

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

**EP 0 793 742 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention  
of the grant of the patent:

**27.10.1999 Bulletin 1999/43**

(21) Application number: **95902535.4**

(22) Date of filing: **14.11.1994**

(51) Int Cl.<sup>6</sup>: **D04H 11/00**

(86) International application number:  
**PCT/US94/13056**

(87) International publication number:  
**WO 96/15302 (23.05.1996 Gazette 1996/23)**

(54) **FUSION-BONDED CARPET SYSTEM AND METHOD OF PREPARATION**

SCHMELZVERBUNDENES TEPPICH-SYSTEM UND VERFAHREN ZUR HERSTELLUNG

TAPIS A LIAISON PAR FUSION, ET SON PROCEDE DE FABRICATION

(84) Designated Contracting States:  
**AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL  
PT SE**

(43) Date of publication of application:  
**10.09.1997 Bulletin 1997/37**

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**US-A- 3 951 022**                      **US-A- 3 957 555**  
**US-A- 4 391 665**

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## Description

**[0001]** Carpets, such as free-lay carpet or backed carpet tile, have been prepared as either a tufted or a fusion-bonded carpet material having a wear face surface.

**[0002]** Tufted carpet tile generally comprises a primary carpet base sheet material having a plurality of tufted yarns through the primary base sheet material to form a wear face surface of loop or cut pile, and usually with a precoat, such as of a latex-type material, like carboxylated styrene-butadiene-styrene precoat, on the back surface to bond the yarn to the primary back. Tufted carpet roll goods usually have a secondary backing of jute, woven polypropylene or foam. Tufted carpet tile includes a backing layer which generally comprises a solid, thermoplastic material, such as atactic polypropylene, bitumen or polyvinyl chloride, preferably with a glass fiber sheet material, such as a mesh or fleece material, embedded therein to impart dimensional stability to the carpet tile. The backing may also include a foam-type backing layer, such as a PVC or urethane foam layer. Non-thermoplastic materials, such as polyurethane, may also be used for the backing. In addition, the tufted carpet tile may include a secondary backing sheet, such as of fiberglass, polypropylene or polyester-type material, or in fact, may be laminated and/or contain a pressure-sensitive, adhesive, strippable layer for application to a substrate.

**[0003]** Fusion-bonded carpet has essentially the same backing except that the fusion-bonded carpet is characterized by a plurality of cut pile yarns, for example, of nylon or other natural or synthetic fibrous-type material, implanted in an adhesive layer, particularly a thermoplastic, like a polyvinyl chloride layer, or a hot-melt adhesive layer. Where a polyvinyl chloride plastisol is used, heating of the layer gels and then fuses the layer into solid form, while with hot-melt adhesive material, a melted layer is applied and subsequently cooled into solid form. The plurality of fibrous yarns are bonded to and extend upright from the adhesive base layer to form a face wear surface. Generally, a fusion-bonded carpet also includes an adjacent backing layer of a glass fiber scrim material having large open areas and a glass fiber fleece which serves as a stabilizing carrier.

**[0004]** Fusion-bonded carpets may be prepared employing a number of well-known, but different techniques and machines in both horizontal and vertical processes known as the I-bond or U-bond processes. The single-end fiber implantation technique, known as the I-bond process, holds the ends of the severed yarns in place by a layer of an adhesive material on a backing material, for example, a fiberglass scrim-type material adjacent to a non-woven, glass fiber fleece layer. Thereafter, the free ends of the fusion-bonded carpet may be embedded in another adhesive layer as before on the same or different backing material, and the resulting sandwich-type carpet then cut, for example, with an oscillating blade in a vertical fusion-bonding method or by

a continuing band knife in the horizontal fusion-bonding method, to form two rolls of fusion-bonded carpet having a cut wear face surface for backing into carpet tile or used as roll goods. In another I-bond process, the severed yarn has one end implanted directly into an adhesive layer on a backing sheet, with the other severed end forming the wear face surface of the carpet.

**[0005]** The U-bond process generally includes a corrugated or pleated layer of yarn, wherein each loop end is placed in a layer of adhesive material on backing sheet material, and then the sandwich-formed carpet material cut to form two rolls of fusion-bonded carpet, each roll having cut loops of yarn embedded in the adhesive layer; hence, the name U-bond process.

**[0006]** The fusion-bonded carpet material prepared by these various processes can then be used as free-lay carpet or be converted into carpet or carpet tile with the application of a suitable backing layer and cutting or trimming it into suitable form.

**[0007]** It is desirable to provide for a new and improved fusion-bonded carpet material prepared by a modified I-bond process, including a carpet tile characterized by novel design patterns on the face wear surface and for a method for preparing such carpet material.

**[0008]** US-A-4 391 665, on which the preambles of independent claims 9 and 14 are based, discloses a method of making pile material comprising the steps of providing a bundle of pile strands held in pressurised engagement with each other by a wrapper surrounding the strands, cutting the bundle into slices and placing the slices into forms. The wrapper is then removed so that the slices expand laterally outward into engagement with the wall of the forms. Thereafter a backing member is bonded to the pile strands on one face of the slice.

**[0009]** US-A-3 943 028 discloses an apparatus and process for manufacturing non-woven textile pile. Slices having fused fibre outer faces with strands extending there between are manufactured by simultaneous cutting and fusing of a plurality of longitudinally extending strands. In the preferred embodiment the slices are received between opposed pairs of driven feed rolls which also receive two continuous sheets of backing material which have had adhesive applicated to the outer faces. The individual slices are received between the adhesive coated faces of the backing material. The slices and the backing material are then passed through a heating device and cooling device to complete the bonding of the backing material to each of the fused faces of the slices. The strands between the fused faces of the slice are then cut and the separate sheets of non-woven pile fabric are taken off the apparatus.

**[0010]** According to a first aspect of the present there is provided a system for the manufacture of a fusion-bonded carpet, which system comprises:

a source of multiple strands composed of a plurality

of yarn materials, the yarn material selected to have different characteristics;

rope forming means for receiving the multiple strands of yarn material from the source and for forming the multiple strands in rope form;

rope bundling means for forming the rope form into rope form bundles;

rope bundle securing means for securing the rope form bundles to maintain the integrity of the rope form bundles during subsequent processing;

means for supplying a backing sheet material;

means for coating onto one surface of the backing sheet material an adhesive coating layer;

means for severing the rope bundles to a selected height and for forming severed rope bundles having a one end and an other end;

means for implanting the one end of the cut secured rope form bundles into the adhesive coating layer on the backing sheet material; and

means for heating the adhesive coating layer to fusion-bond the implanted one end of the severed rope form bundles to the adhesive coating layer and thereby form a fusion-bonded carpet having a wear face surface of the other end of the rope form bundles.

**[0011]** According to a second aspect of the present invention there is provided a method of the manufacture of a fusion-bonded carpet having a fibrous wear face surface composed of selected yarn materials, the method comprising the steps of:

coating a layer of adhesive material onto a backing sheet material;

clamping and cutting yarn material to a defined height, the yarn material having a one and the other end, the yarn material selected to form the wear face surface of the carpet; and

implanting into the adhesive coating layer in a plane generally perpendicular to the backing sheet material, one end of the cut yarn material; and

securing the cut and implanted yarn material in the adhesive coating layer to form a fusion-bonded carpet having a wear face surface, said step of clamping and cutting comprising forming rope forms, wherein each rope form comprises multiple strands composed of a plurality of yarn materials;

characterised in that said step of clamping and cutting further comprises:

bundling a plurality of the rope forms together to form a plurality of rope form bundles wherein the yarn material of the rope forms or rope form bundles is yarn material having selected characteristics and securing the integrity of the rope form bundles; cutting the rope form bundles to form a plurality of cut rope form bundles having a one and the other

end and having a selected height sufficient to form a fibrous wear face surface; and said steps of implanting and securing comprise:

implanting the one end of a plurality of the secured cut rope form bundles into the adhesive coating layer and securing the one end to the coating layer to provide a fusion-bonded carpet having a selected pattern on the wear face surface.

