Sept. 10, 1935. J. B. HAWLEY 2,013,955

SOUND REPRODUCING DIAPHRAGM AND A METHOD OF MAKING THE SAME

Filed Feb. 12, 1934 2 Sheets-Sheet 1

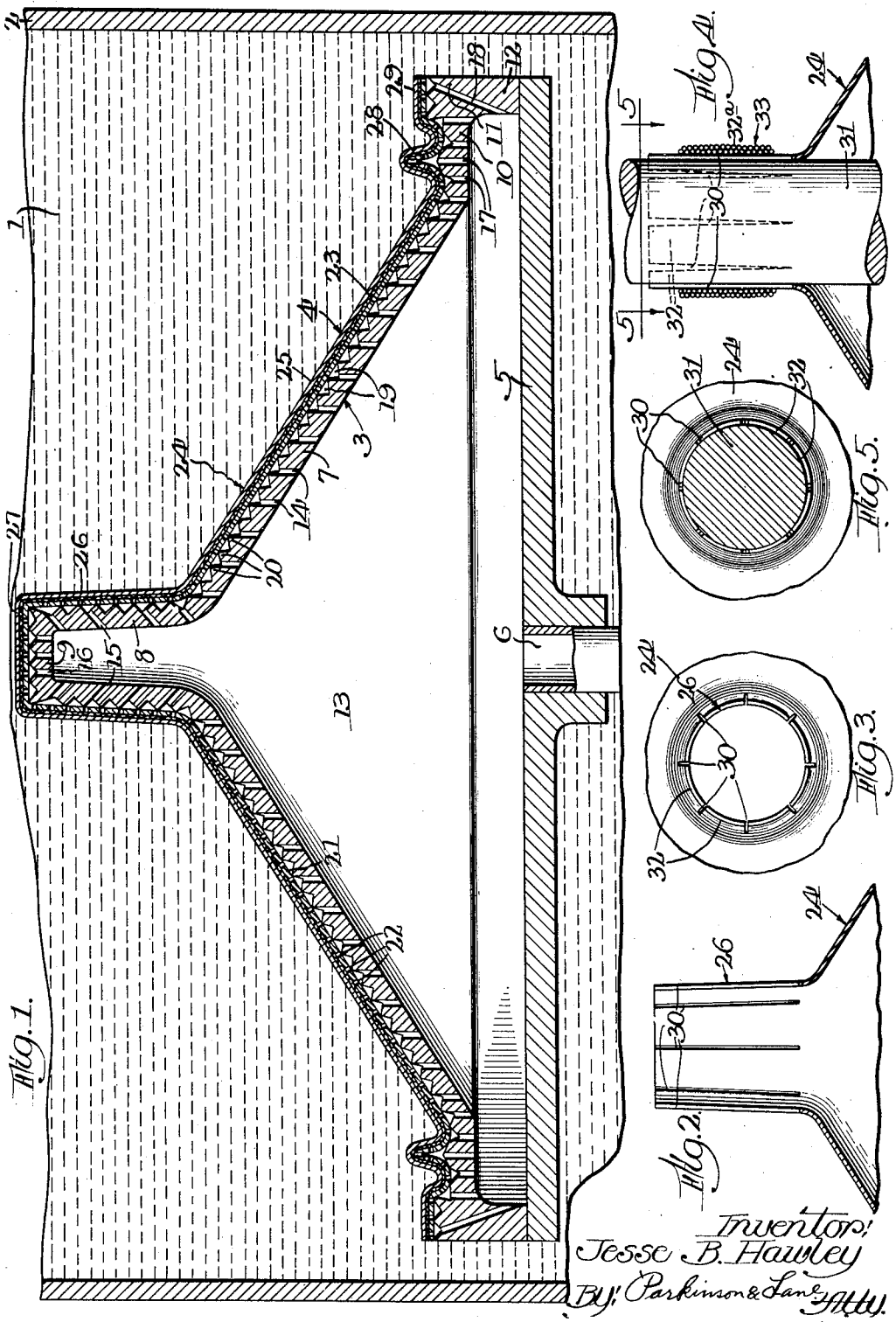

Fig. 1.

Fig. 4.

Fig. 5.

Fig. 3.

Fig. 2.

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Fig. 6.

