CUSHION MATERIAL AND METHOD OF MAKING SAME

INVENTORS

WALTON E. CLAUSON
LORANT T. ZSOKA

By George Sullivan
Agent
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Walton E. Clauson, Milpitas, and Lorant T. Zsoka, Los Altos, Calif., assignors to Lockheed Aircraft Corporation, Burbank, Calif.

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This invention relates generally to the field of packaging and is more specifically directed to new and versatile cushioning structures utilizing one or more individually formed "cell" units, and the method of making such structure.

The packaging industry has utilized many materials having varying degrees of resiliency for cushioning articles packed in high impact strength outer containers. Among these materials have been conventional "cellular" strips of paper, shavings or strippings of wood, kapok, felt, expensive foam material, and the like. One of the major difficulties which has been encountered with the use of these materials has been a lack of controlled load bearing and shock absorbing characteristics, and often variability of load bearing and shock absorbing characteristics of the entire pack is needed for shipment by merely stuffing paper, felt, "excelsior," or the like between the article being packed and the outer container. These materials often "mat" or compress together and leave voids in the packing which cause bumping and breakage as the outer container of the package is handled.

Attempts have been made to improve upon prior packaging methods by employing a multiplicity of layers of flat, felt-like material such as fiberglass or the like. However, this practice has not proven acceptable because of the problem of compacting as noted above. Also, multi-layered packing material furnishes a more or less flat load bearing surface and has been found to resiliently contain equipment only when the load is impressed thereon within a narrow range of diversion from the perpendicular.

To alleviate the above problems and to provide a new cushioning material of improved characteristics, we have developed and tested the herein described invention which has for one of its primary objects the provision of a standard "off-the-shelf" type of individual packing unit which can be combined with other like units to produce a cushioning structure which will conform to almost any desired shape thus eliminating the necessity to incorporate specially designed and produced packing material as model changes and the like occur in a given product.

Another object of our present invention is to provide a cushioning unit which is essentially a spring member and which may be stored for extended periods of time and, for example, many years without suffering from deterioration and, which, in use, does not suffer from "fatigue" or decreased resiliency.

As a further object our invention provides a packing material which is adapted to resiliently support loads and absorb shocks which are impressed upon it from a plurality of directions whether or not these loads are simultaneously exerted.

A further object of our invention is to provide a cushioning material the resiliency of which may be easily varied in manufacture and which may be inexpensively fabricated in quantity with a minimum of costly equipment. Additionally, an important aspect of our invention resides in the particular method by which the cushioning material having these characteristics is manufactured.

With these and other objects in mind, the invention will be more specifically described by reference to the accompanying drawings wherein:

FIGURES 1 and 2 illustrate conventional methods of providing load and shock absorbing packing material.

FIGURE 3 is an isometric view of one end of an individual cell constructed in accordance with the present invention.

FIGURE 4 is a "sheet" formed by placing a number of the units shown in FIGURE 3 in side-wise relation.

FIGURE 5 is a cushioning structure comprising a stacked combination of the units of FIGURE 3, and

FIGURE 6 is a schematic operation diagram showing the method of making a cushioning unit such as shown in FIGURE 3.

Referring first to FIGURES 1 and 2, there is therein diagrammatically shown two prior art cushioning structures which have proven unsatisfactory for a number of applications. Specifically referring to FIGURE 1, it is seen that a cushioning material 1 is comprised of a plurality of fibrous "layers" lying in substantially parallel relationship one to the other. Loads are placed upon the top and bottom surfaces respectively of this material which is resilient to a given degree. However, as loads are placed upon the surfaces at an angle to the perpendicular as shown by the double arrow, the load being applied to the material is not adequately utilized. Similarly, as loads are placed on the end surfaces, little or no resiliency is encountered resulting in either a "hard" packing or a crushing of the material, thus leaving voids between the material and the equipment to be packed which allows shocking movement therebetween upon rough handling and the like.

In FIGURE 2 another standard cushioning practice is shown wherein equipment 2 is rolled in or otherwise surrounded with a plurality of layers of cushioning material such as shown in FIGURE 1. As a load is placed upon this packing material as indicated, delaminations and the formation of voids occur in the upper portion thereof, while the lower portion is compacted. Additionally, shear stress is placed upon the adjacent layers and fibers of the material in the side areas which results in further deterioration.

In accordance with the teaching of the present invention, a multi-sided or polygonal individual cellular cushion is provided by appropriately shaping a fibrous material which has been previously wound on a mandrel, the shape of which is maintained by a heat curing operation during which the individual fibers of the material are secured in the proper relation by a plastic binder. In FIGURE 3 it will be seen that cellular cushion unit 5 is of hexagonal configuration and consists of a number of layers of spirally wound material 6 which is secured in place as noted above.

