United States Patent [19]

Marangoni

[11] **3,829,900**

[45] **Aug. 20, 1974**

[54] **SAFETY HAT ENERGY ABSORBING LINER**

[75] Inventor: **Roy D. Marangoni,** Pittsburgh, Pa.

[73] Assignee: **Mine Safety Appliances Company,** Pittsburgh, Pa.

[22] Filed: **Aug. 30, 1973**

[21] Appl. No.: **392,957**

[52] **U.S. Cl.** ..... **2/3 R,** 161/68

[51] **Int. Cl.** **A42b 3/00**

[58] **Field of Search** ..... 2/3 R, 4, 5, 6, 192, 200; 5/345 R, 355, 361 B, 361 R; 161/68; 52/629, 746, 747

[56] **References Cited**

UNITED STATES PATENTS

728,594	5/1903	Meeker	5/361 R
2,451,685	10/1948	Moilanen	2/18
2,477,852	8/1949	Bacon	161/68
3,039,109	6/1962	Simpson	2/3 R
3,123,907	3/1964	Thomas	161/68 X
3,208,080	9/1965	Hirsch	2/3 R
3,248,738	5/1966	Morgan	2/3 R
3,447,163	6/1969	Bothwell et al.	2/3 R

FOREIGN PATENTS OR APPLICATIONS

945,412	12/1963	Great Britain	2/3 R

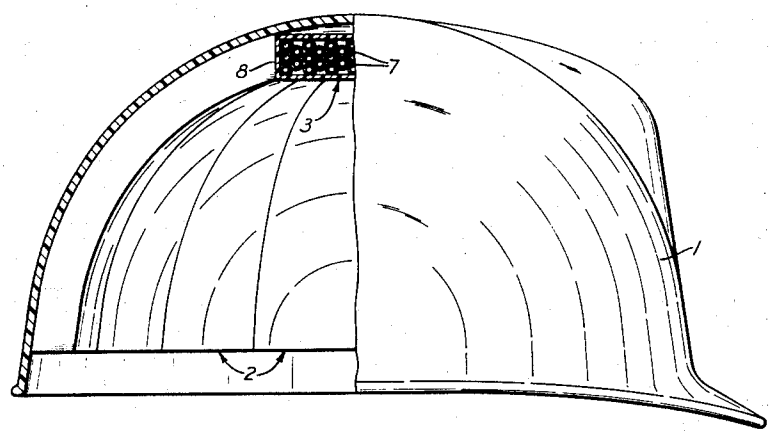
Primary Examiner—James R. Boler

Attorney, Agent, or Firm—Brown, Murray, Flick & Peckham

[57] **ABSTRACT**

A dome-like liner that will fit inside of a safety hat is formed from a plurality of stacks of stiff but deformable tubes, the tubes in each stack being arranged in superimposed rows with the tubes in each row parallel and staggered relative to the tubes in the immediately adjoining rows. Each of the stacks is enclosed in a flexible sheath, the sheathed stacks being assembled to form the liner.

