

Oct. 4, 1955

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2,719,802

FIBROUS, NON-WOVEN TEXTILE-LIKE SHEET MATERIAL

Filed Dec. 22, 1951

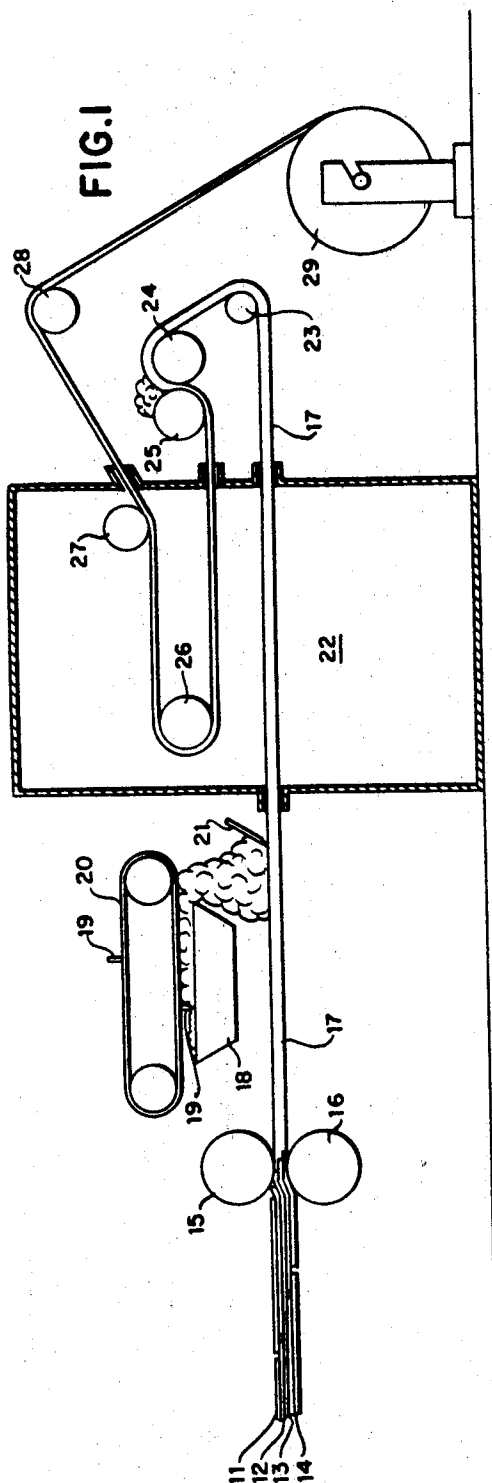
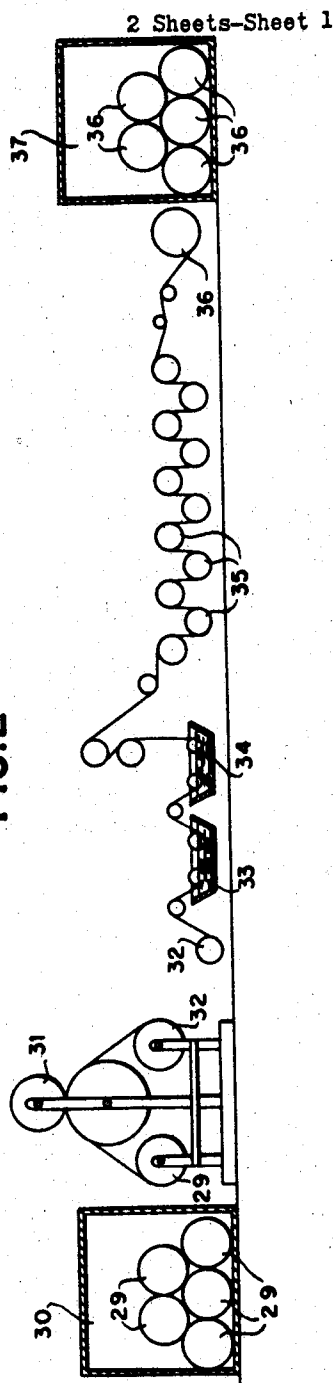


