# United States Patent

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[54] **COCARDED BLEND OF MICROCELLULAR AND CONVENTIONAL FIBERS**
**7 Claims, 2 Drawing Figs.**


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[51] **Int. Cl.** ..... **A47c 27/22**
[50] **Field of Search** ..... 161/169, 178; 57/140; 5/361



[56] **References Cited**

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**ABSTRACT:** A cocarded blend of 1–80 percent closed-cell microcellular staple fibers and 99 percent to 20 percent dense, substantially noncellular staple fibers is cardable and inexpensive and has desirable bulk, resiliency, load bearing capacity and recovery upon removal of a load.

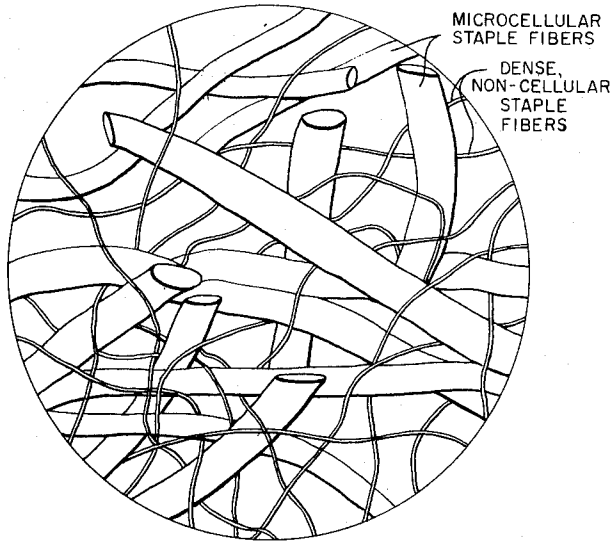



FIG. 1

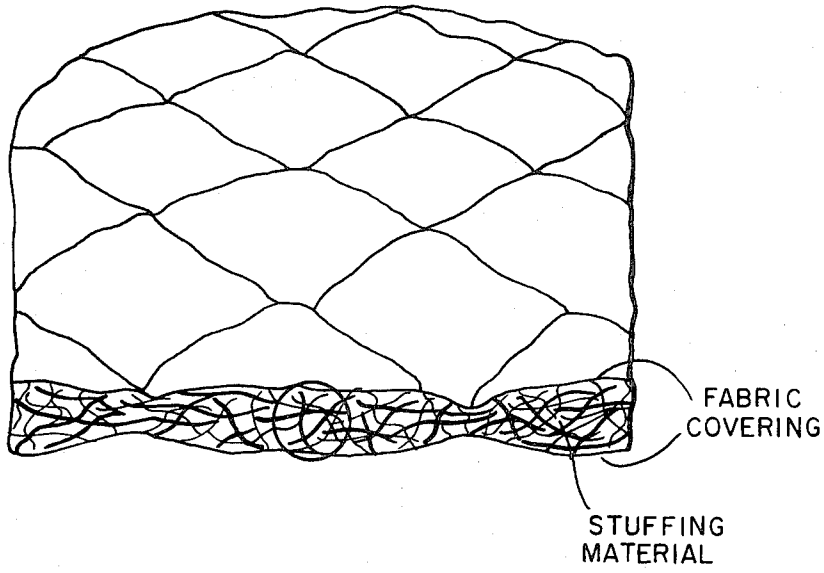
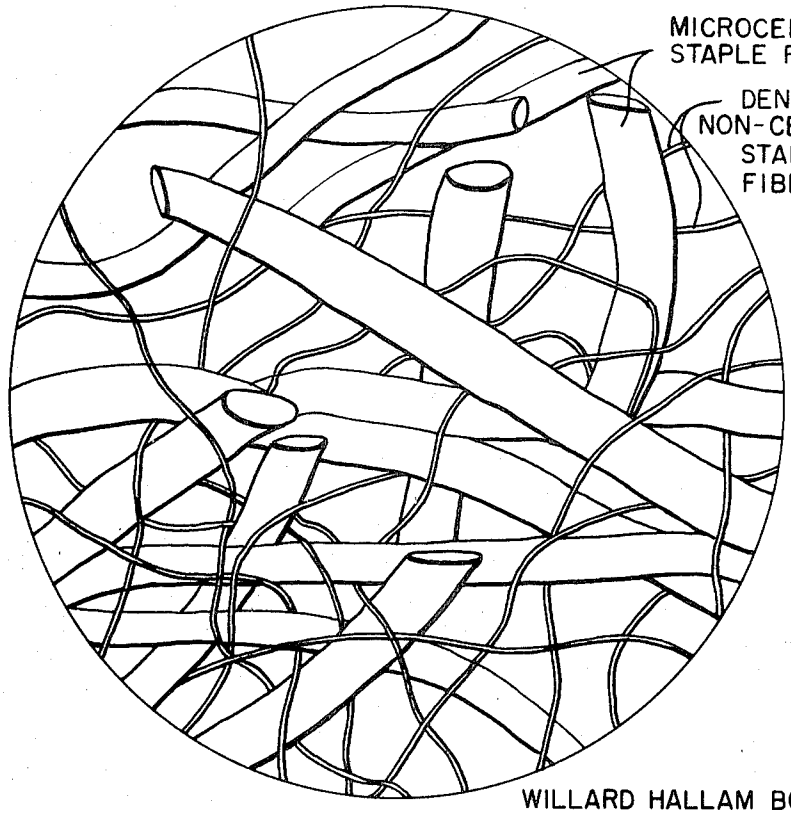