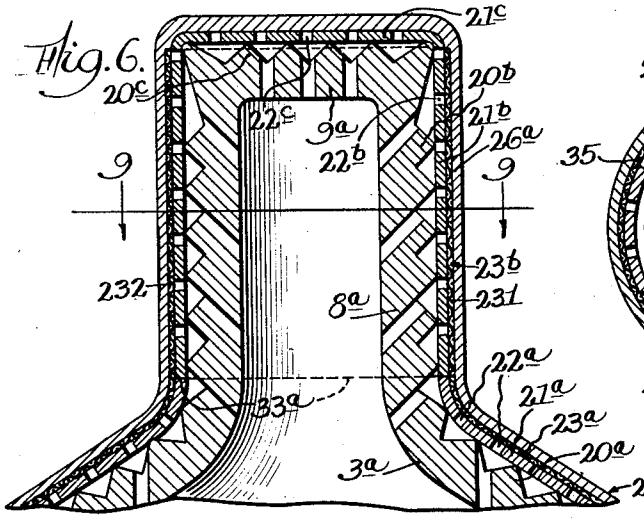


Fig. 9.

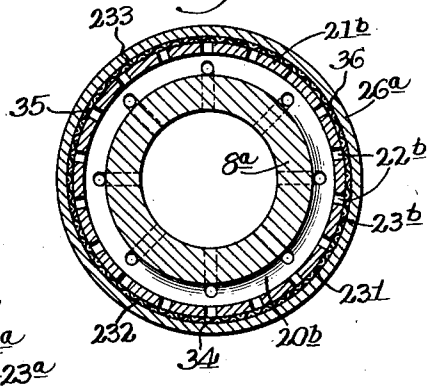


Fig. 10.

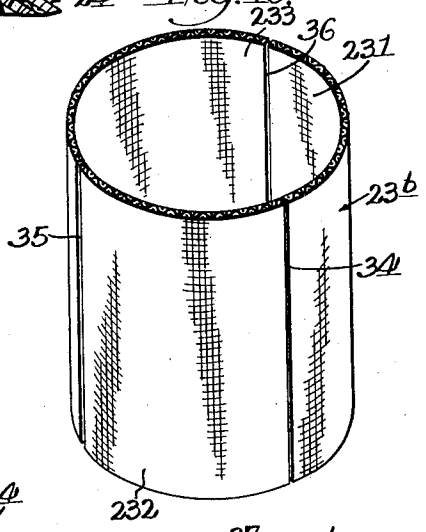


Fig. 7.

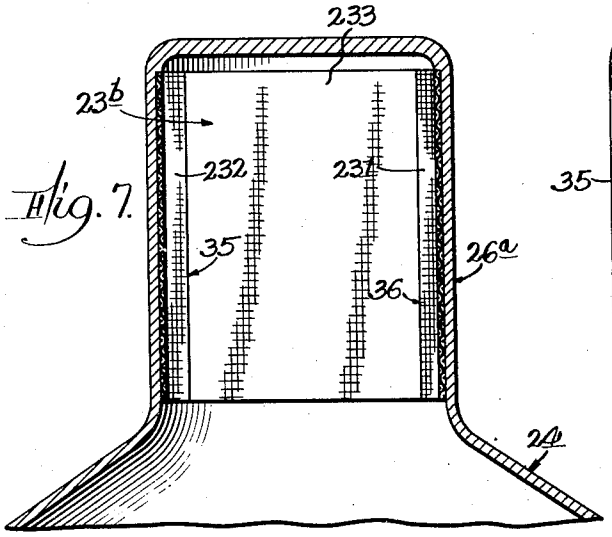


Fig. 11.

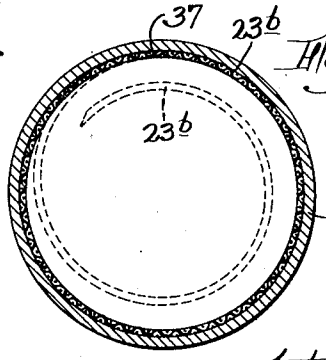
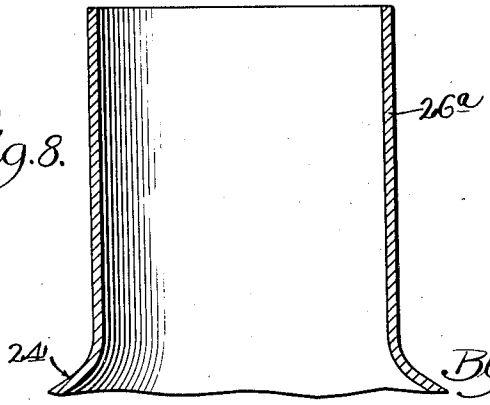


Fig. 8.



