

June 19, 1945.

K. J. KOPPLIN

2,378,642

PROCESS OF MAKING FIBER-BODY ARTICLES

Filed Sept. 2, 1941

2 Sheets-Sheet 1

Fig. 1.

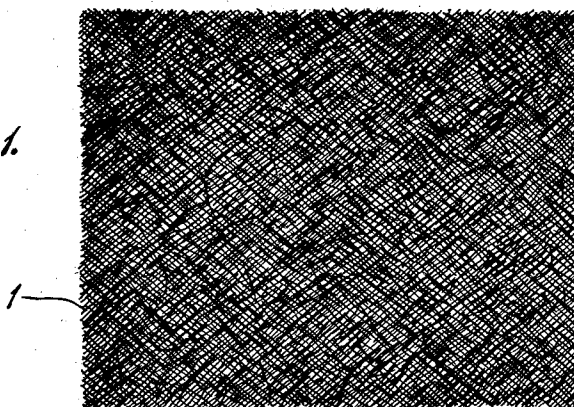


Fig. 2.

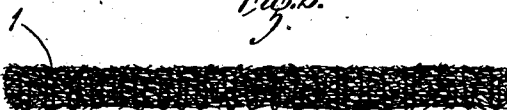


Fig. 3.

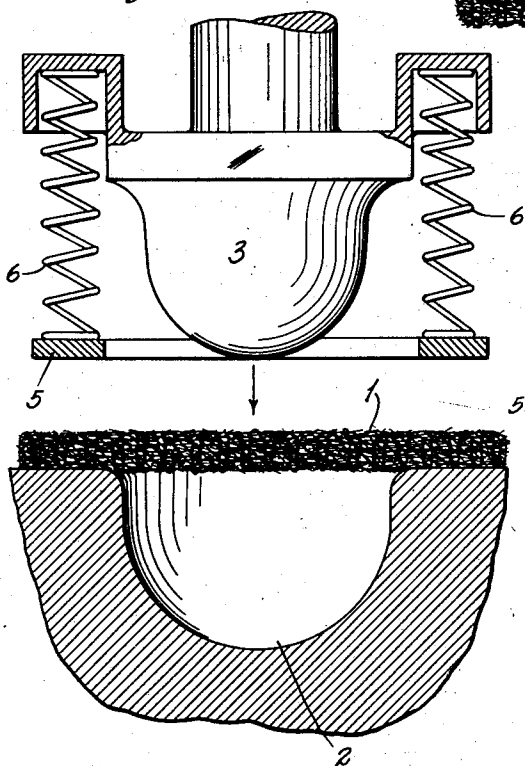
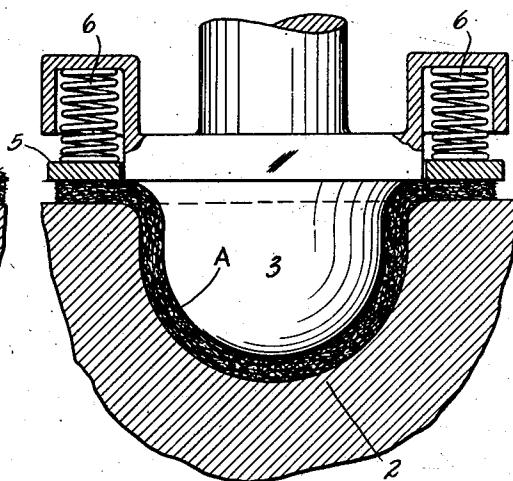


Fig. 4.



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2 Sheets-Sheet 2

Fig. 5.

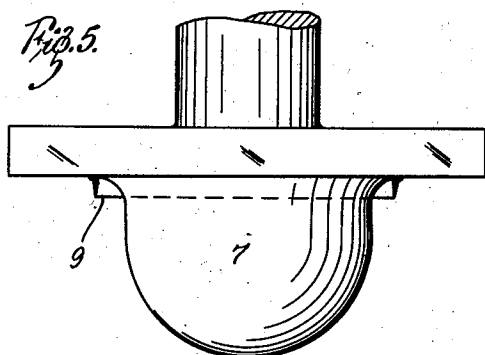


Fig. 6.