**[0012]** According to a third aspect of the present invention there is provided a fusion-bonded carpet having a cut fibrous wear face surface and having a selected pattern on the cut face wear surface, which carpet comprises:

a backing sheet;

a layer of adhesive material on the backing sheet; yarn material of a defined height having a one end and an other cut end, the yarn material of selected characteristics to form a selected pattern on the wear face surface, one end of the yarn material implanted and secured in the adhesive layer, and the other cut end forming the wear face surface; and the wear face surface comprising a plurality of rope forms comprised of multiple strands of yarn material and rope form securing means to maintain the integrity and secure the multiple strands together in each rope form; characterised in that carpet further comprises a plurality of rope form bundles comprised of a plurality of rope forms and rope bundle securing means to maintain the integrity and secure the rope forms together in each rope form bundle, the rope forms and rope form bundles having yarn material of selected characteristics to form a fibrous wear face surface with a selected pattern.

**[0013]** The invention relates to a method and system for the manufacture of fusion-bonded floor covering, such as carpet tile, and particularly to an I-bond, fusion bonded carpet tile, having a multicolored pattern on the face wear surface thereon.

**[0014]** The present invention is directed to a fusion bonded carpet, and more particularly an I-bond fusion-bonded carpet, and to a method of preparing the fusion bonded carpet, particularly a carpet tile which fusion-bonded carpet and method provide for a repeatable or random pattern in the face wear surface, particularly a multicolored repeatable or random pattern of selected design.

**[0015]** The method comprises coating a layer of an adhesive material onto a sheet backing material, feeding the yarn material to a clamping means, cutting the yarn material to a defined height, implanting cut yarn material into an adhesive coated layer in a plane generally perpendicular to the backing material and bonding the implanted yarn material into the adhesive coated layer.

**[0016]** The improvement comprises preparing multi-

ple strands of the yarn material in rope form, forming selected bundles of the rope-formed yarn material with the yarn material composed of yarn of different characteristics, such as being of different colors in the strands of the rope form, severing the rope-formed bundles and implanting one end of the severed rope bundles in the adhesive layer to form a pattern of the ends of the rope bundles as the face wear surface of the carpet material. Optionally, and preferably, the other end of the severed rope bundles are implanted in an adhesive layer on a backing sheet to form a sandwich-type construction and then severing the implanted yarn material generally intermediate the sandwich to form two separate rolls of carpet material. Optionally, the carpet material may then have a backing applied thereto and cut when carpet tile is being prepared.

**[0017]** The fusion-bonded carpet of the invention comprises a carpet having a face wear surface which is formed in whole or in part by the display of the end view of the yarn material placed in strands in rope-like forms and bundles, the bundles bonded onto an adhesive layer material on a backing sheet, the severed ends of the rope-formed bundles forming the face wear surface of the carpet material.

**[0018]** The invention comprises a system for the manufacture of a fusion-bonded carpet, which system comprises a source of multiple strands of yarn material, the yarn material selected to have different characteristics; rope making means to receive the multiple strands of yarn material from the source and to form the multiple strands in rope form, which rope form includes means to maintain the integrity of the rope form during subsequent processing; means to include a plurality of the rope forms from the rope making means into rope form bundles, and includes means to maintain the integrity of the rope form bundles during subsequent processing; means to sever the rope form bundles to a selected height and to form cut rope form bundles having a one and other end; means to implant the one end of the cut rope form bundle into an adhesive coating layer on a backing sheet material; and means to secure the implanted cut rope form bundles to the adhesive coating layer to form a fusion-bonded carpet having a face wear surface.

**[0019]** The system for the manufacture of a fusion-bonded carpet comprises a plurality of strands of yarn material arranged in a generally parallel, untwisted, rope form and a means to maintain the integrity of the strands of yarn material in the rope form for subsequent processing.

**[0020]** The invention permits the creation of a selected repeatable or random pattern in an I-bond, fusion-bonded carpet, particularly of a multicolored pattern as the face wear surface of the carpet by employing yarn material in strand form with the strands making up a selected rope form and the ropes bundled together. The rope-like bundles may be sliced to desired yarn height and implanted at one end in the adhesive layer to display

the other end view of the selected ropes in the rope bundle, or preferably both ends implanted and then cut to form two separate rolls of carpet material with the selected yarn face wear surface. The method and the resulting carpet material provides for easily ready flexibility in the selection repeatable or random patterns to make up the face wear surface of I-bond, fusion-bonded carpet.

**[0021]** In the present techniques of preparing I-bond, fusion-bonded carpet, individual yarns are fed from beams to a clamping beam wherein the yarns are accumulated to a desired thickness determined by the size and number of the individual yarns, and the clamped yarns are sheared by a guillotine blade and implanted into an adhesive coating layer on a backing sheet. The other end of the yarn is then implanted in an opposite adhesive layer on a backing sheet, and then the sandwich is cut to form two rolls of carpet material. If varied yarn colors are employed, straight lines or patterns would be formed employing this prior art system. Space-dyed yarns can be used to promote the highlights on the face wear surface, but the size of contrast color insert is quite limited in the present I-bond, fusion-bonded carpet methods. In the invention, yarn materials are prepared in strands of predetermined yarns and then formed into a rope form, and the rope form prepared in predetermined multiple rope form bundles. The strands making up the rope-like form and the rope-end bundles are held together to maintain strand, rope-like and bundle integrity. The yarn material may be produced in multiple selected strands to make up in rope form, then selected rope formed together to make up selected rope bundles which are to be held, clamped and implanted in the adhesive layer, as in a typical I-bond, fusion-bonded carpet method.

**[0022]** The invention comprises a modification to the conventional I-bond methods of preparing carpet material, and particularly for carpet tile material, to form carpet material of varying yarn color or characteristics as the face wear surface. The sheet backing material employed in connection with the carpet material may comprise for example any woven, non-woven, natural or synthetic sheet material, but particularly would include sheet material as employed in I-bond or in carpet manufacture to include, but not be limited to, natural materials, such as jute, synthetic materials, such as polyester, woven or non-woven sheet material, such as glass fiber scrim, and in particular, glass fiber, non-woven tissue material, which backing sheet materials may be used alone or in various combinations.

**[0023]** The adhesive material employed to form the adhesive coating layer and to retain the implanted yarn material in a generally upright and typically perpendicular position may comprise any type of adhesive-type material, to include but not be limited to, vinyl chloride resin material, such as a vinyl chloride resin plastisol, which may be applied as a liquid coating layer and subsequently on heating, gels and fuses to form a solid pol-

vinyl chloride layer or a not-melt adhesive layer composed of a thermoplastic polymer material which on heating melts, and on cooling solidifies, such as for example atactic polypropylene, bitumen, modified bitumen, or other type material. Other polymers may include olefinic-vinyl acid ester, such as ethylene vinyl acetate, and copolymers, polyurethane, elastomeric material, styrene-butadiene material, SBS rubber, polyamides, polyurethane and various latex-type materials to include SBS rubber, carboxylated SIS rubber and ethylene vinyl acetate. The latex adhesive may include, but not be limited to, various vinyl lattices such as acrylic-vinyl, copolymer and olefin-vinyl esters, such as ethylene vinyl short-chain esters, like ethylene vinyl acetate. The adhesive composition may be compounded with other components, fillers and additives.

**[0024]** The yarn material employed may comprise any fibrous-type material, natural or synthetic, and combinations thereof, but more typically comprises nylon, polyester or olefinic-type resin, or natural products such as wool and combinations thereof, and such fibrous-type materials as used in preparing carpet material, particularly carpet tile material. The carpet material so prepared may be employed as a free-lay carpet on top of a separate solid or foam or other type of carpet support or may have a separate backing attached thereto. Carpet tile material may include a solid or foam material secured to the back surface of the backing sheet, alone or with a secondary backing sheet. Thus, the carpet material may be employed as a free-lay carpet, or more particularly, may be further coated, such as with a vinyl chloride resin, atactic polypropylene or bitumen or foam material, then cut to form carpet tile. The carpet tile material may be freely laid or may also include pressure-sensitive adhesives on the secondary backing or back surface.

