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Videen

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[54] **RESILIENT FELTED FIBROUS WEB**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 119,702, March 1, 1971, abandoned.

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[58] **Field of Search** 161/170; 264/112, 113, 264/128; 162/165; 156/62.2, 62.4

[56] **References Cited**

UNITED STATES PATENTS

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2,899,353	8/1959	Engel	162/165
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3,181,225	5/1965	Kroepfler et al.	117/145
3,249,667	5/1966	Gregory	156/62.2

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Stille; John K., Introduction to Polymer Chemistry, John Wiley & Sons, Inc., N.Y., 1962, pp. 102, 103.

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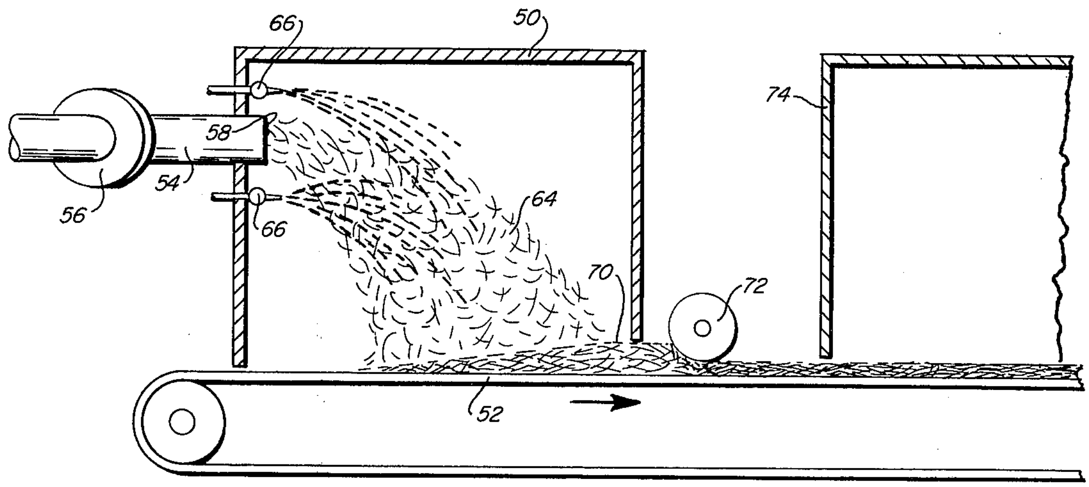
[57] **ABSTRACT**

A felted fibrous web having enhanced resiliency is produced from fibers such as cellulosic fibers which absorb aqueous liquids when treated with an aqueous solution of a phenolic resin which penetrates into the fibers to enhance the resiliency of the web when the resin is subsequently cured and set. The web is preferably treated with a suitable conventional binder in addition to the specified aqueous solution of phenolic resin.

6 Claims, 1 Drawing Figure



PRIOR ART

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RESILIENT FELTED FIBROUS WEB

This application is a continuation-in-part of application Ser. No. 119,702, filed Mar. 1, 1971 now abandoned.

Felted fibrous webs of many kinds are known and are used for a variety of purposes, including upholstery padding, mattress padding and filling, package cushioning, other cushioning and padding applications, and thermal insulation.

Such webs, particularly in upholstery and mattress applications have been found advantageous because of their ability to prevent spring feel from being transmitted to the surface. This is an advantage over materials which have little compressive resistance and as such tend to "bottom out" thus permitting the feel of the underlying structure to pass through to the surface. These other materials, notably foams such as polyurethane, do exhibit, however, excellent resiliency which is not characteristic in any marked degree in most felted fibrous webs.

Accordingly, it is one object of this invention to improve the resiliency of felted fibrous webs.

Still another object of the invention is to provide such enhanced resiliency without detrimentally affecting the compressive resiliency of such webs which has been one of their better properties.

These and other advantages will be evident to those skilled in the art from the following description and drawing in which:

The single FIGURE shows one type of apparatus for producing felted fibrous webs.

Methods of enhancing the resiliency of felted fibrous webs have been known. In recent years one of the more significant discoveries in this regard has been the treating of cotton fibers and first-cut cotton linters with cellulose reactive cross-linking reagents. Such a treatment is disclosed in U.S. Pat. No. 3,181,225 issued to N. B. Knoepsler et al.

While the process of enhancing resiliency by treatment with such cellulose reactive cross-linking reagents works quite well, it involves the use of relatively expensive reagents and resins.