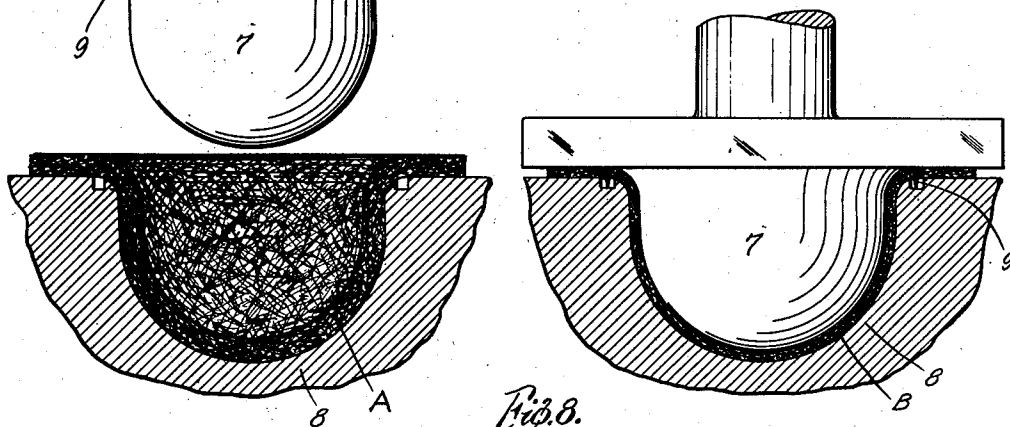


Fig. 8.

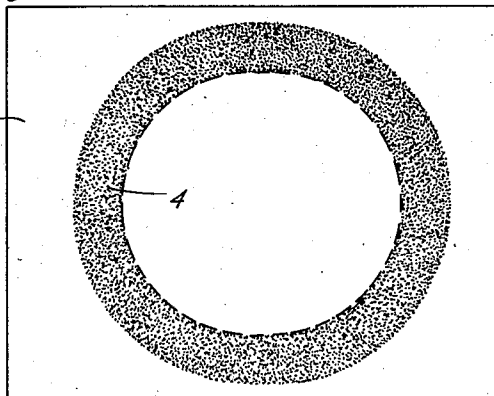


Fig. 7.

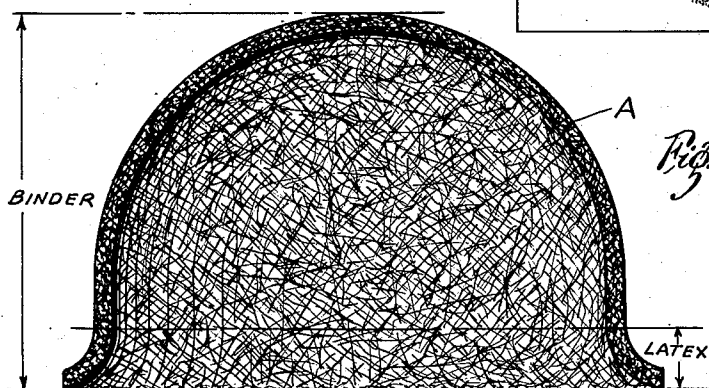
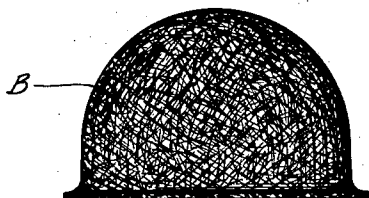


Fig. 9.

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UNITED STATES PATENT OFFICE

2,378,642

PROCESS OF MAKING FIBER-BODY
ARTICLES

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Application September 2, 1941, Serial No. 409,220

7 Claims. (Cl. 18—56)

My invention relates to the utilization of long fibers in the manufacture of hollow or deeply drawn products. The principal object of the invention is to devise a method whereby long fibers, such as raw sisal, can be drawn into hollow products of substantial tensile strength in various directions ready for diverse uses such as foundations for upholstery, helmet linings or coverings and cushions for other articles, and as "preforms" for further processing into resin bound articles. The invention consists in the process hereinafter described and claimed.

In the accompanying drawings, wherein like reference numerals refer to like parts wherever they occur,

Fig. 1 is a plan view and

Fig. 2 is a cross-sectional view of a fiber blank,

Fig. 3 shows the blank or work-piece in its initial position relative to a forming die,

Fig. 4 illustrates the work-piece or "preform" in relation to the forming die with the plunger at the end of its forming stroke,

Figs. 5 and 6 illustrate a preform in relation to a pressure die in its initial position and at the end of its forward stroke, respectively,

Fig. 7 is a view of a finished product,

Fig. 8 is a view of a flat blank with a ring of latex thereon; and

Fig. 9 is a sectional view of a preform ready for entry into the pressure die, and showing the distribution of the latex and binder thereon.

The present process starts with a substantially flat mat of long unwoven fiber, preferably raw sisal, laid loosely in layers, as by a camel-back machine, with the fibers of adjacent layers disposed in the same general direction and criss-cross in relation to the fibers of adjacent layers, thereby forming a loose mat that is somewhat compacted and stabilized by the operation of needling which forms some of the fibers into loops or bights that extend transversely through the mat and serve as transverse ties therefor. In such a mat, many of the individual fibers, which may be a yard or more long, zig-zag crosswise of the mat and, being loosely laid, are more or less crooked or curved.

