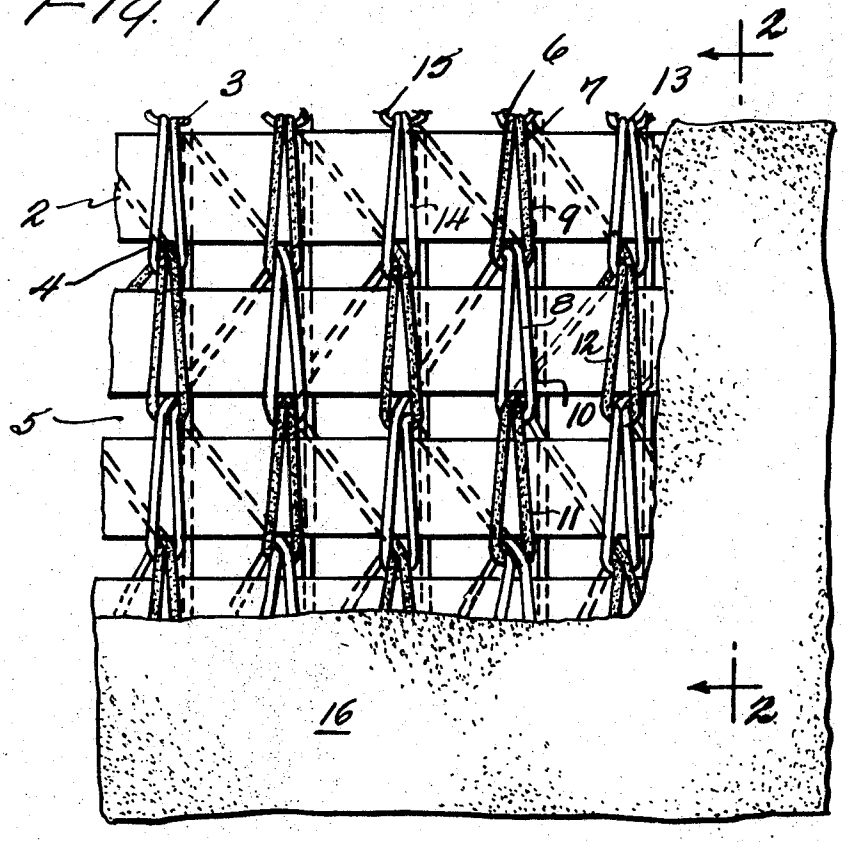
March 2, 1971 R. L. JONES ETAL 3,567,565

LAMINATE OF FOAM AND STITCH BONDED FABRIC

Filed Nov. 9, 1967

Fig. 1



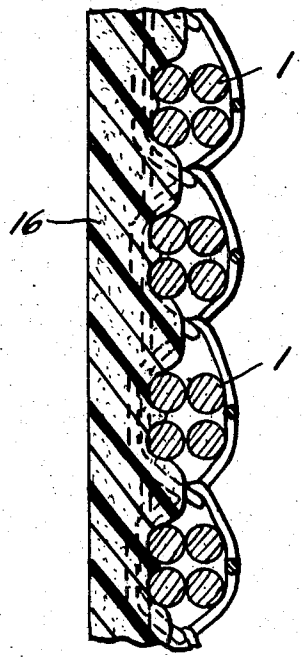


Fig. 2

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LAMINATE OF FOAM AND STITCH BONDED FABRIC

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U.S. Cl. 161—50 6 Claims

ABSTRACT OF THE DISCLOSURE

A warp knitted fabric comprising loose filling threads held together by chain stitches of sewing thread which gather the filling threads into clusters separated by spaces where the stitches pass through the fabric. The fabric is laminated with a foamed polymeric material which is fluid or becomes fluid during the process so that it can flow into the spaces between clusters of filling threads and interlock with them and the sewing thread. After flowing into position while fluid the foam is gelled and, if necessary, cured to take on its permanent configuration.

