METHOD OF PREPARING A BLANK FOR
A CONICALLY SHAPED DIAPHRAGM
Filed Sept. 9, 1946
METHOD OF PREPARING A BLANK FOR A CONICALLY SHAPED DIAPHRAGM

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Application September 9, 1946, Serial No. 693,006

3 Claims. (Cl. 154—101)

1 This invention relates to articles integrally formed of fibrous material. This application constitutes a continuation-in-part of my copending application Serial No. 423,388, filed December 10, 1941 and which has issued as United States Patent No. 2,402,038 on September 24, 1946, which application was a continuation-in-part of my application Serial No. 121,604 and was filed January 21, 1947, now abandoned. The invention is described herein with particular reference to the manufacture of acoustic diaphragms and in the manufacture of blanks from which acoustic diaphragms can be readily produced. It is to be understood that the invention is not limited to the particular articles disclosed herein.

According to present practice acoustic diaphragms are at present manufactured of fibrous materials according to either one of the two following methods:

1: A cutout blank is made of a piece of paper which is impregnated in a somewhat conical shape using cement to effect the splice and this blank is subsequently shaped to a piece and otherwise treated to make the finished acoustic diaphragm.

2: A seamless hollow blank is acerated on a screen to the approximate shape of the finished article desired and is subsequently trimmed and treated to make the finished acoustic diaphragm, there being no splice in the diaphragm made in this way.

The objection to the above-noted method is that the splice in the conical portion of the finished diaphragm unbalances the diaphragm as well as serving as an awkward and expensive method of making the diaphragm. The second method is acceptable but the processes involved in making it are expensive and costly and the concentration and distribution of binders has not been easy to regulate.

Herefore the application of binders has been done by dipping and could not be finely distributed so that the range of application and the number of fibers in contact with the binder materials in a certain area was not possible to regulate accurately. Hence stretch could not be had in blanks heretofore.

The present invention overcomes both the objections above-mentioned and devises a structure composed of intermingled or heterogeneously arranged textile fibers bonded to each other by the intermingling of thermoplastic particles which are distributed preferably by spraying or squirting throughout the fibrous structure in certain areas the bonding thermoplastic particles are so distributed as to produce flexible sections and in certain areas are so distributed as to give stiffness.

The object of this invention is to provide a more economical and efficient method of producing hollow articles such as blanks for acoustic diaphragms which results in a more uniform product and a lower cost product. Another object of my invention is to provide a method of making hollow articles wherein the thickness of various sections may be varied although the articles are integral. Another object of my invention is to make a blank as for an acoustic diaphragm which can be subjected to heat and pressure and cured to its final shape. Another object of my invention is to make a blank for a hollow article such as an acoustic diaphragm which can be distorted at least 20% to 30% under heat and pressure. Another object of my invention is to provide articles formed integrally of deposited fibrous material having areas of widely varying rigidity. Another object of my invention is to provide a blank formed integrally of fibrous material having a relatively rigid conical section and a relatively flexible flange to act as a suspension therefor. Another object of my invention is to eliminate or substantially cut down greatly the amount of liquid mediums now used to suspend fibers for deposition in the making of hollow fibrous articles such as acoustic diaphragms. Another object of my invention is to make a blank for an acoustic diaphragm which has improved wet strength. Another object of my invention is to make an acoustic diaphragm which is moisture resistant.

The present invention involves the production of hollow articles from fibrous materials such as fibers of cotton, rayon, kapok, wool and wood and other textile fibers by the simultaneous but separate spraying of such fibers or a mixture thereof in the substantially dry state with a binder such as cellulose acetate or resins or plastic materials or latex upon a form and either compacting the deposited binder in the fibrous material and the deposited fibrous material upon said form while subjecting it to heat and pressure or removing it from the form upon which the layers were deposited and subjecting it to heat and pressure to compact and shape in a mold. Preferably the operation of depositing the blank is carried out by means of a number of spray devices or ducts placed closely together and directed to cover the form. At least one spray device is employed to discharge fibrous material in dry form and another spray device is employed to discharge the binding material. The separate spraying of the
fibrous material and the binder enables the spraying operation to be carried out in the proportions desired and to regulate easily the deposition of fibers and the deposition and distribution of the binder. A solvent may be used with the binder to facilitate spraying and distribution or the binder may be rendered liquid by heat and ejected from the spraying device through fine orifices under hydraulic pressure or the binder may be applied in particles.