FIG. 2




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# COCARDED BLEND OF MICROCELLULAR AND CONVENTIONAL FIBERS

This application is a division of our copending application Ser. No. 559,979, filed June 23, 1966, now U.S. Pat. No. 3,521,328.

This invention relates to a cocarded fibrous blend suitable for use as a filling material in upholstery cushions, mattresses, sleeping bags, insulated garments, etc. More particularly, the invention relates to cocarded mixtures of closed-cell microcellular staple fibers and dense staple fibers, either natural or synthetic.

Batts of randomly oriented natural staple fibers have long been used as stuffing materials for cushions, mattresses and the like, but for many uses they have a number of inherent disadvantages. More recently synthetic fiber staple batts have found commercial acceptance—particularly those formed of the more resilient polyester fibers such as polyethylene terephthalate fibers. For many purposes, however, these newer materials have been relatively expensive in comparison with their natural fiber counterparts. Accordingly, the economics have created a tendency to use only a minimum weight of such fibers in stuffing a given volume although at a sacrifice to other properties such as load support, durability, refluffability, and appearance.

Still more recently, the problems heretofore associated with even the synthetic fiber stuffing materials, particularly that of maximum load support at low or economic weights of fiber, would seemingly be obviated by the pneumatic closed-cell ultramicrocellular synthetic fibers as described in Blades et al. U.S. Pat. No. 3,227,664. Nonetheless, for certain cushioning applications the unique nature of these low-density cellular filaments has introduced further considerations, to be discussed in greater detail later, both with respect to the utilization of conventional textile equipment and to the attainment of other desirable cushioning properties.

In accordance with the invention the deficiencies of such prior art materials is overcome by the provision of a composite resilient stuffing material comprised of a cocarded mixture of 1 to 80 percent by weight of closed-cell microcellular staple fibers of a synthetic polymer, which fibers are characterized by having substantially all of the polymer present as filmy elements of a thickness less than 2 microns, together with 99 to 20 percent by weight of dense, substantially noncellular staple fibers, the cocarded mixture being in the form of an intimate, interentangled blend of said microcellular and dense fibers.

Unexpectedly it has been found that the addition of as little as 20 percent by weight of dense fibers, which act as carrier fibers, to the microcellular fibers permits the formation of highly useful fibrous batts not only possessing the desirable attributes of each component but, in addition, having properties not characteristic of either and which would be essential to certain cushioning applications. Significantly the presence of even such a small amount of dense fibers permits textile operations such as carding processes which are not feasible with the microcellular fibers alone. Additionally, a coherent product can be obtained which, owing to the large difference in densities of the fiber components, visually appears to be comprised of microcellular fibers alone. In this regard, since the density of the dense staple fibers may exceed that of the microcellular fibers by a factor of nearly 100 or more, the presence of as little as 1 percent of the microcellular fibers in such a blend will greatly contribute to bulk, resiliency, load-bearing capacity and recovery upon removal of a load. Particularly in the case of cushioning materials such as mattresses and pillows designed for body comfort, an optimum range of the fibers is 25 to 65 percent by weight of microcellular fibers and 75 to 35 percent by weight of dense fibers.

The formation of the novel stuffing material of the invention involves the use of any standard carding machine and, in most instances, the microcellular fibers need not previously be converted to staple length because continuous lengths will be reduced to staple lengths, say of 1 inch or so, by the action of the card.



