 900mm × 1800mm × 19mm. The sheets were trimmed to the required sample size to fit the 1210mm width of the timber frame. The resulting sheet was 1210mm × 900mm, and the sheets were laid such that the tongue and groove joint ran across the width of the

frame at right angles to the longitudinal joists. The layout of the testing material and apparatus of Example 1 is shown in Figures 5 and 6.

A uniformly distributed load test was carried out in accordance with ASTM E72-98, "Standard Test Method for Conducting Strength Tests of Panels for Building Construction." Each frame was placed over the horizontal opening of the Uniformly Distributed Load Testing Apparatus and it was ensured that the sample was sealed against the apparatus. An appropriate sealer was applied to ensure an airtight seal between the sample and the perimeter edges of the test chamber.

After the sample was installed into the testing apparatus, the air within the test chamber was evacuated, thereby inducing a uniformly distributed load to the sample. The load applied was monitored both by a water manometer, and a pressure transducer connected to an appropriate data acquisition system. The resulting test thereby applied a suction pressure to the underside of the test sample and thus produced a uniformly distributed load.

Linear variable differential transformers (LVDTs) 13 were used in conjunction with the computerised data acquisition system to capture the deflection data. The LVDTs were placed midway between the studs to measure the maximum deflection of the sheets.

The test was run again, after the sample had been saturated with water as per the testing standards. The edge of the frame was adequately sealed against the sample to provide a water-tight seal. The frame was then filled with water, and a minimum 25mm head of water was maintained for a minimum of 7 days. The water was then drained and the test was performed substantially as described above. The results of the dry and wet deflection tests are shown in the Table 2 below.

	Deflection (mm)						
Board Condition	Pressure (kPa)	LVDT 1 centre (mm)	LVDT 2 joint (mm)	LVDT 3 joint (mm)	LVDT 4 centre (mm)	Average Displacement (mm)	Average Moisture Content
Dry (as received)	9.72	8.1	7.1	3.2	5.9	6.1	10.8%
Saturated	9.79	3.7	7.4	7.3	7.2	6.4	35.7%

Table 2

The test was continued until the uniform pressure exceeded 9.7 kPa, at which point the pressure was relieved and the test was completed. According to the data presented above, it is clearly seen that the 19mm tongue and groove fibre cement wet area flooring, installed on joists at 450mm centres and saturated with water, was able to withstand an average UDL value in excess of 9.7kPa, which far exceeds the 5kPa requirements of AS/NZS 1170.1. Furthermore, the floor sheet and flooring configuration described above meets the flooring imposed load concentrated actions requirements for domestic and residential activities described in AS/NZS 1170.1.

Never before to the applicant's knowledge has such a fibre cement wet area flooring material been able to withstand such a high load, yet maintain a dry density below 1.25g/cm^3 to accommodate installation methods such as nailing. The strength and waterproof properties of the fibre cement sheet also make it suitable for use in external wet areas such as decks and other areas of residential housing typically exposed to moist floor areas.

It will be appreciated that the invention provides modular flooring system that is lightweight, nailable, resistance to moisture absorption, and relatively easy to transport and install. Furthermore, the flooring system reduces the need for the use of trimmers, and the chemical structure of the fibre cement sheet significantly decreases the likelihood of swelling if the sheet comes into contact with water. In these and other respects, the invention represents a practical and commercially significant improvement over the prior art.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

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CLAIMS:

1. A fibre reinforced cement bound flooring sheet that is suitable for use in domestic wet area flooring, is lower in density than conventional compressed fibre cement wet area flooring, and is nailable, wherein said flooring sheet has a bending strength sufficient to withstand a uniformly distributed load of at least 5 kPa when supported at 450mm centres along its length, and wherein said sheet includes connecting means at opposed edges, such that the sheet may be interlockingly engaged with an adjacent complementary sheet to form a coplanar support surface,

wherein said connecting means include tongue and groove formations disposed respectively on opposite longitudinal edges of each flooring sheet, whereby the tongue on one sheet and the groove on the adjacent sheet cooperate to provide secure interlocking engagement between adjoining sheets and

wherein a longitudinal cavity is formed between the interlocking tongues and grooves, to permit insertion of a sealant or a glue between the adjoining sheets.

