Nov. 27, 1973 C. D. GILMORE 3,775,526

METHOD OF MODIFYING THE CHARACTERISTICS OF FLEXIBLE CELLULAR MATERIAL

Original Filed Aug. 1, 1969

Fig. 1.

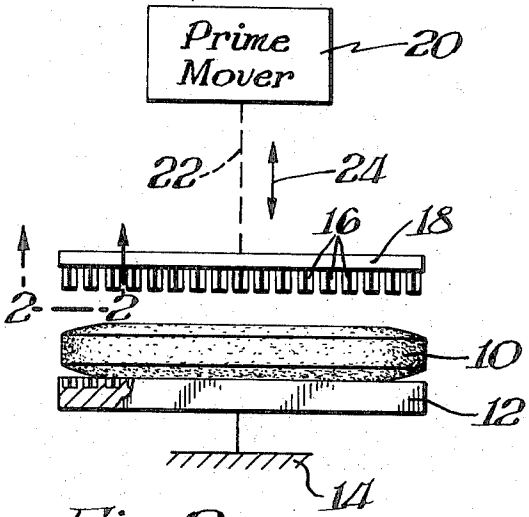


Fig. 2.

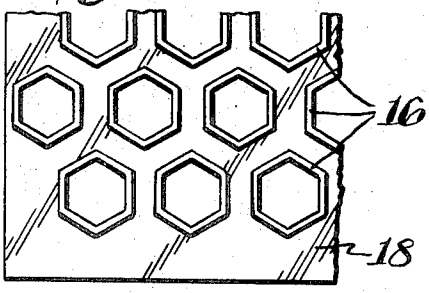


Fig. 3.

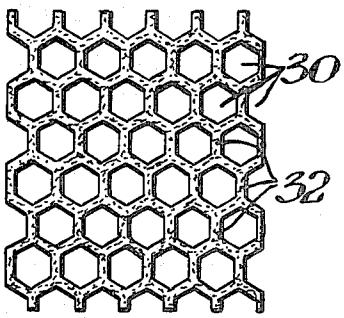


Fig. 4.

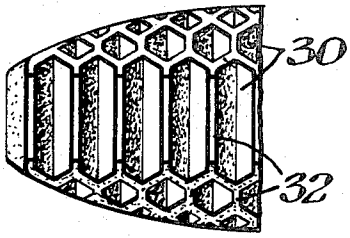


Fig. 5.

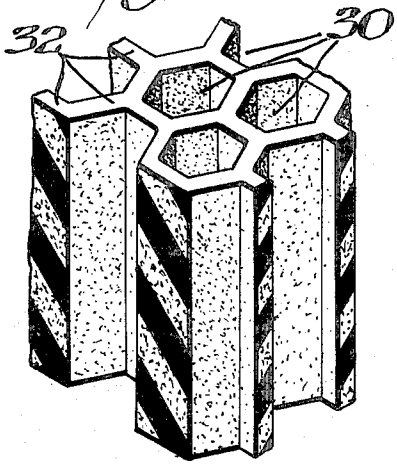
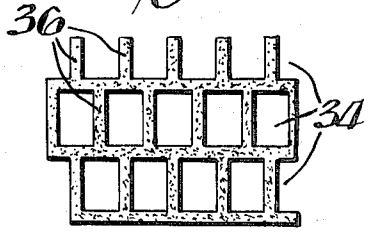


Fig. 6.



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United States Patent Office 3,775,526
Patented Nov. 27, 1973

3,775,526

METHOD OF MODIFYING THE CHARACTERISTICS OF FLEXIBLE CELLULAR MATERIAL

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Continuation of abandoned application Ser. No. 846,880, Aug. 1, 1969. This application Jan. 12, 1972, Ser. No. 217,404

Int. Cl. B29d 27/00

U.S. Cl. 264—156 8 Claims

ABSTRACT OF THE DISCLOSURE

There is described herein a method of modifying the characteristics of a foam bun for use as a pillow and the like by producing a flexible foam structure whose cells are at least partially mechanically reticulated. This mechanical reticulation, provided by mechanically cutting cores from the bun, enhances the porosity and resilliency of the bun.