**[0025]** For purposes of illustration only the method will be described with the double implantation I-bond method wherein each end of the rope bundles are immersed in a molten or liquid adhesive layer on a backing sheet to form an I-bond fusion-bonded carpet. In the double implantation method as used, both ends of the rope end bundles are employed and placed in an adhesive layer to form a sandwich and then the yarn material severed to form two separate carpet rolls. The selection of materials employed in the method may vary as desired and to provide compatibility. For example, where a vinyl plastisol is employed as the adhesive coating layer, the carpet tile backing layer would employ a vinyl chloride compatible material, such as a polyvinyl chloride solid backing layer. If the adhesive material comprises a SIS or carboxylated SIS adhesive coating layer, then the carpet tile backing material would comprise a compatible backing layer of a bitumen or polymer-modified bitumen layer to form the carpet tile material.

**[0026]** The yarn material is selected for a selected, designed face wear surface, for example, the yarn material strands thereof or the rope which is made up of

the strands or the end rope bundles made up of the rope, may vary. The yarn material is selected to provide for the desired characteristics, such as, for example, the yarn material, strands or rope so formed from these strands may be formed of multicolored or separate colors, and then blended in the end rope bundles to form a random or repeatable pattern as desired as the face wear surface of the carpet. For example, the yarn material employed in either the strands, rope or bundles can vary in a number of different characteristics to include a multiple texture, random or repeatable pattern on the carpet tile created by varying for example the yarn sizes, the yarn plies, the twist level, the yarn twist direction, the yarn heat setting, the yarn color and other fibrous yarn material characteristics. Thus, the method and the resulting carpet material provide for a wide variety of textures and patterns on the face surface, including varying the yarn material, such as blending yarn material of various yarn sizes, colors and plies to arrive at a desired pattern. The multiple end rope bundles of the yarn materials used in conjunction with the method may be made as the major part or all of the face wear surface of the carpet material. They can also be used in conjunction with single end yarns of selected characteristics, for example, to fill in the voids or to modify any desired pattern on the face wear surface of the carpet. The single yarn material may represent a major or minor component of face surface of the carpet. The method is directed to providing a repeatable, selected pattern on the face wear surface. However, random patterns are also possible by just varying the input and location of the multiple bundles.

**[0027]** In the invention, yarn material is formed into various and multiple strands, for example, strands of two to twenty groups of yarn material of the same or different colors or characteristics. The strands are then fed into a ropemaking machine or may be formed within the ropemaking machine to form a rope material composed for example of four to twelve, for example, six to ten strands. The rope material so emerging may be bundled together to form rope bundles which are to be severed and employed in the invention.

**[0028]** The yarn strand may be composed of yarn of the same material or multicolored material. A rope is then made of various intertwined, woven or twisted or straight strands, either single or multicolored, then the ropes placed together in four to twelve or more, for example, six to ten or more, rope bundles to form the rope bundles to be clamped, severed and implanted in the adhesive coating.

**[0029]** It has been found that twisting of the strands in the rope tends to place the fibers at an angle to the base material, while untwisted rope and rope bundles made of untwisted rope with the yarn strands generally parallel permits the fibers to remain generally upright and erect from the sheet base or backing material. Therefore, in one preferred embodiment, desirable results are achieved by employing rope and rope bundles

composed of straight and parallel yarn material. The straight, parallel rope and rope bundles are maintained by wrapping the exterior surface of either with preferably a yarn material or a braided wrap to insure rope and rope bundle integrity. Any ropemaking machine may be employed into which the yarns are fed to form a rope material. One ropemaking machine comprises a ropemaking machine designed to make smaller diameter ropes ranging from about 3mm in diameter to 13mm in diameter (rope 501) which is manufactured and sold by Zima S.p.a. of Italy. Such ropemaking machines, such as Rope Layer 501, a Zima compound ropemaking machine, employs a plurality of yarn strand spools, then the machine with the run of the strands and the rope produced has 4-inch for 1-inch twist on the strands and 2-inch for 1-inch twist on the rope. The rope produced by the ropemaking machine may be used directly in the I-bond method.

[0030] Optionally, the strands of the yarn material making up the rope as well as the rope bundles are retained together for the purposes of rope and rope bundle integrity during the carpet manufacturing method. The rope and the rope bundles may be retained together by a variety of means including an adhesive means, either temporarily or permanently arranged, or bonded or more particularly, retained together by a yarn material, such as mono- or multifilament spun wrapped spirally around the ropes and then around the rope bundle so that the ropes and the rope bundle material may be effectively moved into the clamping means and guillotine blade of the I-bond machinery. The means to retain the rope and rope bundles together may also include a heat-shrinkable filament or film wrap material or any other means to retain the rope and the rope bundles together without adversely effecting the employment of the strand or rope and rope end bundles as yarn material in the I-bond, fusion-bonded process. The carpet may be made of single yarns, rope or rope end bundles together as desired to make up the face wear surface of the carpet material. Typically, the retaining means employed in the rope and the rope end bundles are, particularly where it is a monofilament or multifilament type material loosely wrapped around the external surface of the rope and rope bundled materials, are left in place after the clamping, cutting and implantation of the rope and rope end bundles as they do not adversely effect the face wear surface of the resulting carpet material.

[0031] The employment of rope and rope bundles of yarn materials in use in the invention is restricted to I-bond methods of manufacture. The employment of the U-bond method for providing fusion-bonded carpets does not permit the adhesive layer to penetrate the rope or rope end bundles sufficiently.

[0032] The invention will be described and illustrated in connection with certain illustrated embodiments.

### **Brief Description of the Drawings**

[0033] Fig. 1 is a schematic illustration of the method of the invention.

5 [0034] Fig. 2 is a fragmentary, perspective view from above of a plurality of strands of yarn material in rope form.

[0035] Fig. 3 is a fragmentary, perspective view from above of a plurality of rope yarn material in rope bundle form for use in an I-bond, fusion-bonding method.

10 [0036] Fig. 4 is a large sectional, perspective view from above of a carpet tile prepared by the method of the invention.

[0037] Fig. 5 is a schematic illustration of the optional final step in the dual implantation method of the invention.

[0038] Fig. 1 is a schematic illustration of a method of forming an I-bond, fusion-bonded carpet material of the invention, which method 10 employs a plurality of yarn sources 12, 14, 16 and 18 to feed separate strands of yarn into a ropemaking machine 20 as illustrated with eight strands of yarn entering the ropemaking machine and providing the strands in rope form 22 (see Fig. 2), the strands of yarn are held together for the purposes of integrity by spirally winding of a monofilament 26, such as nylon, about the exterior surface along the length of the rope 22. Rope 22 is then placed in a rope pattern bundling machine 28 whereby the rope 22 made up of various yarn strands is then formed into rope bundles 30 (see Fig. 3) in which the ropes within the bundle are maintained in the rope bundle integrity by the employment also of a monofilament nylon 32 spirally wrapped around the exterior surface of the rope bundle 30. The rope bundle 30 is then connected to a clamping guillotine blade 48 wherein the rope bundle 30 is cut to a predetermined selected height, for example, about 3mm to 12mm, with each rope bundle 30 having eight strands and with the yarn material making up the strands, for example, composed of nylon with one, two, three or more ropes 22 of different color than the other rope making up a rope bundle 30 to provide a desired random or repeatable pattern on the face surface of the resulting carpet.