2. A flooring sheet according to claim 1, having a dry density of less than around 1.5 g/cm^3.

3. A flooring sheet according to claim 1 or claim 2, having a dry density of less than around 1.25 g/cm^3.

4. A flooring sheet according to any one of claims 1 to 3, having a thickness of between 10mm and around 30mm.

5. A flooring sheet according to any one of claims 1 to 4, having a thickness of between 16mm and around 22mm.

6. A flooring sheet according to any one of claims 1 to 5, having a thickness of around 19mm.

7. A flooring sheet according to any one of claims 1 to 6, having a bending strength sufficient to withstand a uniformly distributed load of at least 5 kPa when supported at 450mm centres along its length, when dry or saturated with water.

8. A flooring sheet according to any one of claims 1 to 7, having a bending strength sufficient to withstand a uniformly distributed load of at least 9 kPa when supported at 450mm centres along its length, when dry or saturated with water.

9. A flooring sheet according to any one of claims 1 to 8, having at least one surface sealed with a surface coating adapted to provide resistance to moisture absorption.

10. A flooring sheet according to claim 9, wherein said surface coating is formed from a polymeric material.

11. A flooring sheet according to claim 9 or claim 10, wherein said surface coating is applied to an outer surface of the sheet.

12. A flooring sheet according to any one of claims 9 to 11, wherein said surface coating is applied to substantially all surfaces of the sheet.

13. A flooring sheet according to any one of claims 9 to 12, wherein said surface coating is adapted to bond to tile adhesives and bedding materials.

14. A flooring sheet according to any one of claims 1 to 13, being reinforced with a substantially continuous layer of reinforcing material.

15. A flooring sheet according to claim 14, wherein said reinforcing material is formed from one or more materials selected from the group comprising metal, plastics, inorganic fibres, polymeric fibres, glass fibres, polymer-coated glass fibres or carbon fibres.

16. A flooring sheet according to claim 14 or claim 15, wherein said reinforcing layer of reinforcing material is positioned between the outer surfaces of the sheet.

17. A flooring sheet according to claim 16, wherein said reinforcing material is embedded between outer layers during green forming of said sheet.

18. A flooring sheet according to claim 16, wherein said reinforcing material forms an outer surface of the sheet.

19. A flooring sheet according to claim 16, wherein said reinforcing material is sandwiched between outer layers of the sheet after curing of the outer layers.

20. A flooring sheet according to any one of claims 16 to 19, wherein said reinforcing material is adapted to be alkali-resistant.

21. A modular flooring system for a wet area, said flooring system including at least one flooring sheet as defined in any one of claims 1 to 20, and complementary connecting means permitting said flooring sheet to be interlockingly engaged with an adjacent sheet to form a substantially coplanar support surface.

22. A modular flooring system according to claim 21, wherein said adjacent sheet is formed substantially from particle board.

23. A modular flooring system according to claim 21, wherein said adjacent sheet is a flooring sheet as defined in any one of claims 1 to 20.

24. A modular flooring system according to any one of claims 21 to 23, wherein the flooring sheets are generally rectangular and wherein the connecting means are disposed on at least one longitudinal edge of each sheet.

25. A modular flooring system according to claim 24, wherein the connecting means extend along both longitudinal edges of each flooring sheet.

26. A modular flooring system according to any one of claim 21 to claim 25, wherein the tongues are configured with protrusions along their lengths and the groove are configured with corresponding recesses along their lengths, thereby to provide a locking mechanism resisting disengagement of the adjoining sheets.

27. A modular flooring system according to any one of claim 21 to claim 26, wherein each flooring sheet includes grooves disposed respectively on opposite longitudinal edges and

wherein the groove of one longitudinal edge receives an elongate strip such that said one longitudinal edge with said elongate strip forms one said tongue.

28. A modular flooring system according to any one of claims 21 to 27, wherein the flooring sheets are formed substantially from a fibre reinforced cement formulation including microspheres, pearlite or volcanic ash.

29. A method of installing a modular flooring system as defined in any one of claims 21 to 28, including the steps of aligning two or more of the flooring sheets on a support platform and engaging the connecting means on the adjoining sheets so as to form a coplanar support surface.

30. A method according to claim 29, wherein the support platform is formed from spaced apart framing members.

31. A method according to claim 29 or claim 30, including the further step of securing the flooring sheets to the support surface.

32. A method according to claim 31, wherein the flooring sheets are secured to the support surface by fastening means selected from the group comprising nailing, screwing and gluing.

33. A method according to any one of claims 29 to 32, wherein the connecting means are formed using a production technique selected from the group comprising machining, casting, extruding, and fastening.