BACKGROUND OF THE INVENTION

This is a continuation of application Ser. No. 846,880 filed Aug. 1, 1969, now abandoned.

Although feather or down pillows have been in use for many years they are difficult to clean and tend to become thin and dusty after extended use. Such pillows are completely unsuitable to repeated cleanings, and further cause great dismay to many of those suffering from allergies. Over the years attempts have been made to use other types of more suitable materials in the production of pillows. For example, foam rubber and more recently, synthetic, flexible polymeric materials have been used. Unfortunately, none of these other materials has been entirely suitable. Some are difficult to wash and this tends to limit the life of the pillow. Others have such a high degree of resiliency that they are uncomfortable to users; still others do not "breathe" and hence, are hot and tend to cause perspiration of the user particularly in the case where such materials are used for the mattress as well as the pillow.

Attempts to improve the resiliency or "feel" of the prior art of pillows and the like have included molding the pillows to provide a network of ribs enclosing a pattern of cavities. While these products have been more satisfactory than those generally available in the prior art, the molding process tends to seal the cellular structure of the polymer material so that the pillow cannot easily be cleaned and, even so, the pillows are often too resilient for the user. If the cavities are formed large enough so that the resiliency is decreased sufficiently, the pillow has pressure points which are uncomfortable to the user.

Another object of this invention is to provide an improved method of forming resilient, open celled foam articles.

BRIEF DESCRIPTION OF THE INVENTION

In a preferred embodiment of the invention a flexible, isocyanate-polyurethane derived polymer foam bun-like body is subjected to the simultaneous cutting and compressing action of a matrix of symmetrically disposed dies. Each of the dies cuts or cores a cavity in the foam bun having a polygonal cross-section and is disposed in the matrix such that the network of the foam material is left in the bun with each of the cavities separated by walls of the foam having uniform thickness. During the compression of the bun, which occurs during the die cutting process, many of the individual cell walls that remain unbroken after the foam is produced are ruptured. This additional pore rupturing so enhances the porosity and resilience of the foam that it is far more pleasing to the user. In the application of the bun for a mattress or pillow, it is preferred that the cavities have a hexagonal cross-section. This produces a pillow or mattress which is cool and comfortable to the sleeper, non-allergenic, easily washable and dryable, breathable so that the pillow does not feel hot, and which provides body support without spotty or uneven pressure or push-back to the body. This latter feature along with its breathability tends to prevent bed sores. The fact that the cavities extend through the depth dimension of the pillow and the fact that the walls have a uniform thickness provide easy access of air or water for cleaning to all portions of the pillow.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will be best understood from the following description when read in connection with the accompanying drawings in which:

FIG. 1 is a block diagram of a press utilizing a die matrix arranged according to a preferred embodiment of this invention to modify the physical characteristics of a bun of foam;

FIG. 2 is a bottom view of the dies utilized in the press of FIG. 1;

FIG. 3 is a plan representation of a pillow produced utilizing the press and dies of FIG. 1 in which the individual dies are hexagonal in cross-section and arranged in a regular matrix network;

FIG. 4 is an elevation view of the pillow shown in FIG. 3;

FIG. 5 is a pictorial view of two or three of the cavities of the pillow illustrated in FIGS. 3 and 4; and

FIG. 6 is a partial plan view of another shape of cavity that may be formed or used in foam articles produced in accordance with this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 a bun **10** of a flexible foam material having a cellular structure to be processed according to this invention into a pillow, mattress or the like is placed upon a plate or bed **12** secured to a suitable support **14**. The bun **10** may be any synthetic, plastic polymer. In a preferred embodiment of the invention the polymer may be a flexible foamed, isocyanate-polyurethane derived polymer. Polymers derived from isocyanate are generally designated according to the type of polymeric groups forming the major portion of the ultimate molecule. These groups include polyesters, polyethers, polyether amines and the like. Thus these polymers may be termed polymeric-polyester-polyurethane, a polymeric-polyether-polyurethane, and so forth.