Applicant has discovered that small quantities of relatively inexpensive resins such as the water soluble relatively low molecular weight phenolic resins which are not cellulose reactive cross-linking reagents may be used to enhance the resiliency of the web. It has been found that the specified phenolic resins penetrate or are absorbed into the fibers and as a result the web will have enhanced resiliency when the resin is cured and set upon application of heat without any apparent detriment to the compressive resiliency of the web.

Phenol formaldehyde resins which are water soluble, fusible and capable of being converted to the thermoset stage upon application of heat have been used as binders in felted fibrous webs for many years. As is known, these resins are produced by condensing phenol and formaldehyde in the presence of an alkaline catalyst. When excess formaldehyde is used, the resin can be cured and set with heat to the thermoset stage. As used herein, the term 'phenol' is intended to include phenol, cresol, resorcinol and mixtures thereof which are conventionally condensed in alkaline medium with an excess of formaldehyde to form a heat curable phenolic resin. It is also known that in the course of the condensation reaction phenol alcohols and methylol phenols such as the mono, di and tri methylol phenols are formed and that upon further condensation the resinification proceeds in three stages from the A stage, resoles to the B stage resistols and finally to the C stage resites which are insoluble and infusible. As the resinification proceeds the molecular weight of the resin increases and water solubility decreases. The molecular weight of the resin or its water solubility under stated conditions are generally used for identifying the point to which the condensation is to proceed within a stage for the desired resin characteristics for the particular application at hand.

The phenol formaldehyde resins which have heretofore been used as a binder for felted fibrous webs are condensed to the stage where the molecular weight is so high that the resinous material will not remain in solution at infinite dilution with water at ordinary room temperatures and neutral pH of about 6.5 to 7.5. At this relatively advanced stage of condensation the resin forms a thin film, coating or size on the surface of the individual fibers. It is necessary to form a resin film that remains on the surface of the individual fibers so that when the resin is cured it will bond the fibers together at the surface cross over points and form the structure of the web. Resiliency of the web structure formed with the phenol formaldehyde binder may be improved by incorporating other additives such as latex into the web structure.

In accordance with the present invention it has been discovered that it is possible to enhance the resiliency of these felted fibrous webs by utilizing a phenol formaldehyde resin that will penetrate or be absorbed from the surface into the interior of the fiber. It has now been found that resole phenol formaldehyde resins which remain in solution on infinite dilution with water at ordinary room temperatures and neutral pH of about 6.5 to 7.5 will have such a relatively low molecular weight that the resin will be absorbed into the fiber and with hollow fibers even accumulate within the hollow space inside the fibers. The specified water soluble phenolic resin is not a cellulose reactive crosslinking reagent and it was, therefore, quite unexpected to find that it was capable of enhancing the resiliency of the web. When the resin is cured and set, it apparently stiffens the individual fibers in such a way that the resiliency of the web structure is enhanced without detriment to the compressive resiliency of the web structure.

Any of the known fibers used in the manufacture of felted fibrous webs capable of absorbing aqueous liquids such as the cellulosic wood and cotton fibers may be employed in accordance with the present invention to produce a web in conventional manner having a density of not over about 6 pounds per cubic foot and preferably from about 1.5 to 3.0 pounds per cubic foot. This provides a relatively open network structure suitable for use in cushioning and padding applications as distinguished from the so called 'hardboard' products in which the web is compacted to a density of about 15 to 60 pounds per cubic foot or more to produce a rigid product with the strength required for use as structural elements in furniture or as wall partitions, etc.

Best results are achieved in carrying out the present invention when 100 percent of the resole remains in solution at infinite dilution with water and neutral pH but the solution may contain some higher molecular weight resole resin which will not remain in solution at infinite water dilution and neutral pH as long as the major proportion of the resinous material remains in solution at infinite water dilution and neutral pH. In general, the resole phenol formaldehyde resin used in accordance with the present invention will have a relatively low molecular weight of about 125 to not over about 3,000. The lower molecular weight resol resins of up to about 1,000 may be used with particular advantage. One resole resin that gives particularly good results in accordance with the present invention is sold by the Catalin Division of Ashland Oil Company under the trademark AROFENE 183.