30 [0039] The I-bond, fusion-bonded carpet is first prepared through a typical technique of employing a non-woven, glass fiber tissue sheet material 34 together with a fiberglass mesh material 36 to form the backing sheet of the resulting carpet 44. A polyvinyl resin plastisol 38 dispensed from a trough 40 to form a thin, liquid, adhesive coating layer 42 which penetrates the open fiber glass mesh material 34, but does not penetrate the non-woven glass fiber sheet 34. The coating layer 42 may vary in thicknesses but typically ranges from about 2mm to 10mm, for example, 2mm to 6mm. One end of the severed rope bundle ends is then inserted into the liquid plastisol layer 42 and the back surface of the backing sheet then heated, such as through a hot air oven or infrared heat 46 to gel and then fuse the plastisol layer

so as to retain the end of the rope bundles in the layer 42. The rope end bundles 30 are supported and moved on a conveyor belt 50, and the resulting carpet 44 then rolled up and may be used as a free-lay carpet with a separate independent backing or may be coated with a separate backing and then cut to form carpet tile.

**[0040]** Fig. 2 shows a rope 22 produced by the rope-making machine 20 and composed of a plurality of yarn strands of a continuous nylon fiber in which the fiber has been selected to have desired characteristics, for example, of one particular color and with the strands of yarn material maintained in the rope form by an exterior monofilament of wrapped nylon fiber 26.

**[0041]** Fig. 3 is a perspective of the rope bundles 30 showing selected ropes 22 of Fig. 2 in a bundled configuration and with the bundle integrity maintained during the bonding process through the employment of an exterior monofilament, like nylon wrapping, 32. One or more the ropes 22 within the bundle 30 is of one color and the remaining ropes 22 are a different color or a variety of colors or may have different fiber characteristics to provide the desired pattern on the face surface of the carpet 44.

**[0042]** Fig. 4 is an enlarged, sectional, perspective view from above of a carpet tile 56 prepared by the method of the invention which has polyvinyl chloride solid backing layer 52 which has been applied to the back surface of the non-woven fiberglass tissue sheet material 34. As particularly illustrated on the face surface, there is shown a surface composed of rope end bundles 30 which are composed of ropes 22 wherein the security binders 32 and 26 are retained in place and wherein as illustrated some of the rope bundles 22 are of a different color than others in the same rope or in the same rope bundle to provide a desired pattern. Also, single fibers 54 have been implanted in a typical, regular I-bond process to fill in the voids and to provide a desired different pattern in combination with the rope end bundles 30.

**[0043]** Fig. 5 is a schematic illustration of the I-bond double implantation method of the invention wherein the I-bond fusion-bonded carpet material 44 is employed with the other end of the rope end bundles 30 implanted in the layer 42, and in Fig. 1 are implanted in an opposite layer 42 heated to gel and fuse the layer to form an I-bond, fusion-bonded sandwich material 64 which is severed by an oscillating blade 62 and two separate rolls of carpet material 60 prepared. As illustrated, the backing layers and the adhesive layers on both sides are the same; however, the backing layer and/or adhesive layer may be different as required.

**[0044]** The invention as disclosed and illustrated provides for a unique I-bond, fusion-bonded carpet material, particularly carpet tile, wherein the face wear surface layer maybe composed of rope or rope end bundles wherein repeatable or random design patterns employing said rope or rope end bundles may be used.

## Claims

1. A system for the manufacture of a fusion-bonded carpet, which system comprises:

a source (12, 14, 16, 18) of multiple strands composed of a plurality of yarn materials, the yarn material selected to have different characteristics;

rope forming means (20) for receiving the multiple strands of yarn material from the source and for forming the multiple strands in rope form (22);

rope bundling means (28) for forming the rope form into rope form bundles;

rope bundle securing means for securing the rope form bundles to maintain the integrity of the rope form bundles during subsequent processing;

means (34, 36) for supplying a backing sheet material;

means (38, 40) for coating onto one surface of the backing sheet material an adhesive coating layer;

means (48) for severing the rope bundles to a selected height and for forming severed rope bundles having a one end and an other end;

means (50) for implanting the one end of the cut secured rope form bundles into the adhesive coating layer on the backing sheet material; and

means for heating the adhesive coating layer to fusion-bond the implanted one end of the severed rope form bundles to the adhesive coating layer and thereby form a fusion-bonded carpet having a wear face surface of the other end of the rope form bundles.

2. A system according to claim 1, wherein the source (12, 14, 16, 18) of yarn material comprises yarn material having selected characteristics of yarn size, yarn ply, yarn twist level, yarn twist direction, yarn colour, yarn heat setting and combinations thereof.

3. A system according to claim 1 or claim 2, further comprising:

means (34, 36, 40) for providing a second backing sheet material coated with a second adhesive coating layer on the other end of the severed rope form bundles to form a sandwich carpet material;

means (46) for heating the second adhesive coating layer; and

means (62) for cutting the sandwich carpet material to form two separate, severed, fusion-bonded carpets.

4. A system according to any one of claims 1 to 3 which includes means (36) for securing a backing layer to the backing sheet material.
5. A system according to any one of claims 1 to 4, which includes means for cutting the fusion-bonded backed carpet to form carpet tiles.
6. A system according to any one of claims 1 to 5, further comprising rope form wrapping means for wrapping filament material (26) about the exterior surface of the rope forms (22) to maintain the integrity of the rope forms.
7. A system according to any one of claims 1 to 6, wherein the rope bundling securing means (28) comprises filament wrapping means to spirally wrap filament material (32) about the exterior surface of the rope form bundles (30) to maintain the integrity of the rope form bundles.
8. A system according to any one of claims 1 to 5, wherein said rope form securing means and said rope form bundle securing means comprise means to adhesively secure together the rope forms (22) and the rope form bundles (30).
9. A method of the manufacture of a fusion-bonded carpet having a fibrous wear face surface composed of selected yarn materials, the method comprising the steps of:
- coating a layer of adhesive material (38) onto a backing sheet material;
- clamping and cutting yarn material (12,14,16,18) to a defined height, the yarn material having a one and the other end, the yarn material selected to form the wear face surface of the carpet; and
- implanting into the adhesive coating layer in a plane generally perpendicular to the backing sheet material, one end of the cut yarn material; and
- securing the cut and implanted yarn material in the adhesive coating layer to form a fusion-bonded carpet having a wear face surface, said step of clamping and cutting comprising:
- forming rope forms (22), wherein each rope form comprises multiple strands composed of a plurality of yarn materials;
- characterised in that said step of clamping and cutting further comprising bundling a plurality of the rope forms (22) together to form a plurality of rope form bundles (30) wherein the yarn material of the rope forms or rope form bundles is yarn material having selected characteristics and securing the integrity of the rope form bundles;
- cutting the rope form bundles to form a plurality of cut rope form bundles having a one and the other end and having a selected height sufficient to form a fibrous wear face surface; and said steps of implanting and securing comprise:
- implanting the one end of a plurality of the secured cut rope form bundles into the adhesive coating layer and securing the one end to the coating layer to provide a fusion-bonded carpet having a selected pattern on the wear face surface.
10. A method according to claim 9, which includes securing the rope forms to maintain the integrity of the rope forms.
11. A method according to claim 10, wherein securing the rope forms includes wrapping a filament about the exterior surface of the rope form to maintain rope form integrity.
12. A method according to claim 9, 10 or 11 which includes implanting one and the other end of the plurality of rope form bundles into separate adhesive coated layers on separate backing sheet materials to form a sandwich fusion-bonded carpet material and thereafter severing the sandwich carpet material to form two separate fusion-bonded carpets, each having a wear face surface with a selected pattern.
13. A method according to any one of claims 9 to 12 which includes securing the rope form bundles by employing a filament material or an adhesive.
14. A fusion-bonded carpet having a cut fibrous wear face surface and having a selected pattern on the cut face wear surface, which carpet comprises:
- a backing sheet;
- a layer of adhesive material on the backing sheet;
- yarn material of a defined height having a one end and an other cut end, the yarn material of selected characteristics to form a selected pattern on the wear face surface, one end of the yarn material implanted and secured in the adhesive layer, and the other cut end forming the wear face surface; and
- the wear face surface comprising a plurality of rope forms (22) comprised of multiple strands of yarn material (12,14,16,18) and rope form securing means (26) to maintain the integrity and secure the multiple strands together in each rope form; characterised in that carpet fur-



ther comprises a plurality of rope form bundles (30) comprised of a plurality of rope forms (22) and rope bundle securing means (32) to maintain the integrity and secure the rope forms together in each rope form bundle, the rope forms and rope form bundles having yarn material of selected characteristics to form a fibrous wear face surface with a selected pattern.

