United States Patent [19]

Graebe

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[45] **Mar. 11, 1975**

[54] **MULTICELLED STRUCTURE APPARATUS FOR MAKING SAME**

[76] Inventor: **Robert H. Graebe,** 4 Signal Hill Blvd., Belleville, Ill. 62223

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[52] **U.S. Cl.** **425/269,** 425/275, 425/403, 161/116

[51] **Int. Cl.** **B29c 13/00**

[58] **Field of Search** 425/93, 269, 275, 403, 425/383; 161/116

[56] **References Cited**

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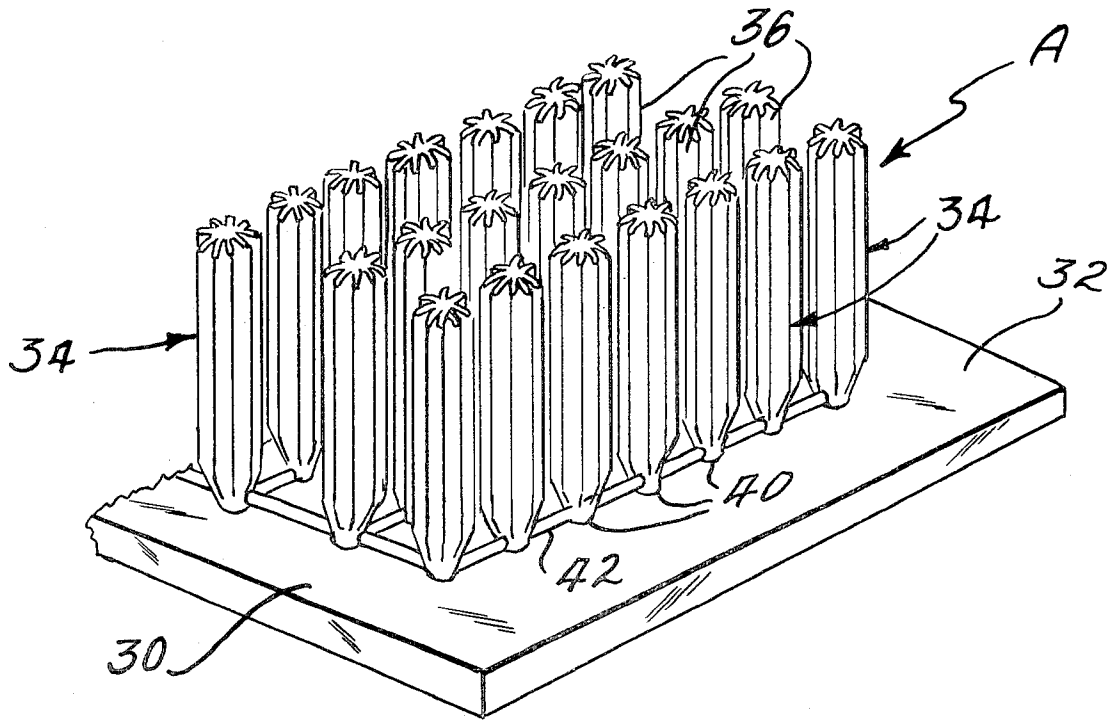
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Primary Examiner—Robert L. Spicer, Jr.
Attorney, Agent, or Firm—Gravely, Lieder & Woodruff

[57] **ABSTRACT**

A multicelled structure which may be used as a body support or other cushioning device has inflatable cells against which a supported or cushioned body bears. The structure is formed from a flexible material on mandrels which have a fluted or other shaped configuration and spaced apart. This prevents the material which is in a soft or uncured condition from bridging adjacent cells during the forming operation. The fluting or shape on the resulting cells is configured to enable the side walls of adjacent cells to closely approach or contact each other when the cells are expanded by internal fluid pressure so that the end walls of the cells form a generally continuous surface.