FIG. 2



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2 Sheets-Sheet 2

FIG.3

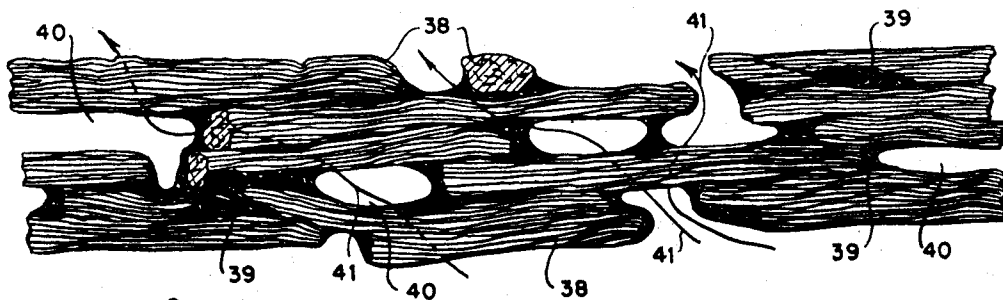
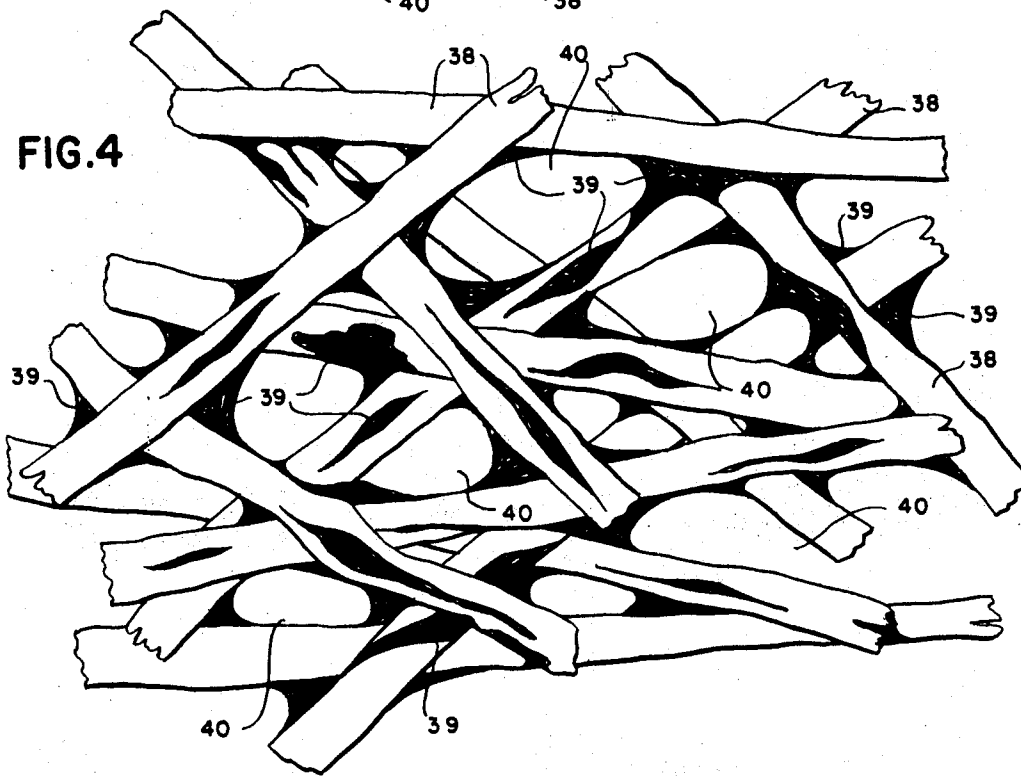


FIG.4



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FIBROUS, NON-WOVEN TEXTILE-LIKE SHEET MATERIAL

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Application December 22, 1951, Serial No. 262,942

Claims priority, application Germany October 1, 1948

9 Claims. (Cl. 154-46)

The present invention relates to porous, crease-resisting, shrink-proof fibrous sheet material.

This application is a continuation in part of my co-pending U. S. patent applications Ser. Nos. 102,423 and 102,425, both filed on June 30, 1949, both now abandoned.

One object of my invention is to produce a porous, air permeable, shrink-proof, fabric-like sheet material uniformly resistant to creasing in any direction and which has a high resistance to shearing and is capable of being sewed, stitched or padded.

Another object of my invention is to produce a fabric-like porous, air permeable, shrink-proof sheet material resistant to creasing, which consists of an open skeleton of intermingled, fine, cardable fibers arranged in random directions, said skeleton having uniformly distributed therethrough and adhering to the fibers, filmy particles of a flexible, solid binder material, said binder particles cementing adjacent fibers together in the region of their crossing points with preservation of numerous relatively large interstices between the fibers.

Still another object of the invention is to produce a porous, fabric-like, sheet material of the type described, the thickness of which may vary from about 0.14 to 1.5 mm.

A still further object of the invention is to provide a highly porous, fabric-like sheet material of light weight, such as about 45 to 400 g. per m.² and containing about 25 to 60%, by weight, of binder material.

A still further object of the invention is to provide a fabric-like, porous, air-permeable sheet material resistant to creasing or folding which has substantially flat, uniformly distributed pores extending mainly in planes parallel to the general plane of the sheet.

A special object of the invention is to produce a fabric-like porous, air-permeable, sheet material which is isoelastic or isotropic, i. e., substantially equally stretchable in all directions, as well as resiliently and uniformly resistant to creasing or folding in any direction.

These and other objects, which will appear more clearly as the specification proceeds, are accomplished, according to my invention, by the products set forth in the following detailed description.

Generally, a preferred process for the manufacture of fabric-like, porous, air-permeable, shrink-proof, crease-resistant sheet material according to my invention comprises the following steps: A plurality of webs of fine, cardable polyposed fibers, each web having a thickness of about 0.1 mm. to 1.2 mm. and weighing from about 15 to 35 g. per m.², are laid upon one another and united by means of pressure and heat with slight stretching to form a loose fleece weighing from about 40 to about 400 g. per m.².

In order to give to this loose fleece sufficient stability to permit a subsequent through impregnation, at least one surface of the fleece is first treated with a liquid to produce a light surface cohesion. Preferably, for this purpose, a first binder material in a liquid carrier is applied

2

to at least one surface of the loose, unstable fleece and dried to deposit about 3 to about 10 parts by weight of solid filmy binder particles per 100 parts by weight of fibers on the treated surface or surfaces, thus providing a light surface cohesion without appreciable reduction of the porosity of the fleece.

Next, an aqueous binder material in the form of a stable, flowable foam is pressed into the pre-treated fleece through at least one surface thereof under a pressure to cause a substantially complete and uniform penetration of the fleece with simultaneous destruction of part of the foam cells and incorporation into the fleece of about 20 parts to about 140 parts (solid weight) of binder material per 100 parts, by weight, of fibers and with preservation of a substantial porosity in the impregnated sheet formed. The impregnated sheet is then dried without pressure, the ensuing removal of the water causing a collapse of the remaining foam cells and a precipitation of solid binder particles on the fibers uniformly throughout the fleece and principally at the crossing points of adjacent fibers, whereby the fibers are cemented together at their crossing points with preservation of numerous, relatively large interstices having the form of flat pores, the majority of which extend substantially in planes parallel to the general plane of the sheet.

The aqueous binder material, which is used for the preparation of the foam, may contain about 15% to about 40% by weight of binder solids and also a substantial proportion of wetting agent which may amount to as much as about 60 parts (dry weight) of wetting agent per 100 parts by weight of solid binder material.

The binder foam contains about 2 to 10 volumes, and preferably about 5 volumes of gas per volume of liquid binder.