The invention will be further understood from FIG. 1 which shows in schematic and enlarged form a cushioning article in which the composite, resilient stuffing material of the invention, i.e., which is composed of a cocarded mixture of microcellular and dense fibers, is sandwiched between layers of a covering fabric. It will be understood that the fabric covering and quilted configuration are optional features of the invention.

FIG. 2 shows an enlarged view of the composite, resilient stuffing material, depicting in detail the cocarded mixture of the closed-cell microcellular staple fibers and the dense, noncellular staple fibers.

The invention is importantly dependent upon the character of the microcellular fibers; that is, they must be of a particular closed-cell variety so as to be capable of retaining gases therein. Such fibers when inflated are thus pneumatic, i.e. individual cells acting as miniature balloons, and a maximum contribution is made both with respect to load-bearing abilities and to thermal insulation properties. However, the invention also contemplates composite stuffing materials, in which the microcellular filaments are initially collapsed, i.e. to less than their normal or fully expanded thickness. Such products find unique utility in manufacturing operations where this relatively compact form facilitates handling, or where the closed cell nature of the microcellular filaments permits subsequent "in-place" postinflation of the products to their full pneumatic potential.

Microcellular filaments employed according to this invention are substantially homogeneously foamed throughout to provide closed polyhedral-shaped cells of less than about 1,000 microns each in maximum transverse dimension, each cell completely enclosed by thin filmlike polymeric cells less than about 2 microns thick. By "substantially homogeneously foamed throughout" is meant not only that there is a narrow distribution of cell sizes but also that the filament is devoid of separately identifiable skins, webs, or casings of dense polymer surrounding the foamed portion; i.e., the outer surface is composed of thin cell walls. The density of gas-inflated microcellular filaments is in the range of 0.005 to 0.05 g./cc. Dense polymeric skins are undesirable because they can crack upon repeated compressive flexing, because they restrict the pneumatic behavior of the enclosed foam, and because their weight per unit volume of enclosed gas is too great to obtain low densities.

Microcellular filaments must have predominantly closed foam cells. Otherwise gases cannot be confined within the cells and a high degree of pneumaticity of the filaments cannot result. The determination of closed-cell contact is ordinarily made by visual or microscopic observation. Alternatively, a gas displacement technique such as that described by Remington and Pariser in *Rubber World*, May 1958, p. 261, can be used if modified to operate at the lowest possible pressure differentials. A predominantly closed-cell content is qualitatively indicated if a gas-inflated microcellular filament feels pneumatic when squeezed between the fingers and recovers its original size and shape immediately thereafter.

Microcellular filaments must also be yieldable and resilient such that substantial cross-sectional deformation results from externally applied compressive loads. Generally, this requirement is satisfied if a gas-inflated filament is reduced in thickness by at least 10 percent under a load of 10 p.s.i. (0.70 kg./cm.$^2$), based on an area computed from the length and original diameter, the load being maintained for 1 second, and if there is an immediate thickness regain to at least 50 percent, and preferably to substantially 100 percent, of the original thickness on release of the load.

A particularly desirable microcellular filament for use in the products of this invention is ultramicrocellular as disclosed by Blades et al. in U.S. Pat. No. 3,227,664. Ultramicrocellular filaments are additionally characterized in that the polymer in their thin cell walls exhibits uniplanar orientation and uniform texture as described in said patent. These latter two properties provide the surprisingly great strength of the filaments and render their cell walls particularly resistant to gas permeation.

A wide variety of both addition and condensation polymers can form microcellular filaments with the essential characteristics. Typical of such polymers are: polyhydrocarbons such as polyethylene, polypropylene, or polystyrene; polyethers such as polyformaldehyde; vinyl polymers such as polyvinyl chloride or polyvinylidene fluoride; polyamides such as polycaprolactam, polyhexamethylene adipamide, or polymetaphenylene isophthalamide; polyurethanes such as the polymer from ethylene bischloroformate and ethylene diamine; polyesters such as polyhydroxypivalic acid or polyethylene terephthalate; copolymers such as polyethylene terephthalate-isophthalate; polynitriles such as polyacrylonitrile or polyvinylidene cyanide; polyacrylates such as polymethylmethacrylate; and equivalents.

