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J. B. HAWLEY

2,006,830

SOUND REPRODUCING DIAPHRAGM

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Fig. 1.

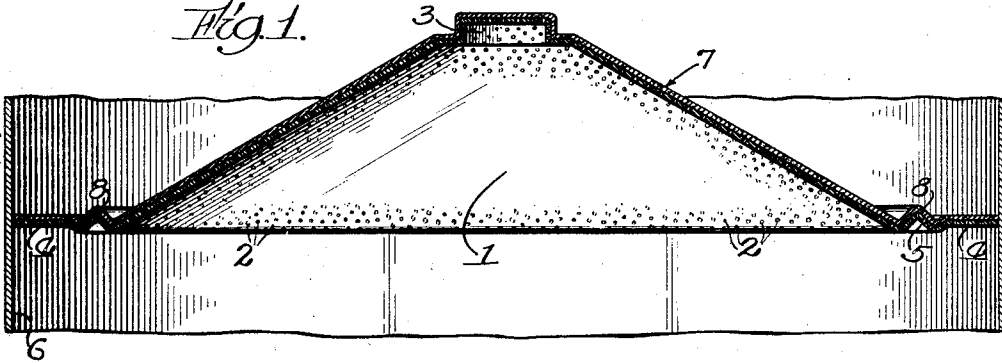


Fig. 2.

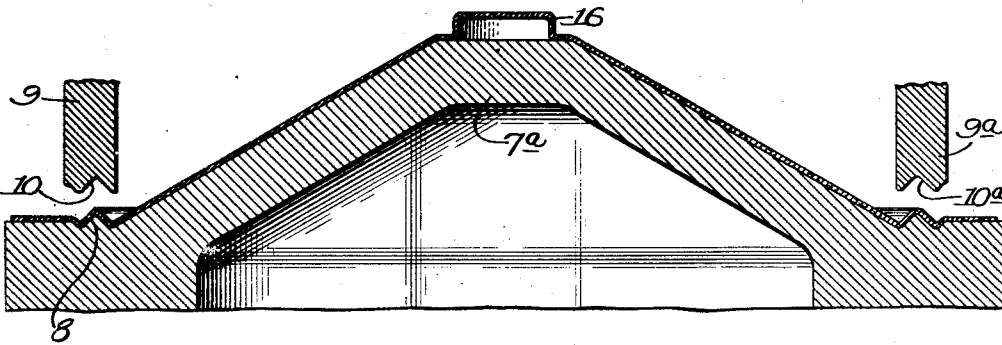


Fig. 3.

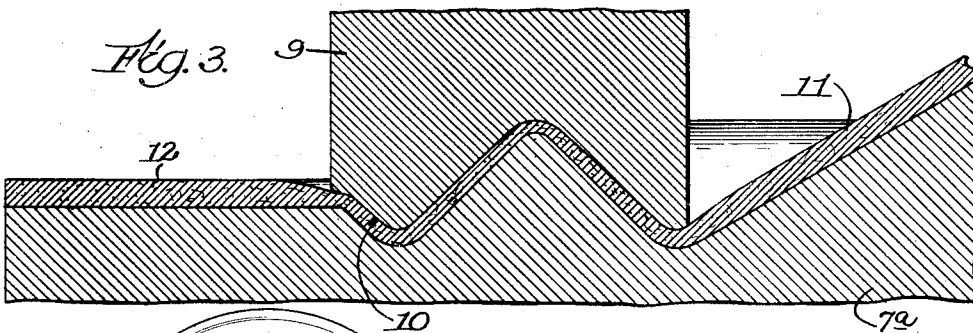
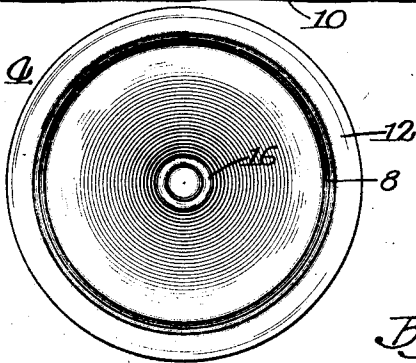


Fig. 4.



