

UNITED STATES PATENT OFFICE

2,455,534

RETICULATED STRUCTURE AND METHOD
OF MAKING THE SAMEAnselm Talalay, New Haven, Conn., assignor to
The Sponge Rubber Products Company, Shel-
ton, Conn., a corporationNo Drawing. Application January 26, 1946,
Serial No. 643,822

4 Claims. (Cl. 154-101)

1

This invention relates to fibrous material in open-mesh or reticulated form and comprising a binder such as rubber or the like which anchors at least some of the fibers to each other at their crossing positions and also provides an elastic sheath or coating for individual fibers, and to procedure for the manufacture of such products.

Such products have various uses, including air-filtering, heat insulation and others, but they are chiefly important as cushioning material and especially in the field of furniture upholstering and similar uses.

Heretofore it has been known to rubberize hair, such as "curled" hog hair, in open mesh form, as by spraying or dipping or both, and also to produce a fiber-reinforced sponge-like material by causing a dispersion of rubber or the like to extend itself by foaming into the interstices of an open mesh body of hair.

In such procedures, however, with hair or its equivalent as the fibrous material, the range of physical properties and mechanical characteristics in the product has been limited by the character of the fibrous material.

My chief object is to provide new products having desirable characteristics such as are not obtainable in the employment of hair as above referred to, and especially to provide a cushioning material combining extremely light weight with some or all of the advantages of strong cushioning resistance, durability under conditions of use such as those of a furniture cushion, for example, and effectiveness as a vibration-damping material.

I find that I can attain these objects with results of quite a different order from those attained in the use of even curled hair, by employing, with suitable procedural steps, natural sheep's-wool or its equivalent, as the fibrous material.

One example of the wide divergence of my invention from the prior art is that, without using any blowing agent in, or foaming or frothing of, the binder, but by simpler and less expensive steps, I obtain an integral cushioning body, extensive and of closely similar structure in each of the three dimensions, which has characteristics closely comparable to those of a fiber-reinforced sponge rubber, but with even lighter weight for a given cushioning resistance, durability, or shock absorbing property.

In the preferred procedure for the practice of my invention the fibrous material, which may be either virgin or reprocessed wool or the like, is

2

picked on a standard textile picker and then carded out on the usual type of carding machine, to produce a very thin and open-mesh web.

The web or a small number of superimposed webs, is then sprayed with rubber latex or the like from one side and dried and then from the other side and dried, the drying preferably being effected by passing the web under a hot air blast. Next the web is dipped in a dilute latex or like dispersion, the surplus liquid is allowed to drain off and the web is again dried.

The resulting web material is then plied up in a multiplicity of layers, a latex or other suitable cement being used for adhesion of the laminations to one another, and in this way the structure can be built up to any desired thickness.

The integrated mass is then treated to cause the binder to set, as by vulcanization in the case of rubber latex, and in such treatment the material can be subjected to suitably light molding pressure, either between flat plates to produce a slab of even thickness or in a contoured mold for producing desired shapes.

Because of the three-dimensional character of the kinks of the wool or the like, in conjunction with the use of the adhesive, striation is hardly observable in a cross-section of the product, and the mass has pronouncedly open-mesh structure in all three of the dimensions, with the binder evenly distributed upon the fibers.

The remarkable properties of the product are strikingly brought out by comparison with foam rubber, which has a theoretically desirable structure or geometrical arrangement of the substance but has limitations in that it can not be made commercially lighter than about $4\frac{1}{2}$ pounds per cubic foot because at lighter weight it is subject to collapse during the jelling step and when produced in lighter weight its strength against distortion is inadequate for supporting necessary loads.

As an example, a piece of neoprene foam of 2.8 lbs. per cu. ft. was found to have a 50% compression resistance of only .075 lb. per sq. in., whereas a sample of my product weighing only $2\frac{1}{2}$ lbs. per cu. ft. had 50% compression resistance of about 0.5 lb. per sq. in., with a ratio of rubber to fiber of 3 to 1, being thus suitable for use as an overlay pad on a spring case of an automobile seat or of an inner-spring mattress, in spite of its extremely low weight.

The surprising new results obtained are in my opinion due, with suitable procedure applied, to one or more of several characteristics of the wool or the like in which such materials differ

widely from the hair or the like which has heretofore been used, as follows:

1. Natural wool has a filament diameter of about 0.0006" to 0.001" as compared with about 0.005" to 0.007" for cattle or hog hair.

2. The average number of waves or kinks per linear inch of wool is in the neighborhood of 15 to 25 per inch as compared with perhaps 1 to 3 for even "curled" animal hair.