Planar molecular orientation of the polymer in the cell walls contributes significantly to the strength of the filaments. A preferred class of polymers for forming suitable microcellular filaments is, therefore, one including those which respond to orienting operations by becoming tougher and stronger. This class includes linear polyethylene, stereo-regular polypropylene, polycaprolactam, polyethylene terephthalate, polyvinyl chloride, and the like. Further preferred is the class of polymers known to be highly resistant to gas permeation, such as polyethylene terephthalate and polyvinyl chloride.

The microcellular filaments employed preferably contain sufficient impermanent inflatant to provide a total internal pressure within the cells of at least atmospheric pressure. An impermeant inflatant is a gas which permeates the cell walls so slowly as compared to air that it is substantially permanently retained within the cells. The presence of impermeant inflatant within the cells creates an osmotic gradient for the inward permeation of air (or other ambient gaseous atmosphere.). Thus, at equilibrium with air, the cells of microcellular filaments contain not only air at about one atmosphere but also impermeant inflatant at a given partial pressure. The combined pressure, then, is at least atmospheric and guarantees that the filaments are fully gas inflated and turgid. Loss of air by permeation during compression is ordinarily insufficient to prevent full reinflation immediately upon release of the load. If, however, full reinflation does not result immediately, the osmotic gradient provided by the impermeant inflatant causes spontaneous reinflation by equilibration with ambient air.

The rate of permeation for an inflatant gas through a given polymer increases as its diffusivity and solubility increase. Accordingly, impermeant inflatants should have as large a molecular size as is consistent with providing the required vapor pressure and should have very little or no solvent power for the polymer. A preferred class of impermeant inflatants is exemplified by compounds whose molecules have chemical bonds different from those found in the confining polymer, a low dipole moment, and a very small atomic polarizability.

Suitable impermeant inflatants are selected from the group consisting of sulfur hexafluoride and saturated aliphatic and cycloaliphatic compounds having at least one fluorine-to-carbon covalent bond and wherein the number of fluorine atoms preferably exceeds the number of carbon atoms. Preferably the saturated aliphatic and cycloaliphatic compounds are, respectively, perhaloalkanes and perhalocycloalkanes in which at least 50 percent of the halogen atoms are fluorine. Although these inflatants may contain ether-oxygen linkages, they are preferably free from nitrogen atoms, carbon-to-carbon double bonds, and reactive functional groups. Specific examples of impermeant inflatants include sulfur hexafluoride, perfluorocyclobutane, sym-dichlorotetrafluoroethane, perfluoro-1,3-dimethylcyclobutane, perfluorodimethylcyclobutane mixtures, 1,1,2-trichloro-1,2,2-trifluoroethane, $CF_3CF_2CF_2OCFHCF_3$, chlorotrifluoromethane, and dichlorodifluoromethane. Mixtures of two or more impermeant inflatants can often be used to advantage.

The dense, substantially noncellular, staple fibers suitable for use in this invention may be either natural fibers such as cotton, kapok, animal hair etc. or synthetic fibers such as polyamides, polyesters, polyhydrocarbons, rayons, etc. They are quite dense in comparison with the microcellular fibers, ordinarily having a density of at least 0.8 g./cc. and usually at least 1.0 g./cc. Although often containing a few random closed or open cells, they are essentially noncellular. Staple fibers of polyethylene terephthalate are preferred due to their high resilience, chemical inertness, resistance to moths, etc. These fibers are conventionally supplied as a batt of fibers in more or less random array, as prepared for example on the Garnett machine or a random webber. The utilization of staple fibers is further advantageous because of the fiber mobility, resilience and high recovery afforded.

In a particularly preferred embodiment, both the microcellular filaments and the dense staple fibers are composed of polyethylene terephthalate. Such a blend is advantageous not only from the standpoint that these two types of fibers have individually superior cushioning characteristics and other properties, but also for the reason that generally lower bulk densities can be employed while obtaining a given degree of load support.

Although pneumatic microcellular fibers could be employed as the sole stuffing material in certain cushioning applications to provide very low-density resilient and pneumatic fillings, such fillings nevertheless have a relatively high compression modulus and consequently may be too firm for optimum comfort. In marked contrast, the 100 percent dense fiber staple fillings tend to be unduly soft, particularly at the low stuffing densities which are often required by reason of the economics involved. The present invention effectively overcomes these previous deficiencies and provides intermediate degrees of firmness and softness by appropriate selection of the ratio of components. In addition to the provision of aesthetically very desirable stuffing materials, the invention further provides the manufacturer with the advantage of being able to supply a diverse range of stuffing materials tailored to meet individual compressibility requirements from a stock of only two components.