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SOUND REPRODUCING DIAPHRAGM

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13 Claims. (Cl. 181-32)

Among the objects of the invention is to provide a novel sound producing or reproducing diaphragm or diaphragmatic member and a novel method of making or producing it.

To obtain a sound producing or reproducing diaphragm capable of producing or reproducing sound true and faithful to the original sound to be reproduced, it is necessary that the diaphragmatic member be as light in weight as possible and not subject to a natural period or fundamental frequency, yet sufficiently stiff to set up the proper waves in the sound medium.

An object of this invention is to produce such a sound producer or reproducer which will have a substantially even response curve, where all sounds of the audible range will be produced or reproduced with substantially equal efficiency.

In an illustrative embodiment of the invention the sound producer is preferably of moulded fibrous material. It is made in one integral piece and without any seam. It may be of any desired shape, as pyramidal, cone shaped, conoidal, cissoidal and other similar shapes, with an integral basal flange by which the diaphragmatic member may be supported. It is very thin and very light in weight to reduce to a minimum, the mass inertia or momentum thereof. The flange is preferably made with a border portion for retention by a support or holding means, and a thinner portion between the border portion and the body part of the device, whereby the freedom of vibration of the sound producer may be greatly enhanced, the thinner portion mentioned being very easily flexed or having increased flexure. This portion is also preferably undulated to aid the pliability or flexure at the region above indicated.

This thinner portion may be and preferably is effected by compressing or compacting the fibrous material at the juncture between the body portion or cone part of the diaphragmatic member, and the basal flange. In the process of moulding, the fibres are preferably deposited on a porous former to form a blank. The thickness of the deposit, is substantially uniform throughout the blank. The blank, either while still wet or moist, or after it is dried, is then subjected to compression, as between dies, or rollers, or the like, for compressing or compacting the fibres at the region mentioned. If desired, the whole diaphragmatic member may be calendered or compressed to compact the fibres, and additional pressure applied at the juncture between the body and basal flange portions, for the purpose above mentioned. Or, if de-

sired, the member may be left uncompressed or uncalendered.

Another object of the invention is to impregnate the sound producer with moisture or water proofing material or substance, whereby the acoustic properties of the diaphragm will not change with the humidity of the sound medium, such as the air of the atmosphere. The impregnation may be of different degrees over the diaphragm, so that different parts of the diaphragm may be efficiently responsive to the different periods of the audible range of sound to the end of making the diaphragm substantially non-fundamental in periods.

A further object is to provide a novel process of making such a diaphragm as by depositing the fibres of a bath on a porous former, applying pressure on the part of the fibrous blank to be made thinner for flexure, with or without impregnating the blank, and finishing, as by drying, compressing and the like. The pressing may be effected while the blank is wet, or after the blank has been dried, or after the blank has been treated.

Other objects, advantages, capabilities, features and process steps are comprehended by the invention as will later appear and as are inherently possessed thereby.

Referring to the drawing;

Figure 1 is a vertical sectional view through a former and a moulded blank of fibrous material.

Figure 2 is a similar view of compressing means and a blank to be compressed at the juncture between the body or cone portion and the basal or flange portion of the diaphragmatic member.

Figure 3 is a fragmentary sectional view on an enlarged scale through the compressing means, and the compressed portion of the diaphragmatic member.

Figure 4 is a top plan view of a finished blank.

Referring now more in detail to the drawing, the diaphragm of this invention is made by depositing fibres upon a porous former 1 having pores or apertures 2, from a bath of fibrous material in a liquid such as water. The former 1, as in the illustrative construction, is of any desired shape, and the particular shape of the blank to be moulded, has a cap 3 which may be either closed or porous as desired, and a flange 4 which is also porous. Between the flange and the body portion 1 the former is preferably provided with an undulated or corrugated juncture portion 5. This former may fit into a container 6 of the bath. Within and below the former a partial vacuum may be created so that the liq-

uid of the fibrous bath may be sucked through the pores 2 of the former and cause a deposit of fibres 7 upon the former as shown in Figure 1. These fibres are preferably deposited with substantially uniform thickness throughout the whole blank. During the sucking action, the bath may be and preferably is agitated and vibrated to maintain the fibres in suspended and dispersed condition, and also to aid in the proper laying and interlacing of the fibres deposited and accreted on the former.