Various cardable fiber materials may be used for the formation of the fiber fleece. Suitable vegetable fibers are, for instance, cotton, ramie and denatured flax hemp and jute. Suitable animal fibers are, for instance, wool, goats' hair, camel hair or human hair. Suitable synthetic fibers include rayon, acetate, alginate fibers, polyacrylonitrile fibers, polyvinyl fibers, polyvinylidene fibers, superpolyamides, protein fibers, glass wool, asbestos wool, etc. It is essential for the successful operation of my invention that the fibers are cardable. It has been found that long, thick fibers and fibers having entirely smooth surfaces, such as horse hair, coconut fibers and the like, cannot be firmly bound in the fibrous structures obtained according to my invention. Fibers which are too short for carding, on the other hand, do not lend themselves to the production of the loose fiber fleeces which form the starting material of my process.

According to a preferred embodiment of the invention, which serves for the production of an isoelastic sheet material, the fiber mixture used of the preparation of the fleece contains at least 15% by weight, and preferably close to 50% by weight or more of an elastic natural or synthetic fiber material, such as wool, hair, acetate fibers, polyamide fibers, polyvinylidene fibers or protein fibers, and the liquid binder material pressed into the fiber fleece in the form of a foam is adapted to yield filmy binder particles which are elastically stabilized by vulcanization. In this embodiment of the invention, suitable binder materials are, for instance, the natural and the synthetic vulcanizable or prevulcanized rubber latices which may contain, in addition to the binder material itself, suitable quantities of wetting agents, vulcanizing agents, vulcanization accelerators, foam stabilizing agents and antioxidants. Softening agents, such as glycerine, fillers, such as kaolin, clay, calcium carbonate etc., silica dispersions, dyes, water repellent lubricants, such as wax and paraffin, or starches and the like, etc., may also be present. Dispersions of synthetic rubbers which have a

negligible tendency towards ageing, such as butadiene acrylonitrile polymers, butadiene styrene polymers or chloroprene have given excellent results. Where vulcanizable binding agents are employed, vulcanization may be effected during or after the drying stage. Such vulcanization is carried out without subjecting the sheet material to any substantial pressure.

Instead of incorporating water repellent lubricants into the liquid binder material, the isoelastic sheet material obtained may subsequently be treated with a water repellent permanent lubricant selected from the group consisting of paraffin and wax, with or without water-proofing salts, such as aluminum salts. Preferably, about 2 to 10% by weight of lubricant are incorporated into the material to produce a sheet material which can be stitched, padded or sewed on sewing machines and through which needles will pass without undesirable friction so that an overheating of the needles is obviated.

Some thermoplastic resin, such as a polyvinyl ester, for instance, polyvinyl chloride, or a polymeric ester of an acrylic acid, such as, for instance, polymethylmethacrylate, polystyrene, the polyvinylidene esters, or mixtures thereof may be incorporated with the elastic binder material.

The impregnation of the fiber fleeces is effected preferably by the method described and claimed in my simultaneously filed U. S. Patent application Ser. No. 262,941, which is also a continuation-in-part of my copending U. S. Patent applications Ser. Nos. 102,423 and 102,425 of June 30, 1949. This preferred process will now be described in some detail with reference to the accompanying drawing in which:

Fig. 1 is a flow diagram illustrating the impregnating process according to the present invention in general.

Fig. 2 is a flow diagram showing a series of additional steps which, in one embodiment of the invention, are added to the steps illustrated in Fig. 1.

Fig. 3 is a greatly enlarged cross-section through a porous, flexible sheet material according to the invention; and

Fig. 4 is a similarly enlarged top plan view of a sheet material produced according to the invention.

Referring now to the drawings, a fiber fleece is built up by laying upon one another, for instance, four thin carded webs 11, 12, 13, and 14 of fine, polyposed fibers. Adjacent webs are disposed at an angle to each other. The resulting multi-layer material, containing fibers which are polyposed or arranged in a plurality of intersecting or random directions, is passed between heated rollers 15 and 16, where it is compressed to form a light, loosely coherent fleece 17. Simultaneously, the fleece is stretched lengthwise.

A foam of a liquid binder material, such as rubber latex, is produced in a foam trough 18, and successive quantities of foam are pushed by blades 19 mounted on an endless conveyor 20 over the edge of the foam trough 18 and caused to drop on the upper surface of the fleece 17. As the fleece 17 travels on, the foam is spread uniformly on the surface of the fleece 17 by means of a doctor blade 21. The fleece, now carrying on its upper surface a very light surface coating of foamy binder material, is next passed through a drier chamber 22, where the foam is caused to collapse and to solidify in very thin, filmy particles, thus producing a light surface cohesion on one side of the travelling fleece without appreciable loss of porosity. The pretreated fleece 17 is next passed over a guide roller 23, and hence over one of a pair of pressure rollers 24, 25 in such a way that the pretreated surface of the fleece travels in contact with the surface of the roller 24.

Additional latex foam 26 is placed on the untreated surface of the fleece in the nip of the two rollers 24, 25 and is pressed into the fleece at a predetermined pressure as the fleece traverses the constricted passage between the two rollers. The pressure exerted by the pres-

sure rollers 24, 25 upon the foam and the fleece is regulated to cause a complete and uniform penetration of the fleece by the foam, with incorporation into the fleece of a predetermined quantity of solid binder material. Due to the pressure of the rollers 24, 25, some of the foam cells are destroyed and the fleece is condensed to a part of its original thickness, while numerous, relatively large interstices in the plane of the resulting sheet are still maintained between the fibers. The impregnated fleece runs partly around the second pressure roller 25 and then re-enters the drying chamber 22, where it is guided over rollers 26 and 27. During the drying operation, which takes place without any substantial pressure, the remaining foam cells collapse and the solid binder material, contained in the foam and in the liquid forming the foam, is precipitated in the form of small, filmy particles on the fibers of the fleece and mainly at the crossing points between adjacent fibers without filling the interstices between the fibers. The completed fleece is guided out of the drying chamber 22 over a roller 28 and wound upon a reel 29. During the transportation of the material through the several impregnating and drying stages, it undergoes a further longitudinal stretching of about 19 to about 100% of its original length with a corresponding reduction in fiber weight per m.² of about 16% to 50%.