The microcellular fibers, when fully inflated may have diameters varying over a very wide range, e.g. 0.008 inch to 0.4 inches. For most cushioning applications, however, they will preferably have diameters of less than about 0.05 inch.

The intimately blended batts of this invention are formed in a cocarding operation. The microcellular fibers by themselves cannot be carded on conventional textile machinery owing to their large diameter which prevents a sufficient degree of fiber entanglement necessary to produce a coherent web or mass. However, it has been discovered that addition of 20 percent by weight or more of dense staple fibers makes the carding operation feasible, as well as contributing desirable properties to the blended stuffing material. It is a further surprising feature that the microcellular fibers may be furnished either as staple or continuous filament. Thus, when a standard wire-clothed sample card or a metal-clothed garnett card is employed, the continuous filament microcellular fiber is adequately converted into the desired length staple during the carding operation by the tearing action between the main cylinder and the licker-in, worker and stripper rolls. Both inflated and collapsed postinflatable microcellular fibers operate satisfactorily in the cocarding operation. It is noteworthy in this respect that even the collapsed microcellular fibers alone cannot be effectively carded since again, the filament diameters are unduly large.

A furnish for the carding operation is conveniently formed by supplying a crude sandwich of desired proportions by weight of dense fiber batts surrounding a layer of microcellular fibers, as might be directly piddled onto a conveyor belt, for example. The carding operation responds favorably to application of fiber finishes to the microcellular fibers to assist in decreasing any static generated. The blended carded web can be wound up directly on a roll, sewn to a cheesecloth backing, or built up in layers to any desired thickness as by a camelback lapper. These blended webs may either be used directly as stuffing materials or stored indefinitely for later use as desired.

If the stuffing materials of this invention have been prepared from collapsed cellular fibers, they may be inflated either before or after the stuffing operation.

The stuffing materials may conveniently be handled with a conventional pillow- or cushion-stuffing machine, they may be stuffed by hand, or the batt may be quilted between covers as in preparation of comforters, sleeping bags, insulated clothing, and the like. The blended batts may be impregnated if desired with elastic adhesives to further enhance batt coherence and minimize fiber packing. Flameproofing agents, and the like, can also be added, either by spray or dip.

The following examples illustrate a number of the features of this invention. The low-density synthetic organic cellular fiber component, in each example, is comprised of polyhedral-shaped cells whose filmy cell walls are less than 2 microns thick. The cellular components in example I through example IX are the preferred ultramicrocellular species where in addition the filmy cell walls exhibit uniform texture and uniplanar orientation.

## EXAMPLE I

Polyethylene terephthalate ultramicrocellular foam fibers containing a quantity of perfluorocyclobutane were spun from a solution of 400 parts polyethylene terephthalate, 325 parts methylene chloride, 42 parts dichlorodifluoromethane and 42 parts of perfluorocyclobutane (all parts by weight) extruded at a temperature of 210° C. and a pressure of 1,000 p.s.i. through a 24-hole spinneret, each hole being 4 mils in diameter. The filaments had a tenacity of 0.44 g.p.d., and a denier of 48 (5.3 tex), and a relative viscosity of 25. When fully inflated and equilibrated with air these pneumatic filaments had a density of 0.022 g./cc. and a diameter of 23 mils.

A quantity of these continuous filament inflated ultramicrocellular fibers was distributed evenly over an equal weight garnetted batt of 4 d.p.f. (0.44 tex) polyethylene terephthalate 2-inch staple fibers, fiber density of 1.38 g./cc., and run through a standard metal-clothed garnett card manufactured by Proctor and Schwartz. The garnett card had a 30-inch diameter main cylinder, a 20-inch diameter doffer cylinder, a 10-inch diameter licker-in roll, 4 worker rolls each 7 inches in diameter, 4 stripper rolls each 3 3/16 inches in diameter, and top and bottom feed rolls each 3 inches in diameter. All rolls were 20 inches in diameter and were covered with metallic clothing.

The fibers processed well to form an intimately blended carded batt of ultramicrocellular/dense fibers having an overall density of only 1.2 lbs./cu. ft. The continuous filament cellular fibers were reduced to an average staple length of 1 inch by the carding operation.

The above example was repeated substituting continuous cellular filaments spun from a 3-mil multihole spinneret. These filaments had a density of 0.03 grams per cc. and an inflated diameter of 12 mils. They processed equally well to yield a blended batt of density 0.7 lbs./cu. ft.

