Nov. 25, 1952 J. B. BRENNAN 2,619,012

METHOD OF MAKING LOUD-SPEAKER DIAPHRAGMS

Filed Aug. 5, 1947

Fig. 1

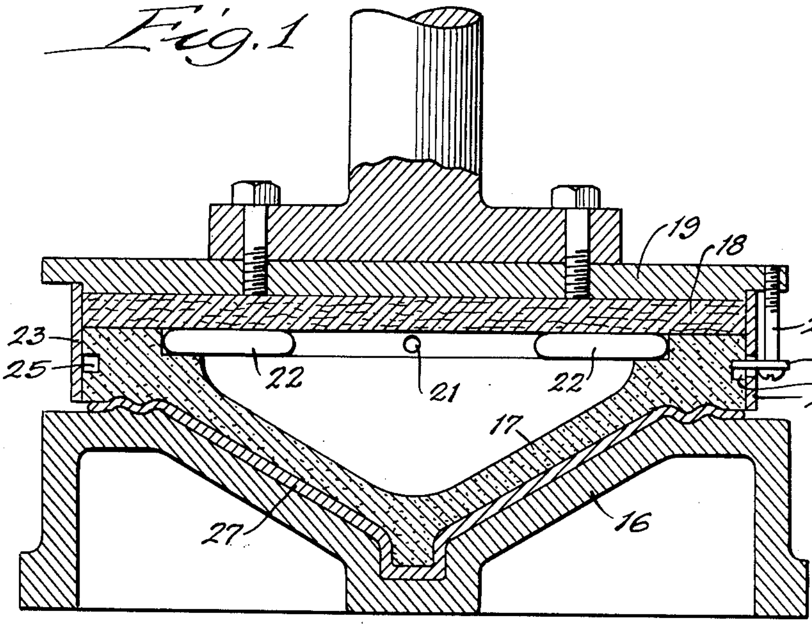


Fig. 2

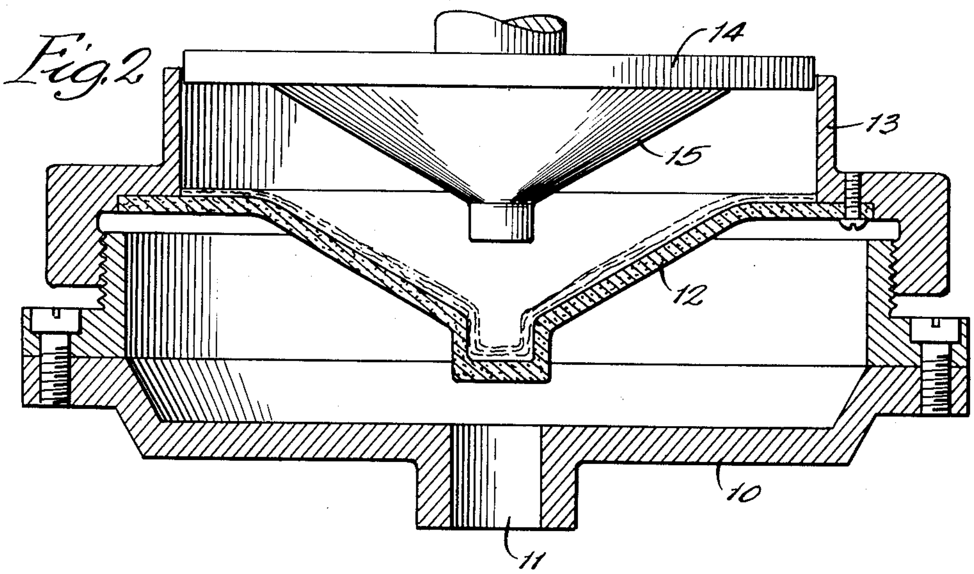
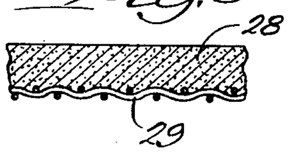


Fig. 3



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METHOD OF MAKING LOUD-SPEAKER DIAPHRAGMS

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2 Claims. (Cl. 92—54)

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This invention relates to method of making loud speaker diaphragms and the like and particularly to the deposition of fibrous material from a suspension to form a blank and to compressing the formed blank to complete the article.