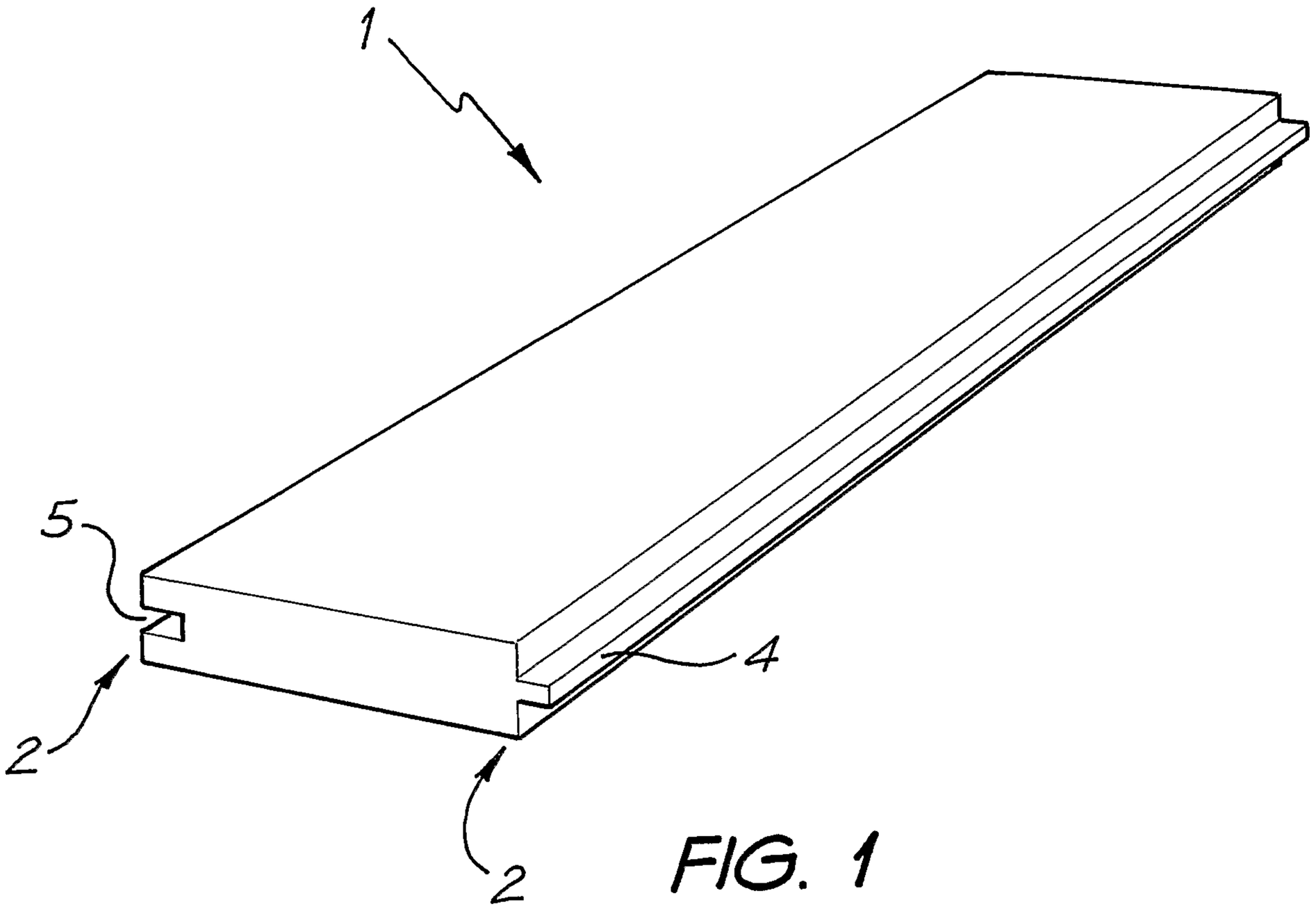


FIG. 1

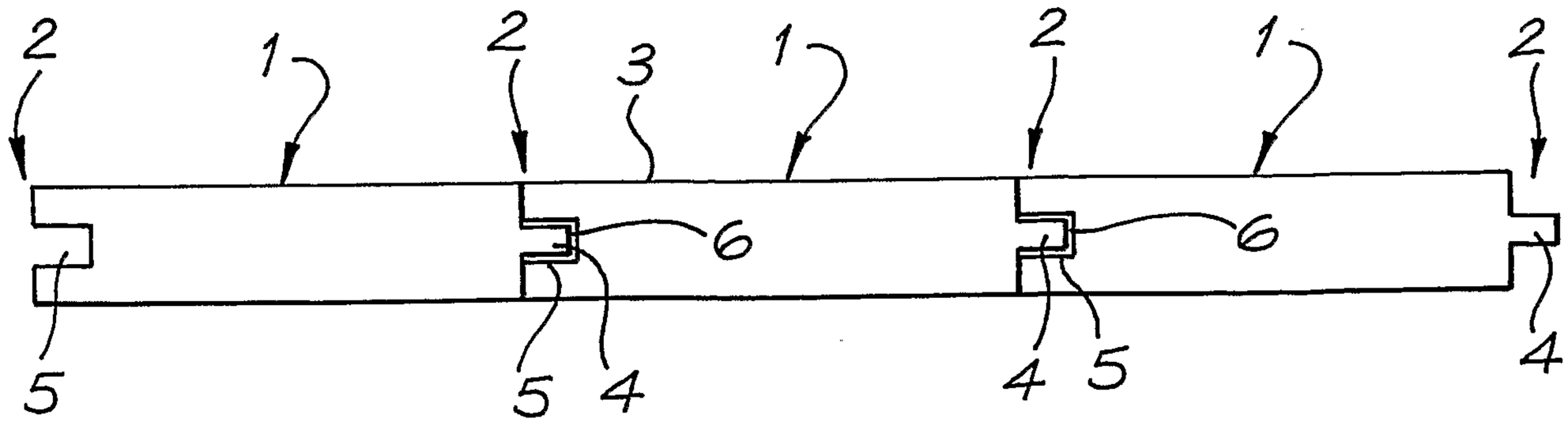


