Feb. 9, 1932. F. C. HINCKLEY ET AL 1,844,657

DIAPHRAGM

Filed Dec. 19, 1925

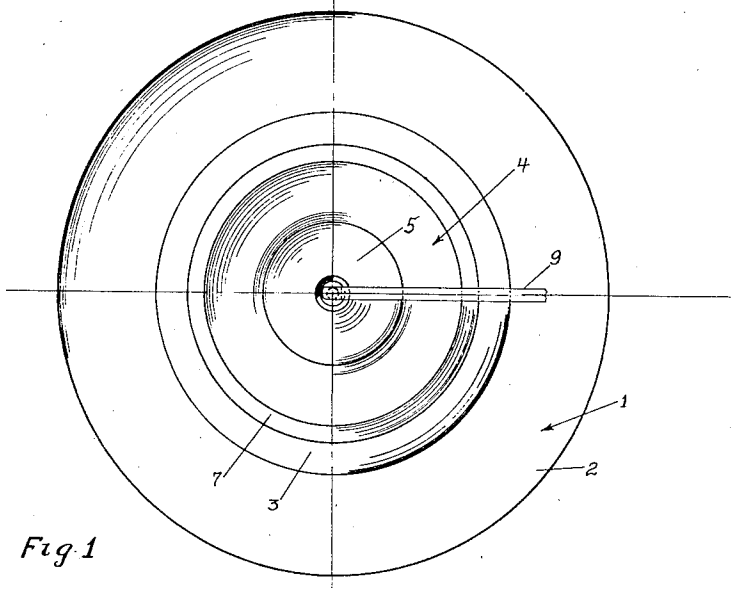


Fig. 1

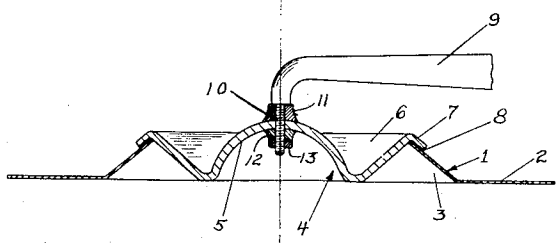


Fig. 2

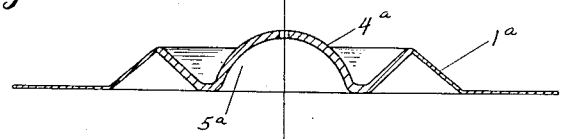
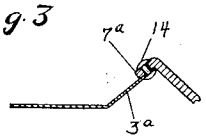


Fig. 3



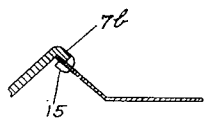


Fig. 4

Fig. 5

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UNITED STATES PATENT OFFICE

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DIAPHRAGM

Application filed December 19, 1925. Serial No. 76,351.

This invention relates to new and useful improvements in diaphragms for use on recording machines, reproducing machines, telephones and the like, and has particular reference to a diaphragm for use on a reproducing phonograph.

An object of the invention is to provide a diaphragm for the purpose stated, which will faithfully reproduce the entire musical scale.

Another object is to provide a diaphragm which will give a heavy full bass and will also accurately reproduce the highest notes of a piano.

A further object is to provide a diaphragm possessing great elasticity and which so vibrates that large volume is obtained.

An additional object is to provide a means for securing the stylus bar to the diaphragm in such a manner as to prevent any relative movement between such members, which movement would result in loss of volume in reproduction and in an obnoxious rattle when the diaphragm is of metal.

Other objects and advantages will become more apparent as the description proceeds.

Referring to the drawings, wherein, for the purpose of illustration only, we have shown preferred embodiments of the invention:—

Fig. 1 is a plan view of a diaphragm in accordance with one embodiment of the invention, a portion of the stylus bar being shown connected thereto;

Fig. 2 is a sectional view centrally of Fig. 1;

Fig. 3 is a central sectional view of a slightly modified form of the invention;

Fig. 4 is a detailed sectional view showing modified means for connecting the central portion of the diaphragm to the annulus thereof; and

Fig. 5 is a further modification showing another means for connecting the central portion and annulus of the diaphragm.