After the blank has been completely formed in the manner above described, the blank may be removed from the former and placed upon a compressing member, such as a die 7^a having the proper and desired configuration or contour as clearly shown in Figure 2. It is preferable that this compressing member have a counterpart corresponding to the corrugated portion 5 of the former and to fit properly with the corrugated portion 8 of the blank. A second compressing member, such as a die 9 or a roller 9^a having a counterpart undulated or corrugated surface 10 or 10^a is made to engage with the opposite surface of the corrugated portion 8 of the blank as clearly shown in Figures 2 and 3. The compressing members are then made to function so as to compress the fibrous material therebetween for the purpose of compacting such fibres and also to render the thickness of the compressed portion of the fibres less than the body portion 11 and the flange portion 12 of the diaphragmatic member. In this way the compressed juncture will be made more durable and lasting although the same is made more pliable or flexible by reason of making the material thinner than the body and flange of the blank. By making the juncture also undulated or corrugated, the flexibility or pliability of the juncture is enhanced.

If desired, before the compression of the juncture is effected the whole blank may be compressed to compact the fibres, and then the juncture given an additional pressure or compression to effect the desired thinner and tougher portion as above described.

It is preferable to treat the blank either when it is soft and wet or after it has been dried, with some impregnating material which has moisture or water proofing properties. As for example, the apical or central portion of the diaphragm or cone may be impregnated with such substances as duco, lacquer or like similar substances. The remainder of the diaphragm may be impregnated with such substances as rubber cement or other water proofing material so that this part of the diaphragm will be more supple or limber than the central portion of the diaphragm. The central portion of the diaphragm is preferably impregnated with a denser substance so that such central portion will be stiffer than the remainder of the diaphragm. The basal flange portion may be impregnated with such material as rubber cement, latex and other like and similar materials. The impregnation may vary over different areas so that the stiffness and flexibility may vary accordingly.

If desired, the impregnating material might be mixed in the pulp bath so that when the fibres are deposited, they will also carry with them the proofing material. Such material as asphaltum, latex, resin, size and sulphate of aluminum may be used. These may help to toughen and water proof the material of the diaphragm so that the diaphragm will have the desired acoustic char-

acteristics mentioned above. Any kind of fibre may be used.

The diaphragm is of extremely light weight, and very flexible in the flange portion thereof, particularly at the thin portion or juncture between the cone or body portion and the flange portion.

In use a hollow cylinder is attached to the neck 16 and carries a coil of fine wire located in an annular magnetic gap of a dynamic type of actuator. The border 12 is clamped in a fixed part of the sound reproducing mechanism, so that the diaphragm or cone is suspended by way of the thin corrugated juncture 8 of the diaphragmatic member. Suitable flexible means may be connected at the neck portion 16 for movably supporting that end.

As the cone portion is vibrated, the thin corrugated band or juncture 8 permits its freedom of vibration by reason of the thinness and undulatory form of that portion thus giving great flexibility and pliability at the parts located between the flange 12 which is held in fixed position and the moving cone or body 1 of the diaphragmatic member.

In this art, difficulties are met in which a diaphragm of this kind usually has some fundamental period or natural frequency of vibration at which some waves of the same period will be more efficiently rendered or reproduced than others of the audible range. In making a portion of the diaphragm stiffer than another portion, certain frequencies of the audible range will be more efficiently transmitted or emitted by the stiffer portion, while the other frequencies will be more efficiently transmitted by the less stiff portion of the diaphragm. As for example, if the diaphragm be of low natural period tendency, it would tend to reproduce low frequencies more efficiently. By stiffening a portion, that portion will transmit certain frequencies, such as the high frequencies, more efficiently, and by making other portions more flexible, the latter portions will transmit other frequencies, such as low frequencies, more efficiently. In this way the whole audible range may be efficiently reproduced.