14 Claims, 8 Drawing Figures



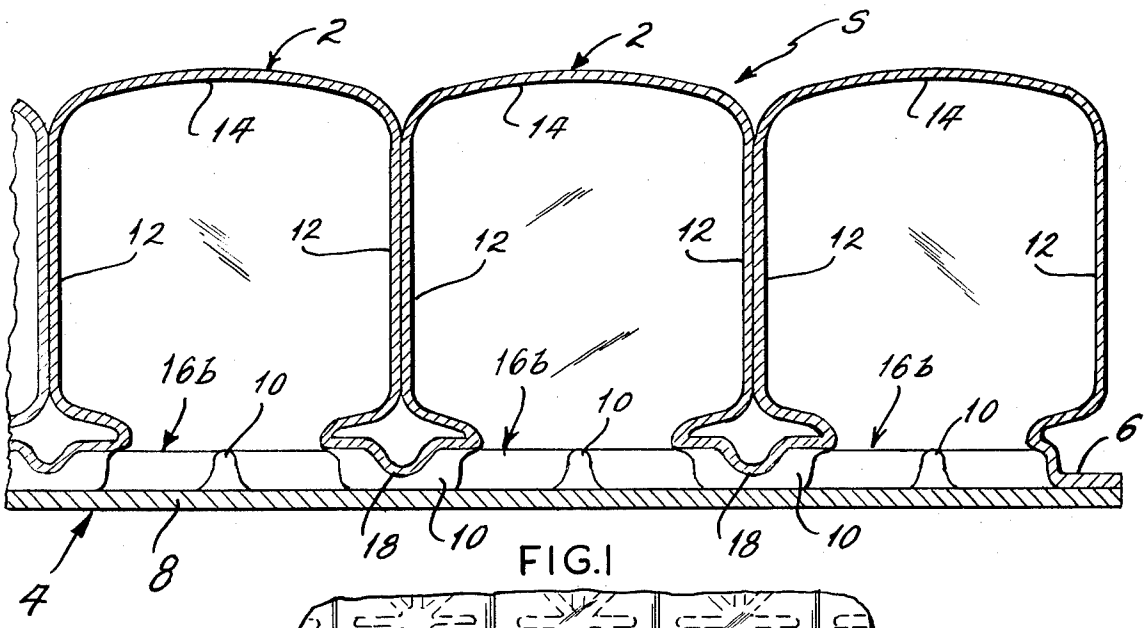


FIG.1

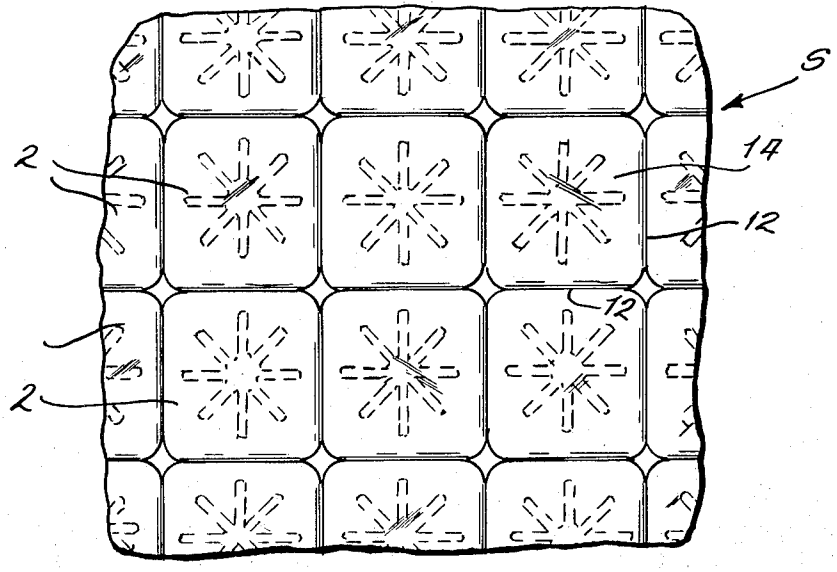


FIG.2

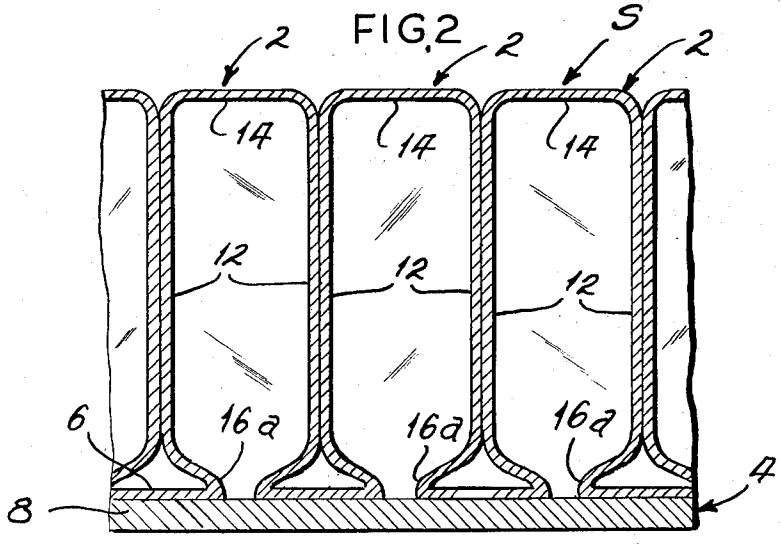


FIG.3

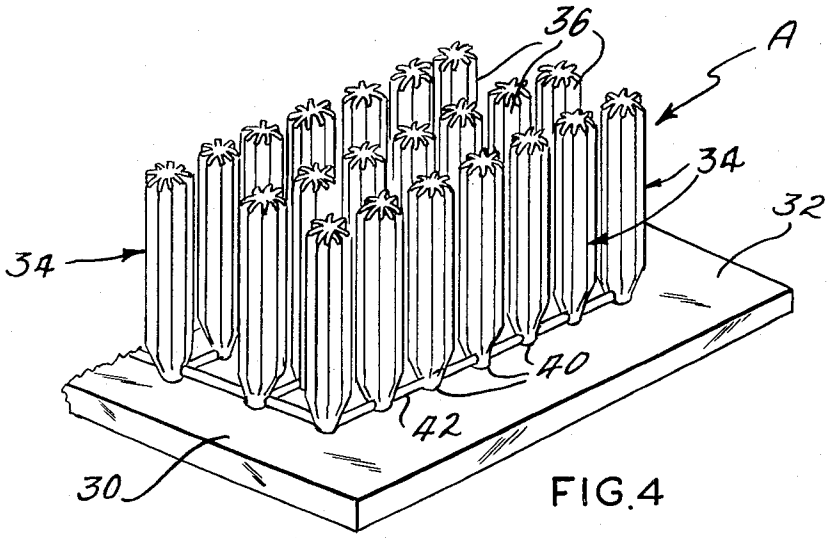


FIG.4

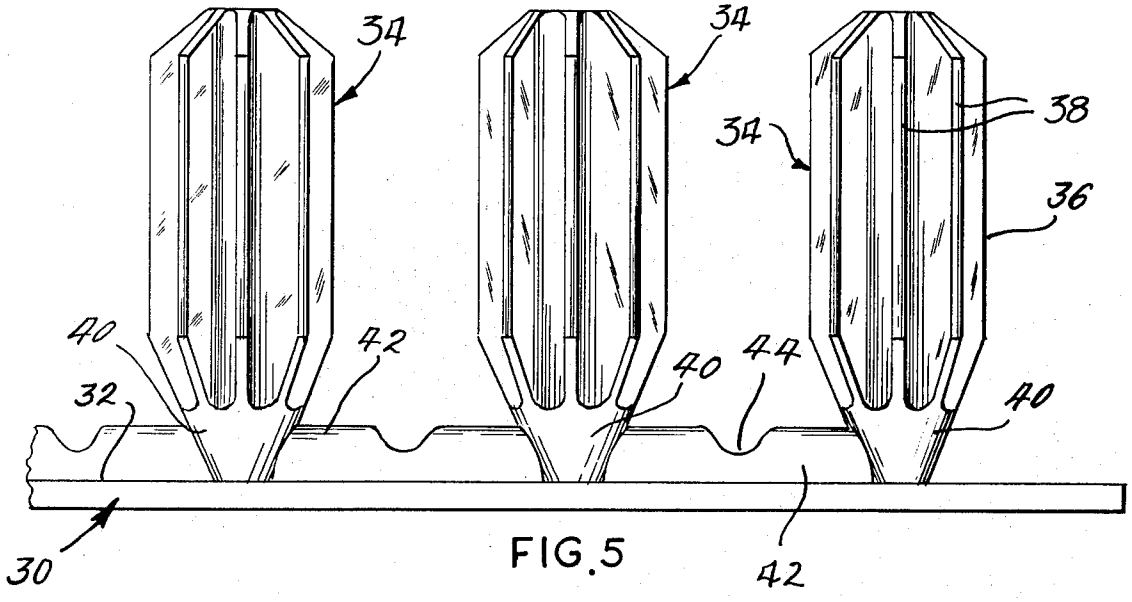


FIG.5

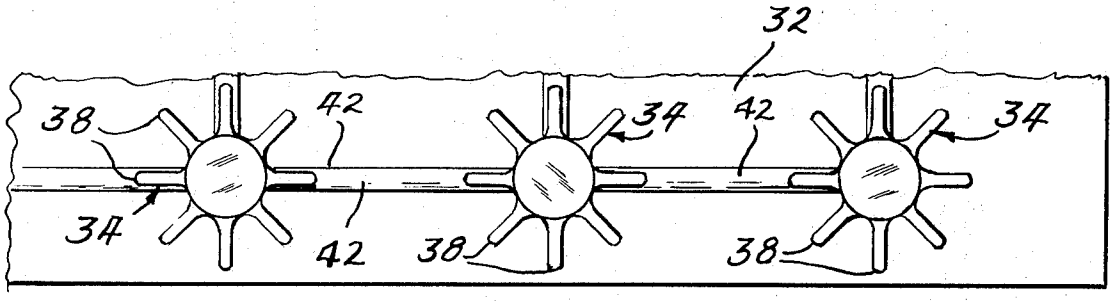


FIG.6

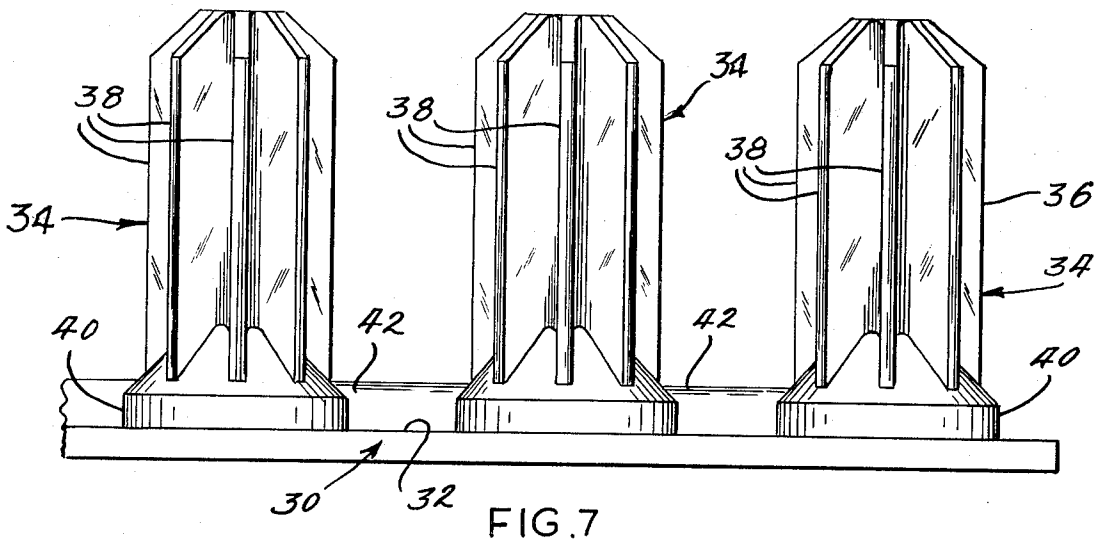

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FIG. 7

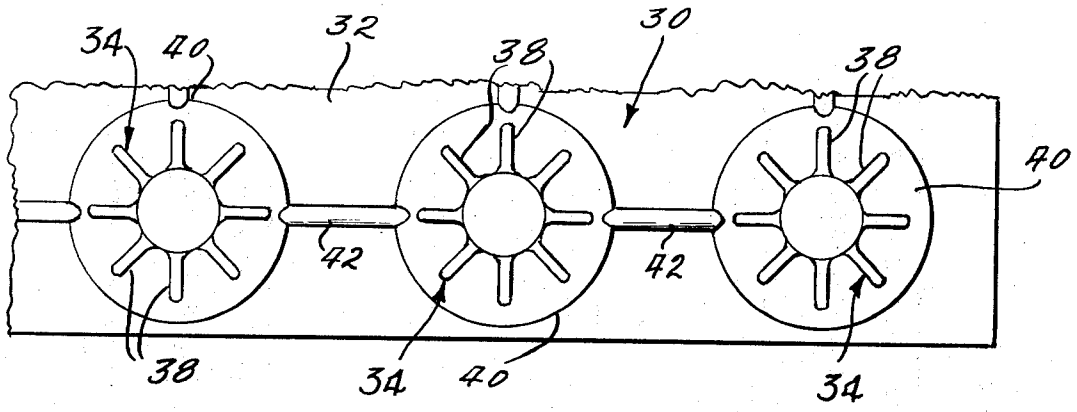

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FIG. 8

MULTICELLED STRUCTURE APPARATUS FOR MAKING SAME

BACKGROUND OF THE INVENTION

This invention relates in general to multicelled structures such as a body supporting device and more particularly to a method and apparatus for forming inflatable devices as well as the inflatable device itself.

