Aug. 2, 1966 S. SANDS 3,264,167

CARPET BACKING LAMINATE

Filed Oct. 17, 1962 3 Sheets-Sheet 1

FIG. 1

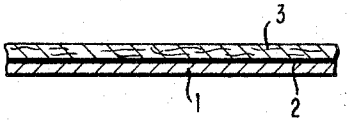


FIG. 2

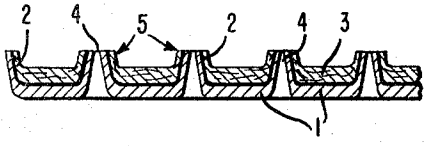


FIG. 3

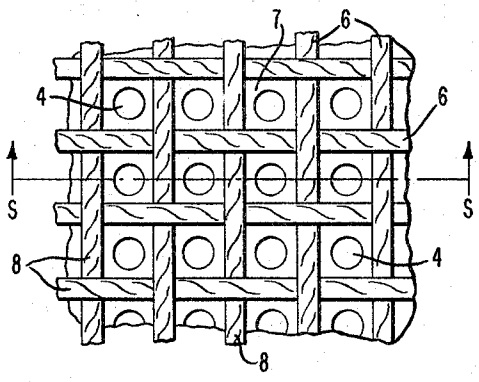
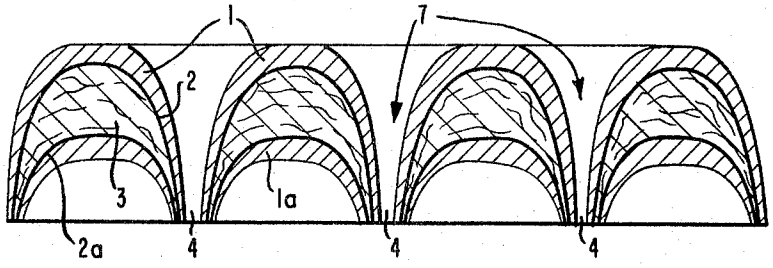


FIG. 4



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CARPET BACKING LAMINATE

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FIG. 5

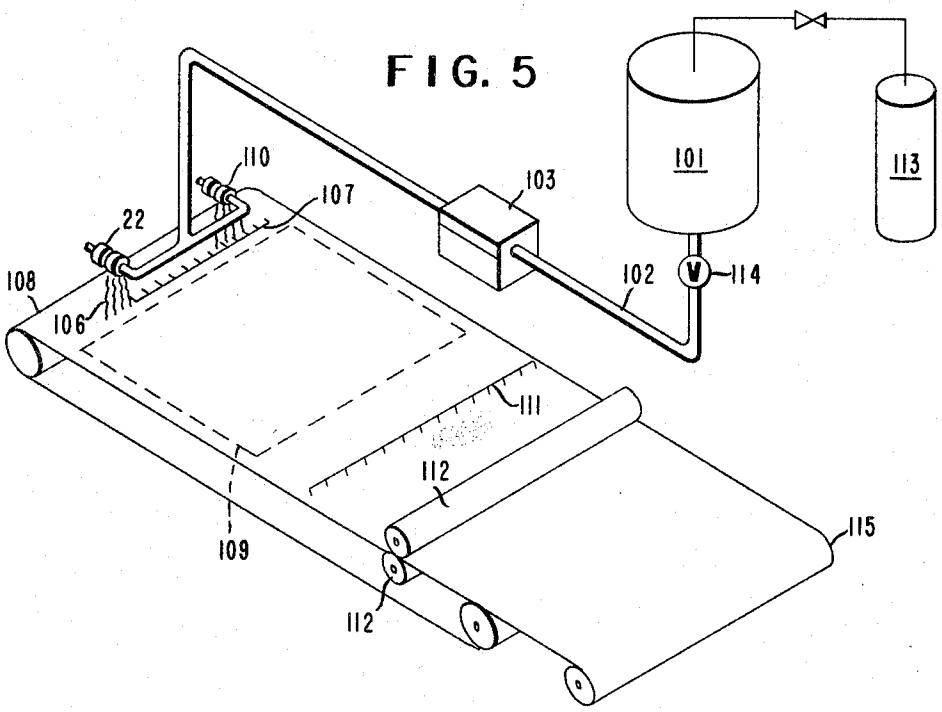
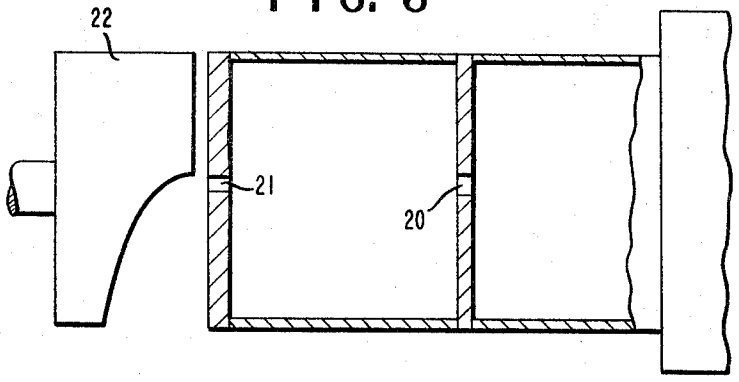