In the embodiment of the invention in which isoelastic sheet material is produced, the binder pressed into the fleece in the form of a foam is a vulcanizable or prevulcanized elastic binder material, such as rubber latex, and the impregnated sheet material may subsequently be treated as shown in Fig. 2. The reels 29 containing the impregnated sheet material are placed in a vulcanizing chamber 30, which may be heated and in which they remain until a substantially complete vulcanization of the elastic binder without pressure has taken place. Next, the sheet material on each reel 29 may be passed through a calendar 31 and then wound up again on a reel 32. From each reel 32 the sheet material is passed to a washing trough 33, in which wetting agents and other water soluble materials carried into the sheet with the latex foam are washed out.

Due to the fact that substantial proportions of wetting agents are deposited, in my foam impregnating process, on and in the fibers and then washed out again after solidification of the binder particles, the fibers, cemented together by the binder particles, remain pliable and soft, and the resulting sheet material has a soft, fabric-like hand and adapts itself readily to any desired form or shape.

After the washing out of the water-soluble materials, the sheet material may be advanced, if desired after an intermediate drying, through an impregnating bath 34 containing, for instance, an emulsion of paraffin which may contain additional materials adapted to impart to the product such desirable properties as water repellency and the like. The sheet material leaving the bath 34 is pressed out, passed through a drier 35, and again wound upon a reel 36. The reel 36 may finally be placed into another vulcanization chamber 37 to insure complete vulcanization of all the vulcanizable binder material.

As seen in Figs. 3 and 4, the sheet material obtained by the process according to the invention consists of an open skeleton of intermingled, fine, cardable fibers 38 arranged in planes substantially parallel to the general plane of the sheet, but within each plane in a plurality of intersecting directions, said skeleton having uniformly distributed therethrough and adhering to the fibers 38, filmy, lamella-shaped particles 39 of a flexible, solid binder material, cementing adjacent fibers together in the region of their crossing points with preservation of numerous relatively large interstices 40 between the fibers. As seen particularly in Fig. 3, these interstices 40 have the form of flat pores extending substantially in planes parallel to the general plane of the sheet and communicating with one

another to provide tortuous air passages 41 transversely through the sheet. The finished sheet material according to the present invention has a thickness of about 0.14 to 1.5 mm. and a weight of about 45 g. to about 400 g. per m.² and contains about 25% to about 60% by weight of solid binder material. Expressed differently, about 40% to about 75% of the weight of the sheet is made up of the fibers plus any additives, and since these additives may constitute up to about 10% the limits for the weight of the fiber are approximately from about 30% to about 75%.

The following examples may serve to illustrate the invention:

Example 1

A fiber mixture is prepared of fine, cardable fibers as follows:

	Parts by weight
Wool	45
Human hair	10
Camel hair	10
Cotton	15
Rayon	20

The mixture is formed into webs consisting of intermingled, polyposed fibers, each web having a thickness of about 0.4 mm. and weighing about 30 g. per m.². Six such webs are laid loosely on top of one another and the resulting multi-layer structure is passed between heated rollers with pressure and slight longitudinal stretching to produce a fleece having a thickness of about 2 to 5 mm. and weighing about 170 g. per m.².

A foam comprising about 10 volume parts of air for each volume part of liquid is formed from a dispersion containing about 9.5% of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadienestyrene polymer (60%)	167	100
Softened water	812	
Sodium-isobutylene-naphthalene sulfonate	30	30
Ultra-vulcanization accelerator dispersion (zinc dimethyl dithiocarbamate) (20%)	5	1
Zinc oxide dispersion (40%)	15	6
Sulphur dispersion (25%)	10	2.5
Antioxidant (phenyl-alpha-naphthylamine) (50%)	2.4	1.2
	1,041.4	

The foam is spread uniformly on one surface of the fleece and dried to deposit about 6 parts by weight of binder per 100 parts by weight of fibers thus producing a light surface cohesion (10 g. per m.²).

For the subsequent through impregnation of the fleece, a foam carrying about 5 volume parts of air per volume part of liquid is prepared from a dispersion comprising about 33 1/3% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadienestyrene polymer (60%)	167	100
Softened water	86	
Sodium-isobutylene-naphthalene sulfonate	15	15
Ultra-vulcanization accelerator dispersion (zinc dimethyl dithiocarbamate) (20%)	5	1
Zinc oxide dispersion (40%)	15	6
Sulphur dispersion (25%)	10	2.5
Antioxidant (60%)	2	1.2
	300	

This foam is pressed into the untreated surface of the fleece by means of pressure rollers to obtain a substantially complete and uniform penetration of the fleece with partial destruction of the foam and incorporation into

the fleece of about 50 parts (solid weight) of binder material per 100 parts, by weight, of fiber.

The impregnated sheet is then stabilized by passing it through a drying chamber heated to about 80 to 120° C. During drying, which may cause more or less complete vulcanization of the binder material, the remaining foam cells collapse and the solid binder material precipitates on the fibers in the form of small, filmy particles which collect mainly at the crossing points of adjacent fibers and cement the fibers firmly together with retention of numerous, relatively large, flat pores in the sheet formed. During its movement through the several impregnating and drying stages, the material undergoes a further longitudinal stretching by about 25% beyond the original length of the fleece, accompanied by a reduction in the weight of fibers per m.² of about 20%.

After drying, the sheet may be further vulcanized at an elevated temperature for a sufficient length of time to effect substantially complete vulcanization of the filmy binder particles. The sheet may then be calendered with light pressure to give it a surface finish, and subsequently the sheet material is passed through warm or hot water, to wash out the wetting agents and any other water soluble components carried into the material by the latices. Finally the sheet is dried.