Gas pressure may be used also as a spray medium and heated steam may be used as a heating means and liquefying or softening means for the binder as well as to assist in the atomization of the binder. Attenuated filaments of the binder may be produced by these spray devices or a fog may be produced of very fine particles of the binder under hydraulic pressure and heat. In other words, the form in which the binder is sprayed can be regulated so that it is necessary to use only a minimum of binder material to produce a strong and stretchy fibrous layer suitable for use in making a hollow acoustic diaphragm. The spray device used to apply the fibers and binder material may be so situated and directed that the fibrous layer applied by one device will have its fibers crossed at an angle by the fibrous layer deposited by another device so that a certain amount of cross-lapping and interlacing of the fibers is affected. Laminations can also be possible. The binding material may be applied in such a way that only a very few of the fibers deposited come in contact therewith or it may be applied in such a way and in such proportions that all or nearly all the dry fibers come in contact therewith and are bound thereby. Immediately after completion of the deposition of the layers wanted on a base or form, the material so deposited may be removed and subjected to heat and pressure as for instance to make an acoustic diaphragm. The material so produced can be handled immediately so that it has considerable stretch and flow and can be molded to make the shape desired and of the thickness desired. Water resistance can be also developed to the degree desired. Porosity can also be regulated to the degree desired. Due to the amount of stretch in the blanks made according to my process seamless hollow acoustic diaphragms can be molded from flat material in certain cases and from blanks which only roughly approximate the finished article in other cases. When the blank is initially deposited it can be handled immediately thereafter and subjected to heat and pressure as in a mold. The fibrous material may consist of wood, cotton, rayon, wool or synthetic fibers or a mixture of paper or textile fibers. Binders, preferably thermoplastic, may consist of lacquers or resins, natural or synthetic, various plastic materials or rubber-like materials. A number of binders as well as a number of fibers each having different characteristics may be used to make the same blank or hollow articles such as an acoustic diaphragm. Different materials or layers of material may be used for different areas of the same integral article to produce desired characteristics. Thus the hollow body portion of an acoustic diaphragm may be made of a mixture of cellulose acetate binder and cotton fibers, the cellulose acetate being partially applied as a liquid and partially applied in small powders or filaments. Thermoplastic materials such as cellulose acetate may be applied or intermingled with the fibers having a certain content of a gas-producing agent such as ammonium car-
articles of thermoplastic materials to make hollow molded fibrous articles having relatively stiff and pliable areas and areas of differing thicknesses as well as areas of different density. Also by my process flat blanks or sheets can be made and subsequently distorted in a mold under heat and pressure to produce a finished shape. Or intermediate shaped blanks can be made by my invention and readily distorted under heat or pressure to the desired shape. In some cases where extreme distortion is desired moistening of the blank prior to pressing is helpful.

Flat sheets of paper can be a flat sheet with heat after deposition of binder thermoplastic and fibers and subsequently adding lacquers and/or thermoplastic solutions prior to molding is also contemplated according to my invention. By this method flat sheet material can be made in lengths and stored until used. Wetting this sheet prior to or during pressing assists in the distortion to form the finished shape of the acoustic diaphragm. This sheet may be wetted with thin thermoplastic liquids to assist in molding and waterproofing prior to pressing.

Preheating of the fibrous plastic materials to facilitate production can be resorted to when desired according to my invention. It is according to my invention to be understood that fibers of any length can be used to make the blank and a mixture of fibers as to length, size, and density may be used. Also it is to be understood according to my invention that fibers may be laid in single layers on end or with ends sticking up and rolled down in alternate direction with heated rolls so that one layer of fibers is at an angle to the adjacent layer which is rolled in another direction after deposition and bonded in this angular relationship by the thermoplastic binder.

The heat used in the mold should be sufficient to soften the thermoplastic binder.

Thermosetting plastics may be used if only partially reacted prior to application and in this case the heat of the mold should be sufficient to cure.

The method and article of the invention are illustrated in the accompanying drawing in which

Figure 1 is a partial sectional view illustrating formation of the blank; and

Figure 2 is a similar view illustrating the final forming operation.