3. The density of wool is about 1.30 as compared with about 1.15 for hair.

4. Considering the action of a rubberized filament of wool or of hair as being analogous to that of a coil spring, the ratio of filament diameter to "coil" diameter is less in the case of wool than in the case of hair, and because of that, and because of the large number of "kinks" per inch, the strain in the wool filament, and in its coating, is less than in the case of rubberized hair, assuming proportionate, evenly distributed coatings in the two cases, so that the coated wool is the less subject to fatigue. At the same time, because of the fineness of the wool and of its kinks, and because of the three-dimensional character of the kinks in an individual wool fiber, a mass of the bonded wool product has, as a whole, a strong resistance to compressive forces in relation to its total weight, suitable procedure having been employed for providing a uniform disposition of the binder.

5. Wool is a highly elastic substance, having an elongation at break as high as 30% or even 50%, which puts it in a range quite different from that of hair.

6. Wool presents, per pound, a vastly greater surface area for reception of the binder than hair does, so that it can receive, without the irregularity of distribution which results from over-loading, a larger amount of the binder, which is important for obtaining the desired characteristics in the product without excessive weight.

Assuming the following,

Density of wool=1.30

Density of hair=1.15

Mean diameter of wool=0.001"

Mean diameter of hair=0.006"

one pound of wool will be represented by a single filament 26.5×10^6 in. long, with a surface area of 83,000 sq. in. and one pound of hair by a filament 0.845×10^6 in. long with a surface area of 15,900 in.².

The surface area available for deposition of rubber is thus in the ratio of at least 5 to 1. This is important for the production of a permanently elastic rubberized fiber space lattice. It was found that at a given total density of rubberized material, say 3 pounds per cubic foot, the lasting properties of the material are directly in relation to the ratio of (evenly distributed) rubber to fiber. That is to say, a material made up of 2 lbs. rubber and 1 lb. of fiber (ratio 2:1) is a more permanently elastic body than one containing $1\frac{1}{2}$ lbs. of each (ratio 1:1) and a material having $2\frac{1}{2}$ lbs. rubber and $\frac{1}{2}$ lb. fiber (ratio 5:1) even surpasses the material with the ratios 3:1 or 4:1. This is conditional upon the ability to distribute the rubber evenly throughout. Normal rubberized hair has a fiber to binder ratio of about 1:1. When we attempt to deposit more rubber on the hair, the deposition becomes discontinuous, i. e. globules and droplets (beads) are formed along the fibers. Thicker coats are no substitute for a greater number of rubber-sheathed strains.

A close-mesh space lattice has yet another ad-

vantage from the standpoint of an upholstery material. It was found that the vibration damping properties of a reticulated material improve rapidly as the mesh size is reduced.

7. The wool-reinforced product has a physical structure in which the numbers of bonds between fibers is of a different order from that of the open-mesh rubberized fibrous materials of the prior art. For analogy, the bonded wool product can be considered as substantially a macroscopic model of a rubber molecule, which, according to modern teachings, is made up of more or less coiled or kinked chains held together at selective points by cross linkages. The coiled molecules are represented by the kinked wool filaments and the linkages by latex bonded points.

An attempt can easily be made to calculate the number of "cross-links" in my product as compared to a comparable weight and volume of rubberized hair.

Assuming in each instance that one pound of fiber is evenly distributed in one cubic foot of space, and that one third of all filaments run along the x, the y, and the z axis, we find that 30,000 times as many cross links can be expected in any given volume of my material as compared with rubberized hair.

8. Each of the three wetting-and-drying operations pronouncedly increases the thickness of the web, and these successive increases of thickness apparently are not merely the result of the addition of bonding material to the faces of the web but apparently are in large measure due to an increase of the three-dimensional kinkiness of the wool fibers, effected by the wetting and drying steps, uneven shrinkage of the binder as it dries possibly being a factor. Another possible factor is that in bonding the fibers one to another at their crossing positions the liquid dispersion may space them apart at those positions by being drawn in between them by capillary attraction, and this factor may be large by reason of the very large number of such crossing positions in wool or the like.

Whatever the reasons may be, these increases of the thickness of the web are pronounced and, as they are cumulative, the web thickness in the final, laminated product is usually two or more times the original thickness of the untreated web.

Because of the thickening of the webs in the successive wetting-and-drying operations, a cushion of appropriate thickness can be built up by the stacking up of a comparatively few layers of the treated web material.

While I prefer to use natural wool, in its virgin form, including nolls or combings, or reclaimed wool, which is satisfactory in my process in spite of its short fiber length, other fibers having characteristics similar to those of wool can be substituted, examples being crimped, fine denier rayon, supplied by Celanese Rayon Corporation under the trade name "Celereze," and crimped casein fibers, supplied by National Dairy Products Corporation under the trade name "Aralac."