These batts were quite resilient and exhibited excellent recovery properties from deformation due to their impermeant perfluorocyclobutane content and the mobility of the carded fiber structure. They were highly suitable for use as stuffing materials in upholstery cushions, comforters, sleeping bags, insulating garments and the like.

## EXAMPLE II

An inflated pneumatic continuous filament polyethylene terephthalate ultramicrocellular yarn spun from a multihole 4-mil spinneret was collapsed by being immersed in boiling methylene chloride for about 15 minutes. This treatment increases the density of the yarn from 0.022 to 0.55 grams per cc. Layers of the dried collapsed continuous filament yarn were sandwiched between batts of polyethylene terephthalate fiberfill in a 50/50 weight ratio and carded on a standard garnett card. Well-blended uniform battings were produced in which the cellular filaments had been reduced to lengths ranging from 1/2 to 16 inches.

The collapsed cellular filaments in the batting were readily postinflated. One suitable technique was to immerse the batt in a boiling 50/50 volume mixture of methylene chloride/1,1,2-trifluoro-1,2,2-trichloroethane for 15 minutes. An equally satisfactory technique was to immerse the batt in a boiling 80/20 volume mixture of 1,2-dichlorotetrafluoroethane/methylene chloride for 30 minutes followed by drying in an air oven at 90° C. The volume of the batting increases markedly as the cellular filaments reexpand to their original low density of 0.022 grams per cc. The bulk density of this postexpanded batting was only 0.31 lbs./cu. ft. The dense polyester fiberfill in the batt was difficult to see, being obscured by the much bulkier expanded cellular filament whose inflated diameter is 18 mils.

## EXAMPLE III

A collapsed ultramicrocellular polyethylene terephthalate yarn of density 0.11 grams per cc. was spun directly from a 4-mil multihole spinneret. Collapsed filaments result when the impermeant inflatant is omitted from the spinning solution. This yarn was passed directly from the spinneret through a hand-held air-operated jet and thus deposited in a batt of randomly oriented continuous filaments. This batt was sandwiched in a 50/50 weight ratio with commercial samples of polyethylene terephthalate fiberfill batting. The sandwich was fed through a standard garnett card and rolled up manually. Thorough and uniform distribution of foam and polyester fiberfill was obtained. Foam fiber length in the carded batting varied from 1/2 to 7 inches with an average length of 2 to 3 inches. The foam fibers appeared to be the major component in the batting. The collapsed foam fibers in the blended batt were subsequently postexpanded by the techniques described in the preceding example.

## EXAMPLE IV

Mixtures of the following parts by weight of foam fiber/dense fiber of polyethylene terephthalate were prepared: 6/94; 30/70; 50/50; 70/30; and 80/20. These mixtures were supplied as the furnish to the standard garnett card. The carded blends were taken from the card on a moving belt and lapped to a uniform package. All battings showed uniform foam/dense fiber distribution. The first three blends processed well, while the blend containing 70 percent foam fiber processed marginally because the lightweight batting did not release uniformly from the compacting roll. The blend containing 80 percent of foam fiber could be processed through the card, but it was necessary to roll it up manually. The dense fiber staple was necessary to the carding of the foam fibers. One hundred percent foam fiber could not be processed in the garnett card.

## EXAMPLE V

Staple lengths (2 inches) of polyethylene terephthalate foam filaments were mixed with polyethylene terephthalate dense fiber staple in a 50/50 by weight mixture. This mixture was processed on a standard garnett card to form an intimately blended batt. The 2-inch staple length foam fibers were further broken up during the carding operation to an average length of 0.8 inch. This mixture of foam and dense staple fibers processed well in the carding operation.

## EXAMPLE VI

Collapsed polyethylene terephthalate foam filaments were spun directly from a 3-mil multihole spinneret. A portion was cut into 2-inch staple lengths. These collapsed foam fibers have a diameter of approximately 7 mils, a tenacity of approximately 1 gram per denier, and were approximately 10 denier per filament. The continuous filament (portion A) and staple (portion B) were each mixed at 50/50 weight ratios with polyethylene terephthalate fiberfill and processed on a conventional sample card having fillet clothing on the main cylinder and metallic clothing on the worker and stripper rolls, manufactured by Davis and Furber (Phila.). Portion B processed well, as did portion A when the precaution of a

moderate feed rate was observed to prevent card jamming. The average foam fiber length in portion A was reduced to 2.3 inches and in portion B to 1.9 inches by the carding operation.