As shown in Figure 1, the blank may be formed on a conical foraminous form such as a fine screen 10. The screen is supported at its periphery on a ring 11 which is rotatably mounted on a suction box 12. A conduit 13 connects the interior of the ring 11 and the lower surface of the screen 10 to a vacuum pump or other source of vacuum. Except for the particular shape of the screen this construction is substantially similar to that disclosed in my Patent No. 2,408,038.

The dry fibers are sprayed onto the screen through a plurality of nozzles 14 which are spaced around and above the screen. As shown, more nozzles may be located near the apex of the screen and more nozzles are desired to form a conical blank 15 which tapers in thickness from its apex to its periphery. The binder is sprayed simultaneously with the fibers through nozzles 16 which are located adjacent to the nozzles 14 and are spaced to produce the desired distribution of the fibers and the binder. The binder is sprayed to deposit more binder in proportion to the mass of fibers adjacent to the apex of the blank than adjacent its periphery to make the diaphragm somewhat harder and stiffer adjacent its apex.

The binder, as described above, is sprayed in such a manner and in such quantities as to produce discrete particles or filaments of binder material mixed with the fibers. In addition, the binder may have a foaming agent mixed therewith to cause it to foam during subsequent treatment.

After a sufficient quantity of fibers and binder have been sprayed on the screen to form a blank of the desired thickness, the blank is removed and placed in a mold as shown in Figure 2. This mold comprises a hollow base 17 through which heating fluid may be circulated through pipes 18. The top of the base is formed by a generally conical plate 19 whose upper surface is shaped to conform to the desired diaphragm shape. As shown, the plate 19 provides a central substantially cylindrical portion 21 to form the neck of the diaphragm, a corrugated edge portion 22, and an annular intermediate shoulder 23.

A hollow ram 24 completes the mold and may be heated by circulation of heating fluid through pipes 25. The ram has a lower conical closure plate 26 generally complementary to the plate 19 to leave a space between them corresponding to the desired diaphragm shape when they are brought together. As shown, the conical tapers of the two plates are slightly different to form a diaphragm as indicated at 27 which tapers in thickness from its apex to its rim.

As the mold parts are brought together on the blank it will be shaped and compressed to the desired final shape. During this operation the binder particles are made soft and adhesive due to the heat and pressure to bind the fibers together at spaced points. After the molding operation, the diaphragm may be varnished or otherwise sealed and is then ready for use.

Having described my invention what I claim is:

1. The method of preparing a blank for a conically shaped diaphragm comprising the steps of collecting separated fibers on a foraminous form, connected to means for evacuation, as a layer in which the fibers are haphazardly arranged in intertwined relation, and dispersing finely divided resinous binder particles with the fibers prior to their deposition whereby the binder particles collect at spaced apart points on the surfaces of the fibers, the arrangement of fibers and binder particles being such as to enable the layer subsequently to be shaped to conical form with the binder particles securing the fibers together at spaced apart points.

2. The method of preparing a blank for a conically shaped acoustical diaphragm comprising the steps of spraying dry fibers from separate sources onto a conical form in greater quantities adjacent to the apex of the form than at points spaced from the apex to provide a layer tapered radially in thickness from the apex of greater wall thickness to the base of least wall thickness, and spraying finely divided resinous binder particles on the fibers prior to deposition to collect in spaced apart relation on the surfaces of the fibers where they are able to secure the fibers together.

3. The method of preparing a blank for a conically shaped acoustical diaphragm comprising the steps of spraying dry fibers from separate sources onto a conical form in greater quantities adjacent to the apex of the form than at points spaced from the apex to provide a layer tapered radially in thickness from the apex of greater wall thickness to the base of least wall thickness, and spraying finely divided resinous binder particles on the fibers prior to deposition to collect in spaced apart relation on the surfaces of the fibers where they are able to secure the fibers together.
spaced from the apex to provide a felted layer having a wall thickness tapered from the apex of greatest wall thickness to the base of least wall thickness, and spraying dry finely divided thermoplastic resinous binder in a predetermined pattern on the fibers to provide resinous binder at spaced-apart points on the surfaces of the fibers in varying concentrations where they are able to secure the fibers together to form a product with varying characteristics.

JOSEPH B. BRENNAN.

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