10 Claims, 4 Drawing Figures



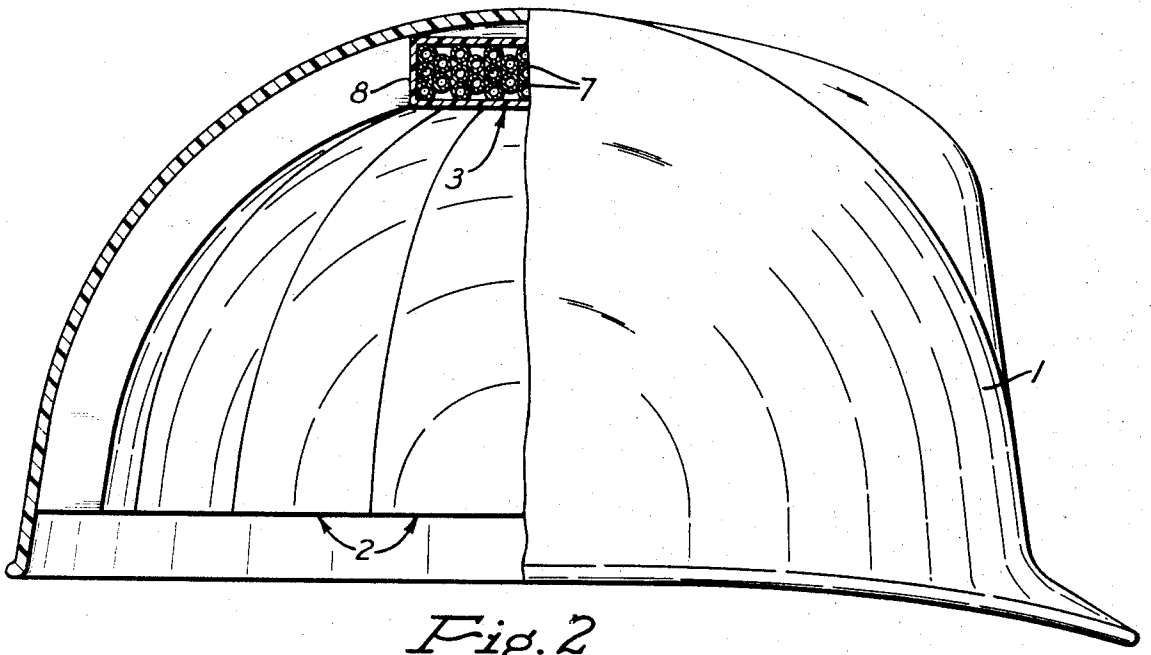


Fig. 2

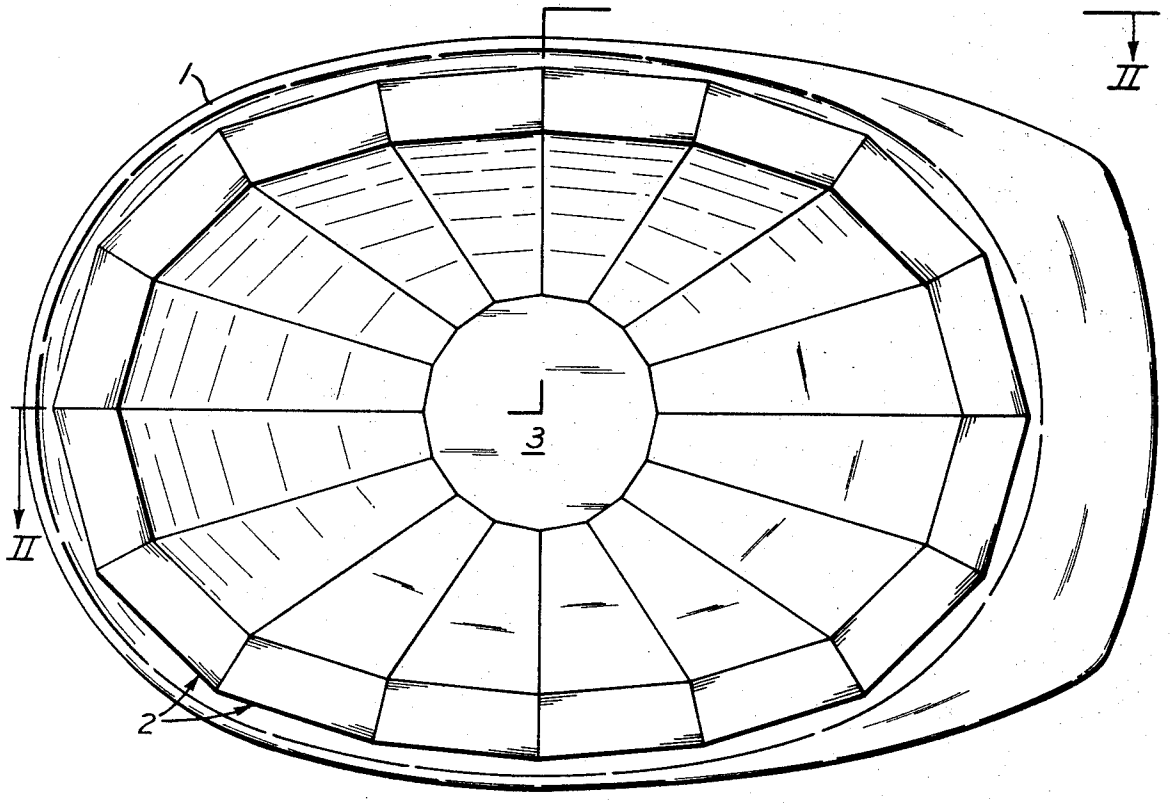


Fig. 1

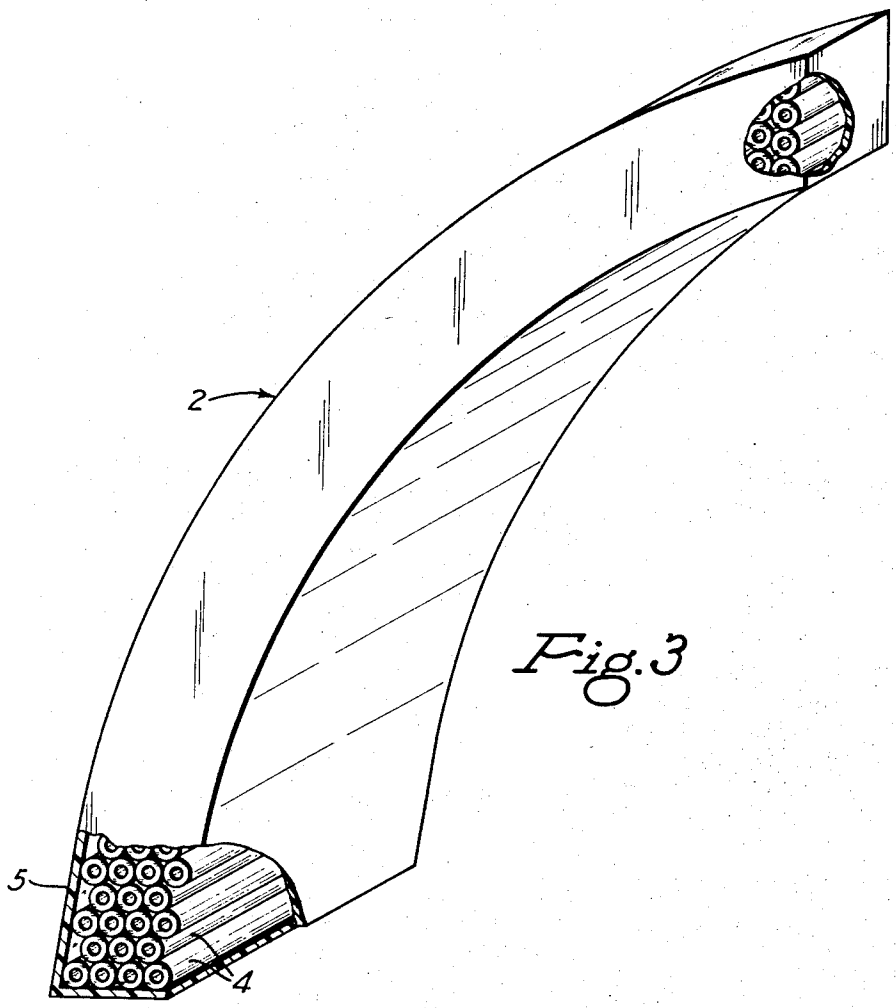


Fig. 3

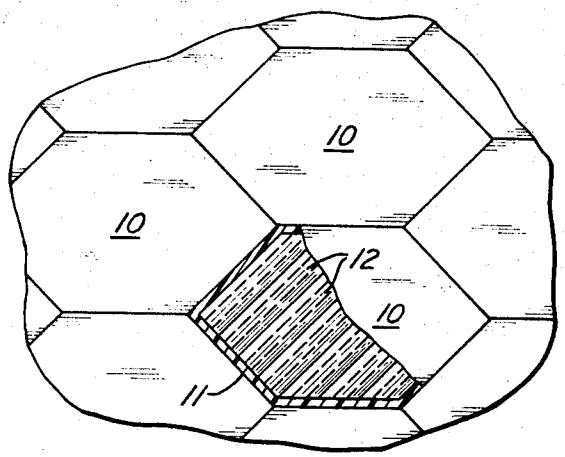


Fig. 4

SAFETY HAT ENERGY ABSORBING LINER

Safety hats or helmets are often provided with liners made from material that will crush when subjected to a predetermined pressure, whereby to absorb as much as possible of the impact energy in order to protect the head of the wearer. For this purpose, solid liners of foamed plastic have been used, as well as honeycombs filled with foamed plastic. Inflated flexible tubes have also been used, but they are not as effective as crushable material because they are resilient and therefore will rebound the moment the pressure on them is released.

It is among the objects of this invention to provide a safety hat energy absorbing liner which will furnish a maximum of energy absorption within a minimum space, and which is lightweight and economical to produce.

The invention is illustrated in the accompanying drawings, in which

FIG. **1** is a bottom view of a helmet containing the new liner;

FIG. **2** is a combined side view and vertical section taken on the line II—II of FIG. **1**;

FIG. **3** is an enlarged perspective view of one of the segments of the liner with parts of its side wall broken away; and

FIG. **4** is a fragmentary plan view of a modification, partly broken away in section.