A blank 1 of suitable size is cut from the stabilized or needled mat and the blank, without further preparation or treatment, is laid over the end of the hollow member 2 of a forming die. The plunger 3 of the forming die is then actuated to force the blank or work-piece 1 into the hollow of the die to become a "preform" A or product, depending on its use. Due to the facts that the fibers were crooked and loosely laid, and that

there is no adhesive or binding material in the blank or work-piece, the long fibers of the work-piece adjust themselves to the shape of the mold and are held by friction in their adjusted positions. Thus, the work-piece, as distinguished from its individual fibers, stretches in planes that are substantially axial or parallel to the axis of the die, while these individual fibers, which extend approximately in those planes, merely shift their positions and straighten out under the action of the plunger.

In this operation of die forming, the portion of the blank or work-piece which in the flat, is just beyond the hollow of the die, contracts circumferentially somewhat after the manner of a metal plate in the operation of drawing. The structural looseness of the work-piece enables those fibers, that are disposed more or less radially with relation to the axis of the die, to crowd closer together by shifting their position circumferentially and thereby adapt themselves to the die, while the same looseness of the work-piece enables those fibers that are disposed more or less circumferentially to adapt themselves to the changing situation by bending or kinking individually and remaining relatively slack, at least in sections, in the product. In this die-forming operation, the criss-cross arrangement of the fibers is an important factor in maintaining the integrity of the work-piece and adequate strength thereof at all points and in all directions. Ordinarily, the operations hereinbefore described are carried out without applying any latex or binding material to the work-piece, as, due to frictional engagement of the fibers, the "preform" thus produced has sufficient stability of shape and dimensions for convenient handling, such as entering into a pressure die. When, however, an untreated work-piece is deeply drawn, the natural springiness of the sisal or other fibers tends to enlarge the diameter of the hollow produced therein by the forming die and make the subsequent handling thereof somewhat more difficult. For this reason, it is desirable to spray a limited amount of liquid latex (say about ½ ounce of latex containing about fifty percent solids per square foot of surface) on one or both surfaces of the flat work-piece in the form of a band or ring 4 of larger diameter than the concavity of the die and concentric therewith, the band being wide enough to be partly inside and partly outside of the die when the plunger reaches home. The latex solvent is quickly evaporated and the small film of elastic latex remaining on the blank in the form of a

band or ring does not seriously interfere with the ability of the fibers to adjust themselves to the mold, while, on the other hand, the ring of latex remaining in the "preform" acts as an elastic binder to stabilize and fix the dimensions of the hollow thereof. Instead of latex, other binder may be used that will not seriously interfere with the slippage or adjustment of the fibers.

When the blank or work-piece is to be drawn only to a shallow depth, it is not necessary to clamp the edges thereof. But when the work-piece is to be deeply drawn, the edges thereof are clamped against the end face of the die by a pressure plate 5 whose pressure is exerted by means of springs 6 that are preferably made adjustable to regulate the clamping pressure. The proper clamping pressure is high enough to insure stretching or drawing of the work-piece to the required depth but low enough to permit slippage of the work-piece when the tension therein, due to the force of the plunger, threatens to break the fibers.

The foregoing operation of die-forming the work-piece into a "preform" may slightly decrease the thickness thereof but is not ordinarily relied upon for this purpose. After making the "preform," a suitable liquid binder is applied to the hollow portion and portion adjacent thereto and the "preform" is then placed in a heated pressure die 7, 8 and compressed to substantially decrease the thickness thereof, say, for instance, to about one-third its thickness before pressing. The preform is thus converted into a resin-bound product which may be complete in itself or further processed if desired. Preferably the binder is a thermo-setting synthetic resin and the die is heated so that, in the process of die-pressing, the binder flows into the voids, or interstices between fibers, and sets and thereby stabilizes the work at the size, shape and thickness produced by the pressure die. Synthetic thermo-setting resins suitable for this purpose include the phenolformaldehyde and ureaformaldehyde condensation products. In some instances it may be desirable to use thermo-plastic binders, such as ethyl-cellulose or vinyl chloride resin, in which case the temperature of the pressure die or mould is lowered below the softening point of the binder so as to set the binder before removal of the work-piece from the die.

The amount of binder required is dependent upon the characteristics desired in the finished article. For example, binder in the proportion of ten percent of binder to ninety percent of fiber is sufficient to stabilize the article for some uses. On the other hand, as much as fifty percent of binder may be required to obtain maximum moisture resistance and a high polish finish.

In carrying out my process, either a thermo-plastic binder or a thermo-setting, that is, heat hardenable, binder may be used, as above stated. When a thermo-plastic binder is used in the manufacture of a deep drawn article, it is convenient to use some of the binder in the preforming operation by applying a small quantity thereof to the region of the flat work-piece that lies adjacent to the center of the latex band or ring. This central region of the workpiece is not subject to great deformation but remains nearly flat, so that the presence of the binder in this region does not interfere to any considerable extent with the ability of the fibers to adapt themselves to the conditions brought about in the forming operation. On the other hand, the use of such limited

quantity of thermo-plastic binder is helpful in stiffening and stabilizing the preform.