Example 2

The sheet material obtained in accordance with Example 1 is subjected to an after-treatment with water repellent lubricants by passing the material at a temperature of 50° C. through an impregnating bath containing a 15% paraffin emulsion and aluminum tri-formate. The sheet is then dried in a suitable drier and may eventually be subjected to another vulcanization.

The resulting sheet material has a thickness of about 0.8 mm. and weighs approximately 210 g. per m.². It is shrink-proof and air permeable, but water repellent and consists of a skeleton of polyposed fibers cemented together at their crossing points by flexible binder particles, with relatively large interstices in the form of flat pores extending mainly in planes parallel to the main plane of the sheet. It contains about 60%, by weight, of fiber material, about 35%, by weight, of solid binder material, and about 5% by weight of paraffin.

The finished sheet material is soft and pliable and has shearing resistance in all directions and practically complete isoelasticity, that is, uniform, resilient resistance to creasing or folding in any direction. It can be cut at any desired angle and along any selected lines without danger of ravelling at the cut edges, and it can be stitched, padded or sewed on fast running machines without undesirable heating up of the needles. The material is suitable as stiffener material for garments, particularly for use in combination with an outer fabric and an inner lining as a stiffening or as a cold and dust protecting interlining, as described and claimed specifically in my U. S. patent application Ser. No. 262,944, filed December 23, 1951, which is a continuation-in-part application of my copending U. S. patent application Ser. No. 102,423, filed on June 30, 1949.

Example 3

A fiber mixture is prepared, containing 50% by weight of wool, 30% by weight of wool comber waste and 20% by weight of torn cotton.

This mixture is formed into loose webs having a thickness of about 0.6 mm. and weighing about 26 g. per m.². Six such webs are laid on top of one another and the resulting multi-layer structure is passed between heated rollers with pressure and little longitudinal stretching to produce a fleece weighing about 145 g. per m.².

A foam comprising about 12 parts of air for each part of liquid is formed from a dispersion containing about

7.5% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Natural rubber latex (60%)	125	75
Softened water	825	
Wetting agent	15	15
Ultra-vulcanization accelerator dispersion (10%)	10	1
Zinc oxide dispersion (40%)	12	5
Sulphur dispersion (30%)	10	3
Antioxidant (40%)	3	1.2
	1,000	

The foam is spread uniformly on one surface of the fleece and dried to deposit about 4 parts by weight of rubber per 100 parts by weight of fibers, thus producing a light surface cohesion, as described in Example 1.

A foam is then prepared to comprise about 2 volume parts of air per volume part of liquid from a dispersion containing about 40% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadienestyrene polymer (60%)	200	120
Softened water	56	
Wetting agent	6	6
Ultra-vulcanization accelerator dispersion (20%)	6	1.2
Zinc oxide dispersion (50%)	20	10
Sulphur dispersion (40%)	10	4
Antioxidant (65%)	2	1.3
	300	

This foam is pressed into the untreated surface of the fleece, as described in Example 1, with incorporation into the fleece of about 100 parts (solid weight) of binder material per 100 parts, by weight, of fibers. The thickness of the sheet is simultaneously reduced to about 1.2 mm. The impregnated sheet is dried under moderate heat without pressure to cause precipitation of small, filmy particles of binder material mainly at the crossing points of adjacent fibers and the sheet is then vulcanized without pressure, calendered, washed and dried. During the passage through its various impregnating and drying stages the material is stretched by about 25% beyond the length of the original fleece and its fiber weight per m.² is reduced by about 20%.

The resulting sheet may be given an after treatment substantially as described in Example 2 with an 8% paraffin emulsion. The finished sheet material has a thickness of about 1.0 mm. and weighs approximately 240 g. per m.². It contains about 48%, by weight, of fiber material, about 50%, by weight, of solid rubber, and about 2%, by weight, of paraffin. The sheet material may be used for the same purposes as the material described in Examples 1 and 2.

Example 4

A fiber mixture is prepared of fine cardable fibers as follows:

	Per cent by weight
Cotton	30
Ramie	30
Spun rayon	40

The mixture is formed into webs consisting of intermingled, polyposed arranged fibers, each web having a thickness of about 0.15 mm. and weighing about 15 g. per m.². Three webs are placed on top of one another. After pressing of the multi-layer structure between heated rollers, a fleece is obtained weighing about 40 g. per m.².

A foam comprising about 9 volume parts of air for each volume part of liquid is formed from a dispersion

containing about 8% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Polyvinyl chloride emulsion (40%)	250	100
Softened water	982	
Wetting agent	18	18
	1,250	

The foam is spread uniformly on one surface of the fleece and dried to deposit about 15 parts by weight of solid binder material per 100 parts by weight of fibers, thus producing a light surface cohesion.

Next, the fleece is treated by pressing into its opposite untreated surface a foam comprising about 7 volume parts of air per volume part of liquid and prepared from a dispersion containing about 25% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Polyvinyl chloride emulsion (40%)	100	40
Polymethylmethacrylate emulsion (40%)	200	80
Wetting agent	10	10
Softened water	170	
	480	

About 35 parts by weight of binder material are incorporated into the fleece per 100 parts by weight of fiber. The material is then dried without pressure by passing it through a drying chamber, washed in cold water and dried again.

The resulting sheet material has a thickness of about 0.14 mm. and a weight of about 45 g. per m.². Its length exceeds that of the original fleece by about 33 1/3% of the starting length, while its fiber content per m.² is about 25% less than that of the starting fleece. The material contains about 33 1/3% by weight of solid thermoplastic binder material. It is shrink-proof, air and water-permeable and can be adhered to other fabrics by hot ironing. It constitutes a suitable stiffening material for shirt collars and cuffs and other washable garments, such as blouses, as described specifically in my U. S. patent application Ser. No. 262,945 filed December 23, 1951, which is a continuation-in-part application of my copending U. S. patent application Ser. No. 102,423, filed on June 30, 1949.