Also the rubber latex can be substituted by the synthetic lattices such as neoprene latex type 60 or type 571, GRS lattices, Buna N lattices, and artificial dispersions of reclaimed rubber. Advantages inherent in such use of neoprene (a chloro-butadiene polymer) are that this elastomer is flame resistant, which, in conjunction with the good flame resistant properties of wool, results in a final material that will not support combustion; that chemical vulcanization of neoprene is not

affected by sulphur liberated by breakage of sul-

5

phur linkages in the heating of the wool; and that with neoprene as the elastomer the product has high resistance to deterioration by oils or hydrocarbon solvents, so that the final material is well suited for use in articles requiring to be dry-cleaned in the course of their use.

It is not necessary to use any setting agent, as setting occurs by evaporation of water in the drying steps and the compounding technique is governed mainly by the requirements of good stability for storage, transport, spraying and dipping. Vulcanization is desirable but not indispensable.

It is desirable that the web or superposed webs be of well carded open structure at the time of spraying and yet of such thickness of the mass as to avoid loss of material in the striking through, and escaping into the exhaust, of the latex. To conform to both of these considerations the webs can be carded very thin and a plurality of them superposed before they are sprayed. Also, if desired, the somewhat preferential alignment of fiber in one direction can be compensated by crossing the individual webs, as by the use of "cross-lappers," which are well known in the textile art.

Uniformly of deposition of the rubber or the like upon the filaments, which is highly important, as above mentioned, presents a problem in the case of filaments which are in a non-wettable condition, as in the case of natural wood which by reason of its nature or because of treatment given it in textile processes, has its filaments coated with a greasy or oil-like substance.

If such wool is immersed into latex and withdrawn, a non-uniform deposition will result. Globules will form, especially at the intersections, and leave regions which will remain uncoated.

I have found that the uniformity of distribution can be achieved by a number of means:

a. The wool can be completely degreased by scouring, extraction, solvent washing, or in any known or preferred manner. Thereupon a wetting agent is deposited on the wool by a spraying or dipping process, before the latex treatment. If material so treated is sprayed with or dipped into latex, it will exhibit a satisfactory distribution of latex on its surface.

b. An alternative, and very successful method, is as follows:

The material, not necessarily degreased, is coated by spraying it with or dipping it in a surface coagulant.

Example of coagulant:

	Parts
(1) Methanol	60.0
Acetone	20.0
Calcium nitrate ¹	12.5
Calcium chloride (dessicator grade)	12.5
(2) Methanol	80
Calcium nitrate	20

¹ Common commercial product, containing 4 molecules of water.

The coagulant is caused or allowed to drain and dry. This can be done in any stage prior to dipping process, i. e., it can be done in the bulk before carding, or the web, consolidated by spraying, can be put through a coagulant bath before dipping it into the latex bath. A great virtue of the coagulant dip method is that the coating is of uniform thickness, flowing off being counteracted

6

by the coagulative phenomenon. Thickness of deposit controlled by concentration of latex and time of immersion.

The procedure and the product are susceptible of variation without sacrifice of all of the advantages above set out and without departure from the scope of the appended claims.

I claim:

1. The method of making a stereoreticulate structure which comprises applying an aqueous dispersion of an elastomer to coat and bind to one another at their crossing positions the fibers of a three-dimensionally open-mesh, unwoven and unfelted web of fibrous material having substantially the fiber size and kink characteristics of wool, and plying up and adhering to one another a multiplicity of laminations of the so treated web material, the resulting structure being thus brought to its final condition of internal structure while in open-mesh, net-work form in all of the three dimensions, the coating and binding being effected by first spraying the web with the said dispersion and drying it, and then dipping it in the said dispersion and drying it, and adhesion of the laminations being effected by applying an adhesive to the sprayed, dipped and dried web material, the product by steps defined, being given a final ratio of elastomer to fiber greater than 2 to 1 by weight.

2. A stereoreticulate structure comprising a mass of unwoven and unfelted fibrous material having substantially the fiber size and kink characteristics of wool, the fibers being individually coated and bonded to one another at their crossing positions by a substance having substantially the resilient deformability of soft-rubber, the structure in its final condition being of substantially the same net-work form in all of the three dimensions, and the coating and bonding substance being distributed with substantial uniformity upon the fibers and the ratio of the coating and bonding substance to the fiber being more than 2 to 1 by weight.

3. A method as defined in claim 1 in which the elastomer is a chloro-butadiene polymer.

4. A structure as defined in claim 2 in which the substance with which the fibers are coated and bonded as defined is a chloro-butadiene polymer.

ANSELM TALALAY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,906,028	Weber et al.	Apr. 25, 1933
1,988,843	Heldenbrand	Jan. 22, 1935
2,057,167	Sherman	Oct. 13, 1936
2,341,130	Unsworth	Feb. 8, 1944

FOREIGN PATENTS

Number	Country	Date
542,687	Great Britain	Jan. 23, 1942

OTHER REFERENCES

Ser. No. 202,136, Nottebohm (A. P. C.), published May 11, 1943.