One of the objects of the present invention is to provide a method of forming loud speaker diaphragms and the like in which a blank is formed by depositing fibrous material and is thereafter pressed to compress the deposited fibers and to shape the blank into the desired finished shape. According to one feature of the invention, the flange portion of the diaphragm is formed flat in the blank and is drawn into one or more annular corrugations during the pressing operation. I nave found tnat this increases the flexibility of the flange portion of the diaphragm without substantially effecting its strength.

Another object is to provide a method of making diaphragms and the like in which fibers are deposited from a suspension, such as an aqueous suspension, under super-atmospheric pressure. Preferably, the fibers are deposited on a porous mold plate which is subjected to vacuum on its lower side so that the fibers will be accreted rapidly. If desired, a plunger member may be employed to produce the super-atmospheric pressure in the suspension and may also serve to compress the deposited fibers against the mold plate to reduce the moisture content and increase the density.

The above and other objects and advantages of the invention will be more readily apparent from the following description when read in connection with the accompanying drawing, in which—

Figure 1 is a sectional view through a pressing mold embodying the invention;

Figure 2 is a similar view through a fiber depositing apparatus; and

Figure 3 is a partial enlarged section through a mold part.

In carrying out the invention, loose fibers, such as cotton, kapok, wood fibers, or the like, are deposited on a mold plate which may roughly approximate the desired finished diaphragm shape to form a relatively soft blank. The blank so formed is thereafter pressed in a two-part mold to compress the fibers to the desired density and to bring the blank to the desired finished shape. Preferably, portions of the blank, such as its peripheral flange portion, are actually drawn during the pressing operation to stretch the blank. I have found that this substantially increases the flexibility of the blank flange portion without adversely affecting its strength.

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Figure 2 illustrates an apparatus for forming blanks by depositing fibers from an aqueous suspension. As shown, the apparatus comprises a hollow housing 10 formed in its lower part with an outlet connection 11 through which liquid may drain and which is connected to a source of suction, such as a vacuum pump. The housing carries a porous mold plate 12 which is formed with a downwardly concave generally conical central portion and a flat flange portion. An upwardly extending rim 13 is secured above the mold plate adjacent the periphery thereof and forms with the mold plate a receptacle to receive a measured quantity of an aqueous fiber suspension. It will be seen that by filling the rim to its upper edge, a predetermined quantity of suspension will be held above the mold plate so that a fibrous article of predetermined thickness will be formed. It is noted that a greater quantity of suspension will lie over the central portion of the mold plate than over the flange portion so that fibers will be deposited to greater thickness in the central part than at the edge. This produces an article which is thicker and more rigid in its center body portion than in its flange, which is a highly desirable construction in loud speaker diaphragms.

A plunger indicated generally at 14 is formed to fit slidably within the rim 13 and is movable toward the mold plate 12 to force the suspension therethrough. The plunger, as shown, includes a central conical portion 15 which is complementary to the central conical portion of the mold plate.

In forming a blank with the apparatus as so far described, the rim 13 may be filled with aqueous suspension of fibrous material and the plunger may be forced downwardly in the rim while the lower surface of the mold plate is subjected to vacuum through the connection 11. Due to the action of the vacuum and the super atmospheric pressure produced by the plunger, the liquid will be forced rapidly through the mold plate leaving the fibers deposited on the upper surfaces of the mold plate. If desired, the plunger may be forced down against the fibers to compress them against the mold plate thereby to squeeze water from the deposited fibers and partially to compress the deposited fibers. Upon completion of this operation, the plunger may be raised and the blank formed by the deposited fibers may be removed from the mold plate.

The blank formed as described above may then be subjected to a pressing and forming operation in the apparatus, as shown in Fig. 1. This apparatus comprises a two-part mold having a lower female part 16 whose upper surface agrees with the desired finished shape of the diaphragm. The mold part 16 corresponds with a male mold part 17 which is preferably hollow and is formed of a porous material. The mold part 17 is open at its enlarged upper end and is adapted to fit against a mold plate 18 which serves to close the upper end of the part 17. The mold plate may in turn fit against a plunger 19 which is adapted to be moved vertically toward and away from the lower mold part 16. The interior of the hollow mold part 17 may be subjected to suction through a suction passage 21 communicating therewith and may be heated by one or more electric heating elements 22 mounted between the hollow mold part and the plate 18.