Various methods and apparatus are known for producing fibrous webs, including conventional garnett devices, and various apparatus for producing felted webs from air suspensions of fibers. One such device for producing webs or blankets from air suspensions of fibers is disclosed in U.S. Pat. No. 3,010,161 issued to T. C. Duvall. Said U.S. Pat. No. 3,010,161 discloses an apparatus similar to that shown in the drawing. Such apparatus includes a chamber **50** positioned over a continuously moving conveyor **52.** At one end of the chamber **50** there is provided a duct **54,** connected to a disperser mechanism **56** of the hammermill type. The disperser **56** provides an air suspension of fibers in the duct **54.** Adjacent the outlet **58** of the duct **54** are spray nozzles **66** which serve to spray liquid particles of binder and other materials into the stream **64** to provide binder on the fibers as they felt upon the screen **52** forming the mat **70.** The conveyer then conveys the mat **70** under suitable compression rolls **72** and into a dryer mechanism **74.**

As indicated above, conventional garnett mechanisms may be utilized to felt the web and may be provided with suitable spray nozzles for applying the binder as indicated in the above-mentioned U.S. Pat. No. 3,181,225. It is, however, generally difficult to handle the short fibers of raw or chemically pulped wood on such garnett machines in any large quantity. Other conventional apparatus used in the production of nonwoven textiles may also be used. Many of these such as the garnett produce webs that have the fiber so mechanically interlocked that no binder is necessary. In others, it is necessary to apply an added binder.

By any of the methods and apparatus referred to above, suitable felted fibrous webs with added applied binder (if desired or required) may be produced, which are then subsequently dried if necessary and heated to activate and set the binder in conventional manner. It is preferred, however, to use the apparatus shown in the drawing and described above. The felt produced by this method and apparatus requires additional applied binders supplied through the spray nozzles **66,** as above indicated. All of the following examples were produced on such apparatus.

In accordance with the present invention, the water soluble resole resin is absorbed into the fibers to enhance the resiliency of the web. The resole is not used to bond the fibers together in the structure of the web unless used in such excessive quantities as to form a film coating on the fiber surface after the individual fibers are saturated with the resinous solution. Such excessive quantities may be used but this is just a waste since there are a number of conventional binders available which are much less expensive than the specified water soluble resole resins. In general, the amount of the specified water soluble resole resin used for enhancing resiliency of the web will not be over about 3.0 parts of resin solids by weight for each 100 parts by weight of fiber and preferably the amount of resin is less than that required to bond the fibers into the web structure. In the examples below the water soluble resole resin of the present invention is identified as a 'penetrating resin' which was cured and set within the fibers by the conventional application of heat.

In each of the following examples the products made were tested for four product characteristics, as follows:

The compressive resistance after one cycle was determined by stacking 6 × 6 inch samples to a height of about 3 inches and then accurately measuring the height of the stack. The stack was then compressed between two flat metal plates of 6 × 6 inches or larger at a rate of 2 inches per minute to one-third of its original measured height. The amount of pressure to compress the stack was measured in pounds and converted to pounds per square foot.

The resiliency after one cycle is expressed in per cent and was determined by immediately removing the load from the stack after it had been compressed to one-third its height (in determining the compressive resistance after one cycle) and permitting the recovery of the stack for 45 seconds. After that time, the height of the stack was again measured and the resiliency after one cycle was determined in per cent by dividing the recovered height by the original free height and multiplying by 100.

The compressive resistance after 20 cycles was determined by repeating the compression and release cycle 20 times and measuring the pressure in pounds required on the 20th cycle to compress the stack to one-third its original measured height and converting such pressure in pounds to pounds per square foot.

The resiliency expressed in per cent after 20 cycles was determined by removing the load from the stack immediately after the 20th compression and permitting the stack to recover for 45 seconds. Again, the height was measured and divided by the original free height of the stack and multiplied by 100.

In all instances the samples are first conditioned to equilibrium in a constant temperature constant humidity room to 50% humidity and 70°F.