DISCLOSURE

The present invention relates to a fabric and more particularly to a warp knitted type fabric comprising chain stitches holding together an array of loose filling threads transverse to the stitching, and to a method of making the fabric. In accordance with this invention, considerable increase in strength and dimensional stability is achieved by means of a foamed polymeric material laminated to one side of the fabric and partially filling certain spaces between the loose filling thread.

Fabrics of the type mentioned above may be made on the type of apparatus described in Mauersberger U.S. Pat. 3,030,786. In that apparatus, the loose filling threads are provided from continuous threads which are wound back and forth across a kind of tenter frame by a carriage, and around heddle hooks on moving conveyor belts at either side of the frame. The conveyors are moving while the carriage traverses the space between them, so that the filling threads are made more or less oblique to the machine direction and in two sets which are oblique to each other. That is, after a set of parallel threads are caught on the hooks of one of the conveyors, it moves directly across to the other conveyor. While the carriage moves across, the conveyors are moving perpendicularly to the carriage and, by the time the carriage reaches the other conveyor, it has moved a short distance. Therefore the heddle hooks on which the threads are caught on the second conveyor are not directly opposite the hooks used on the first conveyor, and the threads are oblique to the machine direction. When the carriage returns to the first conveyor, an opposite effect is observed, and the threads laid down are oblique to the machine direction and to the threads laid down in the previous traverse.

The conveyors move the filling threads to a sewing head where a set of needles forms several lines of chain stitches which bind the filling threads together. In some cases, the sewing thread supplied to the needles is supplied alternately to adjacent needles and is sewed alternately into adjacent stitches. This causes a kind of interlocking effect between adjacent lines of stitches which tends to reduce the likelihood of ripping a chain of stitches if one loop is damaged. The interlocking stitch has the further advantage of permitting use of loose warp threads which are simply laid on one side of the loose filling threads, but are not woven. The warp threads are held against the filling threads by the sewing thread as it zig-zags back and forth between adjacent rows of stitches.

An important characteristic of the fabric produced is the arrangement of the filling threads after sewing. In many fabrics, the stitches may be, for example, 2–3 mm. apart. Between stitches, several filling threads are clustered together relatively tightly, while at points where stitches pierce the fabric, the filling yarn is pushed away. Thus the fabric has the appearance of spaced clusters of relatively parallel yarns separated by spaces at points where the sewing yarn pierces the fabric. There is a tendency for some of the filling yarns to cross this space, connecting adjacent filling yarn clusters, but generally speaking the fabric appears to consist of spaced parallel filling yarn clusters. In some cases, the above-mentioned spaces are deliberately accentuated by omitting filling yarn between some stitches. In these areas, the fabric has the form of warp knit goods.

Fabrics of this type have significant cost advantages. Estimates have indicated that one sewing machine can produce 20–40 times as much fabric as a loom. Relatively inexpensive material may be used as the filling yarn, further reducing costs.

The present invention is concerned with improving these fabrics by reinforcing them with a foamed polymer which adds relatively little weight or stiffness to the fabric but increases its bulk and opacity, and provides an ornamental appearance. More specifically, the fabric described above is laminated with a polymeric material which is either foamed or is capable of being foamed. The polymeric material is either applied as a fluid or is applied as a material capable of becoming a fluid during processing, so that it can penetrate partially the spaces between clusters of warp yarns. The fluid material is caused to penetrate partially those spaces and is gelled and, if necessary, cured, to form a layer of foamed polymer on one side of the fabric and interlocked between the aforesaid clusters. The foam surrounds the sewing thread on one side of the fabric and portions of the sewing thread extending through the fabric at the stitches, and it also anchors warp yarn, if any, between it and the filling yarn. Normally, warp yarn, if any, is on the same side of the fabric as the foam, unless it is being used for ornamental purposes.

If the polymer is colored or contains a coloring material which is different from the yarn, it provides an ornamental effect of dots or lines of background showing through the fabric.