FIG. 6



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CARPET BACKING LAMINATE

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FIG. 7

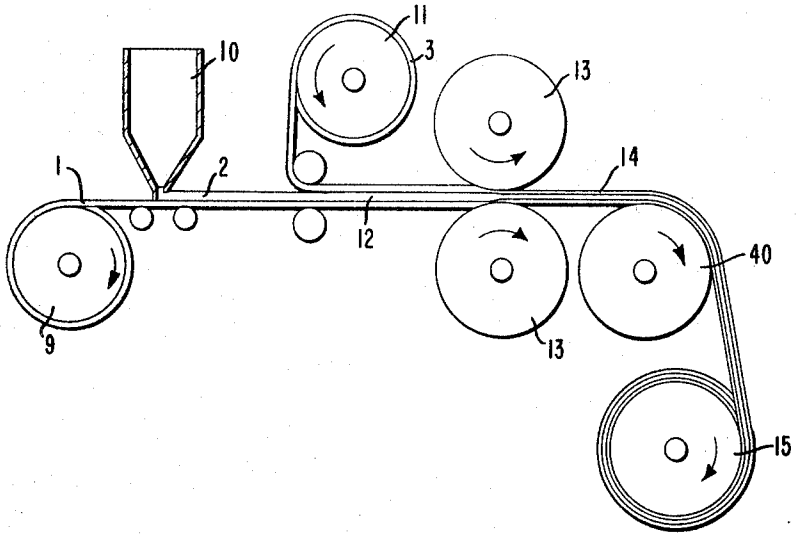
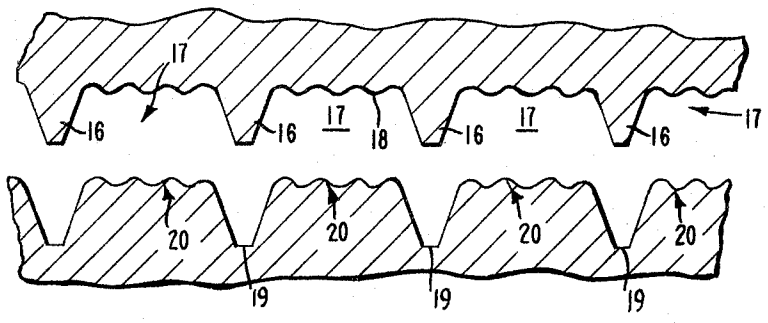


FIG. 8



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United States Patent Office 3,264,167 Patented August 2, 1966

3,264,167

CARPET BACKING LAMINATE

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Filed Oct. 17, 1962, Ser. No. 231,154
9 Claims. (Cl. 161—111)

This invention relates to laminated non-woven fibrous sheets for use in carpet backings, particularly in a secondary backing which is cemented to a tufted carpet after tufting.

Tufted carpets are formed on machines resembling a sewing machine by drawing loops of heavy denier yarn through a previously-formed woven fabric (a primary-backing) of jute or other inexpensive fiber. The tufts which form the pile are fastened in the fabric by applying a latex or cement to the back of the fabric after tufting. In addition a secondary backing of woven jute or similar fiber is often glued to the back of the carpet after tufting. The purpose of the secondary backing is to give increased stiffness in order to prevent wrinkling on the floor, to give tighter cementing of the tufts, to give additional thickness or cushioning for the carpet, and to improve appearance. The present invention is concerned primarily with these secondary backing materials.

The textile processing of jute to obtain staple yarns and the weaving operation itself are relatively expensive and time-consuming operations consequently, simpler processes for manufacturing carpet backings have been sought for some time. In addition the commonly used jute-backed carpets exhibit considerable growth or stretching on the floor when humidity increases, thus giving rise to an undesirable wrinkled appearance. Numerous non-woven materials are known which would appear to be satisfactory for backings, but which in fact have been unsatisfactory because of still other deficiencies. For example, such backings of heavy basis weight papers or of resin impregnated papers have often been characterized by such inadequate strength as to be unsuitable for wall-to-wall installations where the carpet must be stretched to give a smooth unwrinkled surface.