Having detailed reference to the drawings, and particularly to Figs. 1 and 2 thereof, the diaphragm includes a relatively thin flexible annulus 1, of aluminum or duralumin, which consists of a flat peripheral portion 2 and an inwardly-inclined, annular inner wall 3. This annulus 1 is approximately .002″ thick and is of uniform thickness throughout and before being cut is rolled several times to give it temper.

Our diaphragm also includes a central portion 4 of uniform thickness. Portion 4 is shown as twice the thickness of the annulus 1, although it may well be of greater relative thickness. Said central portion includes a parabolic or dome-shaped portion 5 and an outwardly-inclined, annular wall 6 carrying an annular flange 7. This flange, as best shown in Fig. 2, overlies the upper portion of the inclined wall 3 of annulus 1 and is secured thereto by any suitable means, as, for instance, wax, cement or the like, as at 8.

The angle between the walls 3 and 6 is preferably about 90°. In this way a substantially inverted V-shaped arrangement is provided and its action when the diaphragm is being used to reproduce a phonograph record is much like that of a toggle. This is true, since when vibrations are imparted to the relatively rigid center portion 4, the pressure therefrom is delivered at the apex of the inverted V formed by the walls 3 and 6. A toggle-like action occurs in that these walls spread apart under pressure, and when the pressure is released, they immediately spring back to their normal positions. Owing to the great pressure which is obtained through this toggle action, a diaphragm is provided which gives very large volume when used in a phonograph reproducer.

As shown in Figs. 1 and 2, the stylus bar 9 is connected to the dome-shaped member 5, centrally thereof. The end 10 of the stylus bar is reduced and screw-threaded, and is provided with a shoulder against which a lug 11 is jammed when threaded home on end 10. One face of lug 11 is concaved to snugly engage that portion of the dome 5 with which it contacts when the parts are assembled. Lug 11 engages the outer surface of the dome 5 and the inner surface thereof is engaged by a lug 12 which is held in place by a nut 13. The lug 12 has a convex surface curved to snugly engage the inner surface of dome 5, and when the nut 13 is screwed home, the diaphragm is tightly clamped between the lugs 11 and 12.

Owing to the parabolic or dome-shape given the central portion 5, it is extremely strong, and will not flex or bend under the pressure applied to it by the vibration of the stylus bar during the reproduction of a phonograph record. Also, the connection between the dome 5 and stylus bar 9 is such that a very tight joint is provided and any free relative movement of the parts prevented. This coupled with the non-flexing characteristic of the central member 4, and dome 5, in particular, prevents lost motion in these parts and causes the flexing of the diaphragm under impulses transmitted to it by the stylus bar to take place in the annulus 1.

We may also construct our diaphragm in the manner shown in Fig. 3, wherein the annulus and central portion, while of different thicknesses, are formed integral. In making up this diaphragm, a piece of material, of the thickness of the central portion 4^a is used, and during the shaping operation, pressure is applied to the outer portion thereof while it is between the dies so as to spread it and form the thin annulus 1^a. The stylus bar will be connected to the dome 5^a of this diaphragm in the manner described in connection with Figs. 1 and 2.

Figs. 4 and 5 disclose modified means for connecting the annulus and central portion of the diaphragm. In accordance with the structure shown in Fig. 4, this means will include rivets, being shown at 14, which pass through the flange 7^a of the central portion and the inclined wall 3^a of the annulus. The means for connecting the central portion and annulus (in that form of the invention shown in Fig. 5) consists of lugs 15 formed on the flange 7^b of the central portion, and which in the assembling operation are passed through openings in the annulus and then clinched as shown. Wax or other material will be used to fill in and make an air-tight connection between the annulus and central portion of the diaphragm shown in Figs. 4 and 5.

At present, for manufacturing reasons, it is desirable to make the diaphragm in two pieces and then assemble the pieces. According to this method of manufacture, the annulus 1 is cut from very thin sheets of aluminum or duralumin of say about .002″ in thickness. These sheets are then shaped to provide the inclined inner wall 3, either by a spinning operation or by shaping them between suitable dies. The central portion 4 is cut from thicker sheets of material so as to be comparatively rigid, and is preferably from .004″ to .006″ in thickness. Dies may be used for shaping this central portion, although it may also be spun to give it the desired shape.