Through clinical tests it has been determined that one of the better methods of preventing the development of bed sores on invalids is to support such persons on a series of flexible intercommunicated cells. Since the cells are intercommunicated all exert an equal supporting force against the engaged individual. Such an arrangement of cells is disclosed in U.S. Pat. No. 3,605,145.

In order to have the supporting force distributed over as large an area as possible, it is necessary to have the sides of the cells in close proximity to one another and preferably touching one another. When this condition exists, the ends of the cells form a generally continuous and conformal surface on which the supported individual sits or reclines. Such devices may be used for general cushioning and impact protection purposes also.

Heretofore, the only practical method of producing multicelled structures with closely spaced or contacting cells was to mold, dip or otherwise form the cells individually and then secure them to a base capable of providing physical support and/or intercommunication between the cells. This procedure is not only time consuming and expensive, but also leaves the finished product with a multitude of seams along which leaks may develop. Hence, it is desirable to form the multicelled structure as an integral unit.

SUMMARY OF THE INVENTION

One of the principal objects of the present invention is to provide a process and an apparatus for producing a multicell structure such as a body supporting device in which the cells are formed along with a base as an integral unit and when inflated will contact or nearly contact one another. Another object is to provide a process and an apparatus of the type stated which are economical and easy to use. A further object is to provide a process and an apparatus for producing a multicell structure which has a minimum amount of seams and hence is very reliable. It is a further object to produce cells which have a large range of height to diameter or base area ratios. An additional object is to provide a multicell structure which is inexpensive and extremely reliable. These and other objects and advantages will become apparent hereinafter.