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2,013,955

SOUND REPRODUCING DIAPHRAGM AND A METHOD OF MAKING THE SAME

Jesse B. Hawley, Geneva, Ill.

Application February 12, 1934, Serial No. 710,854

21 Claims. (Cl. 181—32)

The present invention relates to sound reproducing diaphragms and the art of making them.

Among the objects of the invention are to provide a novel sound reproducing diaphragm having an integral voice coil carrying part, and a novel method of producing the same.

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 drawings:

Fig. 1 is a vertical sectional view of a device including a porous former or mold for producing the diaphragm of the invention;

Fig. 2 is a fragmentary sectional view of a diaphragm made in accordance with the invention;

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

Fig. 4 is a view similar to Fig. 2 and showing the use of a mandrel for shaping the voice coil carrying part to cylindrical form;

Fig. 5 is a transverse sectional view taken in a plane represented by line 5—5 in Fig. 4 of the drawings;

Fig. 6 is a fragmentary sectional view of a porous former and the voice coil carrying part of the diaphragm showing the direct cylindrical forming of said part;

Fig. 7 is a similar sectional view of the diaphragm with a cylindrical voice coil carrying part and a collapsible or contractible part of the porous former;

Fig. 8 is a similar sectional view of the finished voice coil carrying part of the diaphragm before fixing the voice coil thereto;

Fig. 9 is a transverse sectional view taken in a plane represented by line 9—9 in Fig. 6 of the drawings;

Fig. 10 is a perspective view of the collapsible part of the porous former; and

Fig. 11 is a transverse sectional view through the voice coil carrying part and an alternate form of collapsible part of the porous former.

Referring more in detail to the drawings, the invention is effected by the accretion, interlacing and integration of fibrous material held in dispersed suspension in a water bath 1 contained in a suitable tank or vat 2 upon a porous former or mold 3 to form an integral, seamless, uniform, symmetrical and unitary diaphragm 4, the former 3 being supported upon a table 5 having a pipe 6 connected to a source of suction or pressure (not shown). The table 5 is adapted to be raised or lowered in the vat 2 by any suitable means (not shown) as desired.

The former or mold 3 comprises a metal plate having a conical portion 7, an apical tubular portion 8, a cap portion 9, a basal portion 10, a marginal portion 11, and an annular depending flange 12, the latter resting on the table 5. These together with the table define a chamber 13 which is normally the suction chamber in the device.

The plate portions 7, 8, 9, 10, 11, and 12 are provided with draining apertures 14, 15, 16, 17, and 18 extending from draining grooves 19 formed in the surface of the mold portions 7, 8, 9, 10, and 11. Ridges 20 are thus provided between the grooves.

Upon these ridges sits a thin metal sheet 21 contoured to fit with the mold portions mentioned, and having a large number of fine holes or apertures or pores 22 through which the water of the bath may pass during the forming of the diaphragm.

On this sheet 21 fits a screen or reticulated sheet 23 also contoured to fit with the mold portions mentioned, the interstices of the sheet 23 affording passage for the water of the bath during the forming of the diaphragm. It is upon the surface of sheet 23 that the fibrous blank or diaphragm 24 is formed.

The blank as shown in Fig. 1 comprises a conical portion 25, an apical tubular portion 26, a cap portion 27, a basal portion 28, and a marginal portion 29. It will be noted that the mold part 10 is undulated so as to form the blank portion 28 with undulations, this undulated part constituting the flexible connection or the articulation between the conical or vibratile part 25 and the marginal or supporting part 29 of the diaphragm. In the form shown in Fig. 1, the apical tubular part of the mold has a slight taper to afford sufficient draft for withdrawing the blank from the mold after the blank is formed.