15. A carpet according to claim 14, which comprises a carpet tile having a solid backing layer thereon.
16. A carpet according to claim 14 or claim 15, wherein the rope form securing means and the rope form bundle securing means comprise an adhesive means to secure the multiple strands of the rope form and the plurality of rope forms in each rope form bundle together.
17. A carpet according to claim 14 or 15, wherein the rope form securing means and the rope form bundle securing means comprise a filament means (26,32) to secure the multiple strands of the rope form and the plurality of rope forms in each rope form bundle together.
18. A carpet according to claim 14, 15, 16 or 17, wherein the yarn material (12,14,16,18) of the rope form is yarn material having selected characteristics selected from the group consisting of yarn size, yarn ply, yarn twist level, yarn twist direction, yarn colour, yarn heat setting properties and combinations thereof.

#### Patentansprüche

1. System zur Herstellung eines schmelzgebundenen Teppichs, welches System umfaßt:

eine Quelle (12,14,16,18) multipler Strähnen, zusammengesetzt aus einer Vielzahl von Garnmaterialien, wobei das Garnmaterial auf unterschiedliche Eigenschaften hin ausgewählt ist;  
Strangformung-Vorrichtung (20) zur Aufnahme der multiplen Strähnen des Garnmaterials aus der Quelle und zur Formung der multiplen Strähnen in die Strangform (22);  
Strangbündelungs-Vorrichtung (28) zur Formung der Strangform in Strangformbündel;

Strangbündel-Befestigungsvorrichtung zur Festigung der Strangformbündel zur Beibehaltung der Vollständigkeit der Strangformbündel während der nachfolgenden Verarbeitung;

Vorrichtung (34,36) zur Bereitstellung eines

Rückenbeschichtungsmaterials;  
Vorrichtung (38,40) zum Auftrag einer Haftschrift auf eine Oberfläche des Rückenbeschichtungsmaterials;  
Vorrichtung (48) zur Abtrennung der Strangbündel bei einer ausgewählten Höhe und zur Bildung abgetrennter Strangbündel mit einem Ende und einem anderen Ende;  
Vorrichtung (50) zum Implantieren des einen Endes der abgeschnittenen gefestigten Strangformbündel in die Haftschrift auf dem Rückenbeschichtungsmaterial; und  
Vorrichtung zum Erhitzen der Haftschrift zum Schmelzbinden des implantierten einen Endes der gefestigten Strangformbündel an die Haftschrift und dadurch Herstellen eines schmelzgebundenen Teppichs mit einer Schauseite, bestehend in dem anderen Ende der Strangformbündel.

2. System nach Anspruch 1, wobei die Quelle (12,14,16,18) des Garnmaterials ein Garnmaterial mit ausgewählten Eigenschaften hinsichtlich Garngröße, Garnfachung, Garndrehungsgrad, Garndrehungsrichtung, Garnfarbe, Garnwärmefixierung und deren Kombinationen umfaßt.

3. System nach Anspruch 1 oder Anspruch 2, welches außerdem umfaßt:

Vorrichtung (34,36,40) zur Bereitstellung eines zweiten Rückenbeschichtungsmaterials, beschichtet mit einer zweiten Haftschrift am anderen Ende der gefestigten Strangformbündel zum Erhalt eines Sandwich-Teppichmaterials; Vorrichtung (46) zum Erhitzen der zweiten Haftschrift; und  
Vorrichtung (62) zum Schneiden des Sandwich-Teppichmaterials zum Erhalt zweier separater, abgetrennter, schmelzgebundener Teppiche.

4. System nach einem der Ansprüche 1 bis 3, welches eine Vorrichtung (36) zum Befestigen einer rückenverstärkenden Schicht am Rückenbeschichtungsmaterial umfaßt.

5. System nach einem der Ansprüche 1 bis 4, welches eine Vorrichtung zum Schneiden des schmelzgebundenen rückenverstärkten Teppichs zum Erhalt von Teppichfliesen umfaßt.

6. System nach einem der Ansprüche 1 bis 5, welches außerdem eine Strangform-Umwindvorrichtung zum Winden von Filamentmaterial (26) um die Außenseite der Strangformen (22) zur Beibehaltung der Vollständigkeit der Strangformen umfaßt.

7. System nach einem der Ansprüche 1 bis 6, wobei die Strangbündel-Befestigungsvorrichtung (28) eine Filament-Umwindevorrichtung zum spiralförmigen Winden des Filamentmaterials (32) um die Außenseite der Strangformbündel (30) zur Beibehaltung der Vollständigkeit der Strangformbündel umfaßt.

8. System nach einem der Ansprüche 1 bis 5, wobei die Strangform-Befestigungsvorrichtung und die Strangformbündel-Befestigungsvorrichtung eine Vorrichtung zur Befestigung aneinander der Strangformen (22) und der Strangformbündel (30) umfaßt.

9. Verfahren zur Herstellung eines schmelzgebundenen Teppichs mit einer fasrigen Schauseite, zusammengesetzt aus ausgewählten Garnmaterialien, wobei das Verfahren die folgenden Schritte umfaßt:

Aufbringen einer Schicht eines Klebstoffs (38) auf das Rückenbeschichtungsmaterial;

Einspannen und Schneiden des Garnmaterials (12,14,16,18) zu einer definierten Höhe, wobei das Garnmaterial ein Ende und das andere Ende aufweist und das Garnmaterial zur Bildung der Schauseite des Teppichs ausgewählt ist; und

Implantieren in die Haftschrift in einer im allgemeinen zum Rückenbeschichtungsmaterial senkrechten Ebene, eines Endes des geschnittenen Garnmaterials; und

Befestigen des geschnittenen und implantierten Garnmaterials in der Haftschrift zum Erhalt eines schmelzgebundenen Teppichs mit einer Schauseite, wobei der Schritt des Einspannens und Schneidens umfaßt:

Herstellen von Strangformen (22), wobei jede Strangform multiple Strähnen umfaßt, zusammengesetzt aus einer Vielzahl von Garnmaterialien;

dadurch gekennzeichnet, daß der Schritt des Einspannens und Schneidens außerdem das Zusammenbündeln einer Vielzahl von Strangformen (22) zum Erhalt einer Vielzahl von Strangformbündeln (30) umfaßt, wobei das Garnmaterial der Strangformen oder Strangformbündel in Garnmaterial mit ausgewählten Eigenschaften besteht, und das Sicherstellen der Vollständigkeit der Strangformbündel;

Schneiden der Strangformbündel zum Erhalt einer Vielzahl von geschnittenen Strangform-

bündeln mit einem Ende und dem anderen Ende und mit einer ausreichend gewählten Höhe zur Bildung einer fasrigen Schauseite;

und das Implantieren und Befestigen die folgenden Schritte umfaßt:

Implantieren des einen Endes einer Vielzahl der gefestigten geschnittenen Strangformbündel in die Haftschrift und Befestigen des einen Endes an der Haftschrift zur Bereitstellung eines schmelzgebundenen Teppichs mit einem ausgewählten Muster auf der Schauseite.

10. Verfahren nach Anspruch 9, welches das Befestigen der Strangformen zur Beibehaltung der Vollständigkeit des Strangformen umfaßt.