The particular manner in which the buns **10** are formed is not important to the invention since the foamed cellular structures containing isocyanate derived polymers have been well known for years and are available commercially from many companies. It may be stated, however, that to produce a so-called flexible foam, that the foaming process during manufacture is conducted to produce an open cell product. This open cell product may contain a few or many of the cell walls or faces ruptured, i.e., the cells are intercommunicating and hence are porous and the foam bun has a degree of resiliency. In this so-called flexible or open cell foam, many of the faces of the particular cells within the foam are covered by membranes but yet each cell is communicating with at least one other cell through an open face of the cell. These flexible foams have a cellular structure which is resilient and is able to recover its original shape after deformation, either com-

pressive or tensive. As the individual cells expand during the formation of the foam, and they come into contact with adjacent cells, there is some rupturing of the cell faces which occurs due to the gas pressure causing the expansion. Unfortunately, since all the cell faces are not ruptured they tend to give the normal flexible foam materials that are produced a higher degree of resiliency and a lower breathability or porosity than is typically desired for use in a mattress or pillow.

In accordance with this invention, the bun **10** preformed to the general shape of a pillow, mattress, or the like is subjected to the simultaneous cutting and compressive action of a matrix of hollow, polygonal-shaped dies **16** which are positioned upon a press **18** adapted to be driven by a prime mover **20**, acting through a linkage denoted by the dashed line **22**, upwardly and downwardly as denoted by the arrow **24** in the drawing. In the preferred form of this invention, each of the dies **16** has a hexagonal cross-section. The dies are positioned in rows and columns so as to provide a regular matrix as may be seen from the cut product illustrated in FIG. 3. This regular matrix is such that the spacing between the adjacent sides of each die is constant and equal. The plate **12** may have formed therein a corresponding matrix of recesses or mating dies **23** as seen in the partly cutaway portion of FIG. 1, adapted to receive corresponding ones of the dies **16** to aid in forming a clean, sharp, cut in the bun for each cavity **30** (FIGS. 3, 4 and 5).

To modify the foam bun **10** in accordance with this invention, the prime mover **20** is actuated to cause the matrix of dies **16** to compress the pillow **10** to a relatively small thickness until finally the sharpened dies **16** cut through the foam thereby producing a honeycombed product as seen in FIGS. 3, 4 and 5. As may be noted in these figures, the honeycombed product includes a plurality of cavities **30** each having the hexagonal cross-section of the dies **16**. These cavities extend completely through the thickness of the bun **10** as seen in FIGS. 3, 4 and 5 in particular and define a regular symmetrical pattern having a web-like network of walls **32** between the several cavities. Each of the walls **32** between adjacent cavities is of substantially uniform and equal thickness. As the bun **10** is compressed and cut by the dies **16** cooperating with the mating dies **23**, the extreme compression produced thereby along with the cutting action of the dies **16** mechanically ruptures or tears many of the remaining cell faces or walls making up the foam structure such that the reticulation or porosity of the foam is increased.

This increased porosity facilitates washing the pillow. Also because of the increased porosity, the pillow is more breathable and hence cooler to the user. Because of the material it is made of, it is generally non-allergenic and because of the honeycomb design provides firm yet continuous support without causing the usual spotty or variable area pressures upon the body that have been characteristic of many products of the prior art. In a typical case a pillow that is normally four inches thick prior to processing in accordance with this invention is placed within the press containing the matrix of dies **16**. During the cutting operation, the movement of the dies **16** downwardly compresses the foam down from a four inch thickness until it is typically in the neighborhood of one-quarter of an inch thick before the cutting begins. At this point, the cavities **30** are cut within the foam bun quickly, neatly and easily. The compression of the bun prior to cutting is thus seen to be more than 9 to 1. Lower compression ratios may be used, but ratios exceeding 9 to 1 are preferred. Because the cavity walls have been cut rather than molded (as is typical in the prior art) the more rigorous cutting and tearing action of the dies **16** aids, in addition to their compressive action, to open up the cells within the network wall structure **32**.