Referring to FIGS. **1** to **3** of the drawings, a safety hat **1** or helmet of any desired shape contains an energy absorbing liner that may be held in place by an adhesive or by an inner liner that fits inside the energy absorbing liner and is attached to the hat below it. The way the liner is held in place forms no part of this invention. The liner is formed from a plurality of upwardly tapered segments or columns **2** that curve upwardly and inwardly toward one another. The upper ends of these columns do not meet at a central point, but define the wall of a central polygonal opening that is filled by a center pad **3.** This pad and all of the columns around it are joined to one another by an adhesive to form the liner.

As best shown in FIG. **3,** each of the segments or upwardly tapered columns is formed mainly from a stack of stiff tubes **4** held in proper relation to one another by a surrounding thin sheath **5** that may be formed from a plastic. The tubes in each stack are arranged in superimposed rows, with the tubes in each row parallel and preferably staggered for the most part relative to the tubes in the rows engaging them. Preferably, the tubes are straight with a maximum length between about 1½ and 2 inches. A satisfactory outer diameter is about ⅜ inch, while the inner diameter may be between about 1/16 and ¼ inch. Although the cross sectional shape of the tubes may be polygonal, their assembly is easier and they function better if they are cylindrical.

In accordance with this invention, the tubes are made of a material that will deform permanently if subjected to pressure above a predetermined value. The tubes must not spring back to their original shape when the pressure on them is released. The energy required to deform the tubes will be absorbed and not transmitted to the head of the wearer. The tubes can be made of metal that will bend as they are crushed or they can be made of heavy paper or other crushable material. The material that is preferred is a foamed plastic, such as

polystyrene or polyurethane. These plastic materials absorb energy when they are crushed and the foam cell walls break. When the tube walls are solid as distinguished from being cellular, energy is absorbed by the collapse of the tubes. The tubes can all offer the same resistance to crushing, or they can be made in such a manner that different ones will require different pressures to crush them. In the latter case, the tubes are arranged in the stacks with the tubes at the inside of the liner the easiest to crush while the rest of them are progressively more difficult to deform ranging from the inside to the outside of the liner. The different energy absorption characteristics of different tubes can be obtained by making them of different materials or in different sizes or wall thickness. The load or pressure against the outermost tubes is transmitted by them to all neighboring tubes, whereby the applied forces are dissipated over a large area of the liner. Also, there is some movement of the tubes against one another, which produces friction that likewise absorbs some energy.

As shown in FIG. **2,** the central pad **3** at the top of the liner is formed in the same way as columns **2.** That is, staggered rows of stiff deformable tubes **7** are stacked in an encapsulating polygonal sheath **8.**

Instead of making the liner from tapered segments joined side by side, it can be formed in the manner indicated in FIG. **4** from a plurality of hexagonal members **10** that are fitted together in such a manner as to form a dome-like liner for a safety hat. Each of the hexagonal members has side walls and parallel inner and outer walls formed from a thin plastic sheath **11.** Each sheath contains a stack of stiff deformable tubes **12** like those described above and arranged in superimposed rows, with the tubes in each row parallel and staggered relative to the adjoining rows, so that each tube engages two underlying tubes.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. An energy absorbing liner for a safety hat, comprising a plurality of stacks of stiff permanently deformable tubes, the tubes in each stack being arranged in superimposed rows with the tubes in each row parallel, and a thin sheath of predetermined shape enclosing each of said stacks to hold the tubes therein together in said arrangement, said tube-containing sheaths being assembled into the form of a dome-like liner to fit the inside of a safety hat.

2. An energy absorbing liner according to claim **1,** in which said tubes are straight.

3. An energy absorbing liner according to claim **1,** in which said tubes are straight and vary in length from about 1½ to 2 inches with an outer diameter of about ⅜ inch and an inner diameter between about 1/16 and ¼ inch.

4. An energy absorbing liner according to claim **1,** in which said tubes are deformed by crushing them.

5. An energy absorbing liner according to claim **4,** in which said tubes are formed from a foamed plastic.

6. An energy absorbing liner according to claim **1,** in which said tubes are cylindrical.

7. An energy absorbing liner according to claim 1, in which said rows of tubes are progressively more difficult to deform from the inside of said liner to the outside.

8. An energy absorbing liner according to claim 1, in which said stacks of tubes are in the form of upwardly tapered columns that curve upwardly and inwardly toward one another, the tubes in each column being disposed substantially end to end with the tubes in the two columns beside it.

9. An energy absorbing liner according to claim 1, in which said stacks and sheaths are hexagonal.

10. An energy absorbing liner according to claim 1, in which the tubes in each row are staggered relative to the tubes in the immediately adjoining rows.

* * * * *