By making the diaphragm of integral material, such as moulded fibrous substances, certain disadvantages are avoided, such as those that are present in the rolled and seamed cone, or the stretched cone. In the latter forms, the material used is placed under strains and stresses which affect the acoustic properties of the sound reproducer. By the present invention, the shape of the diaphragm is that originally produced and there is no strain nor stress of any kind to affect its acoustic properties. The compressing of the connecting portion or band between the cone and the flange does not produce a distortion or stress or strain in the body portion of the cone from which the sound waves are sent forth in the sound transmitting medium, such as the atmosphere. Moreover, the diaphragm of the present invention is more or less porous even after it is impregnated and its porosity seems to have the characteristic of engaging the sound transmitting medium without any tendency of slippage and hence loss of sound reproduction.

This disclosure is a continuation in part of my co-pending application Ser. No. 489,835, filed October 20, 1930, now Patent No. 1,872,583 granted August 16, 1932.

While I have herein described and upon the

drawing disclosed an embodiment of the invention and a process of producing it, it is to be understood that the invention is not limited thereto, but may comprehend other structures, arrangements of parts, details, features and process steps without departing from the spirit thereof.

Having thus disclosed the invention,

I claim:

1. A sound producer of integral molded fibrous material, comprising a vibratile portion, a supporting portion, and a connecting portion, said connecting portion being thinner and more compact than the remainder of said producer.
2. A sound producer of integral molded fibrous material, comprising a vibratile portion, a supporting portion, and a connecting portion, said connecting portion being flexible and compressed and thinner than the remainder of said producer.
3. A sound producer of integral molded fibrous material, comprising a body portion, a basal portion, and a compressed thinner portion therebetween for enhancing the freedom of vibration of the producer.
4. A sound producer of integral molded fibrous material, comprising a body portion, a basal portion, and a compressed thinner and undulated portion therebetween for enhancing the freedom of vibration of the producer.
5. A sound producer of integral molded fibrous material, comprising a cone portion, a basal flange portion, and a thin flexible connecting portion, said connecting portion being composed of compressed fibres.
6. A sound producer of integral molded fibrous material, comprising a cone portion, a basal flange portion, and a thin flexible connecting portion, said connecting portion being undulated and composed of compressed fibres.
7. A sound producer comprising a diaphragmatic member, a flexible portion and a border, said flexible portion being thinner than the remainder of said member and composed of compressed fibres.
8. A sound producer comprising a diaphragmatic member, a flexible undulated portion and a border, said flexible portion being thinner than the remainder of said member and composed of compressed fibres.
9. A sound producer comprising a diaphragmatic member having a central vibratile portion, a marginal supporting portion, and an intermediate flexible portion of thinner and more compacted material than the remainder of said member.

10. A sound reproducing seamless diaphragm initially formed integrally throughout of accretions of fibrous material, comprising a cone shaped body and an integral supporting flange, the juncture of the body and flange being compressed to render the same pliant and durable whereby the cone shaped body may be controllably vibrated to reproduce sound.

11. A sound reproducing seamless diaphragm initially formed integrally throughout of accretions of fibrous material, comprising a cone shaped body and an integral supporting flange, the juncture of the body and flange being undulated and compressed to render the same pliant and durable for controllable articulation of the body and flange and whereby the cone shaped body may be controllably vibrated to reproduce sound.

12. A sound reproducing seamless diaphragm initially formed integrally throughout of accretions of fibrous material, comprising a cone shaped body and an integral supporting flange, the apical portion of the cone shape body being more rigid than the remainder of said body, said remainder being treated to render it supple whereby said treated remainder is efficiently responsive to the lower frequencies of the audible range of sound reproduced by said body, the more rigid apical portion of the body being efficiently responsive to the higher frequencies of the audible range of sound reproduced by said body, the juncture of the body and flange being thinner and more compact and more pliant than the body and flange for freedom of vibration of the body as a whole when reproducing sound.

13. A sound reproducing seamless diaphragm initially formed integrally throughout of accretions of fibrous material, comprising a cone shaped body and an integral supporting flange, the apical portion of the cone shaped body being treated with stiffening material to render said portion more rigid than the remainder of the body and for making the treated portion efficiently responsive to the higher frequencies of the audible range of sound reproduced thereby, said remainder being treated to render it supple whereby said treated remainder is efficiently responsive to the lower frequencies of the audible range of sound reproduced by said body, the juncture of the body and flange being compressed, thinner and more pliant than the body and flange for freedom of vibration of the body as a whole when reproducing sound.

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