Substantially any yarn can be used for the filling and/or sewing thread. These include natural fibers such as cotton, wool, sisal, jute, flax and silk and synthetic fibers such as regenerated cellulose (rayon), cellulose esters, e.g. cellulose acetate, cellulose acetate/butyrate and cellulose triacetate, acrylics, e.g. polyacrylonitrile, modacrylics, acrylonitrile-vinyl chloride copolymers, polyamides, e.g. polyhexamethylene adipamide (Nylon 66), polycaproamide (Nylon 6) and polyandecanoamide (Nylon 11), polyolefin, e.g. polyethylene and polypropylene, polyester, e.g. polyethylene terephthalate, rubber and synthetic rubber, saran, glass, etc. Sewing yarn sizes ordinarily are about 40 to 200 denier and filling yarns from 3,000 yds./lb. to about 20,000 yds./lb. When warp yarns are used, they may be, e.g. from about 1,000 yds./lb. to 16,000 or 17,000 yds./lb. Typically, the fabric weighs 3 to 10–12 ounces per square yard. Picks, i.e. filling yarns per inch usually are from about 6 to about 120 or 140. Stitch length is about 1–5 mm., preferably about 1 to 3 mm. Gauge runs from about 7 to 22 gauge, i.e. 7 to 22 stitches per inch across the fabric. Warp yarns may be the same as the number of stitch lines or less.

The polymeric foam may be of any of those known to the art provided that the foam must be applied as a fluid or must be capable of becoming a fluid when on

the fabric so that it can flow into the spaces between clusters of filling yarn. The polymer constituting the foam may be rubber, polyurethane, polystyrene, vinyl polymers such as polyvinyl chloride, polyethylene, phenolic resins, silicones and cellulose acetate or others. A very useful material is the cross-linked foamed copolymer of styrene and acrylic acid described in U.S. Pat. 3,215,647. This is formed from a latex containing a copolymer of styrene with another monomer having a reactive group such as acrylic acid. The latex also contains a coreactive material which cross-links the styrene polymer and which is soluble in water or water-miscible solvents. The latex is foamed or frothed by bubbling in a gas or by decomposition of a gas-releasing material. The latex is gelled and subsequently cured after it has been applied to the above-described fabric.

The foam is applied to add a weight of about 0.50 to 10.0 ounces per square yard and weighs about 10% to 100% of the fabric to which it is applied. Ordinarily, the foam will be about 6 to 50 mils thick and have a density of about 3 to 16 pounds per cubic foot. These characteristics control the flexibility of the foam and the lined fabric produced. Ordinarily, it is desired to reduce the flexibility of the fabric partially, to improve its draping characteristics, but not to make it stiff. Therefore, flexible foam formulations are used.

The invention, briefly described above, will be better understood from the following description of a preferred embodiment, reference being made to the drawing in which:

FIG. 1 is a plan view, partially in section, of the fabric of this invention, and

FIG. 2 is a section along lines **2—2** of FIG. 1.

The fabric illustrated in FIG. 1 comprises a plurality of loose filling yarns **1** gathered into clusters **2**. The clusters are held together by sewing thread **3** formed into interlocked chain stitching substantially perpendicular to the filling yarn clusters. Each sewing thread **3** is formed into a plurality of loops **4** spaced along the length of the fabric, each loop passing through the fabric at one of the spaces **5** between adjacent clusters **2**.

The loops are formed into parallel chains, but each chain is formed from two threads which alternately are formed into stitches of adjacent chains. For example, one chain of loops, designated **6** in the drawing, is formed from two threads **7** and **8**. A first loop **9** is formed from thread **7**, the next loop **10** is formed from thread **8** and the next loop **11** is formed from thread **7**, etc. Thread **7** also is formed into loops **12** in chain **13** on one side of chain **6**, alongside loop **10** and other loops in chain **6** which are formed from thread **8**. Similarly, thread **8** also is formed into loops **14** in a chain **15** on the other side of chain **6**, alongside loops **9** and **11** in chain **6**. The arrangement is such that each sewing thread is interlocked with two others in adjacent stitch lines so that, if a thread breaks, it will not pull out a succession of stitches as it would if each chain were formed from a single thread.

FIG. 1 also illustrates warp yarns laid against the filling yarns and held in place by the sewing threads as they extend back and forth between loop chains. Thus the interlocking chain stitch provides the further advantage of making possible the use of warp yarn, which improves dimensional stability of the fabric in the warp direction.