Set forth below in Table I are the details of composition and the properties achieved with respect to products of Examples 1 through 6. Examples 1 through 6 were produced on apparatus like that disclosed above and shown in FIG. **1.** The fibers used in Examples 1 through 6 were all No. 1 sulfite pulp introduced with the disperser mechanism **56.** The binder was introduced as an aqueous dispersion or emulsion (or a sol for the starch) by means of the spray nozzles **66.** The quantities shown in the tables for the binder and for the penetrating resin of the present invention are parts by weight of the solids of the respective ingredients. The penetrating resin (when used) was incorporated in the binder liquid and introduced with the binder through the spray nozzles **66.**

TABLE I

	PARTS BY WEIGHT					
Example	1	2	3	4	5	6
Sulfite Fibers	93	93	90	90	90	90
Penetrating Resin (1)	1.75	0	2.5	0	2.5	0
Binder						
Corn Starch	7	7	0	0	0	0

TABLE I – Continued

Example	PARTS BY WEIGHT 1	2	3	4	5	6
Latex A (2)	0	0	10	10	0	0
Latex B (3)	0	0	0	0	10	10
Properties						
comp. resis. 1 cyc. (PSF)	1180	1120	840	560	380	380
comp. resis. 20 cyc. (PSF)	880	824	636	392	300	252
resiliency 1 cyc. (%)	81.8	78.8	88.6	83.3	92.4	90.6
resiliency 20 cyc. (%)	75.8	68.2	77.1	73.3	84.8	81.3

(1) A water soluble phenolic resin sold under the trademark AROFENE 183 by Catalin Corporation.

(2) A styrene-butadiene latex emulsion sold under the trademark GEN FLO 6028 by General Tire and Rubber Company.

(3) A vinyl-acrylic self cross-linking latex emulsion sold under the trademark RESYN 2873 by National Starch and Chemical Corporation.

It will be noted that Examples 2, 4, and 6 are, in effect, the control samples without the penetrating resin for the samples of Examples 1, 3 and 5 respectively which do contain a penetrating resin. It will be seen that in each instance the resiliency for both 1 cycle and for 20 cycles was improved when the penetrating resin was utilized. Example 1, for example, was improved in resiliency (20 cycles) over Example 2 from a value of 68.2% to a value of 75.8% by use of the penetrating resin.

Other fibers have been used. Set forth below in Table II are Examples 7 through 10 which show the use of the penetrating resin on cotton fibers. Examples 7 through 10 were run in the same manner as Examples 1 through 6 on the same equipment and utilizing the same penetrating resin and latex binders. Only the fiber was changed. The fiber used was second-cut cotton linters.

TABLE II

Example	PARTS BY WEIGHT 7	8	9	10
Cotton Fibers	90	90	90	90
Penetrating Resin	2.5	0	2.5	0
Binder				
Latex A	10	10	0	0
Latex B	0	0	10	10
Properties				
comp. resis. 1 cyc.(PSF)	306	220	104	140
comp. resis. 20 cyc.(PSF)	256	164	80	116
resiliency 1 cyc.(%)	85.3	80.6	84.8	81.3
resiliency 20 cyc.(%)	70.6	67.7	72.7	67.2

Again, Examples 8 and 10 are the control without the penetrating resin for Examples 7 and 9 respectively which do contain the penetrating resin. It will be observed that Examples 7 and 9, containing the penetrating resin, show improvement both at the 1 cycle and at 20 cycles in resiliency over Examples 8 and 10, their respective controls.

The fibers may also be mixed. Set forth below in Table III are Examples 11 through 14 which correspond respectively to above Examples 7 through 10; however, in Examples 11 through 14 both wood fibers and cotton fibers were used. The wood fibers were again No. 1 sulfite pulp and the cotton fibers were again second-cut cotton linters. The same latex binders and penetrating resins were used. The fibers were first mixed in suitable apparatus, not shown, and then introduced through the disperser mechanism **56**, the process being the same as for the previous examples.

TABLE III

Example	PARTS BY WEIGHT 11	12	13	14
Wood Fiber	63	63	63	63
Cotton Fiber	27	27	27	27
Penetrating Resin	2.5	0	2.5	0
Binder				
Latex A	10	10	0	0
Latex B	0	0	10	10
Properties				
comp. resis. 1 cyc.(PSF)	500	500	260	508
comp. resis. 20 cyc.(PSF)	360	352	200	388
resiliency 1 cyc.(%)	90.3	83.9	94.3	87.1
resiliency 20 cyc.(%)	80.6	74.2	80.0	77.4

Examples 12 and 14 are the controls without the penetrating resin for Examples 11 and 13 respectively which do contain the penetrating resin. Again, for both 1 cycle and 20 cycles the resiliency was improved by the use of the penetrating resin.