Example 5

A fiber mixture is prepared of 80% wool and 20% acetate fibers and formed into webs consisting of intermingled polyhosed fibers, each web having a thickness of about 0.1 mm. and weighing about 5 g. per m.². Thirty such webs are laid loosely upon one another and then combined by pressure and heat into a multi-layer fleece weighing about 135 g. per m.².

A foam comprising about 10 volume parts of air for each volume part of liquid is formed from a binder dispersion containing about 9% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadiene acrylonitrile polymer dispersion (40%)	125	50
Butadienestyrene polymer dispersion (58%)	86	50
Softened water	689	
Methylcellulose (10%)	30	3
Sodium lauryl sulfonate solution (wetting agent) (50%)	140	70
Ultra-vulcanization accelerator dispersion (25%)	6	1.5
Zinc oxide dispersion (50%)	20	10
Sulphur dispersion (50%)	4	2
	1,100	

The foam is spread uniformly on one surface of the fleece and dried to deposit about 5 parts by weight of solid binder material per 100 parts by weight of fibers, thus producing a light surface cohesion.

Thereafter, a foam comprising about 5 volume parts of air per volume part of liquid is pressed into the opposite untreated surface of the fleece. This foam is prepared from a dispersion containing about 22.5% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadieneacrylonitrile polymer dispersion (40%)	125	50
Butadienestyrene polymer dispersion (58%)	86	50
Sodium-isobutylene-naphthalene solution (wetting agent) (60%)	100	60
Soapflake solution (33%)	3	1
Softened water	108	1.5
Ultra-vulcanization accelerator dispersion (25%)	6	10
Zinc oxide dispersion (50%)	20	2
Sulphur dispersion (50%)	4	
	452	

About 95 parts by weight of solid binder material are incorporated into the fleece per 100 parts by weight of binder. The material is then dried and vulcanized without pressure by passing it through a heated chamber, then washed and dried again. During the several impregnating stages the material is stretched longitudinally by about 22.5% and its fiber weight per m.² is reduced by about 18.5%.

The resulting sheet material has a thickness of about 1.2 mm. and a weight of about 220 g. per m.². It contains about 50% by weight of binder solids. It is shrink-proof, air-permeable and possesses extraordinary isoelectricity. It may be used as a dust-proofing and form-preserving interlining, particularly in men's overcoats.

Example 6

A fiber mixture containing 15% by weight of wool, 40% by weight of spun rayon and 35% by weight of superpolyamide fibers (nylon) is formed into webs having a thickness of about 1.2 mm. and weighing about 28 g. per m.². Two such webs are combined at an angle of about 45 degrees relative to each other with pressure and stretching into a fleece having a weight of about 50 g. per m.².

A foam containing about 10 volume parts of air per each volume part of liquid is formed from a 15% latex dispersion having the following composition:

	Liquid Weight, parts	Solid Content, parts
Natural rubber latex (ca. 40%)	190	76
Wetting agent	10	10
Colloidal sulphur	2.2	2.2
Zinc oxide	3.8	3.8
Accelerator	1	1
Antioxidant	1	1
Softened Water	292	
	500	

The foam is spread thinly and uniformly on both surfaces of the fleece and dried to precipitate about 14 parts by weight of binder per about 100 parts by weight of fibers, thus producing surface cohesion on both sides of the fleece. About 3.5 g. of binder solids per m.² are deposited on each surface of the sheet.

The fleece is then treated by pressing through both pretreated surfaces thereof into the fleece a foam having the same composition as that used for the preceding surface treatment. About 20 parts by weight of binder

material (solid) are incorporated into the fleece per 100 parts by weight of fibers.

After drying and vulcanization, both effected without pressure, followed by washing and drying, the resulting sheet material has a thickness of about 0.6 mm. and a weight of about 56 g. per m.². Its length exceeds that of the starting fleece by about 19% and its weight of fibers per m.² is about 16% less than that of the original fleece. The final sheet material contains about 25%, by weight, of solid binder material.

Example 7

Pure white acetate fibers are formed into webs having a thickness of about 0.9 mm. and weighing about 35 g. per m.². Eight such webs are combined by laying adjacent webs at angles to each other into a fleece, which after passage between heated rollers has a thickness of about 1-2 cm. and a weight of approximately 260 g. per m.².

A foam containing about 10 parts of air for each part of liquid is formed from a 12% dispersion of butadiene acrylonitrile polymer in water containing about 2.4% by weight of a wetting agent and small quantities of vulcanizing agent, vulcanization accelerator and foam stabilizer. The foam is spread uniformly on one surface of the fleece and dried to deposit about 3 parts by weight of binder solids per 100 parts by weight of fibers (about 7.8 g. per m.²), thus producing a light surface cohesion.

Subsequently, the fleece is through impregnated by pressing into its opposite untreated surface a foam containing about 3 volume parts of air per volume part of liquid. This foam is prepared from a dispersion containing 28% by weight of synthetic solid rubber and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Chloroprene latex (60%)	100	60
Paraffin emulsion (30%)	25	7.5
Wetting agent	9	9
Ultravulcanization accelerator in dispersion (20%)	3	0.6
Zinc oxide dispersion (40%)	17	7
Sulphur dispersion (20%)	5	1
Methyl cellulose (foam stabilizing agent) (50%)	2	1
Softened water	54	
	215	

About 63 parts by weight of solid binder material are incorporated into the fleece by 100 parts by weight of fibers.

The impregnated sheet is dried and vulcanized, then washed and dried again, all without any pressure.

During the various impregnating and drying stages, the material is stretched longitudinally by about 27% beyond the length of the original fleece with a corresponding reduction in fiber weight per m.² by about 21.5%.

The resulting sheet has a thickness of 1.5 mm., weighs about 400 g. per m.² and contains about 40% by weight of solid elastic binder material and 10% by weight of paraffin.

Example 8

A fiber mixture is prepared from 10% by weight of wool, 40% by weight of cotton, 25% by weight of spun rayon and 25% by weight of superpolyamide fibers.