Attempts have also been made to cement plastic sheets or films to the carpet backing to act as stiffeners and dimension stabilizers but the products have normally been unacceptable because a rapid evaporation of volatiles from the cement composition is not achieved.

One object of the present invention is to provide a non-woven carpet backing material which has high strength, good dimensional stability during humidity changes, high thickness at low weight per square yard, and which is sufficiently stiff to prevent creeping of the carpet on the floor.

A further object is to provide a porous non-woven carpet backing material which has high strength, high cushioning ability, and which dries readily after steaming, printing, or latexing.

Another object of the invention is to provide a secondary carpet backing having good adherability to primary carpet backings and, moreover, having high thickness at low weight per square yard.

Another object is to provide a process for making a relatively thick vapor-permeable carpet backing from cellulosic paper, low melting film, and non-woven fibrous sheets composed of crystalline oriented synthetic polymeric fibrous elements.

These objectives are accomplished by providing a cohesive laminar sheet material comprising one or more layers of a cellulosic paper web having a weight of 1 to 6 ounces per square yard, one or more binder layers of low melting polymeric film having a weight of 0.3 to 1.2 ounces per square yard, and one or more layers of a non-

woven fibrous sheet having a weight of 0.5 to 3.0 ounces per square yard and a tear strength of at least 0.3 pound/oz./yd.^{2}, the non-woven sheet being composed of randomly arranged continuous oriented fibrous elements of crystalline organic polymer, each binder layer in the laminate being intimately attached on one side to a paper layer and on the other side to a non-woven fibrous layer. The laminar sheet material is further provided with 30 to 500 holes per square inch, the total open area of the holes comprising 2 to 10% of the laminar sheet area, the laminar sheet having 30 to 500 projections, ridges or points per square inch with a height from trough to crest of 5 to 75 mils.

The laminar sheet can be prepared by bringing together in coplanar arrangement, layers of cellulosic paper, a low-melting polymeric film, and a non-woven fibrous sheet composed of randomly arranged continuous oriented fibrous elements of crystalline organic polymer, each film layer being between a non-woven layer and a paper layer, passing the layers through the nip of a pair of heated pressurized rolls with temperature and pressure high enough to cause the polymeric film to adhere to the paper and to the non-woven fibrous sheet without destroying the crystalline orientation of the fibrous elements in the non-woven sheet. Either during this pressing operation or subsequently the combined sheets are embossed and punctured by passing through a pair of matching rolls, one of which has raised points, needles, or ridges, and the other of which has matching depressions to receive the needles or raised areas of the opposing roll.

The figures which describe the process and products of this invention are as follows:

FIGURE 1 is a cross-sectional view at high magnification of a laminar sheet, consisting of successive layers of cellulosic paper **1**, low-melting film **2**, and fibrous non-woven sheet **3**.

FIGURE 2 is a cross-sectional view of the laminar sheet of FIGURE 1 after embossing and puncturing, showing holes **4** centered in the projections **5** of the sheet, each projection giving the appearance at high magnification of a volcano.

FIGURE 3 is an enlarged plan view of one side of an embossed and perforated laminar carpet backing showing major ridges **6**, arranged to give the pattern of a woven jute carpet backing, with a minor relief pattern **8** impressed on the ridges to simulate filaments in twisted jute yarns, and showing holes **4** in the volcanic depressions **7** of the laminar sheet.

FIGURE 4 is a cross-sectional view of the embossed and punctured laminar sheet of FIGURE 3 along the line S—S, the sheet consisting of successive layers of cellulosic paper **1**, low melting film **2**, fibrous non-woven sheet **3**, low-melting film **2***a* and cellulosic paper **1***a*.

FIGURE 5 is a drawing showing the process of preparing a non-woven fibrous sheet by spinning a solution of an organic polymer from a spinneret under high pressure and at a temperature far above the boiling point of the solvent, impinging the emerging threadline on a baffle, and collecting the resulting continuous three-dimensional fibrous network on a moving belt.

FIGURE 6 shows the spinneret and baffle of FIGURE 5 in detail.

FIGURE 7 shows a process of melt-casting an organic polymeric film onto a moving sheet of paper, depositing a layer of non-woven fibrous sheet on the semimolten film layer, calendering between hot rolls, cooling the composite sheet and winding on a roll.

FIGURE 8 shows the profile of a small portion of the surfaces of matched embossing rolls taken in the roll axis direction showing on one roll needle **16**, major depressions **17** and minor engraved lines **18** and showing on the other

roll holes 19 to receive the needles 16 and raised portions 20 to match the depression 17.