We have found that one of the best materials for manufacturing the polysided cushion 5 is fiberglass of the type which is commercially available, for example, from the Owens-Corning company as noted hereinabove. In this material substantially all of the individual glass fibers are oriented in parallel planes so that substantially none of the fibers deviate angularly from the plane of the complete fiberglass mat. Thus, as illustrated in FIGURE 3, the fibers are flatly oriented in six annular segments or "pie sections" throughout a cross-section of the cushion unit 5. As illustrated in this figure, loads may be impressed upon the polysided cellular cushion 5 from substantially any direction while the resiliency of the matting is substantially preserved.

While in accordance with the teaching of the present invention, other polygonal cross-sectional configurations could be utilized, the choice of a hexagonal cross section will, as illustrated in FIGURE 5, permit "stacking" of the individual cell units in any desired cross-sectional dimension.

In FIGURE 5 it will also be seen that a load exerted
according to the arrow A will break into vector components approximately as shown by the small arrows B, part of the magnitude of which will be resiliently absorbed by a number of individual cell units, especially those surrounding the area of load application.

As noted above, commercially available fiberglass may be utilized in practicing the present invention. It has been found that resiliency and load absorbing characteristics of this invention may effectively and easily be varied by utilizing fiberglass having individual glass fibers of varying diameter, as well as by varying the degree of "cure," the thickness of the individual cells, and the degree of composition before curing, all of which will be explained to a greater extent hereinafter. We have found that fibers of, for example, .0005" to .000150" cross-sectional diameter, respectively, may advantageously be used. This fiberglass has its fibers coated with either a thermoplastic or thermosetting resinous binder. Binding agents which are utilized are phenol-formaldehyde resin, polyamides, polyethylene, melamine, and various vinyl and silicone resins. Normally, fiberglass is available in the form of thick "batts" which may or may not be factory pre-impregnated with the desired binder. In practicing the present invention we have found the utilization of fiberglass batts which have been pre-impregnated with a thermosetting resin by the manufacturer to be desired.

By the use of longer curing times or higher curing temperatures, the degree and depth of "cure", measured at an outer surface of the cellular cushion unit toward the center thereof, can be varied over a wide range depending upon the requirements of a given use.

The resiliency of the cushion material may also be varied by utilizing fiberglass batting having a different density in its uncurt state. Thus fiberglass batting is available from various manufacturers at a density of less than one pound to more than twenty-five pounds per cubic foot. Obviously, as the higher density forms are used, it will not be necessary to "cure" the resinous binder to as high a degree as would otherwise be required for a given resiliency.

Referring now to FIGURES 4 and 5, it will be seen that a plurality of the hexagonal-shaped cushions or a unit have been joined together laterally as shown in FIGURE 4 and in stacked relation as shown in FIGURE 5. In connection with this latter structure, it is noted that the resiliency, especially of the flat "sheet," is enhanced by the fact that there are a large number of "grooves" as indicated at 10 formed between the individual cell units. Thus, as a substantially flat piece of equipment is placed adjacent the composite sheet cushion, the existence of the air spaces in these grooves will aid in at least partially amortizing any shock which is encountered. Also, resiliency will be effected and enhanced by the existence of a small sheet extending the length of each individual cellular cushion formed therein by the removal of the mandrel about which the original fiberglass batting was wound.

In FIGURE 5, a stacked arrangement of cellular cushions is shown which may be made by placing together a number of sheets of cellular cushions as shown in FIGURE 4. If desired, the individual cells and/or the individual sheets made therefrom may be secured together by a plastic binder such as white vinyl plastic. Various other adhesives and plastic adhesives in addition to the "binders" or impregnants noted above may be used. In some cases the adhesive may be rigid when cured which results in a "honeycomb" type of material having excellent insulative characteristics. Obviously, any number of such sheet layers may be stacked one upon another to form a stacked arrangement such as shown in FIGURE 5. These individual sheets may also be varied in resiliency to provide a varying amount of resistance to shock over the distance between an outer container and the equipment to be protected which is contained therein.

It is, of course, a simple matter to assemble together the required number of individual cellular cushions to conform to practically any outer configuration of a device which it is desired to protect. Thus, an almost infinite variety of shapes of packed equipment can be protected by assembling together one multi-sided cushioning units of the present invention.

Referring to FIGURE 6, the method utilized in fabricating the multi-sided, cellular cushion unit of the present invention is schematically depicted.

Since, as noted above, it is desirable to have the individual cushions of the cushion in a substantially flat plane in any given multi-sided segment, it has been found necessary to form each cell unit by rolling or peeling a given thickness, for example, approximately one eighth of an inch, from commercial fiberglass "batting" since such material is ordinarily not available in the narrow thicknesses desired. Element 20 in FIGURE 6 illustrates such a fiberglass bat from which a top layer is being peeled or stripped which is wound into a circular or "jellyroll"-like spiral configuration 21 about mandrel 22. In this way the thickness and degree of compaction of the layer which is rolled into the spiral configuration can be closely controlled.

As the second step 6A, in this process, the rolled matting is placed in a polyisosed mold such as indicated at 24. As shown, mold 24 is divided into an upper and a lower portion to facilitate the insertion of the spirally-wound fiberglass. Alternatively, this spiral roll may be longitudinally forced or fed into one piece mold as is indicated at 6A.