In practice, it is convenient to trim the work piece while it is in the die by means of a cutter 9 mounted on the die plunger.

Among the advantages of the present invention are the following: it permits the use of long fibers in substantially their raw condition, that is, without disentangling the natural vascular bundles in which they occur. It requires a minimum of preparation of the fibers, namely, merely carding, laying preferably with a camel-back machine, and needling. The fibers in the mat are of their full natural length and the only cutting of the fibers is that due to the cutting of blanks from the mat and to the trimming of the work-piece. Another important advantage is that all pulping of the material is dispensed with. Another advantage is that the invention makes it practicable to use raw sisal fiber which has a remarkable tensile strength and is quite inexpensive.

For many uses, the work-piece may be considered as complete as soon as the initial shaping thereof is completed, that is, without being treated with a resinoid binder and die-pressed. For instance, the shaped, but uncompressed, work without binder may be used as foundations for upholstery, particularly automobile arm rests, or as linings and covers for hats, helmets and containers or as cushions for other articles. For such uses, it is preferably to spray one or both surfaces of the work-piece with a limited amount of latex or like elastic material, say at the rate of about one ounce of liquid latex containing about fifty percent solids, per square foot of surface sufficient to stabilize the shape and serve as an elastic binder at and adjacent to one or both surfaces of the work-piece without filling the voids in such work-piece.

What I claim is:

1. The process of making plastic-bound long-fiber hollow articles which consists in starting with a loose unwoven mat of long fibers laid criss-cross in layers, forming said mat in a hollow forming die after applying a binder to said mat in the form of a band that surrounds the hollow in said hollow forming die, then applying binder to the formed work and die pressing the same in a hollow die.

2. The process of making plastic-bound long-fiber hollow articles which consists in starting with a loose unwoven and relatively thick mat of long sisal fibers laid criss-cross, applying a limited quantity of latex to a surface thereof in the form of a closed band, lightly pressing the portion of the mat surrounded by said band into a flaring hollow die of smaller radius than said band, applying liquid binder to the lightly pressed work at the rate of from about 1 ounce to about 2.5 ounces of binder per square foot of said work, and die pressing the lightly pressed work in a hot hollow die to a thickness of less than one third that of the loose mat.

3. The process of making plastic-bound long-fiber hollow articles which comprises starting with a loose unwoven mat of long fibers loosely laid criss-cross, clamping said mat flatwise against the end face of a hollow forming die tight enough to compel the mat to stretch under the pressure of a die but loose enough to permit slippage of the mat and prevent breaking of the fibers when the pressure of the die plunger exceeds a predetermined amount, after applying a band of liquid binder to the portion of the mat shortly beyond the margin of the hollow form-

ing die, forcing said mat into said forming die to produce a loose hollow blank, applying liquid binder to said loose blank and then compressing said loose blank and trimming the margin thereof.

4. The process of making plastic-bound long-fiber hollow articles which comprises starting with a loose unwoven mat of long fibers loosely laid criss-cross, clamping said mat flatwise against the end face of a hollow forming die tight enough to compel the mat to stretch under the pressure of a die but loose enough to permit slippage of the mat and prevent breaking of the fibers when the pressure of the die plunger exceeds a predetermined amount, after applying a band of liquid binder to the portion of the mat shortly beyond the margin of the hollow forming die, forcing said mat into said forming die to produce a loose hollow blank, applying thermo-setting binder to said loose blank and then compressing said loose blank.

5. The process which consists in forming an annular film of latex on the surface of a loose unwoven and relatively thick mat of long sisal fibers laid criss-cross and then die forming with light pressure the portion of the mat surrounded by said band.

6. The process of making plastic-bound long-fiber hollow articles which consists in starting with a loose unwoven mat of long fibers laid in criss-cross layers, forming said mat in a forming die after applying latex to said mat in the form of a band that surrounds and is of greater diameter than the main body of the forming die, then applying binder to the formed work and die pressing the same in a hollow die.

7. The process of making plastic-bound long-fiber hollow articles which comprises starting with a loose unwoven mat of long fibers loosely laid criss-cross, clamping said mat flatwise against the end face of a hollow forming die tight enough to compel the mat to stretch under the pressure of a die plunger but loose enough to permit slippage of the mat and prevent breaking of the fibers when the pressure of the die plunger exceeds a predetermined amount, after applying latex to the portion of the mat in a band shortly beyond the margin of the hollow forming die, forcing said mat into said forming die to produce a loose hollow blank, applying liquid binder to said loose blank and then compressing said loose blank and trimming the margin thereof.

KARL J. KOPFLIN.