The cohesive laminar sheet of this invention can be prepared in a variety of forms. It is necessary, however, to have the three layers in the laminate present in the weight ranges specified so that the desired carpet backing properties may be obtained. Furthermore, the laminate must be cohesive, i.e. all of the layers must be securely bonded together to form a unitary structure. The efficient bonding of the three layers is largely dependent on the temperature and pressure of the laminating rolls. Under heat and pressure, the intermediate film layer softens and flows into close contact with the outside paper layer and with the non-woven fibrous layer. Accordingly it is essential that the temperature of the film layer during lamination be above the softening point of the film to promote flow, but below the softening temperature of the fibrous elements in the non-woven layer. If the softening temperature for the oriented fibrous elements in the non-woven layer is exceeded, they will retract or de-orient. It is essential that the fibrous elements in the non-woven layer be maintained in their oriented condition so that their good tensile properties can be used to advantage in the laminate.

The perforations or punctures in the carpet backing sheet of this invention are essential, being provided to allow rapid drying of the carpet and backing after the two materials have been glued together with rubber latex or other cement. In addition, the perforations permit steaming, or other finishing operations. Preferably, the holes are centered in a conical raised portion and are formed by puncturing with needles rather than by a process which removes any of the sheet material.

The raised points or ridges in the backing material give increased thickness at low weight per square yard, cause the layers to bond more efficiently, and reduce the slickness of the backing material so that it stays in place during the process of gluing to primary backing.

The components of the laminar sheets of this invention can be made in a variety of forms. The common characteristics of the components of the laminate are further described below.

THE FIBROUS NON-WOVEN LAYER

The non-woven fibrous layer weighs 0.5 to 3.0 oz./yd.^{2} and is composed of randomly arranged continuous filaments of oriented crystalline organic polymer. Preferably this layer, or the sum of such layers if there be more than one, constitutes 20 to 50% of the weight of the laminate. The crystallinity and orientation of the polymeric fibers may be measured by X-ray diffraction and other techniques. The fibers have an X-ray orientation angle less than 90°. The fibrous elements of the non-woven layer are described as continuous since there are few if any free fiber ends. The fibrous elements of the non-woven layer may range from extremely fine film-like elements a few tenths of a micron thick to conventional synthetic textile filaments up to 50 microns in diameter. The fibrous elements are arranged in random order in the non-woven layer. In some cases the fibrous elements are arranged in a network structure, but the networks themselves are arranged in random fashion with many intersecting and overlaying networks in the sheet.

The preferred non-woven structures for use in the laminate are those composed of polyolefin fibrous elements. The non-woven sheets may be made either by melt spinning, dry spinning or wet spinning, but the especially preferred forms are those made by direct lay-down of filaments in sheet form rather than by collecting on bobbins.

One of the especially preferred non-woven fibrous layers is made by flash extrusion of a solution of linear polyethylene at a temperature well above the boiling point of the solvent. The solution is kept under pressure at elevated temperatures until it issues from the spinneret. As it extrudes at high speed from the spinneret, the solvent evaporates almost instantly, leaving a continuous fibrous strand composed of a three-dimensional network of film-like fibrils substantially free of fiber ends. This strand which is referred to as a plexifilament is described in British Patent 891,943. For the purpose of the present invention the strand is allowed to strike a deflector immediately after it forms at the spinneret orifice.

The deflector spreads the strand into a web-like form many times greater in width than the original strand. The web-like form is directed immediately to a moving belt without any intervening hold-up of the strand between the deflector and the moving belt. The continuous web-like strand is collected in the form of a loose sheet wherein the film-fibril networks are laid one on top of the other in overlapping multidirectional, intersecting patterns. The deflector may be any flat surface such as a metal plate set at an angle to the issuing stream of polymer and at a point within a half inch of the extrusion orifice.

The plexifilamentary strands in the non-woven fibrous layer are characterized morphologically by a three-dimensional network of film-fibril elements. The film-fibril elements are extremely thin, being less than 4 microns thick. The fillm-fibril elements are at least five times as wide as they are thick, the actual width being between about 1 micron and about 1,000 microns.

Preferably, more than half of the fibrils have lengths under 1.5 cm. (i.e., between points of attachment). The tie points, being spatially arranged in various planes along the width, length, and depth of the strand are responsible for the three-dimensional structure which results.

The predominantly longitudinal orientation of the film-fibrils of all plexifilament strands is readily apparent from the fact that all such strands are much more resistant to tearing or breaking transversely than to splitting lengthwise. The general coextensive alignment of the fibrous elements in the direction parallel to the strand axis is easily discernible to the naked eye for most plexifilamentary species.