11. Verfahren nach Anspruch 10, wobei das Befestigen der Strangformen das Winden eines Filaments um die Außenseite der Strangform zur Beibehaltung der Vollständigkeit der Strangformen umfaßt.

12. Verfahren nach Anspruch 9, 10 oder 11, welches das Implantieren des einen und des anderen Endes der Vielzahl von Strangformbündeln in separate Haftschriften auf separaten Rückenbeschichtungsmaterialien zum Erhalt eines schmelzgebundenen Sandwich-Teppichmaterials und das anschließende Abtrennen des Sandwich-Teppichmaterials zum Erhalt zweier separater schmelzgebundener Teppiche umfaßt, von denen jedes eine Schauseite mit einem ausgewählten Muster aufweist.

13. Verfahren nach einem der Ansprüche 9 bis 12, welches das Befestigen der Strangformbündel durch Verwendung eines Filamentmaterials oder eines Klebstoffs umfaßt.

14. Schmelzgebundener Teppich mit einer geschnittenen fasrigen Schauseite und mit einem ausgewählten Muster auf der geschnittenen Schauseite, welcher Teppich umfaßt:

eine Rückenplatte;  
eine Klebstoffschicht auf der Rückenplatte;  
Garnmaterial einer definierten Höhe mit einem einen und einem anderen Schnittende, wobei das Garnmaterial ausgewählte Eigenschaften zum Erhalt eines ausgewählten Musters auf der Schauseite aufweist und das eine Ende des Garnmaterials implantiert und befestigt in der Haftschrift ist und das andere Schnittende die Schauseite bildet; und  
wobei die Schauseite eine Vielzahl von Strangformen (22) umfaßt, bestehend aus multiplen Strähnen von Garnmaterial (12,14,16,18) und

Strangform-Befestigungsvorrichtungen (26) zur Beibehaltung der Vollständigkeit und Befestigung aneinander der multiplen Strähnen in jeder Strangform; dadurch gekennzeichnet, daß der Teppich außerdem eine Vielzahl von Strangformbündeln (30) umfaßt, bestehend aus einer Vielzahl von von Strangformen (22) und Strangbündel-Befestigungsvorrichtungen (32) zur Beibehaltung der Vollständigkeit und Befestigung aneinander der Strangformen in jedem Strangformbündel, wobei die Strangformen und Strangformbündel Garnmaterial von ausgewählten Eigenschaften zum Erhalt einer fasrigen Schauseite mit einem ausgewählten Muster aufweisen.

15. Teppich nach Anspruch 14, welcher eine Teppichfliese mit einer festen Rückenschicht daran umfaßt.

16. Teppich nach Anspruch 14 oder Anspruch 15, wobei die Strangform-Befestigungsvorrichtung und die Strangformbündel-Befestigungsvorrichtung eine Klebevorrichtung zum Befestigung aneinander der multiplen Strähnen der Strangformen und der Vielzahl von Strangformen in jedem Strangformbündel umfaßt.

17. Teppich nach Anspruch 14 oder 15, wobei die Strangform-Befestigungsvorrichtung und die Strangformbündel-Befestigungsvorrichtung eine Filamentvorrichtung (26,32) zur Befestigung aneinander der multiplen Strähnen der Strangformen und der Vielzahl von Strangformen in jedem Strangformbündel umfaßt.

18. Teppich nach Anspruch 14, 15, 16 oder 17, wobei das Garnmaterial (12,14,16,18) der Strangform ein Garnmaterial mit ausgewählten Eigenschaften ist, gewählt aus der Gruppe, bestehend aus Garngroße, Garnfachung, Garmdrehungsgrad, Garmdrehungsrichtung, Garnfarbe, Garnwärmefixierung und deren Kombinationen.

## Revendications

1. Système de fabrication d'un tapis lié par fusion, lequel système comporte :

une source (12, 14, 16, 18) de multiples brins constitués d'une pluralité de matériaux de fil, le matériau de fil étant sélectionné pour avoir différentes caractéristiques,  
des moyens de formation de toron (20) pour recevoir les multiples brins de matériau de fil provenant de la source et pour former les multiples brins en toron (22),  
des moyens de mise en botte de torons (28)

pour former les torons en botte de torons, des moyens de fixation de botte de torons pour fixer les bottes de torons pour maintenir l'intégrité des bottes de torons pendant un traitement ultérieur :

des moyens (34, 36) pour alimenter un matériau de feuille de support,  
des moyens (38, 40) pour revêtir sur une première surface du matériau de feuille de support une couche de revêtement adhésif,  
des moyens (48) pour découper les bottes de torons à une hauteur sélectionnée et pour former des bottes de torons découpées ayant une première extrémité et une autre extrémité,  
des moyens (50) pour implanter la première extrémité des bottes de torons fixées découpées dans la couche de revêtement adhésif située sur le matériau de feuille de support, et des moyens pour chauffer la couche de revêtement adhésif pour lier par fusion la première extrémité implantée des bottes de torons découpées sur la couche de revêtement adhésif et par conséquent former un tapis lié par fusion ayant une surface formant face d'usure constituée de l'autre extrémité des bottes de torons.

2. Système selon la revendication 1, dans lequel la source (12, 14, 16, 18) de matériau de fil comporte un matériau de fil ayant des caractéristiques sélectionnées parmi la dimension du fil, le retors du fil, le niveau de torsadage du fil, la direction de torsadage du fil, la couleur du fil, le thermofixage du fil et des combinaisons de celles-ci.

3. Système selon la revendication 1 ou 2, comportant de plus :

des moyens (34, 36, 40) pour fournir un second matériau de feuille de support revêtu d'une seconde couche de revêtement adhésif sur l'autre extrémité des bottes de torons découpées pour former un matériau de tapis en sandwich,  
des moyens (46) pour chauffer la seconde couche de revêtement adhésif, et  
des moyens (62) pour découper le matériau de tapis en sandwich pour former deux tapis liés par fusion, séparés, découpés.

4. Système selon l'une quelconque des revendications 1 à 3, qui comporte des moyens (36) pour fixer une couche de support sur le matériau de feuille de support.

5. Système selon l'une quelconque des revendications 1 à 4, qui comporte des moyens pour découper le tapis lié par fusion pour former des dalles de tapis.

