Aug. 16, 1932. J. B. HAWLEY 1,872,583

SOUND PRODUCING DIAPHRAGM AND METHOD OF MAKING SAME

Filed Oct. 20, 1930

Fig. 1.

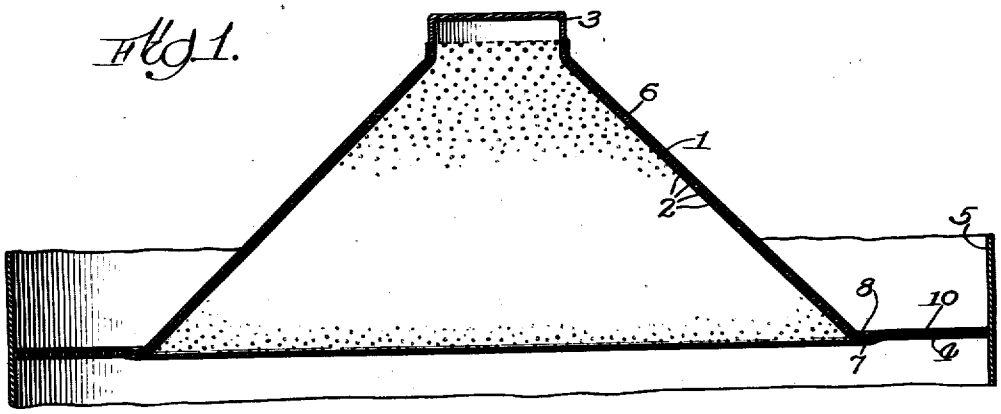


Fig. 2.

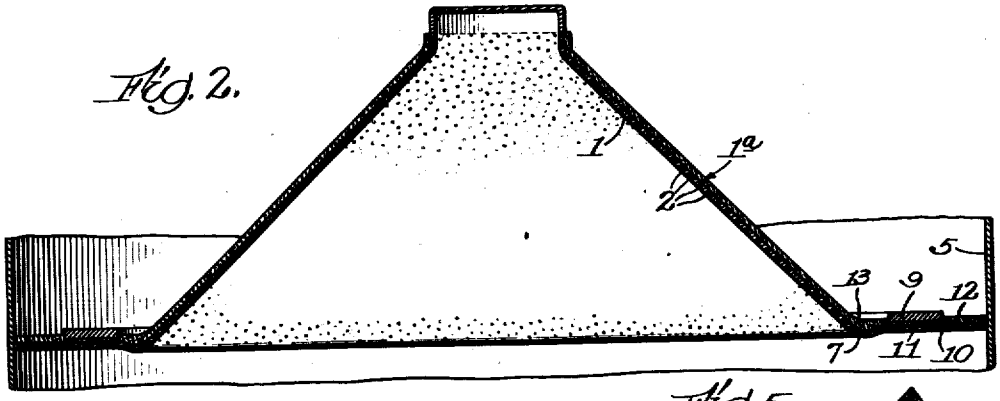
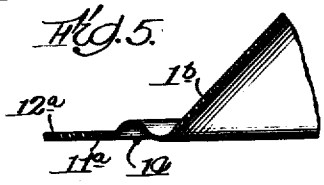


Fig. 5.



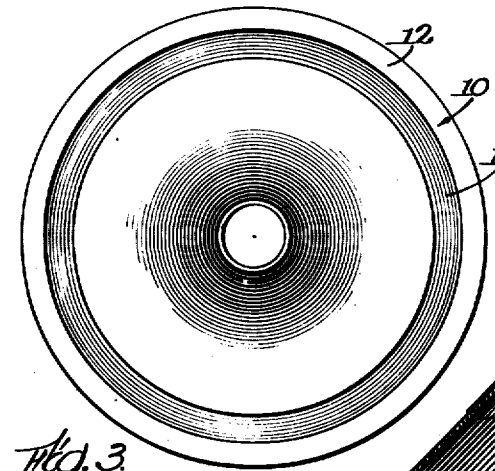
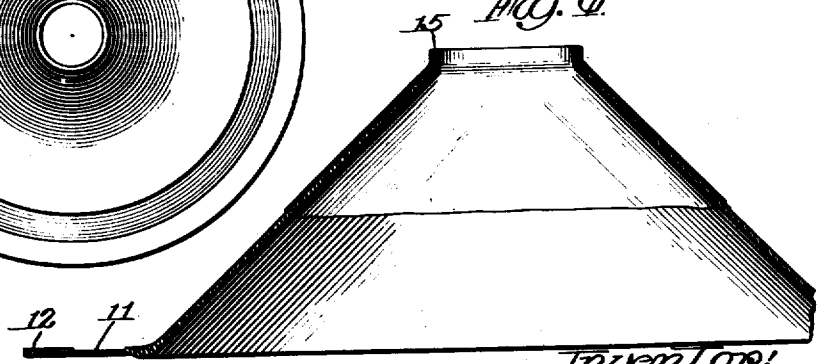


Fig. 3.