The blended batts of collapsed foam filaments were postinflated by a 15-minute treatment in a boiling bath of a 50/50 weight mixture of perfluorocyclobutane/fluorodichloromethane. The densities of the postinflated batts of portions A and B were 0.33 16./cu. ft. and 0.43 lb./cu. ft., respectively. The tactile aesthetics as well as the compression characteristics of these blended fibrous composites are judged superior to those of corresponding 100 percent foam filament batts.

## EXAMPLE VII

A fibrous cushioning structure was prepared by cocarding a 70/30 (weight) mixture of polyethylene terephthalate ultramicrocellular foam fiber/cotton staple fiber. The ultramicrocellular fibers were furnished as a random batt of continuous filaments of 17–20 d.p.f. (approximately 2 tex) and density of 0.030 g./cc., the individual inflated cells containing a quantity of spun-in perfluorocyclobutane and dichlorodifluoromethane (impermeant inflatants). The cotton component was prepared as a garnetted batt from 50-grain sliver El Paso cotton, of 1⅛-inch staple length, and 1.2–1.6 d.p.f. (approximately 0.15 tex). To facilitate preparation of the garnetted cotton batt, the previously finish-free sliver was sprayed with a commercial antistat finish. The dense and foam fiber batts were "sandwiched" and fed to a garnett card, as in previous examples, whereupon an intimate blend was produced and the continuous filament polyethylene terephthalate foam yarns were broken up into staple lengths. Application of talc, dusted onto the cocarded batt, facilitated release of the batt from the card and subsequent transfer and handling operations.

A 3-inch thick cushion was stuffed to a density of 1.4 lb./cu. ft. with this cocarded fiber blend. A similar reference cushion was stuffed to a density of 3.6 lb./cu. ft. with a 100 percent cotton garnetted batt (same cotton used for preparing the blend). In spite of the fact that the density of the blended batt cushioning was only 39 percent that of the reference cushion, the load support of the blended batt cushion was greatly superior (only 34 percent compression vs. 52.5 percent compression for the reference cushion under 1 p.s.i.g. loads).

## EXAMPLE VIII

Ultramicrocellular filaments of linear polypropylene were prepared by charging a one liter pressure vessel with 300 grams linear polypropylene, 325 ml. methylene chloride, 50 grams symmetrical dichloro-tetrafluoroethane and 2.5 grams of Santocel 54 (a finely divided silica aerogel employed here as a bubble nucleating assistant). The pressure vessel was closed, heated to 180° C. and rotated slowly end-over-end for about 16 hours to achieve good mixing and solution of the contents. The pressure vessel was then positioned vertically, the temperature of the solution decreased to 150° C. and a pressure of 950 p.s.i.g. of nitrogen applied just prior to extruding the solution through a 12-hole spinneret, each hole 4 mils diameter by 8 mils long located at the lower extremity of the pressure vessel. Flash evaporation of the methylene chloride as the solution issued from the spinneret generated ultramicrocellular strands of linear polypropylene having a density of 0.012 grams per cc., a tenacity of 0.8 g.p.d. and being 34 d.p.f. (3.8 tex).

These linear polypropylene ultramicrocellular filaments were collected as a random batt which was sandwiched between garnetted polyethylene terephthalate fiberfill staple batts in a 70/30 weight ratio of foam fibers/dense fibers. This composite batt was fed through the garnett card as in previous examples, whereupon an intimate uniform blend was produced, and the ultramicrocellular continuous filaments were reduced to approximately 2-inch average staple length.

A 3-inch thick cushion was stuffed with this blend to a density of only 0.7 lb./cu. ft. Even at this extremely low density, this cushion showed better support under 1 p.s.i.g. load than a reference cushion stuffed to 3.4 lb./cu. ft. with 100 percent polyethylene terephthalate fiberfill, or another reference cushion of 5.0 lb./cu. ft. foam rubber (commercial sample), or another reference cushion of 1.6 lb./cu. ft. polyurethane foam (commercial sample).

## EXAMPLE IX

A cocarded batt was prepared as in previous examples from a 50/50 weight mixture of polyethylene terephthalate fiberfill staple and polyethylene terephthalate ultramicrocelluar fibers. The latter contained a quantity of dichlorodifluoromethane and perfluorocyclobutane as impermeant inflatants, had a density of 0.04 g./cc., a tenacity of 0.8 g.p.d. at a denier per filament of 15–20 (about 2 tex).