6. Système selon l'une quelconque des revendications 1 à 5, comportant de plus des moyens d'enroulement pour enrouler un matériau filamenteux (26) autour de la surface extérieure des torons (22) pour maintenir l'intégrité du toron. 5
7. Système selon l'une quelconque des revendications 1 à 6, dans lequel les moyens de mise en botte de torons (28) comportent des moyens d'enroulement de filament pour enrouler en spirale un matériau filamenteux (32) autour de la surface extérieure des bottes de torons (30) pour maintenir l'intégrité des bottes de torons. 10
8. Système selon l'une quelconque des revendications 1 à 5, dans lequel lesdits moyens de fixation de toron et lesdits moyens de fixation de botte de torons comportent des moyens pour fixer ensemble de manière adhésive les torons (22) et les bottes de torons (30). 15
9. Procédé de fabrication d'un tapis lié par fusion ayant une surface formant face d'usure en fibres constituée de matériaux de fil sélectionnés, le procédé comportant les étapes consistant à : 20
- revêtir une couche de matériau adhésif (38) sur un matériau de feuille de support, serrer et découper un matériau de fil (12, 14, 16, 18) à une hauteur définie, le matériau de fil ayant une première extrémité et une autre extrémité, le matériau de fil étant sélectionné pour former la surface formant face d'usure du tapis, et 30
- implanter dans la couche de revêtement adhésif, dans un plan de manière générale perpendiculaire au matériau en feuille de support, une première extrémité du matériau de fil découpé, et 35
- fixer le matériau de fil découpé et implanté dans la couche de revêtement adhésif pour former un tapis lié par fusion ayant une surface formant face d'usure, ladite étape consistant à serrer et découper comportant les étapes consistant à : 40
- former des torons (22), chaque toron comportant de multiples brins constitués d'une pluralité de matériaux de fil, 45
- caractérisé en ce que ladite étape consistant à serrer et à découper consiste de plus à réunir en botte une pluralité de torons (22) pour former une pluralité de bottes de torons (30), le matériau de fil des torons ou des bottes de torons étant un matériau de fil ayant des caractéristiques sélectionnées, et à fixer l'intégrité des bottes de torons, 50
- découper les bottes de torons pour former 55
- une pluralité de bottes de torons découpées ayant une première extrémité et une autre extrémité et ayant une hauteur sélectionnée suffisante pour former une surface formant face d'usure en fibres, et lesdites étapes consistant à implanter et à fixer comportent :
- l'implantation de la première extrémité d'une pluralité de bottes de torons découpées fixées dans la couche de revêtement adhésif et fixer la première extrémité sur la couche de revêtement pour fournir un tapis lié par fusion ayant un motif sélectionné sur la surface formant face d'usure.
10. Procédé selon la revendication 9, qui comporte la fixation des torons pour maintenir l'intégrité des torons.
11. Procédé selon la revendication 10, dans lequel la fixation des torons comporte l'enroulement d'un filament autour de la surface extérieure d'un toron pour maintenir l'intégrité du toron.
12. Procédé selon la revendication 9, 10 ou 11, qui comporte l'implantation de la première et de la seconde extrémité de la pluralité de bottes de torons dans des couches d'adhésif revêtues séparées sur des matériaux de feuille de support séparés pour former un matériau de tapis lié par fusion en sandwich et après ceci découper le matériau de tapis en sandwich pour former deux tapis liés par fusion séparés, ayant chacun une surface formant face d'usure ayant un motif sélectionné.
13. Procédé selon l'une quelconque des revendications 9 à 12, qui comporte la fixation des bottes de torons par utilisation d'un matériau filamenteux ou d'un adhésif.
14. Tapis lié par fusion ayant une surface formant face d'usure en fibres découpée et ayant un motif sélectionné sur la surface formant face d'usure découpée, lequel tapis comporte :
- une feuille de support, une couche de matériau adhésif située sur la feuille de support, un matériau de fil ayant une hauteur définie comportant une première extrémité et une autre extrémité découpée, le matériau de fil ayant des caractéristiques sélectionnées pour former un motif sélectionné sur la surface formant face d'usure, une première extrémité du matériau de fil étant implantée et fixée dans la couche d'adhésif, et l'autre extrémité découpée formant la surface formant face d'usure, et la surface formant face d'usure comporte une

pluralité de torons (22) constitués de multiples brins de matériau de fil (12, 14, 16, 18) et des moyens de fixation de toron (26) pour maintenir l'intégrité et fixer ensemble les multiples brins sous forme d'un toron, caractérisé en ce que le tapis comporte de plus une pluralité de bottes de torons (30) constituées d'une pluralité de torons (22) et des moyens de fixation de botte de torons (32) pour maintenir l'intégrité et fixer ensemble les torons dans chaque botte de torons, les torons et les bottes de torons ayant un matériau de fil ayant des caractéristiques sélectionnées pour former une surface formant face d'usure en fibres ayant un motif sélectionné.

15. Tapis selon la revendication 14, qui comporte une dalle de tapis ayant une couche de support pleine située sur celle-ci.

16. Tapis selon la revendication 14 ou 15, dans lequel les moyens de fixation de toron et les moyens de fixation de botte de torons comportent des moyens adhésifs pour fixer ensemble les multiples brins du toron et la pluralité de torons de chaque botte de torons.

17. Tapis selon la revendication 14 ou 15, dans lequel les moyens de fixation de toron et les moyens de fixation de botte de torons comportent des moyens formant filament (26, 32) pour fixer ensemble les multiples brins du toron et la pluralité de torons de chaque botte de torons.

18. Tapis selon la revendication 14, 15, 16 ou 17, dans lequel le matériau de fil (12, 14, 16, 18) d'un toron est un matériau de fil ayant des caractéristiques sélectionnées, sélectionnées parmi le groupe constitué de la dimension de fil, du retors du fil, du niveau de torsadage du fil, de la direction de torsadage du fil, de la couleur du fil, des propriétés de thermofixage du fil et des combinaisons de celles-ci.

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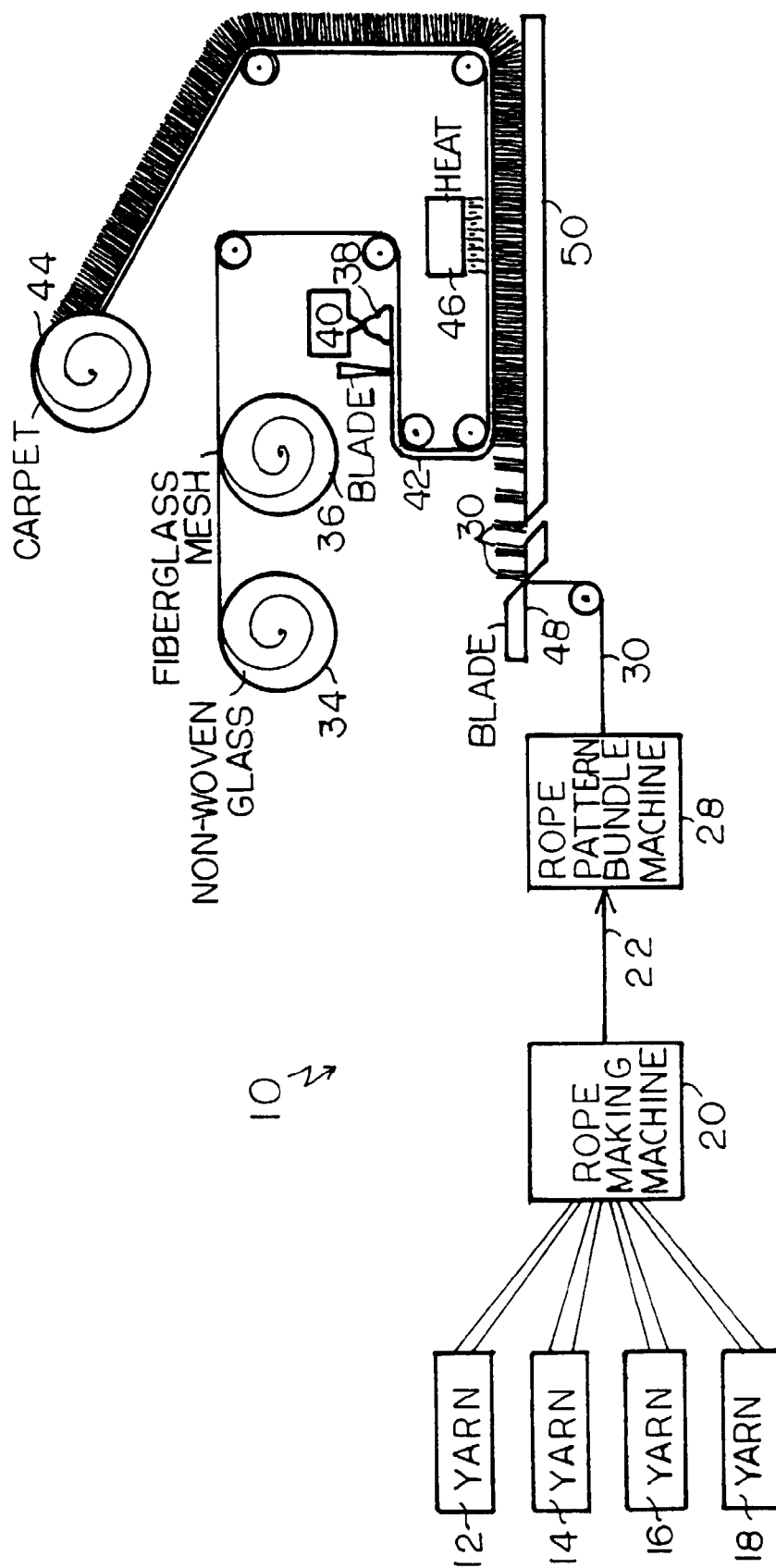