It is not necessary that the penetrating resin be supplied with the binder as in the above examples. The fiber may be first treated with the penetrating resin and then formed into the blanket. In the following Table IV the fiber of Example 15 was first treated with an aqueous solution of the penetrating resin and then dried and cured. The treatment can be accomplished by any one of a number of means including incorporating the penetrating resin in the pulp during manufacture prior to drying of the pulp or spraying the penetrating resin upon the loose fiber in any convenient way and then drying and curing the same. In Table IV below the fibers in Example 15 were pre-treated with the penetrating resin and then dried. These pre-treated fibers were then introduced by means of the dispersed mechanism **56** into the chamber **50** and the binder was applied by the spray nozzle **66** as in the previous examples. The mat was then pressed with the rollers **72** and dried in the oven **74.**

TABLE IV

Example	PARTS BY WEIGHT 15	16
Sulfite Fibers	90	90
Penetrating Resin	2.5	0
Binder		
Latex C (1)	10	10
Properties		
comp. resis. 1 cyc. (PSF)	640	1080
comp. resis. 20 cyc. (PSF)	480	782
resiliency 1 cyc. (%)	89.1	75.0
resiliency 20 cyc. (%)	78.1	66.4
thickness (inches)	0.829	0.560
Density (PCF)	1.8	2.3
Weight/MSF (pounds)	124	108

(1) A self cross-linking latex emulsion sold under the designation 75-5675 by Paisley Products, Inc.

It will be seen that again both for 1 cycle and for 20 cycles the resiliency of Example 15 containing the penetrating resin surpasses that of Example 16 without the penetrating resin. It was also discovered that by using a pre-treated fiber (that is treated before being formed into the blanket) the loftiness of the blanket is enhanced as shown above by comparison of the thickness of Examples 15 and 16. When passing through the rollers **72** all samples were pressed to stop in an effort to achieve approximately one-half inch in thickness in the final dried product. It was found that with the pretreated fiber the blankets tended to be softer or less dense and loftier. While this tended somewhat to be the case even when the penetrating resin was introduced with the binder, the increased loftiness and softness was much more pronounced when the fibers were first treated with the penetrating resin and then formed into the blanket with the binder.

Many varieties of fibers may be used. It is only necessary that they be water absorptive. Such fibers include particularly the natural and synthetic cellulose fibers such as wood fibers (whether kraft, sulfite, raw or otherwise), cotton fibers or linters, bagasse, jute, rayon (Both vicose and acetate), and the like.

Any suitable conventional binder may be used, recognizing that binders can themselves affect the blanket properties. In addition to the binders used above various starches, latices, thermoset resins, and the like are known as binders for such blankets.

While the Examples above all used a binder, this is in large part due to the deposition chamber method of felting the web. In garnett and other such machines added binder is often not necessary. Webs produced by such devices without use of a binder may also be treated with a penetrating resin as above disclosed to enhance resiliency. The most convenient way to accomplish this is to spray the resin on the web laps as they are being lapped into greater thicknesses of web or blanket and then curing the resin.

It has been found that quite small quantities of the penetrating resin provide the enhanced resiliency and that, generally the greater the quantity of penetrating resin used per pound of fiber the greater the improvement in resiliency achieved. However, once the product is upgraded to the point where the resiliency (1 cycle) is about 90–95% then further increase in the resin is substantially ineffective.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiment of the invention herein chosen for the purpose of illustration which do not constitute departure from the spirit and scope of the invention.

What is claimed is:

1. A web of felted water absorbent natural cellulosic fibers having a density not over about six pounds per cubic foot having enhanced resiliency imparted by absorption in the individual fibers of a resinous material comprising a resole phenol formaldehyde in which the major proportion of resinous material at the time of absorption is a resole phenol formaldehyde which is water soluble at infinite dilution in water and neutral pH, said resole phenol formaldehyde resin being cured and set in the individual fibers to enhance the resilience of the web.

2. The web specified in claim **1** which includes a binder which bonds the fibers together at the surface cross over points in the web structure.

3. The web specified in claim **2** in which the binder is a starch.

4. The web specified in claim **2** in which the binder is a latex.

5. A web of felted water absorbent natural cellulosic fibers having enhanced resiliency imparted by absorption in the individual fibers of a water soluble resinous material comprising a resole phenol formaldehyde resin in which the major proportion of resinous material at the time of absorption is a resole phenol formaldehyde which is water soluble at infinite dilution and neutral pH and having a molecular weight not over about 3,000 said resole phenol formaldehyde resin being cured and set to enhance the resiliency of the web.

6. The web specified in claim **5** which includes a binder on the surface of the fiber which bonds the fibers at the surface cross over points in the web structure.

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