The plexifilamentary strands of the invention are made of crystalline polymer. It has been found, quite unexpectedly, that the pellicular material in the as-spun strand when consisting of a crystalline polymer is substantially oriented as measured by electron diffraction, i.e., it has electron diffraction orientation angles smaller than 90°. It is believed that the high strength of the plexifilamentary strand as spun is closely related to the crystalline orientation within the film-like ribbon and in the structural arrangement of the fibrils themselves in the strand. In the preferred crystalline oriented products of the invention, the film-fibrils have electron diffraction angles of less than 55°. The orientation of the crystallites in the film-fibrils is in the general direction of the film-fibril axis. Preferably, the spun-bonded material has a basis weight of 0.5 to 3.0 oz./yd.^{2}.

Another type of non-woven fibrous layer which can be used for the laminate is described in Belgian Patent 608,646. These fibrous sheets are prepared by coupled melt spinning of multifilament yarn, drawing, and collection in sheet form. When the melt-spun multifilament yarn is of crystalline polypropylene, the threadline from the spinneret is preferably drawn continuously by passing around two successive rolls, the second one running about 4 times as fast as the first one. After drawing, the fibers pass continuously through an electrostatic field, which spreads them apart after which they fall on a moving belt. Later they are bonded by application of heat or adhesives.

The non-woven fibrous layer contributes a substantial part of strength to the entire laminate. For this reason the non-woven layer alone must have an Elmendorf tear strength alone of at least 0.3 lb./oz./yd.^{2}. Layers prepared from the aforementioned plexifilamentary strands

or multifilament yarns will have tear strengths of at least about 0.5 lb./oz./yd.^{2}.

THE CELLULOSIC PAPER LAYER

This layer consists of high strength papers such as kraft paper made by the sulfate process and described in detail in "Modern Pulp and Paper-making," G. S. Witham, edited by J. B. Calkin, third edition, pages 14 and 139, Reinhold Publishing Co., New York, 1957.

The cellulosic sheet may take various forms. Thus it can be produced from bleached, semi-bleached, or unbleached stocks which can be sized, tub-sized, surface coated or impregnated with conventional paper coating compositions.

Furthermore, it may be a stretchable paper of the type described in U.S. 2,624,245. Preferably, the paper should be mildew resistant. It should have a basis weight between 1 and 6 oz./yd.^{2}, preferably 1 to 3 oz./yd.^{2}, and should provide between 30 and 80% of the weight in the carpet backing. Preferably it should be treated with a resin to impart wet strength.

In a preferred form of the invention both outside layers of the laminate are of cellulosic paper and the paper layers together constitute 50 to 80% of the weight.

THE FILM LAYER

The fibrous non-woven layer and the cellulosic layer are cemented together by means of a low melting film. By low melting film is meant any film which can be melted without melting or de-orienting the fibrous elements of the non-woven sheet to which it is to be adhered. It must preferably have a melting point above 100° C. to permit drying operations. A preferred film is branched chain polyethylene or copolymers of ethylene and some other monomer. The film layer is less than 4 mils thick. Preferably the film provides between 5 and 20% of the weight in carpet backing. Of course, other types of adhesives such as synthetic or natural rubber in solution or aqueous synthetic rubber dispersions may be used. Thermoplastic polymeric films can, if desired, be first applied to the cellulosic paper by conventional extrusion coaters, roll coaters and the like.

LAMINATING, EMBOSSING, AND PUNCTURING

The laminating, embossing and puncturing operations can be performed either in separate operations or in a single operation employing one pair of rolls to impart the required embossing and puncturing patterns while simultaneously applying heat and pressure. The preferred method is to calender through a pair of smooth rolls with the laminate heated to temperatures above 100° C., also above the softening point of the film, and below the melting or retraction temperature of the oriented crystalline fibrous elements. The calendered laminate is then embossed and punctured in a separate pair of rolls at about room temperature. In either case one roll carries 30 to 500 needles but preferably 50 to 150 needles which push out the sheet giving conical volcano-like protrusions having holes centered in them. The same roll not only has long needles but also has large cup-like depressions preferably rectangular in shape, there being 30 to 500 of these per square inch, but preferably 50 to 150. In addition to providing cushioning qualities, the raised portions can be arranged to give an attractive design. For example they may be used to give the appearance of woven jute, linen, or cotton. The maximum height from the tip of the puncturing needles to the bottom of the cup-like depression on the embossing roll is 5 to 75 mils (0.005 to 0.075 inch).

In the embossing and puncturing process the roll opposite the roll with needles and depressed portions preferably has matching depressions to promote the formation of clearer patterns. It is also possible to use a smooth resilient roll opposite the embossing roll.

One of the preferred patterns is shown in FIGURE 3. Since the preferred paper is a brown kraft having the same color as jute, a very pleasing product appearance is obtained. Of course, the paper may be provided with other colors which match the tufted pile yarn and which, therefore, can be more easily covered when the laminate is used as primary backing for carpets with low pile weights.