The mixture is formed into loose webs having a thickness of 0.35 mm. and weighing 23 g. per m.². Six such webs are placed crosswise on top of one another and the resulting multi-layer structure is condensed with heat and pressure to produce a fleece weighing about 130 g. per m.².

A foam comprising about 11 parts of air for each part of liquid is formed from a dispersion containing about

10% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadiene styrene polymer (60%)	167	100
Softened water	773	
Wetting agent	30	30
Sulphur dispersion (25%)	10	2.5
Zinc oxide dispersion (40%)	15	6
Ultra-vulcanization accelerator dispersion (20%)	5	1
	1,000	

The foam is sprayed uniformly on one surface of the fleece and dried to deposit about 10 parts by weight of solid binder particles per 100 parts by weight of fibers thus producing a light surface cohesion, due to the precipitation of about 11.3 g. of binder solids per m.² of fleece surface.

A foam is then prepared comprising about 5 volume parts of air per volume part of liquid, the latter being a dispersion containing about 37½% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadiene styrene polymer (60%)	167	100
Polyvinylidene chloride (50%)	300	150
Polyvinyl acetate (60%)	208	125
Wetting agent	28	28
Sulphur dispersion (25%)	10	2.5
Zinc oxide dispersion (40%)	15	6
Ultra-vulcanization accelerator dispersion (20%)	5	1
Softened water	267	
	1,000	375

This foam is pressed into the untreated surface of the fleece to obtain a uniform penetration of the fleece with partial destruction of the foam. About 140 parts by weight (solid) of binder substances are incorporated per 100 parts by weight of fibers. The impregnated sheet is then dried by passing it through a drying chamber, thus causing collapse of the remaining foam cells and precipitation of the solid binder material on the fibers in the form of small filmy particles cementing the fibers firmly together at the crossing points with retention of numerous, relatively large, flat pores. After drying, the sheet is vulcanized without pressure at an elevated temperature for a sufficient length of time to effect substantially complete vulcanization of the vulcanizable ingredients. Finally, the sheet is washed at low temperature and carefully dried.

The sheet material obtained is suitable as interlining for shirt collars and the like. Its length exceeds that of the original fiber fleece by about 35%, while its fiber weight per m.² is about 26% less than that of the starting fleece. It has a thickness of 0.5 mm. and weighs approximately 240 g. per m.². It is air- and water-permeable and contains about 40% by weight of fiber material and about 60% by weight of solid binder material.

Example 9

A fiber mixture is prepared from 80% by weight of synthetic protein fibers and 20% by weight of cotton fibers.

The mixture is formed into loose webs having a thickness of 0.25 mm. and a weight of 22 g. per m.².

Twenty such webs are placed at an angle on top of one another and the resulting multilayer structure is condensed with heat and pressure and slight longitudinal stretching to produce a fleece weighing about 400 g. per m.². This fleece is passed in a continuous system at a comparatively high speed through the following impregnating stages:

In the first stage, a foam comprising about 10 parts of air for each part of liquid and formed from a dispersion containing about 10% by weight of binder solids is spread uniformly on one surface of the fleece. The binder dispersion has the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadiene acrylonitrile polymer dispersion (40%)	250	100
Sodium lauryl sulfonate solution (wetting agent) (50%)	80	40
Ultra-vulcanization accelerator dispersion (25%)	6	1.5
Zinc oxide dispersion (50%)	10	5
Sulphur dispersion (50%)	6	3
Antioxidant dispersion (50%)	4	2
Softened water	644	
	1,000	

On drying, about 3 parts by weight of solid binder material are deposited per 100 parts by weight of fibers (about 12 g. per m.²), thus producing a light surface cohesion.

In the second impregnating stage, a foam comprising about 3 volume parts of air per volume part of liquid is pressed into the opposite untreated surface of the fleece. This foam is prepared from a dispersion containing about 30% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Butadiene acrylonitrile polymer dispersion (50%)	300	150
Sodium isobutylene naphthalene solution (wetting agent) (60%)	150	90
Ultra-vulcanization accelerator dispersion (25%)	8	2
Zinc oxide dispersion (50%)	16	8
Sulphur dispersion (50%)	6	3
Antioxidant dispersion (50%)	4	2
Softened water	16	
	500	

About 72 parts by weight of solid binder material are incorporated into the fleece per 100 parts by weight of fibers. The material is then dried and vulcanized without pressure by passing it through a heated chamber, then washed and dried again. During the various impregnating and drying stages prior to the vulcanization of the binder, the material undergoes a longitudinal stretching to about twice the length of the original fleece and, correspondingly, the fiber content of the material is reduced by about 50% by weight.

The resulting sheet material has a thickness of about 1.2 mm. and a weight of about 350 g. per m.². It contains about 43% by weight of vulcanized binder solids. It is shrink-proof, air permeable and isoelectric. It has a fabric-like soft hand and is suitable as a heavy duty, warm interlining, affording excellent wind protection.

Example 10

A fiber mixture is prepared from 60% by weight of spun rayon, 20% by weight of ramie and 20% by weight of polyacryl fibers.

The mixture is formed into loose webs having a thickness of 0.3 mm. and a weight of 25 g. per m.².

Twelve such webs are placed at an oblique angle on top of one another and the resulting multi-layer structure is condensed with heat and pressure and slight longitudinal stretching to produce a fleece weighing about 280 g. per m.².

This fleece is treated by spreading on one surface thereof a foam comprising about 10 parts of air for each part of liquid, said foam being formed from a dispersion

13

containing about 8% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Polyacrylonitrile dispersion (40%)	200	80
Sodium lauryl sulfonate solution (wetting agent) (50%)	10	5
Softened water	790	
	1,000	

On drying, about 3 parts by weight of solid binder material are deposited per 100 parts by weight of fibers (about 8.4 g. per m.²), thus producing a light surface cohesion.