FIG. 2

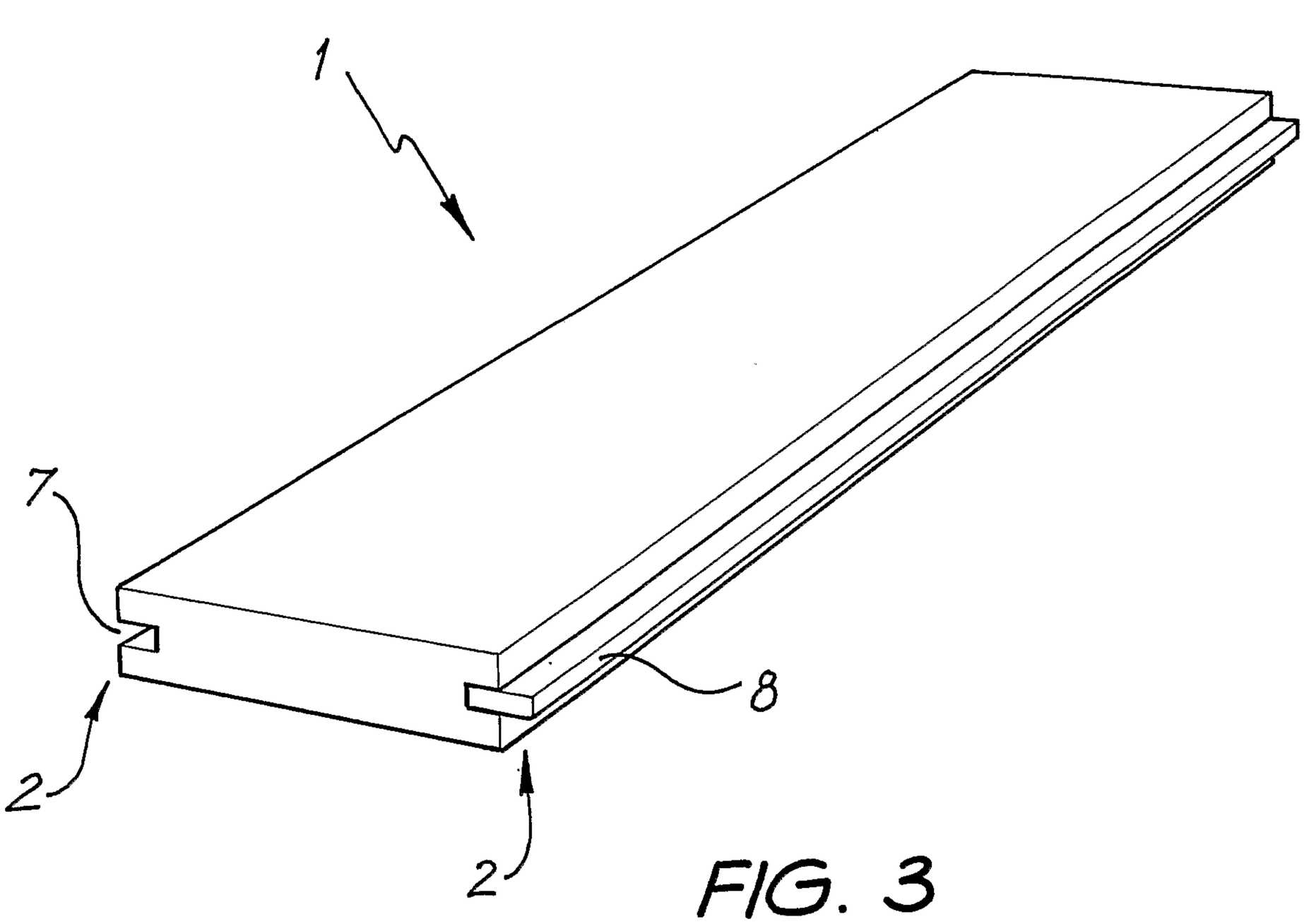


FIG. 3