In the following examples which illustrate the invention, melt index of the polymer is determined by the ASTM Method D–1238–57T, Condition E. The melt index is a measure of flowability for the molten polymer (grams per ten minutes) and is inversely related to molecular weight. The term "linear polyethylene" in the specification refers to polyethylene having densities of 0.94 to 0.98 g./cc., but preferably having densities of 0.95 or higher.

Example I

A non-woven plexifilamentary sheet weighing about 2 oz./yd.^{2} was prepared by flash extrusion of a solution of linear polyethylene in methylene chloride. Referring to FIGURE 5 an autoclave 101 was charged with 293 lbs. of dry methylene chloride, 35 lbs. of linear polyethylene having a density of 0.959, melt index of 1.04 (and containing 39 p.p.m. of 4,4-butylidene-bis(6-tertiary-butyl-n-cresol) antioxidant, and an additional 14.3 grams of the antioxidant was added to the autoclave to obtain an overall antioxidant concentration of 1,000 p.p.m. This mixture was heated and agitated for approximately 2½ hours to obtain a solution temperature of 214° C. at an autogenous pressure of 660 p.s.i. Nitrogen was then added to the autoclave over the solution from a pressure tank **113** and mixed into the solution to obtain an equilibrium pressure of 730 p.s.i. Agitation was then stopped and additional nitrogen was added to bring the total pressure to 800 p.s.i. in the atmosphere over the solution which was held at a temperature of 217° C. A valve **114** was then opened and the solution was then passed through a transfer line **102** to a filter **103** and then to dual side-by-side spinneret assemblies **110**. Within each spinneret assembly the solution passed through a 0.035 inch diameter preflash orifice **20** at 800 p.s.i. as shown in FIGURE 6. Finally, it passed through holes .031-inch in diameter and .031-inch in length **21** into the surrounding atmosphere.

Plexifilamentary strands were formed at the orifice exit and were extruded at high velocity. The strands impinged against a concave deflector **22** shown in FIGURE 6. The strand was spread out by the impact and by the rapid evaporation of solvent to many times its original diameter, giving thereby a wide three-dimensional network of film-fibrils **106** as shown in FIGURE 5.

Approximately 3 inches below the spinneret, the web passed through a 45 kv. electrostatic field induced through the rake-like bar **107**, which is about one inch from the spinning web.

The field served to increase filament separation and improve pinning of the web to an endless neoprene belt **108**, located 25 inches below the spinneret and moving at 15 feet/minute. A ground plate **109** located immediately under the neoprene belt guided the yarn by attraction during the deposit. The web was traversed in the cross-belt direction at 500 cycles/minute by oscillation of the deflector, the included angle of oscillation being about 22°. This traversing action enhanced a natural tendency of the yarn to deposit randomly on the belt.

The deposited yarn was then removed from the laydown area by the moving belt, passed under the static dissipator **111** located over the belt and through a pressure roll **112** and wound up on roll **115**. The resulting sheet weighed 2 oz./yd.^{2} and had a density of 0.39 g./cc. The sheet was composed of web-like strands which were three-dimensional networks of film-fibrils. The film-fibrils were less than 4 microns thick, were crystalline, and had an electron diffraction orientation angle less than

90°. The sheet material had a surface area of at least 2 m.²/g. and a tear strength of 1.5 lbs./oz./yd.².

A laminate was prepared from the plexifilamentary sheet, a layer of branched polyethylene film (density 0.910 g./cc.), and a layer of kraft paper. The kraft paper was a high strength paper prepared by the sulfate process and having a basis weight of 2.5 oz./yd.². Referring to FIGURE 7 the paper **1** was passed from a supply roll **9** at a rate of about 200 feet/minute under the slot of a melt film casting device **10**. The melt casting device at 600° F. deposited a thin film of molten branched polyethylene **2** on the paper layer; the film layer being about 1 mil thick and weighing about 0.6 oz./yd.².

The plexifilamentary sheet **3** of linear polyethylene was fed from roll **11** onto the surface of the still molten branched polyethylene film. The laminate **12** was passed through a pair of rolls **13** which exerted a force of about 100 lbs. per linear inch of roll length and then was passed over a cooled roll **40**. The consolidated laminate **14** was wound up on roll **15**. The consolidated laminate consisted of a paper layer firmly bonded to the plexifilamentary sheet by the intermediate layer of branched polyethylene. The fibrous elements of the plexifilamentary sheet retained their crystalline orientation.