In either event, the spirally-wound fiberglass material assumes the polyisosed shape of the mold, shown in this instance to be hexagonally shaped since it has been found that this configuration may be more readily stacked together while at the same time furnishing a large number of load bearing surfaces.

Next, as indicated at 6B, the mold with the winding of batting is desirably spun in a direction opposite that in which it was wound. This tends to force the outer peripheral wrap of the fiberglass, and its supporting layers, into close physical contact with the inner surfaces of the hexagonally-shaped mold and, additionally, has been found to decrease the possibility of misaligning or crushing of fibers. It also aids in assuring a more even distribution or density of the fibers throughout the rolled cushion configuration.

As indicated at 6C, the mold members are heated so as to initiate and maintain the curing of the resinous binder which aids in holding the fibers together. It has been found desirable to subject each of the six faces to an equal amount of heat so as to promote the uniform curing of the cushion. This is easily accomplished by rotating the mold member over a source of heat such as has been illustrated by heating coil 26. Obviously, the mold may be provided with electrical or other heating means so that the source of heat is self-contained therein.

After the curing has proceeded to the desired degree, the wound cushion material is removed and is ready to be employed either individually or combined with other such units as packing material (6D).

It has also been found that the cushioning material of the present invention serves as an excellent insulon. This is especially true of cushioning materials formed of fiberglass from the lower density ranges.

Example 1
A hexagonally-shaped cushion was formed in accordance with the teachings of the present invention by rolling or peeling a substantially uniform thickness of approximately one eighth inch off of a standard fiberglass bat having fiber diameter of from .00010" to .000150". This material is available from the Owens-Corning Fiberglas Co., San Jose, California, under the trademarked names "Fiberglas" and "Aeroacor" B or A-A denoting fiber diameters of a range of .00010"--.000150" and .00003"--.00005", respectively. In winding the material it is necessary to prevent its being compressed too tightly which results in a binding or crushing of the fibers resulting in
folds which disrupt the smoothness of the operation and adversely affect the resilient characteristics. The roll of fiberglass material was then inserted into a two-piece mold which in this instance was approximately 20 inches long. The mold containing this roll of uncured fiberglass was then spun in the direction opposite to the winding of the material, the spinning operation taking place at approximately three hundred and fifty revolutions per minute. After spinning, the mold containing the material was subjected to heat, and the same was continuously rotated in this instance.

Example 2
A roll of fiberglass material was made by peeling approximately a one eighth inch thick layer off of a fiberglass bat of Owens-Corning "Aerocoor" A--A in a manner similar to that described in connection with Example 1, following which the roll was longitudinally inserted into a one piece hexagonally shaped mold. Gently forcing the material into the mold in this manner aids in shaping the fiberglass material to conform to the hexagonal configuration and to completely fill the inner portion of the mold. Especially when this type of mold operation is used, the spinning step noted in connection with Example 1 may be omitted if desired although it has been found that a more constant density material results when this step is included. After the fiberglass was inserted into the mold, the same was cycled substantially as noted in connection with Example 1. The "gentle" insertion of the roll into the mold allows the glass fibers to "compact" or interslide one upon the other which aids in eliminating buckling.

Thus, a cushioning structure and method of making the same has been described which provides, in addition to its insulating characteristics, a plurality of predetermined size, load-bearing surfaces upon which loads can be exerted from various directions and which, when assembled into a composite sheet or stack of cushioning material, substantially completely fills a given area with shock absorbing packings, the density of which may be closely controlled over a wide range, thus enabling the resiliency of the individual or composite structures to be precisely predetermined for use in given applications.

While the invention has been described in connection with the accompanying drawings showing specific embodiments thereof, it should be understood that the invention is not to be limited thereto as many variations will be readily apparent to those skilled in this particular art, and the invention is to be given the broadest interpretation within the terms of the following claims.

What is claimed is:
1. A resilient fiberglass cushion structure comprising a plurality of hexagonally shaped resilient cushioning units stacked together with at least two of the six load bearing surfaces in each of said units in contiguous relationship with like load bearing surfaces of adjacent cushioning units, and in which each of said cushioning units consists of a multiplicity of convolutions of fibrous material, the individual fibers of which are resiliently secured together by a heat curable resinous binder, and in which the individual fibers of said fibrous material in a given pie section of cross-sectional structure are maintained in a plurality of substantially parallel planes, said fibrous material extending substantially completely through the diameter of each of said cushioning units.
2. The method of making a polysided cushioning unit comprising the steps of rolling a relatively thin sheet of fiberglass material which has been impregnated with a resinous binder into a roll, inserting said roll into a mold of polygonal cross section, spinning said mold and said fiberglass in the direction opposite to the direction in which said fiberglass roll was wound to ensure that the fiberglass roll assumes substantially the shape of said mold, heating said roll to polymerize to a predetermined extent said resinous binder, and removing the resulting multi-sided resilient cushion unit from said mold.

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