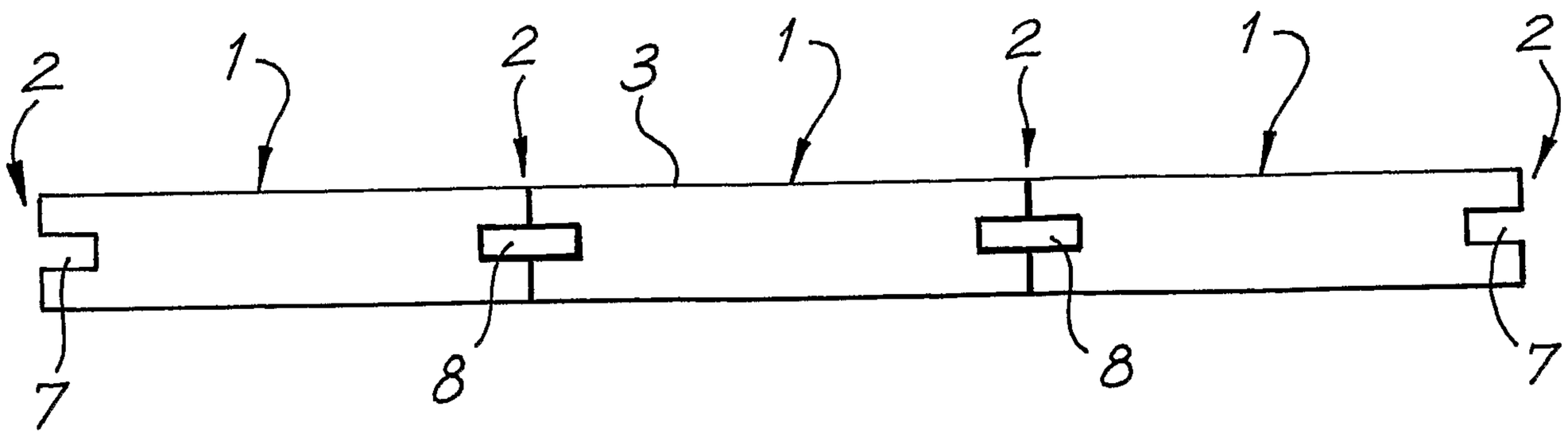


FIG. 4

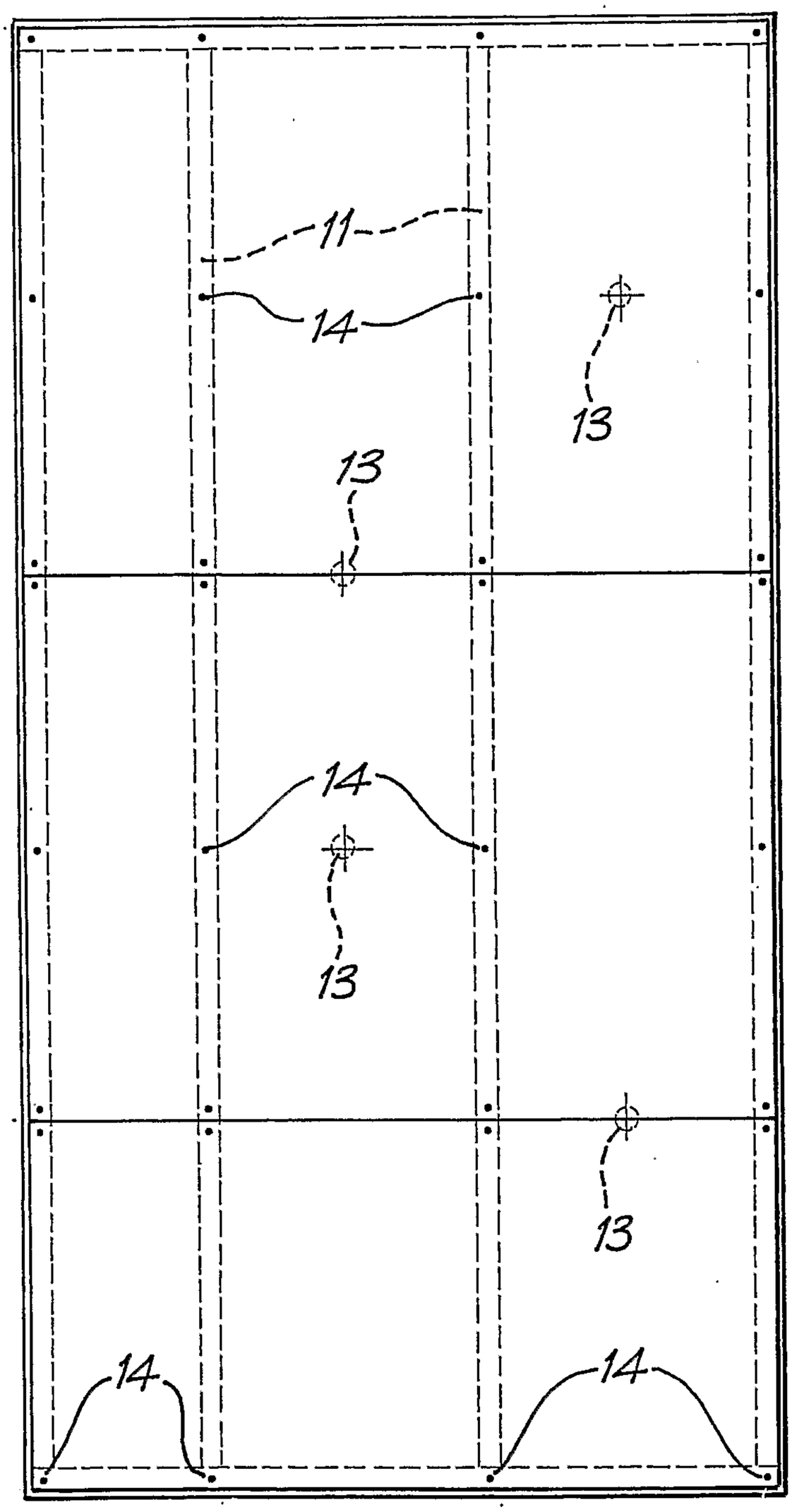