FIG. 1

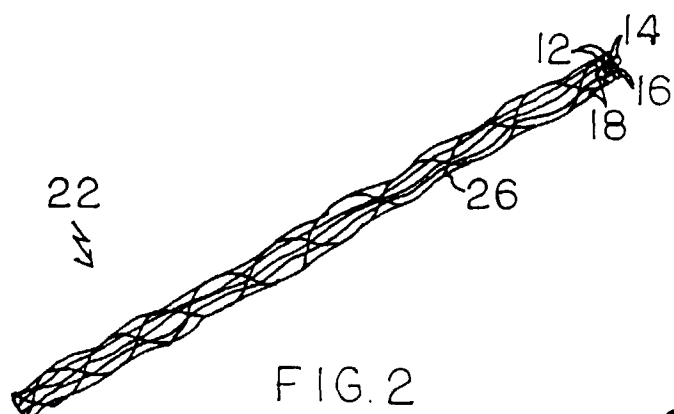


FIG. 2

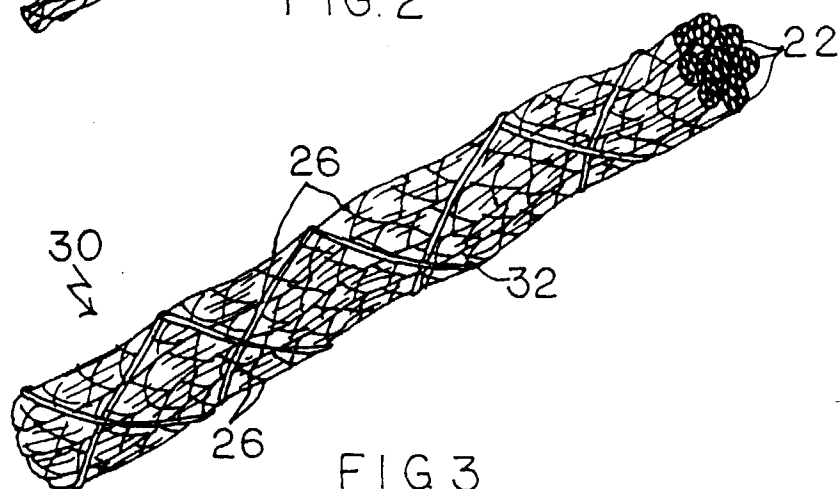


FIG. 3

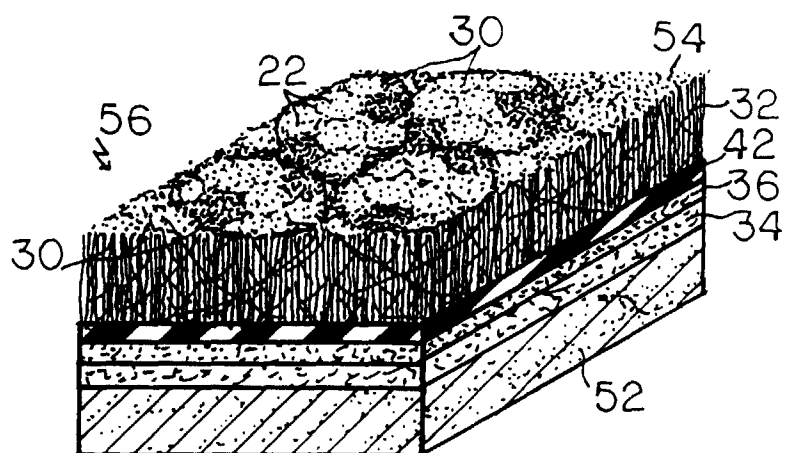


FIG. 4

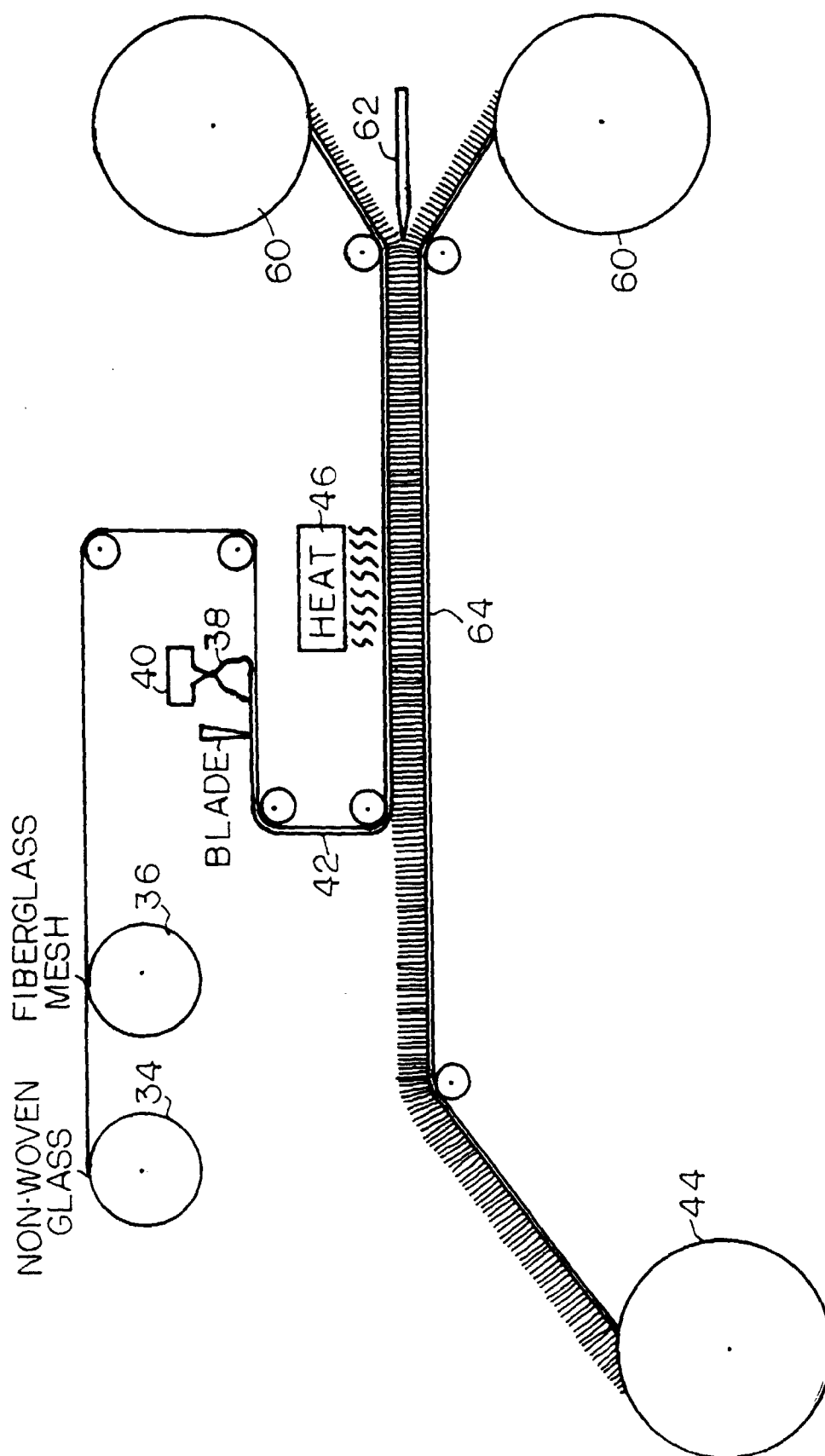


FIG. 5