The present invention is embodied in an apparatus for forming a multicell structure having expandable cells which are initially in a configuration so that the cells when formed are spaced apart but when later expanded by a pressurized fluid can have various shaped cross sections and will contact or be closely spaced to one another at their side walls. The invention also resides in the multicelled structure itself as well as the process for forming the fluted cells. The invention also consists in the parts and in the arrangements and combinations of parts hereinafter described and claimed.

DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form part of the specification and wherein like numerals and letters refer to like parts wherever they occur:

FIG. 1 is a sectional view of a multicell structure such as a body support having intercommunicated cells;

FIG. 2 is a plan view of the multicell structure of FIG. 1 and showing the cells when deflated in interrupted lines;

FIG. 3 is a sectional view of an alternative multicelled structure having pneumatically independent cells;

FIG. 4 is a perspective view of a flat based tool used to form a multicelled structure having intercommunicated cells;

FIG. 5 is a detailed elevational view of the fluted mandrels illustrated in FIG. 4 where the fluted mandrel has a reduced connecting portion;

FIG. 6 is a plan view of one row of the tool illustrated in FIG. 4;

FIG. 7 is an elevational view of a alternate fluted mandrel which may be used to form the multicelled structure of FIG. 1 where the fluted mandrel has a conical pedestal like connecting portions; and

FIG. 8 is a plan view of the tool illustrated in FIG. 7.

DETAILED DESCRIPTION

Referring now to the drawings (FIGS. 1–3), S designates a multicell structure which forms part of the present invention and is produced with the tooling and in accordance with the process of the present invention. The multicell structure S includes a plurality of cells **2** attached to a common base **4** comprised of an intervening layer **6** occupying the area between the cells **2** and a sealing layer **8** underlying the intervening layer **6.** The intervening layer **6** is preferably embossed between adjacent cells **2** to provide internal fluid transfer channels **10** which interconnect the cells **2** so that all the cells **2** are in communication (FIG. **1**). This results in equal pressure within the cells **2.** However, the cells **2** may be pneumatically independent of one another (FIG. **3**).

The base should be provided with a valve for inflating the body support S. The multicell structure S is used as a cushioning device or impact aborbing device. It is ideally suited for use as a body support such as a mattress or seat cushion. Each cell **2** has a side wall **12,** an end wall **14,** and a connecting portion **16** interposed between the side wall **12** and intervening layer **6** of the base **4** for attaching the cell **2** to the base **4.** The connecting portion may take the form of a reduced neck **16***a* (FIG. **3**) or a flared or otherwise enlarged pedestal **16***b* (FIG. **1**). When deflated the side wall **12** possesses a fluted configuration, and the side walls **12** of adjacent cells **2** are spaced a substantial distance apart (FIG. **2,** dotted lines). However, when the cells **2** are pressurized, the side walls **12** assume a generally cylindrical configuration or they can be made to form other cross-sectional shapes. However, the side walls **12** of adjacent cells **2** may contact and interfere with one another to such an extent that they deform each other into more or less rectangular configurations (FIG. **2,** full lines). The fit is quite tight, and as a result the end walls **14** of the air cells **2** form a generally continuous outwardly exposed surface on multicell S. This surface will conform to objects forced against it and hence may be described as a conformal surface. The fluid transfer channels **10** when used may be provided with restrictions **18** to regulate the rate of fluid transfer between cells **2.**

The apparatus or tool A for forming the multicell structure S includes (FIGS. **4–8**) a base member **30** having a generally flat surface **32,** and mandrels **34** pro-

jecting outwardly from the surface **32.** The mandrels **34** are arranged in longitudinally and transversely extending rows (FIG. **4**). Moreover, the mandrels **34** are spaced from one another as may be required to accommodate a mix of mandrel sizes.