The consolidated laminate was embossed and perforated to obtain on one side the pattern shown in FIGURE 3 and on the other side the inverse image. The embossing and perforating operation was performed by passing the consolidated laminate between a pair of matching rolls at room temperature having the desired patterns. On one of the rolls there were 99 needles per square inch arranged in a rectangular pattern with 9 holes per inch in one direction and 11 holes per inch in the other direction. In addition there were 99 major rectangular depressions per square inch on the roll, each having a length of about 0.1 inch and a width of 0.04 inch. The individual rectangular depressions carried a minor engraved pattern consisting of a series of parallel diagonal lines. The major depressions were arranged with their centers in a rectangular pattern surrounding the needle. The individual rectangular depressions were oriented with their long dimension alternately in the roll axis direction and in the circumferential direction, giving the appearance therefore of a woven jute backing. The second roll had matching projections for the depressed portions of the first roll and vice versa. The embossed and punctured laminate which issued from the pair of rolls carried the pattern of FIGURE 3 on one side and the inverse pattern on the other side.

Example II

The unembossed three-component sheet of Example I was used to prepare a five-component laminate. A continuous sheet of paper was supplied as before from the roll **9** indicated in FIGURE 7. The paper was coated with branched chain polyethylene from the casting device **10**. The three-component laminate from Example I (unembossed) was then fed onto the surface of the molten polymer from roll **11**. The axis of the roll was turned 180° relative to Example I so that the plexifilamentary non-woven layer was fed face down onto the molten polyethylene. A five-component laminate was wound up on roll **15**. The laminate consisted of the following successive layers: paper/branched chain polyethylene film/plexifilamentary non-woven fibrous sheet/branched chain polyethylene film/paper. The five-component laminate was embossed and punctured with the same pattern as was used in Example I.

Viewed from one side the products of Example I and Example II each contained 99 holes per square inch, each hole being centered in a volcano-like projection. On the same side of the laminate there were 99 depressed rectangular areas each having a height of 30 mils above the depressed areas.

Example III

The process of Example I was repeated using a melt spun bonded sheet instead of the plexifilamentary sheet prepared by flash extrusion. The melt spun bonded sheet was obtained by a process similar to that described in Belgian Patent 608,646. A crystalline polypropylene polymer was melt spun as a multifilament yarn, the yarn being forwarded continuously to a pair of drawing rolls where it was drawn about 4X, the yarn then passing through an electrostatic field to cause the filaments to diverge, and being finally deposited on a moving screen. The filaments in the resulting non-woven sheet were fused together by passing through a pair of hot rolls. The fibrous polypropylene sheet having a tear strength of 2.2 lbs./oz./yd.² was laminated to paper by means of branched polyethylene film layer as in Example I and was embossed and punctured in the same way. The laminate is used as secondary backing for carpets as described in Example V.

Example IV

A five-component laminate was made by passing the unembossed three layer laminate of Example III through the same system as described in Example II.

The products prepared in Example II and IV were compared to sheets of the prior art. The properties are shown in Table I.

All of the materials in Table I were embossed and punctured (with the same pattern) except for the woven sheet from twisted paper and the woven jute. The unlaminated melt spun bonded, non-woven fibrous sheet of polypropylene was embossed without puncturing, since it already was porous in nature.

The rigidity factor indicated in the table was measured by the method described in TAPPI Standards, T451 m–45. The factor compensates for differences in basis weight and thickness.

The Elmendorf tear measurements were made by the methods described in TAPPI Standards T414 m–49.

The tack strength is a measure of the ability of the backing material to be stretched in the process of fastening the carpet in wall-to-wall installations. The test was run by placing a hook through a piece of the backing material at a point 0.125 inch from the edge of the material. The sheet was mounted vertically and weights were added until the hook pulled through the edge of the material.

Example V

Carpet backing materials described in the above examples were tested in carpets in the following manner. Tufted carpets were prepared on standard carpet-making machinery using a 12 oz./yd.² jute backing. Three ends of 1020 denier bulked continuous filament nylon (denier at tension of 0.1 g.p.d.) were passed through each needle in the tufting machine. The needles were 3/16 inch apart. The carpet was prepared by tufting with 8 tufts per inch and 7/16 inch pile height. The carpet was piece dyed in a beck.