In the through impregnating stage, a foam comprising about 2 volume parts of air per volume part of liquid is pressed into the opposite untreated surface of the fleece. This foam is prepared from a dispersion containing about 25% by weight of binder solids and having the following composition:

	Liquid Weight, parts	Solid Content, parts
Softened polystyrene dispersion (made from 100 parts by weight polystyrene and 25 parts by weight dioctylphthalate) (50%)	250	125
Sodium lauryl sulfonate solution (wetting agent) (50%)	30	15
Titanium dioxide dispersion (50%)	10	5
Softened water	210	
	500	

About 40 parts by weight of solid binder material are incorporated into the fleece per 100 parts by weight of fibers. The material is then dried without pressure by passing it through a chamber heated to 120° C. for 50 minutes, and thereafter lightly calendered, washed and dried again. During the various impregnating stages the material undergoes a longitudinal stretching by about 82% of the original length of the fleeces and the fiber content per m.² is reduced about 45% by weight.

The resulting sheet material has a thickness of 0.8 mm. and a weight of about 224 g. per m.². It contains about 30% by weight of thermoplastic binder solids and about 1.5% by weight of titanium dioxide, it is shrink-proof, air- and water-permeable, and form-holding. It is suitable as a strong interlining for sport shirts, work blouses and the like.

It should be understood that the foregoing examples are not intended to limit the scope of my invention, and that various modifications and changes are possible within this scope.

What I claim is:

1. A fabric-like, porous, air-permeable, flexible sheet material consisting of an open skeleton of intermingled, fine, cardable polyposed fibers, said skeleton having substantially uniformly distributed therethrough and adhering to the fibers filmy particles of a flexible, solid binder material, cementing adjacent fibers together and being disposed primarily in the region of the crossing points of the fibers with preservation of numerous, relatively large interstices the majority of which are in the form of flat pores extending substantially in planes parallel to the general plane of the sheet, said fibers constituting about 30% to about 75% of the total weight of said sheet, the balance of said sheet consisting essentially of said binder.

2. A fabric-like, porous, air-permeable, substantially isotropic sheet material consisting of an open skeleton of intermingled, fine cardable fibers arranged in a plurality of intersecting directions, said skeleton having substantially uniformly distributed therethrough and adhering to the fibers, solid, filmy particles of an elastic rubbery binder material cementing adjacent fibers together and

14

being disposed primarily in the region of the crossing points of the fibers with preservation of numerous, relatively large interstices the majority of which are in the form of flat pores extending substantially in planes parallel to the general plane of the sheet, said fibers constituting about 30% to about 75% of the total weight of said sheet, the balance of said sheet consisting essentially of said rubbery binder.

3. A fabric-like, porous sheet material as claimed in claim 2, in which the elastic rubbery binder material is selected from the group consisting of the natural and synthetic rubbers.

4. A fabric-like, porous sheet material as claimed in claim 2, wherein at least 15% by weight of said fibers are composed of elastic fibers.

5. A fabric-like, porous sheet material as claimed in claim 2, having incorporated therein about 2% to about 10% by weight of a water-repellent permanent lubricant selected from the group consisting of wax and paraffin.

6. A fabric-like, air-permeable, flexible sheet material having crease resistance and consisting of an open skeleton of intermingled, fine, cardable polyposed fibers, said skeleton having substantially uniformly distributed therethrough and adhering to the fibers filmy particles of a flexible, solid binder material cementing adjacent fibers together and being disposed primarily in the region of the crossing points of the fibers, said sheet material having a thickness equal to about 0.14 to 1.5 millimeters with adjacent fibers being relatively closely packed transversely of the plane of the sheet and relatively widely spaced in the plane of the sheet, the interstices between adjacent fibers being substantially unobstructed by the solid binder particles, said fibers constituting about 30% to about 75% of the total weight of the sheet, the balance of said sheet consisting essentially of said binder.

7. A fabric-like, air-permeable, substantially isotropic sheet material having crease resistance and consisting of an open skeleton of intermingled, fine, cardable, polyposed fibers arranged in a plurality of intersecting directions, said skeleton having substantially uniformly distributed therethrough and adhering to the fibers filmy particles of an elastic rubbery binder material cementing adjacent fibers together and being disposed primarily in the region of the crossing points of the fibers, said sheet material having a thickness equal to about 0.14 to 1.5 millimeters with adjacent fibers being relatively closely packed transversely of the plane of the sheet and relatively widely spaced in the plane of the sheet, the interstices between adjacent fibers being substantially unobstructed by the solid binder particles, said fibers constituting about 30% to about 75% of the total weight of the sheet, the balance of said sheet consisting essentially of said binder.

8. An unwoven, porous, air-permeable, flexible, isotropic, resilient sheet having a thickness of from about 0.14 to about 1.5 millimeters and a weight of about 45 to about 400 grams per square meter, said sheet consisting of an open skeleton composed of a plurality of superposed layers with adjacent layers arranged at an angle relative to each other and each layer being formed of fine, cardable fibers, about 25% to about 60% by weight of said sheet consisting of an elastic binder provided in the form of filmy particles cementing said fibers together in the region of their crossing points while maintaining the polyposed arrangement of said fibers without affecting the porosity of said sheet.

9. A fabric-like, porous, air- and water-permeable, crease-resistant, non-woven sheet material consisting of an open skeleton of intermingled, fine, cardable, polyposed fibers, said skeleton having substantially uniformly distributed therethrough and adhering to the fibers, solid, filmy particles of thermoplastic synthetic resin binder material cementing adjacent fibers together and being disposed primarily at the crossing points of the fibers, said sheet material having a thickness equal to about 0.14 to

15

0.8 millimeter with adjacent fibers being relatively closely packed transversely of the plane of the sheet and relatively widely spaced in the plane of the sheet, the interstices between adjacent fibers being substantially unobstructed by the solid binder particles, said fibers constituting about 30% to about 75% by weight of the total weight of the sheet, the balance of said sheet consisting essentially of thermoplastic synthetic resin binder material.

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