Each mandrel **34** for most of its length is fluted, having a fluted portion **36** provided with a plurality of radially directed ribs **38.** The longitudinal axis of each mandrel **34** as well as the longitudinal axes of the ribs **38** thereon are perpendicular to the intervening flat surface **32** and are hence disposed at a steep angle with respect to that surface. The upper ends of the ribs **38** may be tapered to affect the pressurized shape of the cell **2** formed thereon. The opposite end of the fluted portion **36** merges into the attaching portion **40,** or may extend all the way to the surface **32** on the base member **30.** If the tool A is to form cells **2** having reduced necks **16***a*, then the attaching portion **40** of the mandrel **34** should taper inwardly (FIG. **5**). On the other hand, if the mandrel **34** is to form cells **2** having a flared pedestal **16***b*, then the attaching portion **40** of the mandrel **34** should flare outwardly (FIG. **7**). When the fluid transfer channels **10** are desired in the multicell structure S, the attaching portions **40** of adjacent mandrels **34** are joined by elongated embossments **42** which project outwardly from the surface **32** of the base member **30.** Approximately midway between their ends the embossments **42** may be reduced in thickness to form necks **44.**

The cells **2** and the intervening layer **6** of the multicelled structure S may be formed as an integral unit by dipping the tool A into a vat containing a suitable coating material in liquid or semiliquid condition. The tool A is immersed sufficiently to enable the liquid to cover and coat the flat surface **32** on the base member **30.** The material should, of course, adhere to the mandrel **34** so as to coat the mandrel **34** as it is dipped. Preferably, this material is of such a nature that it can be cured to a flexible impervious condition. The tool A is dipped to provide a coating of desired thickness, and once this coating is acquired, the tool A is removed from the vat and the coating is cured to the extent that it assumes desired characteristics. Then the integrally formed cells **2** and intervening layer **6** are stripped from the tool A. If the cells **2** are formed with enlarged pedestals **16***b*, or have ribs **38** extended straight to the surface **32,** adequate draft angles can be used to permit the use of a two piece pressure mold as may be used for injection molding. In this connection, the cells **2** and integral intervening layer **6** can be formed in an injection molding operation also.

Once the integrally formed cells **2** and intervening layer **6** are removed from the tool A, the sealing layer **8** of the base **4** is adhesively or otherwise secured to the back face of the intervening layer **6,** both along the periphery of the base **4** and also between adjacent air cells **2.** The sealing layer **8** is merely a flat sheet of suitable material. As a result those portions of the intervening layer **6** which are molded about the elongated embossment **42** will be raised from the sealing layer **8** and hence, from the fluid transfer channels **10** in the common base **4.** Since the sealing layer **8** is secured to the intervening layer **6** between adjacent cells **2;** the base **4** will not balloon outwardly when the multicell structure S is pressurized.

The ribs **38** on the fluted portion **36** of the mandrel **34** enable the cells **2** to be formed in a configuration relatively small in diameter. This, in turn, prevents the coating material from bridging adjacent mandrels **34** so that the cells **2** as formed are separate and distinct from one another. They need not be cut apart. Nevertheless, the ribs **38** provide sufficient wall surface on the side walls **12** of the cells **2** to enable the cells **2** when pressurized to assume a much larger diameter. Indeed, the side walls **12** possess sufficient material to enable adjacent cells **2** to contact one another and in so doing substantially deform each other. As a result, the end walls **14** of the cells **2** form a substantially continuous surface across the upper end of the body support S.

Other mandrel shapes can also be used. A rectangular or otherwise elongated cross sectional shape in lieu of a fluted cross sectioned shape for the mandrels **34** would produce cells **2** which would also tend to assume a cylindrical configuration when pressurized and therefore be made to contact adjacent cells **2.** The fluted mandrel yields the largest cell inflation diameter to mandrel diameter and is therefore the preferred configuration.

When the multicell structure S is made with all the cells **2** flexible and intercommunicated through the fluid transfer channels **10,** the continuous upper surface formed by the end walls **14** of the cells **2** is highly conformal in nature and will easily conform to the contour of objects placed against it. For example, if an invalid sits or reclines on the multicell structure S, the end walls **14** of the cells **2** will conform to and contact practically the entire skin area overlying the multicell structure S. Therefore, the supporting force exerted by the multicell structure S is spread over the entire skin area and is not concentrated in localized areas as is true of mattresses of current construction. As a result, the chances of bed sores developing are minimized when the structure S is used as a mattress or seat cushion for invalids.