A foamed polymer material is applied to one side of the fabric described above. In a typical embodiment, a latex is applied which already has been foamed. That is, the latex comprises polymer particles dispersed in water, appropriate dispersing or emulsifying agents and small gas bubbles. The gas bubbles may have been generated by passing gas into the latex with agitation to divide gas bubbles to suitable size. Alternatively, gas may have been generated by decomposing a chemical agent, for example, an azo compound, which is dissolved or dispersed in a latex or a plastisol or organisol.

The foam or foamable material, once applied to the fabric in fluid form, seeps into the spaces **5** between clusters of filling yarn and encases the sewing thread passing through those spaces. The foam also surrounds the sewing thread on the side of the fabric which it covered and interlocks with the sewing thread. The effect is that the foam becomes an integral part of the fabric, being firmly anchored to the sewing thread. The foam also forms a layer **16** on one side of the fabric.

After the foam has flowed into the fabric, it is gelled and then cured. Gelling can be described as coagulating the very small polymer particles into larger masses which tend to flow together into a single continuous layer containing dispersed gas. Gelling may be obtained by heating. Curing may be described as the cross-linking of the polymer molecules, which increases their stiffness.

Example 1

In a typical embodiment, the foam is the latex described in Example 1 of U.S. Pat. 3,215,647. This contains a copolymer derived from 30 parts of styrene, 60 parts 1,3-butadiene and 10 parts acrylic acid and a cross-linking system comprising super Amide B–5, a coconut fatty acid diethanolamine condensate, and a water-soluble melamine-formaldehyde resin as well as sufficient water so that the solids content is 42 percent. Small amounts of talc, titanium dioxide and zinc oxide were added as pigments and to reduce tackiness. The latex is mechanically foamed to a gas content of 75% by volume and flowed onto the fabric. Then the fabric is placed in an oven which was maintained at 350° F., for 6 minutes which caused the latex to gell and the polymer to cure. The foam had a density of about 8 pounds per cubic foot and formed a layer approximately 30 mil thick. The weight of foam was about 3 ounces per square yard.

Another type of foam is derived from vinyl plastisol. An extensive discussion of this type of foam is provided in Plastics Engineering Handbook of The Society of the Plastics Industry, 3d Edition, (1960) especially at pages 188–193. In a vinyl plastisol, the polymer usually is polyvinyl chloride in the form of small particles, which is intimately mixed with a plasticizer. The plastisols are quite fluid, but, on heating, they gel. It will be noted that gellation involves a different process in plastisols than in latex foam systems. In the plastisols, gellation is accomplished by heating which causes the plasticizer to diffuse into the polymer particles. The plasticizer initially establishes a relatively high concentration at the surfaces of the particles, which makes them tacky so that they fuse together into a continuous film. Further heating causes the plasticizer to diffuse throughout the film and form a smoothly integrated plasticized vinyl film.

As in the case of latex foams, gas may be supplied by mechanically dispersing a gas into the plastisol or by decomposition of a chemical agent such as an azo compound. In the mechanical process, gas is introduced into the chilled plastisol while it is under pressure. Then the plastisol and dissolved or dispersed gas is extruded through a tube. As the pressure is released, the gas expands to form interconnecting voids. Then the plastisol is gelled by oven heating, e.g. at 360° F.

In the chemical foaming process, the plastisol is mixed with a chemical agent which decomposes when heated. Various agents of this type are available, each having a characteristic decomposition temperature. The agent for any particular system should have a decomposition temperature below the gel temperature of the plastisol. The mixture is coated onto the fabric and then heated in an oven. The chemical agent decomposes, causing foaming, and this is followed by gellation.

Similarly, flexible polyurethane foam formulations may be used. These usually are obtained from a polyester or a polyether, a polyisocyanate and water and/or a volatile inert liquid. Foaming is produced with carbon dioxide

generated by part of the polyisocyanate and water or by evaporation of the volatile inert liquid.