The blank or diaphragm is produced by the accreting and integrating of the fibrous material of the bath 1 upon the surface of the mold or former. The table 5 with the former thereon is lowered into the bath 1 until the mold is completely immersed or submerged, and with a suction effective in the chamber 13, the water of the bath 1 is drawn or sucked through the interstices of the reticulated sheet 23, the pores 22 of the sheet 21, and the grooves 19 and holes 14, 15, 16, 17, and 18 of the mold plate 3, the water being discharged through the pipe 6, thus resulting in a deposit or accretion and integration of the fibres into a layer or stratum 24 on the sur-

face of the mold, that is, the sheet 23. The fibres are so integrated and interlaced as to form an integral, unitary, seamless, uniform and symmetrical blank having the shape or contour of the mold surface.

After a deposit of sufficient or desired thickness of the material, the former and table are raised out of the bath 1, the suction being continued. The drawing of air through the blank and mold removes surplus water. If the air be warm or hot, the blank may be dried by drawing the heated air through the blank and mold. It is preferable to remove the blank before drying. This may be done by placing a suction box (not shown) having an apertured surface having the same contour as the blank, and bringing the same in contact with the blank. The suction in chamber 13 is cut off or changed to a pressure, and suction is effected in the suction box. The blank adheres to the apertured contoured surface of the suction box and when the latter is raised the blank is raised with it. The blank may then be removed and placed upon a suitably contoured die (not shown) and dried in any suitable or desired manner.

The tubular part 26 is tapered to afford a draft for removal from the mold. Inasmuch as the voice coil to be fixed to the part 26 must be cylindrical, it is necessary to shape the part 26 to a cylindrical form before the voice coil is wound thereon and fixed thereto. The cap part 27 is therefore cut off and the tubular part cut with slits 30 (Figs. 2, 3, 4, and 5). A cylindrical mandrel 31 is then inserted in the slitted tubular part 26 so as to expand the tongues 32 to cylindrical position. With the mandrel still in place, the wire 32a of the voice coil 33 is wound upon the cylindrical tubular part 26 (Fig. 4), and glue or collodion or the like is applied to fix the coil and tongues together and maintain them in cylindrical form. The mandrel may then be removed and the diaphragm mounted in the speaker unit.

In the form shown in Figs. 6–11 inclusive, the voice coil carrying part is molded or accreted initially into cylindrical form, thus avoiding the slitting and expanding of such part as shown in Figs. 2, 3, 4, and 5. The mold plate 3a is made like mold plate 3 except the tubular part 8a thereof is cylindrical instead of being tapered. On the ridges 20a of the conical and basal parts of the mold plate fits a thin metal sheet 21a having pores 22a, and around the cylindrical part 8a and over the cap part 9a fits a thin metal sheet member having a cylindrical portion 21b slidable over the ridges 20b, the lower end of portion 21b abutting the upper end of the portion 21a on the line 33a, and having a cap portion 21c resting on the ridges 20c of the cap 9a of the mold. The parts 21b and 21c also have a large number of apertures or pores 22b and 22c.

Over the sheet metal parts 21a and 21b but not over 21c, are reticulated sheets 23a and 23b, the lower end of the latter abutting the upper end of the former on line 33a (Fig. 6).

The reticulated part 23b may be made up of a plurality of sections or segments 231, 232 and 233 (Figs. 7 and 10) with abutting edges or joints 34, 35 and 36 which may be beveled as desired so that they may be easily moved inwardly to collapse the cylindrical assembly 23b (Figs. 7 and 10).

Instead of making this part in segments it may be of one piece as shown in Fig. 11 with a beveled parting 37, and with an inherent resilient tendency to collapse as shown by the dotted line position of it in Fig. 11.

The blank 24 is accreted, interlaced and integrated on this former or mold exactly as described above in connection with Fig. 1. When the blank is removed by the suction box above mentioned, the reticulated part 23b will be removed with it; sliding over the part 21b. Should the latter slide off the mold part 8a and with the reticulated part 21b, it may be removed by hand by sliding it out of the reticulated part 21b.

Then, the part 21b is collapsed by moving the segments (Fig. 10) inwardly, or if the reticulated part shown in Fig. 11 be used, it will automatically contract or collapse and drop out of the tubular part 26a of the blank.

In reassembling the mold, the metal sheet part 21b is slipped back in place over the mold part 8a and then the reticulated part 23b slipped in place over the part 21b. The suction acting through the mold will normally hold the segments 231, 232, and 233 (Fig. 10) in place. If the part shown in Fig. 11 be used, its resiliency makes it clasp the part 21b.