In lieu of forming the base member **30** of the tool with a flat surface **32** from which the mandrels **45** project, the surface **32** may be cylindrical or spherical.

The cells **2** and intervening layer **6** need not be formed from a flexible or elastomeric material, but instead may be formed from a material such as a metal. In that case the metal can be applied on the mandrels **34** and base **30** in a electroforming process.

This invention is intended to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

What is claimed is:

1. An apparatus for producing from an initially fluent material a cushioning device having flexible inflatable cells formed integral with and projecting outwardly from an intervening layer, said apparatus comprising: a base member and mandrels projecting outwardly from the base member such that each of the mandrels except those mandrels located at the periphery of the base is surrounded by other mandrels, the base member having an intervening surface extended between the mandrels with that surface being substantially continuous and substantially free of voids, the mandrels being fluted along their sides to form grooves and ribs with the longitudinal axes of the grooves and ribs for each mandrel being at a steep angle with respect to the portion of the intervening surface surrounding that mandrel whereby, when the mandrels and intervening sur-

face are coated with the initially fluent material and that material is allowed to solidify, the cushioning device is formed with the shape of the flexible cells being determined by the mandrels and the shape of the intervening layer being determined by the intervening surface on the base.

2. An apparatus according to claim 1 and further characterized by means on the base member for further forming the material into embossed channels which open into the interiors of the cells.

3. An apparatus according to claim 1 wherein the ends of the flutes are spaced from the base member and the portions of the mandrels between the flutes and the base member form attachment portions at which the mandrels are connected to the base member.

4. An apparatus according to claim 3 wherein the attachment portions are of lesser thickness than the fluted portions of the mandrels so as to form reduced necks at the ends of the cells.

5. An apparatus according to claim 3 wherein the attachment portions are of greater diameter than the fluted portions of the mandrels so as to form enlarged connecting pedestals at the ends of the cells.

6. An apparatus according to claim 3 wherein the attachment portions are tapered.

7. An apparatus according to claim 3 and further characterized by elongated embossments extending between the attachment portions of mandrels for shaping the material into connecting fluid transfer channels which open into the hollow interiors of the cells.

8. An apparatus according to claim 1 wherein the mandrels are imperforate.

9. An apparatus according to claim 1 wherein the ribs of each fluted mandrel are spaced at equal circumferential intervals around the mandrel.

10. An apparatus according to claim 1 wherein the intervening surface is substantially planar and the axes of the mandrel ribs and grooves are perpendicular to the intervening surface.

11. An apparatus for producing from an initially fluent material a cushioning device having flexible inflatable cells formed integral with and projected outwardly from an intervening layer, said apparatus comprising: a base member and mandrels projecting outwardly from the base member, the base member having an intervening surface extended between the mandrels with that surface being substantially continuous and free of voids, each mandrel having its longitudinal axis presented at a steep angle with respect to the portion of the intervening surface from which the mandrel projects, each mandrel also having lontiduinally extending flutes, the mandrels further being arranged such that each mandrel except the mandrels at the periphery of the apparatus is surrounded by other mandrels, whereby when the mandrels and intervening surface are coated with the initially fluent material and that material is allowed to solidify, the cushioning device is formed with the shape of the flexible cells being determined by the mandrels and the shape of the intervening layer being determined by the intervening surface on the base.

12. An apparatus according to claim 11 wherein the base has embossments on the intervening surface with the embossments extended between adjacent mandrels.

13. An apparatus according to claim 11 wherein the flutes of each mandrel are spaced at equal circumferential intervals around the mandrel.

14. An apparatus according to claim 11 wherein the intervening surface is substantially planar and the longitudinal axes of the mandrels are perpendicular to the intervening surface.

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