Various coating techniques may be used to apply fluid foams. These include knife over roll, roller coating and casting. Since numerous suitable polymer coating techniques already are well known, they need not be described in detail here.

The foams normally contain pigments or dyes which render the fabric opaque and provide an ornamental effect. Opaqueness is provided by the coordinated effects of the foam and the dye or pigment. The foam, having numerous air-polymer interfaces at different angles, scatters light even though the polymer itself may be transparent. Therefore little of any incident light is transmitted. The light scattering also increases the effectiveness of the dye or pigment. That is, the scattered light has a much longer path through the foam than it would have through a solid mass of polymer having the same thickness. Since the amount of light absorbed increases exponentially with the path length, the effectiveness of the pigments is greatly multiplied.

Almost any dye or pigment may be used which is compatible with the polymer. If the dye or pigment has the same hue and depth of shade as the coloring in the fabric, the product will appear to be a tightly woven-uniform color fabric. On the other hand, if a contrasting hue or different depth of shade is used, an ornamental pattern will result. Consequently, the amount of dye or pigment used will vary with the effect desired, but ordinarily it will be about 0 to 75% by weight of the foam. If chemical foaming agents are used, they preferably should be inert with respect to the dye or pigments used. It also is possible to print on the exposed surface of the foam to produce other ornamental effects.

In addition to the ornamental effects obtained with dyes or pigments, the laminated fabrics of the present invention have numerous other advantages. Compared to the loose filling chain stitched fabrics from which they are derived, they have improved dimensional stability in laundering and dry cleaning, improved tensile strength and tear strength, improved sewing properties and seam strength, and important improvements in abrasion resistance. For example, fabrics of this type, without the foam lamination of the present invention, may shrink 6–8% in laundering, even if treated with crease proofing resins. However, in the fabrics of the present invention, shrinkage is within normal limits. As noted above, the fabrics have improved draping properties. They also have better insulating properties, especially if the foam is of the closed pore type.

In part, these properties result from the inherent nature of the fabric. In open mesh fabrics, there is a tendency for the fluid foam material to flow through openings from one side of the fabric onto the other side. This is observed in open casement type fabrics. However, because of the nature of the fabric used in the present invention, composed of loose filling, sewing, and optionally warp threads, excessive migration of the foam to the exposed face of the fabric is avoided.

The following examples further illustrate the invention.

Example 2

A warp knitted fabric of the type described above was formed from yarn composed of 80% rayon and 20% polyester fibers and weighing 5.46 oz./yd.^{2}. After dyeing, the fabric was coated on the back side with a latex foam compound based on the copolymer described in Example 1 of U.S. Pat. 3,215,647. The foam compound was based on 100 dry parts of latex and in addition, contained 5 parts cross-linking resin; 4.2 parts frothing soap; 0.3 part polyacrylate thickener; 7.2 parts zinc oxide; 50 parts aluminum hydrate filler and .25 part methyl cellulose.

The compound was mechanically foamed and sufficient air injected to give a dry foam weight of approximately ten pounds per cubic foot. The foam was applied at a thickness to give an add-on of 1.50 to 2.0 oz./yd.^{2} of foam. After application, foam was dried and cured for a total of five minutes at 300° F. The laminate was washed and dried to evaluate stabilization. The warp direction showed .25% shrinkage compared to 8.9% for uncoated control. The filling direction showed 0% shrinkage compared to 4.2% for control.

Example 3

The fabric described in Example 1 was coated with a latex foam compound based on a copolymer similar to that described in Example 1 of U.S. Pat. 3,215,647. This particular latex contains the cross-linking resin and frothing soap and is identified as Dow Latex QW–3971. The foam compound consisted of 100 parts latex; 40 parts talc filler; 20 parts titanium dioxide; 1 part zinc oxide; 1 part methyl cellulose and sufficient water to give a compound viscosity of 5,600 cps.

The compound was mechanically foamed to give a density of 15 pounds per cubic foot. A thickness of 15 mils was applied and gave a dry foam add-on of 2.6 to 3.2 oz./yd.^{2}. The laminate was dried under infrared lamps and further cured in an oven at 310° F. for 3½ minutes. The laminate showed excellent opacity and physical properties exceeded those of the untreated control.