For supporting the porous mold part 17 and for closing its exposed upper edge to prevent flow of air therethrough, a mounting ring 23 is provided. The ring 23 may be of solid metal, or the like, and fits closely against the outer edge of the porous mold part, as shown. At several points in its circumference, the ring 23 is formed with openings through which fastening plates 24 may extend into an annular groove 25 in the edge of the mold part. The plates 24 may be held by screws 26 threaded into the edge of the plunger 19 so that the mold part 17 and the plate 18 will be drawn up tight against the plunger.

The relatively soft blank as formed on the apparatus of Fig. 2 may be placed in the two-part mold of Fig. 1 and the heated upper mold part may be pressed down against the blank while subjected on its interior to suction. Thus, the blank is compressed to form a completed diaphragm as indicated at 27 which is in the desired finished shape. Due to the combined action of heat and suction, the moisture in the blank will be rapidly dried out so that the blank may be finished quickly. After pressing, the blank is coated or impregnated with lacquer or like filling materials or, if preferred, the lacquer could be applied thereto before pressing the blank.

According to one feature of the invention, the flange portion of the diaphragm is drawn into one or more annular corrugations during the pressing operation. As shown in Fig. 1, both of the mold parts have peripheral flange portions which are annularly corrugated. When the blank with its initially flat flange portion is pressed into the two-part mold, the flange portion will be drawn causing the fibrous material actually to flow to form the annular corrugations. I have found that this provides a flange of extremely high flexibility and of maximum strength. The reason for this may lie, at least partially, in the fact that radial flow of the fibers in the blank to form the corrugations causes the fibers to become radially aligned so that maximum strength in a radial direction is produced.

According to one feature of the invention, either or both of the porous mold parts 12 and 17 may be formed of particles of sintered material. Relatively fine particles of non-corrosive material, such as particles of stainless steel, or bronze, or a mixture thereof, of substantially uniform size are placed in a mold and are sintered to bind the particles together in a porous structure. It is important that the particles be of substantially uniform size and that their fineness be such that when they are sintered together, the spaces or openings between particles will be of smaller size than the fibers. Otherwise the fibers will enter partially into the spaces between the particles and stick therebetween. A mold part, formed as described above, is relatively inexpensive, possesses a high strength and rigidity, and is extremely porous throughout. If desired, different degrees of porosity can be provided in different portions of the mold to vary the thickness of the deposited fibers in different mold portions by employing particles of different size to form the different portions of the mold or by compressing the particles to different degrees during the sintering.

For the pressing mold as shown at 17 a smooth surface is required, particularly in the flange portion of the mold so that the blank can slip over the mold during the drawing operation. I have found that a surface of the necessary smoothness can be produced by machining the mold part after sintering. I have found that the surface when machined with a sharp cutting tool or when ground with a wheel will provide the necessary smoothness without loss of porosity and without any subsequent treatment, such as etching. In the alternative, the surface of the mold part may be covered with a fine porous sheet, such as perforated metal or woven wire, as illustrated in Fig. 3 in which the sintered metal mold part is shown at 28 having one surface thereof covered by a fine woven wire screen 29. When this construction is employed, the screen may be pressed or formed to the same shape as the mold part and may be simply laid over the mold part and clamped thereto at its edges. The screen is preferably of a fineness such that the fibers cannot enter its interstices and provides a surface sufficiently smooth so that the fibrous blank can slip over it during a pressing or forming operation. When such a screen is employed, the sintered metal mold part can be made of larger or courses particles and does not require any surface finishing.

While the invention has been particularly described in connection with the formation of loud speaker diaphragms, it will be understood that in many of its aspects it is applicable to the formation of articles of different character, and, therefore, it is not intended to limit the invention to the exact procedures and structures described herein nor otherwise than by the details of the appended claims.

What is claimed is:

1. The method of making loud speaker diaphragms and the like which consists in depositing fibrous material from a suspension to form a diaphragm blank having a generally conical body portion of substantially the desired finished shape and a flat peripheral flange, and compressing the body portion of the blank at an elevated temperature while maintaining the body portion in said generally conical form, and simultaneously drawing the flat peripheral flange into an annular corrugation.

2. The method of making loud speaker diaphragms and the like which consists in depositing fibrous material from an aqueous suspension to form a diaphragm blank having a generally conical body portion of substantially the desired finished shape and a flat peripheral flange, and compressing the body portion of the blank at an elevated temperature and subjecting at least one face of the blank to the action of suction while maintaining the body portion in said generally conical form, and simultaneously drawing the flat peripheral flange into an annular corrugation.

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