The finished tubular part 26a, cylindrical in form, is shown in Fig. 8.

While I have herein disclosed specific embodiments of the invention, it is to be understood that the invention is not limited thereto but may comprehend other constructions, details, arrangements of parts, features and process steps without departing from the spirit thereof.

Having thus disclosed the invention, I claim:

1. A sound reproducing diaphragm of fibrous material initially accreted in the desired form comprising a vibratile portion and an integral portion for directly supporting a voice coil.

2. A sound reproducing diaphragm of molded fibrous material comprising a vibratile portion for emitting sound, and an integral tubular portion for carrying a voice coil.

3. A sound reproducing diaphragm of fibrous material molded in the desired form comprising a conical vibratile portion, a basal portion, and an apical tubular portion, said portions being integral and of like material throughout.

4. A sound reproducing diaphragm of fibrous material initially accreted in the desired form comprising a sound emitting vibratile portion, a supporting marginal portion, and a voice coil carrying portion, all said portions being integral and forming a unitary diaphragm.

5. A sound reproducing diaphragm composed of accreted and integrated fibrous material in the form of a unitary integral diaphragm comprising a sound emitting vibratile portion, and an integral voice coil carrying portion.

6. A sound reproducing diaphragm composed of accreted and integrated fibrous material in the form of a unitary integral diaphragm comprising a sound emitting vibratile portion, an integral supporting marginal portion, and an integral voice coil carrying portion.

7. A sound reproducing diaphragm composed of accreted and integrated fibrous material in the form of a unitary integral diaphragm comprising a conical vibratile portion for emitting sound, and an integral apical portion upon which a voice coil is wound and carried.

8. A sound reproducing diaphragm composed of accreted and integrated fibrous material in the form of a unitary integral diaphragm comprising a conical vibratile portion for emitting sound, and an integral apical cylindrical portion upon which a voice coil is wound and carried.

9. A sound reproducing diaphragm composed of accreted and integrated fibrous material in the form of a unitary integral diaphragm comprising a conical vibratile portion for emitting sound, a supporting basal portion integral with said vibratile portion, and a cylindrical apical portion integral with said vibratile portion and upon which a voice coil is wound and carried.

10. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the steps of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular part, and fixing a voice coil to said tubular part.

11. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the steps of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular part, shaping said tubular part into cylindrical form, and fixing a voice coil to said cylindrical part.

12. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the steps of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular part which is slightly tapered, slitting said tubular part, and shaping the latter to cylindrical form.

13. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the steps of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular part which is slightly tapered, slitting said tubular part, shaping the latter to cylindrical form, and fixing a voice coil to said cylindrical part.

14. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the steps of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular part, and collapsing a part of the former which is within said tubular part to leave said tubular part in cylindrical form.

15. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the steps of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular part, collapsing a part of the former which is within said tubular part to leave said tubular part in cylindrical form, and fixing a voice coil to said tubular part.

16. A method of making a sound reproducing diaphragm with an integral voice coil carrying part by forming the latter integral with the diaphragm from fibrous material accreted and integrated upon a porous former.

17. A method of making a sound reproducing diaphragm with an integral voice coil carrying part by forming the latter integral with the diaphragm from fibrous material accreted and integrated upon a porous former, and fixing a voice coil on a surface of said part.

18. A method of making a sound reproducing diaphragm with an integral voice coil carrying part by forming the latter integral with the diaphragm from fibrous material accreted and integrated upon a porous former, shaping said part into cylindrical form, and fixing a voice coil on a surface of said part.

19. A former or mold for making a sound reproducing diaphragm with an integral voice coil carrying part, comprising a porous member having a contractible part upon which the voice coil carrying part of the diaphragm is formed by the accretion and integration of fibrous material.

20. A former or mold for making a sound reproducing diaphragm with an integral voice coil carrying part, comprising a rigid porous part upon which the vibratile part of the diaphragm is formed by the accretion and integration of fibrous material, and a separable and contractible porous part upon which the voice coil carrying part of the diaphragm is formed by the accretion and integration of fibrous material.

21. A method of making a sound reproducing diaphragm having an integral voice coil carrying part, comprising the step of accreting and integrating fibrous material upon a porous former into the form of a diaphragm with an integral projecting tubular portion of sufficient length for the fixing of a voice coil on said integral tubular part.

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