After drying, samples of the carpet were latexed with a synthetic rubber latex (20% solids). While the latex was still wet the secondary carpet backings of Examples I to IV were applied to the carpet samples with the volcano-like projections and rectangular cup-like depressions facing the back of the carpet. The carpets with the secondary backing applied were dried and cured at 240° F. in hot air for fifteen minutes. The products from Examples I–IV adhered while wet when hung vertically and adhered tenaciously after drying. The properties of carpets prepared with various backings are indicated in Table II. All of the backings were applied to the same tufted carpet for which the primary backing was woven jute. The load to stretch 2% shown in Table II was measured by ASTM Method D–39, part 10. The percentage growth with change in humidity from 20% to 90% R.H. is the average growth for the length and width of

the carpet. The carpets of Examples I to IV after applying the second backing dried very rapidly. The wet adhesion of the secondary backing was good. This is important in commercial operations and was demonstrated in additional commercial scale experiments. In the commercial operations the latex used to anchor the tufts was different than the latex applied for secondary backing. In these operations the second backing was required to adhere to the lower side of the carpet as it passed between rolls with no other support. This was done successfully despite the higher stiffness of the products of Examples I to IV. The superior stiffness for a given weight was especially valuable in preventing wrinkling of carpets on the floor. The laminated products of the invention were not waxy and slick as is characteristic of many polyolefin materials. The perforations and embossing provided good cushioning of carpet.

Carpets with the secondary backings described in Examples I to IV were compared on the floor with other carpets having backings known in the prior art (jute and paper) and with carpet having no secondary backing. The carpets of this invention were easily stretched in wall-to-wall installation without their tearing out at the edges. After installation, the carpets of this invention exhibited little or no wrinkling during changes in humidity

TABLE I.—PROPERTIES OF CARPET BACKING MATERIALS

Example No.	Construction [1]	Processing		Weight, Oz./Yd.^{2}	Thickness, Mils	Rigidity Factor	Elmendorf Tear Strength, Lbs.	Tack Strength, Lbs.
		Emboss	Puncture					
II	P/F/Plex/F/P	X	X	8.2	44	1.56	1.10	6.0
IV	P/F/MSS/F/P	X	X	8.4	43	1.70	1.20	5.3
	Plex	X	X	2.6	32	0.29	3.90	7.0
	MSS	X	X	2.9	23	0.84	6.30	5.0
	P/F/P	X	X	5.6	46	1.60	0.40	2.8
	P	X	X	2.5	37	0.28	0.15	
	Woven Paper (twisted)			5.6	44			0.20
	Jute			10.2	44			0.10

[1] P=Paper.
F=Film of branched chain polyethylene.
Plex=Plexifilamentary sheet of linear polyethylene.
MSS=Melt-spun bonded sheet of polypropylene.

TABLE II.—PROPERTIES OF CARPETS WITH VARIOUS SECONDARY BACKINGS

Example No.	Backing Construction [1]	Processing		Backing Weight Oz./Yd.^{2}	Load to Stretch 2%, Lbs.	Percent Growth With Change of Humidity From 20% to 90% R.H.
		Emboss	Puncture			
II	P/F/Plex/F/P	X	X	8.2	50	0.13
IV	P/F/MSS/F/P	X	X	8.4	40	0.13
	Jute			10.2	19	0.22
	P	X	X	2.5		0.50
	No secondary backing					0.95

[1] P=Paper Sheet.
F=Film of branched chain polyethylene.
Plex=Plexifilamentary sheet of linear polyethylene.
MSS=Melt spun bonded sheet of polypropylene.

while the paper and jute-backed carpets wrinkled excessively. Actual changes in dimension with humidity change were measured in the laboratory and are indicated in Table II.

What is claimed is:

1. A cohesive laminar sheet material suitable for use as a secondary carpet backing, said sheet material comprising at least three adjacent layers including (a) a heat softenable polymeric film of 0.3 to 1.2 oz./yd.^{2}, (b) adjacent one surface of said polymeric film a non-woven layer of randomly arranged oriented fibrous elements of a crystalline organic polymer, said non-woven layer having a weight of 0.5 to 3 ounces/yd.^{2} and a tear strength of at least 0.3 pound/in./oz./yd.^{2}, and (c) adjacent the other surface of said polymeric film a cellulosic paper web having a weight of 1 to 6 oz./yd.^{2}, said laminar sheet material being provided with 30 to 500 holes/inches^2, the total open area of the holes comprising 2 to 10% of the said laminar sheet material, one surface of said laminar sheet material having 30 to 500 projections/inches^2 with a height from trough to crest of 5 to 75 mils.

2. The sheet material of claim 1 cemented to the back surface of a backed pile carpet.

3. The sheet material of claim 1 comprising consecutive layers of said cellulosic paper web, said polymeric film, said non-woven layer, said polymeric film and said paper web.

4. The sheet material of claim 1 wherein said polymeric film is branched chain polyethylene.

5. The sheet material of claim 1 wherein said fibrous elements of the non-woven layer are composed of continuous strands.

6. The sheet material of claim 5 wherein said strands are plexifilamentary strands.

7. The sheet material of claim 6 wherein the plexifilamentary strands are composed of linear polyethylene.

8. The sheet material of claim 5 wherein said strands are melt-spun multifilament yarns.

9. The sheet material of claim 8 wherein the multifilament yarns are composed of polypropylene.

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