Fig. 4.



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By: Wallace R. Lane. Atty.

Patented Aug. 16, 1932 1,872,583

UNITED STATES PATENT OFFICE

JESSE B. HAWLEY, OF GENEVA, ILLINOIS

SOUND PRODUCING DIAPHRAGM AND METHOD OF MAKING SAME

Application filed October 20, 1930. Serial No. 489,835.

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 molded fibrous material. It is made in one integral piece and without any seam. It may be of cone shape with an integral basal flange by which the cone 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 or cone 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 thinner portion may be effected by interposing a blanking member or stopper ring on the partly formed and molded fibrous blank during the molding process, to stop further deposit of fibres under said ring while further fibres are being deposited in the completion of the remainder of the article.

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 period.

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, interposing a blanking member or stopper on the part of the fibrous blank to be left thin, impregrating the blank, and finishing it, as by drying, compressing, and the like.

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;

Fig. 1 is a vertical sectional view through a former and a partly molded fibrous blank.

Fig. 2 is a similar view showing the interposition of the stopper ring and the completed blank.

Fig. 3 is a top plan view of the means shown in Fig. 2.

Fig. 4 is a sectional view of a completed sound reproducer; and

Fig. 5 is a fragmentary sectional view of an alternate form.

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 and a liquid such as water. The former 1 as in the illustrative construction, is of cone shape and has a closed or non-porous cap 3, and a flange 4, which is porous. This former may fit into a container 5 of the bath. Within and below the former a partial vacuum is created so that the liquid of the fibrous bath may be sucked through the pores 2 of the former and cause a deposit of fibres 6 upon the former as shown in Fig. 1.

The former 1 may also have a curved portion 7 so as to form a corrugation 8 in the fibrous blank 6 being formed on the former.

After there has been a partial deposit of the fibres upon the former, a blanking or stopping ring 9 may be positioned over the flange portion 10 of the blank to stop further deposit of the fibres at the area 11 when further fibres are being deposited upon the former to effect the finally made blank 1^a as clearly shown in Fig. 2. This leaves a thin fibrous portion 11 between the border portion 12 of the flange 10, and the juncture between the cone 1^a and said flange. The juncture 13 between the cone and the thin portion 11 may be slightly thicker than the remainder of the blank, to strengthen the blank at such point.

If desired the juncture may be made thin and formed with a double corrugation 14 as shown in Fig. 5 and connected between the thin portion 11^a and the corrugation 14, as clearly indicated in that figure. This aids in the flexure between the border 12^a and the cone 1^b. After the blank is formed it may be removed from the former and placed upon a similar former for finishing, or the original former with the blank may be removed to a finishing machine. In a finishing process, hot air may be sucked through the blank and the supporting porous member so as to dry the fibrous blank. If desired, the blank may also be compressed. This may be done either mechanically or by increasing the suction on one side of the holder for the blank and the pressure of the hot air on the other side. In this way the fibres may be more compact.

It is preferable to treat the blank 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 as by dipping or spraying 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 impregnations 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 as 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 characteristics 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 11. In use a hollow cylinder is attached to the neck 15 and carries a coil of fine wire located in an annular magnetic gap of an electrodynamic type of actuator.

The border 12 is clamped in a fixed part of the sound reproducer mechanism, so that the diaphragm or cone is suspended by way of the thin band 11. Suitable means, as usually used may be used at the neck portion 15 for movably supporting that end.

As the cone portion is vibrated, the thin band 11 permits its freedom of vibration by reason of the thinness of the portion 11 and its flexibility. This may be aided by providing one or more corrugations 14 or even a single corrugation such as that formed at 8 as shown in Fig. 1.

One of the difficulties met with in this art, is that 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 the 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 portion 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 molded 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 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.

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 details, arrangement 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 body portion and a base portion, said base portion having a part of less thickness than the remainder of the producer for enhancing the freedom of vibration of the producer.

2. A sound reproducing seamless diaphragm, initially formed integrally throughout of accretions of fibrous material, comprising a cone shaped body and a basal flange, said flange having a thing annular area for increasing the flexure of the flange portion.