Aluminum may now be purchased in sheets as thin as .002″, which makes it desirable for use in diaphragms since such sheets are very light and when rolled several times have a sort of springy temper. A flat disc of aluminum of .002″ when used as a diaphragm is too tender to pump the air under it, and plays very weakly because of this fact. Such a diaphragm will bulge, due to the resistance of the air entrapped under it and when it bulges or gives, there is lost motion with a resultant loss in volume.

By corrugating, such a disc, it is strengthened substantially, and gives excellent results, in that the bass and upper register may be reproduced in a manner far superior to anything heretofore obtained. However, when the stylus bar is connected to such a diaphragm, the center of the diaphragm does not have sufficient strength to stand up under the constant blows delivered to it during the reproduction of high frequency notes. In addition, such a diaphragm gives a thin weak bass which is undesirable.

We have discovered that by cutting out the center portion of the thin diaphragm and super-imposing on the same a center of aluminum twice or three times the thickness of the thin portion (which is in the shape of an annulus when cut out), a full and heavy bass is obtained without in any way affecting the extreme sensitiveness of the diaphragm when made of .002″ thickness throughout. Also, the heavy center stands up well under the pressure delivered to it by the stylus bar during the reproduction of high frequency notes.

Heavy fuller bass is obtained, owing to the fact that the thick metal at the center of the diaphragm does not vibrate but simply acts as a driver and transmits vibration to the very thin rim of the diaphragm. Consequently, instead of just the center of the diaphragm moving back and forth, the major portion of it moves somewhat in the manner of a piston, and in this way much more air is displaced than is displaced by the ordinary diaphragm, and as a result much greater volume is obtained. Also, this composite diaphragm, comprising the thin annulus and the thick central portion gives the heavy bass which has long been desired.

While we have shown and described preferrred and satisfactory embodiments of our invention, it is to be understood that the disclosures are by way of illustration, and not to be construed as limiting the invention for a definition of which, reference must be had to the appended claims.

Having thus described the invention, what is claimed is:

1. A metal diaphragm comprising an annulus not exceeding .002 inches in thickness and a relatively thick central portion.

2. A metal diaphragm comprising a flexible annulus not exceeding .002 in thickness and a rigid central portion.

3. In a metallic diaphragm, a flexible an-

nulus a relatively non-flexible central portion overlapping the edge of the annulus and rigidly secured thereto, said annulus and said central portion being of the same material.

4. A diaphragm comprising an annulus having an inclined inner wall, a central portion having an inclined outer wall and said central portion having a flange at the edge of its inclined wall adapted to overlie the edge of the inclined wall of the annulus and be secured thereto near the upper edge thereof.

5. A diaphragm as in claim 6, the central portion being provided centrally with a dome-shaped member adapted to have a stylus bar connected to it.

6. In combination with a diaphragm having a dome-shaped central portion, a stylus bar having a reduced end providing a shoulder and threaded beyond said shoulder, means to connect the stylus bar to said central portion, said means including a lug secured on the stylus bar and having a concave surface to engage the convex surface of the dome, a lug on said stylus bar having a convex surface to engage the concave surface of the dome, and a nut on said threaded end to clamp said lugs between itself and said shoulder and against the respective surfaces of the dome.

7. A diaphragm comprising a flexible metallic annulus and a non-flexible central portion, said annulus and central portion overlapping at their edges and being rigidly secured together.

8. In a corrugated diaphragm, means for delivering vibrations to the apex of one of said corrugations said means comprising a relatively thick wall of said corrugation.

9. In a diaphragm having a corrugation including oppositely inclined walls connected at their upper edges, one of said walls adapted to initially have vibrations delivered to it and being of greater rigidity than the other of said walls for causing the pressure of vibrations to be delivered to said diaphragm transmitted at the point of connection of said walls, whereby as pressure is applied to the diaphragm and released from it, these walls are spread apart and return to normal position.