In another embodiment of the invention, the cavities need not have a hexagonal cross-section but rather may have any other polygonal shape, so long as the cavities are arranged in a regular pattern with the spacing between the walls of adjacent cavities being equal, i.e., the wall thickness of the network **32** defining the cavities should be uniform. For example, the cavities may have a rectangular cross-sectional area **34** as is illustrated in FIG. 6. The rectangular cavities **34** are defined by walls **36** having uniform thickness. The rows of cavities **34** preferably are offset or staggered to improve the sidewise support provided by the walls **36**. In other embodiments, the cross-section area may be diamond-shaped, square, triangular, etc. The particular size of the walls and cavities is not vital, but for the preferred hexagonal cross-section cavity a diameter of ¾ inch and wall thicknesses of ¼ inch have been found to provide particularly desirable qualities for the pillow. Actually, the wall thicknesses may vary between 1/16 and 1 inch and the cavity diameters (or maximum width dimension) between ¼ and 3 inches.

There has thus been described a novel method and a structure which finds use as a pillow, mattress or other body supporting or aiding element. The structure produced is porous and thereby easily cleaned and yet provides a good "feel" to the user. In actual tests run a pillow 4 x 15½ x 23 inches constructed according to this invention and a comparably sized block of flexible foam were contaminated with bacterial cultures of *Serratia marcescens* and *Bacillus subtilis*. The pillow and block of foam were then washed in a home washer. The pillow of this invention showed a 400-fold reduction in contaminant level after washing while the block of foam showed only a 14-fold reduction in contaminant level. Further after washing, the pillow dried more quickly than the block of foam. The cut material or cores may be removed from the dies and sold as packaging material if desired.

It is obvious that many embodiments may be made of this inventive concept and that many modifications may be made in the embodiments hereinbefore described. Therefore, it is to be understood that all descriptive matter herein is to be interpreted merely as illustrative, exemplary, and not in a limited sense. It is intended that various modifications which might readily suggest themselves to those skilled in the art be covered by the following claims, as far the prior art permits.

What is claimed is:

1. A method of producing cavities in a flexible cellular material which cavities have walls of uniform thickness which method comprises:

placing said material upon a support,

pressing upon said material with a vertically reciprocating pressure element containing a plurality of hollow non-rotating, cutting dies having sharp cutting edges for subjecting said material to compression and simultaneously subjecting said material to the unidirectional cutting action of said edges, thereby producing a plurality of cavities characterized by clear, sharp walls and axes that are substantially parllel, thereby rupturing some walls of cells in said material, and

removing said pressure element from the resulting material which due to its flexibility substantially recovers its original shape and which due to said cavities and said ruptured cells has increased porosity and resilience.

2. A method in accordance with claim **1** in which the plurality of hollow cutting dies are arranged in a regular, symmetrical pattern.

3. A method in accordance with claim **1** in which said material is a polymeric urethane foam and in which said plurality of hollow cutting dies is arranged in rows and columns, whereby said walls have substantially uniform thickness, porosity and resilience.

4. A method in accordance with claim **1** in which said pressing is effected to result in the compression of said material in a ratio of at least about 9 to 1.

5. A method in accordance with claim **1** in which said plurality of hollow cutting ides are spaced with their

peripheries between about 1/16 inch to about 1 inch apart.

6. A method in accordance with claim 1 in which said plurality of hollow cutting dies have a polygonal cross-section, whereby said walls have substantially uniform thickness, porosity and resilience.

7. A method in accordance with claim 6 in which said polygonal hollow cutting dies lie in substantially parallel planes thereby forming a web-like network of said walls of uniform thickness between said plurality of cavities.

8. A method in accordance with claim 1 in which said compression is effected prior to any substantial cutting effected by said cutting edges of said dies.

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U.S. Cl. X.R.

264—54, 163, 321