A 70-gram portion of this batt was used to fill a perforated metal cage 8¾ inches × 8¾ inches × 5 inches which was then dipped in a 4 percent solution of a commercial urethane polymer adhesive in 1,1,2-trichloroethane. When the excess solution had drained through the cage, the batt was dried in a circulating air oven at 250° F. (about 121° C.) for one-half hour. The batt picked up 20 g. of the elastic adhesive which resulted in increased coherence and durability. This bonded batt had a density of only 0.98 lb./cu. ft. and was compressed 17 percent at 0.2 p.s.i.g. (14 g./sq. cm.), 48 percent at 0.6 p.s.i.g (42 g./sq. cm.), and 61 percent at 1.0 p.s.i.g. (70 g./sq. cm.).

## EXAMPLE X

Partially collapsed polypropylene microcellular filaments were prepared by blending in a heated extruder equal parts by weight of isotactic polypropylene (Hercules' "Pro-Fax" 6223) and fluorodichloromethane. The resulting solution was extruded at 170° C. and 1,250 p.s.i.g. (about 85 atm.) through a cylindrical orifice 4.5 mil diameter × 8 mils long (114×203 microns) to generate a microcellular filament as the superheated solvent flashed off. These microcellular filaments were comprised of polyhedral cells defined by textured walls less than 2 microns thick. After equilibrium with ambient air was established, the filaments were in a partially deflated condition with a density of 0.0249 g./cc., a diameter of 14 mils (0.36 mm.), a tenacity of 0.4 g.p.d.

These partially collapsed microcellular filaments were fed with an equal weight of commercial polyethylene terephthalate fiberfill batting to a standard garnett card. During the blending operation the microcellular continuous filament component was reduced to staple of 1 to 4 cm. in length. The microcellular and dense fibers were uniformly distributed in the blended batt thus prepared. The blended batt was subsequently exposed under pressure for 30 minutes to an atmosphere of perfluorocyclobutane vapor in equilibrium with the liquid phase at 55° C. followed by a 15-minute heating in an air oven at 100° C., which treatment fully inflated the microcellular component filaments to a density of 0.0132 g./cc. and a diameter of 23 mils (0.58 mm.). These particular polypropylene microcellular filaments, although apparently still fully inflated, were observed to have lost all their perfluorocyclobutane inflatant within a few days after the postinflation treatment. This relatively rapid loss of inflatant is attributed at least in part to the fact that the cell walls do not exhibit uniform texture.

The blended foam/dense fiber batting was stuffed into a cotton ticking to provide a 6¾-inch (approximately 17 cm.) - diameter test cushion of approximately 4 inches (10 cm.) height. The initial filling density of 0.92 lb./cu. ft. increased to 1.26 lb./cu. ft. upon overnight exercising of the cushion to a 1½ ½p.s.i. (approximately 105 g./sq. cm.) load 8,000 cycles. This blended batting thus affords useful cushioning ability although its durability to cyclic loading is not so good ad that of comparable blended batts prepared from ultramicrocellular foamed fibers.

What is claimed is:

1. A composite resilient stuffing material comprised of a cocarded mixture of 1 to 80 percent by weight of closed-cell microcellular staple fibers of a synthetic organic polymer and characterized by having substantially all of the polymer present as filmy elements of a thickness less than 2 microns, together with 99 to 20 percent by weight of dense, substantially noncellular staple fibers, the cocarded mixture being in the form of an intimate, interentangled blend of said microcellular and dense fibers.

2. The material of claim 1 wherein said polymer is crystalline and said microcellular fibers are untramicrocellular fibers exhibiting uniplanar orientation and uniform texture.

3. The material of claim 2 wherein said ultramicrocellular fibers are composed of polyethylene terephthalate.

4. The material of claim 3 wherein said dense fibers are composed of polyethylene terephthalate.

5. The material of claim 1 wherein the cells of the microcellular fibers are fully inflated and contain an impermeant inflatant.

6. The material of claim 1 containing 25 to 65 percent by weight of said microcellular fibers and 75 to 35 percent by weight of said dense fibers, said microcellular fibers being composed of polyhedral-shaped cells having an average transverse dimension of less than 1,000 microns and which contain an impermeant inflatant, said microcellular fibers having a density of less than about 0.05 g./cc. and a diameter of less than about 0.4 inch.

7. A cushioning article containing the material of claim 1 as a stuffing.

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