3. A sound reproducing diaphragm comprising a cone-shaped body, an annular flange and an annular integral juncture between the body and the flange, said body, juncture and flange being composed of deposited fibrous pulp the fibres of which have been initially deposited in the form of said body, juncture and flange, said fibres being arranged in interlaced accretions and normally free of internal stresses which may tend to change the form or shape of the diaphragm as originally formed, said juncture being thinner than said body and acting to permit the free and unimpeded vibratile action of said body when generating sound but at the same time supporting said body for a balanced vibration thereof.

4. A sound reproducing diaphragm comprising a cone-shaped body, an integral annular basal juncture and an integral basal flange, all composed of accretions of interlaced fibres which have been initially deposited in the form of the body, juncture and flange, said body and juncture being normally free of internal stresses that would tend to change the form or shape of said body and juncture as originally formed, the fibres of the body and juncture being arranged to provide a cellular construction therein, the body being of substantially uniform thickness in a plane normal to the axis of the cone, said juncture being thinner than said body for increasing the flexure of the basal part of the diaphragm and acting to permit the free and unimpeded vibratile action of the body when generating sound but at the same time supporting said body for a balanced vibration thereof.

5. A sound producer of integral molded fibrous material, comprising a diagragmatic member having a supporting border, said member having an area of thinner material than a remainder of said member for enhancing the freedom of vibration of said member.

6. A sound producer composed of integral molded fibrous material and comprising a diaphragmatic member impregnated with moisture proof material.

7. A sound producer composed of integral molded fibrous material and comprising a diaphragmatic member impregnated with moisture proof material, the central portion of said member being more densely impregnated to give said portion greater stiffness than the remainder of said member.

8. A sound producer, comprising a diaphragmatic member impregnated with moisture proof material, the central portion of said member being impregnated with a denser material than the remainder of said member to give said central portion greater stiffness than the remainder of said member.

9. A sound producer composed of integral molded fibrous material and comprising a cone portion and a flange portion, said flange portion comprising a border and a supporting portion between the cone portion and the border portion, said supporting portion being thinner than the remainder of the producer.

10. In a process of making molded fibrous diaphragmatic sound producers, the steps of forming a blank on a porous former, and placing a stopper on a portion of the blank during its forming to leave the portion of the blank under said stopper thinner than the remainder of the blank.

11. In a process of making molded fibrous diaphragmatic sound producers, the steps of forming a blank on a porous former, placing a stopper on a portion of the blank during its forming to leave the portion of the blank under said stopper thinner than the remainder of the blank, and drying the blank.

12. In a process of making molded fibrous diaphragmatic sound producers, the steps of forming a blank on a porous former, placing a stopper on a portion of the blank during its forming to leave the portion of the blank under said stopper thinner than the remainder of the blank, and impregnating the blank with moisture proofing material.

13. In a process of making molded fibrous diaphragmatic sound producers, the steps of forming a blank on a porous former, placing a stopper on a portion of the blank during its forming to leave the portion of the blank under said stopper thinner than the remainder of the blank, impregnating the central portion of said blank with a moisture proofing and stiffening substance, and impregnating the remainder of said blank with a moisture proofing supple producing substance.

14. A sound reproducing seamless diaphragm, initially formed integrally throughout of accretions of fibrous material comprising a vibratile cone shaped body, and an annular flange having a pliant juncture integrally connecting the body and flange, said

juncture being of thinner material than said cone shaped body and acting to permit the free and unimpeded vibratile action of the cone shaped body when generating sound but at the same time supporting said body for a balanced vibration thereof.

15. A sound reproducing seamless diaphragm, initially formed integrally throughout of accretions of fibrous material, comprising a vibratile cone shaped body, and an annular flange having a pliant juncture integrally connecting the body and flange, said juncture being of thinner material than said cone shaped body and undulated in form and acting to permit the free and unimpeded vibratile action of the cone shaped body when generating sound but at the same time supporting said body for a balanced vibration thereof.

In witness whereof, I hereunto subscribe my name to this specification.

JESSE B. HAWLEY.

CERTIFICATE OF CORRECTION.

Patent No. 1,872,583. **August 16, 1932.**

JESSE B. HAWLEY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 20, claim 2, for "thing" read "thin"; and line 64, claim 5, for "a" read "the"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of November, A. D. 1932.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

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15. A sound reproducing seamless diaphragm, initially formed integrally throughout of accretions of fibrous material, comprising a vibratile cone shaped body, and an annular flange having a pliant juncture integrally connecting the body and flange, said juncture being of thinner material than said cone shaped body and undulated in form and acting to permit the free and unimpeded vibratile action of the cone shaped body when generating sound but at the same time supporting said body for a balanced vibration thereof.

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