10. In a diaphragm having a corrugation, means for causing a toggle-like action to take place in said corrugation, said means including one wall of the corrugation which is relatively rigid and delivers the impulses transmitted to the diaphragm to the upper edge of the outer wall of the corrugation.

11. A diaphragm having a corrugation, the inner wall of which is of greater rigidity than the outer wall thereof.

12. A metallic diaphragm having a corrugation, one wall of which is of greater rigidity than the other.

13. A metallic diaphragm having a corrugation, one wall of which is of greater thickness than the other wall thereof.

14. A diaphragm comprising an annulus having an angularly disposed inner wall, a central portion having an angularly disposed outer wall, said walls being connected at their adjacent margins.

15. A diaphragm comprising an annulus having an angularly disposed inner wall, a central portion having an angularly disposed outer wall, said walls being connected at their adjacent margins and said central portion including a dome-shaped portion adapted to have a stylus bar connected to it.

16. In a metallic diaphragm, a flexible annulus, a relatively non-flexible central portion, said annulus and said central portion each having an angularly disposed wall and said walls arranged in intersecting relationship and rigidly secured together at their point of intersection.

17. A diaphragm comprising a flexible outer portion, a relatively non-flexible inner portion, said portions having inclined walls at their adjacent edges and said walls being secured together.

18. A diaphragm comprising a flexible metal annulus of one uniform thickness and a non-flexible metal central portion of greater but uniform thickness, said central portion being rigidly secured to said annulus.

19. In a diaphragm, a flat flexible peripheral portion, a relatively rigid central portion, and a corrugation connecting said portions, said corrugation and central portion projecting beyond the plane of but one surface of said flat peripheral portion.

20. In a two piece diaphragm, a flat peripheral portion, a central portion connected thereto, and at least one corrugation disposed between said portions, said corrugation projecting beyond the plane of but one surface of said flat peripheral portion.

21. In a two piece diaphragm, a flat peripheral portion, a central somewhat dome-shaped portion connected to said peripheral portion, and at least one corrugation located between said portions, said corrugation and central portion projecting beyond the plane of but one surface of said peripheral portion.

22. In a diaphragm, a dome-shaped central portion a flat peripheral portion, a corrugation connecting said portions, said corrugation complete independent of said portions and said central portion rigidly connected with said corrugation.

23. A diaphragm comprising a disk materially reduced in thickness on its outer periphery and having a circular channel formed in one side of said disk which partially includes the portion of said disk which is reduced in thickness, whereby an area of flexibility is formed in said diaphragm adjacent the outer periphery thereof.

24. A diaphragm comprising a single ply central portion of metal approximately .004" in thickness, and an outer relatively flexible

metallic portion approximately .002″ in thickness.

25. A diaphragm comprising a single ply central portion approximately .004″ in thickness and having a deformation therein to prevent flexure, and an outer flexible member approximately .002″ in thickness, both of said portions being composed of a metallic substance approximating the specific gravity of aluminum.

26. A diaphragm comprising a central conical member and an outer annular relatively thin member, said members being composed of a metallic substance substantially as light in weight as aluminum and secured together by an interlocking joint.

27. A diaphragm comprising a single-ply metallic central portion approximately .004″ in thickness and an outer flexible portion approximately .002″ in thickness, both of said portions being composed of a metallic substance approaching the low specific gravity of aluminum.

28. A diaphragm composed of an extremely light, metallic substance and having a central portion of substantially uniform thickness in one piece with an outer relatively thin flexible portion of substantially uniform thickness.

29. A diaphragm composed of an extremely light, metallic substance and having a central portion approximately .004″ in thickness in one piece with an outer portion approximately .002″ in thickness.

30. A diaphragm composed of an extremely light metal and having a central portion approximately .004″ in thickness in one piece with a relatively thin outer portion approximately .002″ in thickness, and means for strengthening said central portion and preventing flexure thereof.

31. A diaphragm comprising a central portion, approximately .004″ in thickness, in one piece with an outer portion having a ground face and being approximately .002″ in thickness throughout.

Signed at Bridgeport, in the county of Fairfield and State of Connecticut, this 14th day of December, A. D. 1925.

FRANK C. HINCKLEY.
JOHN J. HUDSON.