Example 4

A drapery fabric similar to that described in Example 1 was coated with an open cell mechanically blown polyvinyl chloride foam. The plastisol for the foam consisted of 100 parts plastisol grade PVC resin; 95 parts octydecyl phthalate; 5 parts epoxy plasticizer; 3 parts barium-cadmium-zinc stabilizer; 15.4 parts titanium dioxide, 12 parts silicone surfactant such as Dow Corning DC–XR–6–3701. The plastisol viscosity was 3,000 cps.

The plastisol was fed into a mechanical foamer and air flow adjusted to give a foam density of 16–18 pounds per cubic foot. Foam was applied at levels of 5 to 35 mils in thickness. Drying and curing were accomplished by heating for six minutes in a forced air oven set at 325° F.

The fabrics coated with this foam showed excellent stability to washing and a very noticeable improvement in abrasion resistance.

The product may receive various finishing treatments for water repellency, softening, reduced soiling, improved soil release during laundering, crease-proofing and the like, including the resin treatment described in U.S. patent application of Jones et al., Ser. No. 651,478, filed July 6, 1967. The foam can be embossed for other ornamental effects. Various other changes may be made in details of construction and mode of operation without departing from the scope of the invention, as defined in the appended claims.

We claim:

1. A laminated fabric comprising a first layer comprising a plurality of loose filling yarns substantially gathered in clusters separated by spaces and a plurality of loop chains of sewing thread extending along one surface of said layer generally perpendicular to said loose filling yarn with stitches through said spaces and sewing thread connecting between said loops extending through said spaces and along the other surface of said layer,

and, as a second layer a foamed polymer closely conforming to one surface of said first layer and to said loose filling yarns on that surface of said first layer and intimately surrounding said sewing thread on said one side and in said spaces, and extending at least partly through said spaces, so as to cover one of the surfaces of said first layer, the other surface of said first layer being exposed,

so that said foam is substantially integral with said first layer and is interlocked with the yarn and sewing thread thereof.

2. A laminated fabric as set forth in claim 1 in which there are about 6–140 of said loose filling yarns per inch of fabric length and said spaces through which said sewing thread stitches pass are about 1–5 mm. apart.

3. A laminated fabric as set forth in claim 2 in which said first layer has a weight of about 3 to 12 ounces per square yard and said second layer has a weight of about 0.5 to 10.0 ounces per square yard.

4. A laminated fabric as set forth in claim 3 in which said second layer weighs about 10–100% of the weight of said first layer.

5. A laminated fabric as set forth in claim 4 in which said second layer is about 6 to 50 mils thick and has a density of 3 to 16 pounds per cubic foot.

6. A laminated fabric comprising:

a first layer comprising a plurality of loose filling yarns substantially gathered in clusters separated by spaces, said yarns being about 3,000–20,000 yards per pound and about 6 to 140 picks per inch along said fabric, and a plurality of loop chains of sewing thread extending along one surface of said first layer generally perpendicular to said loose filling yarn with stitches through said spaces and sewing thread connecting between said loops extending through said spaces and along the other surface of said layer, said sewing thread being about 40 to 200 denier, the sewing thread stitches being about 1 to 5 mm. long and about 7 to 22 per centimeter across the fabric, substantially each sewing thread end being alternately formed into loops in a pair of adjacent loop chains and substantially

each of said loop chains having alternate loops of two different sewing thread ends, said first layer having a weight of about 3–12 ounces per square yard,

and, as a second layer, a foamed polymer closely conforming to one surface of said first layer and to said loose filling yarns on that surface of said first layer and intimately surrounding said sewing thread on said one side and in said spaces, and extending at least partly through said spaces, so as to cover one of the surfaces of said first layer, the other surface of said first layer being exposed, said second layer having a weight of about 0.50 to 10.0 ounces per square yard, a density of about 3 to 16 pounds per square foot, a thickness of about 6 to 50 mils, and a weight about 10–100% of the weight of said first layer,

said foam being substantially integral with said first layer.

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