FIG. 5

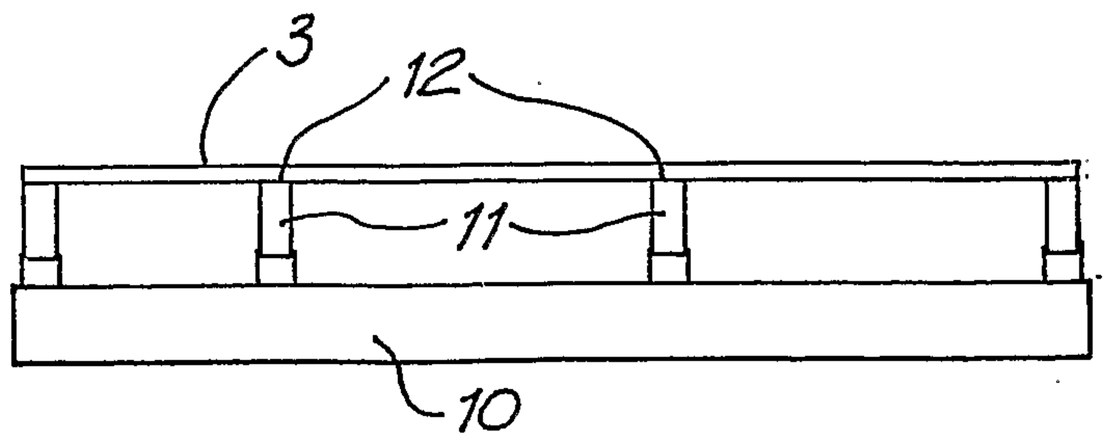
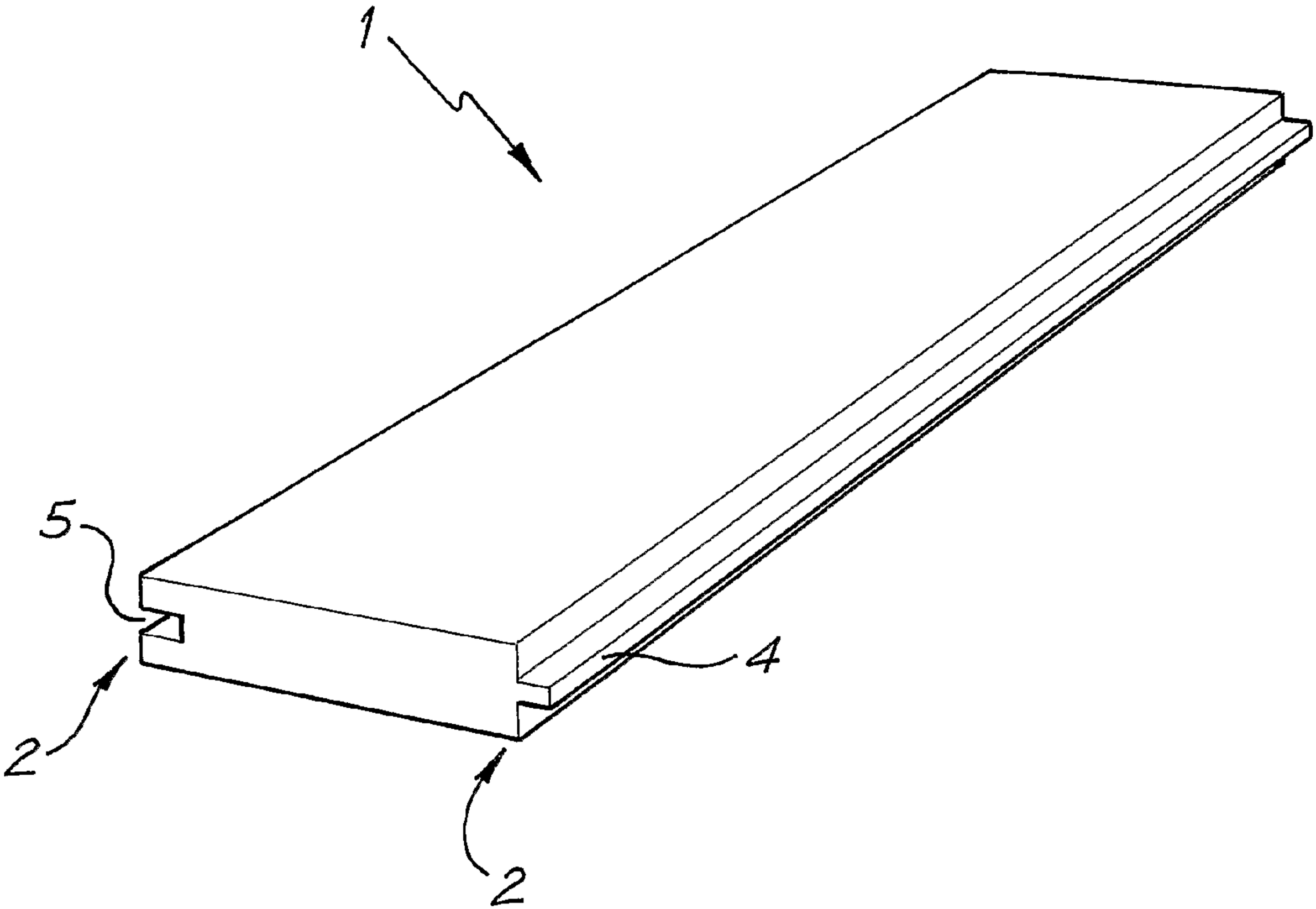


FIG. 6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