May 27, 1924. 1,495,515

F. C. HINCKLEY

DIAPHRAGM FOR SOUND REPRODUCERS

Filed April 4, 1921

Fig. 1

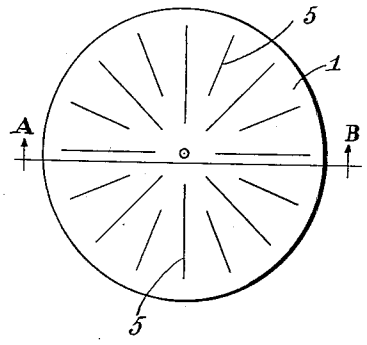

Fig. 2

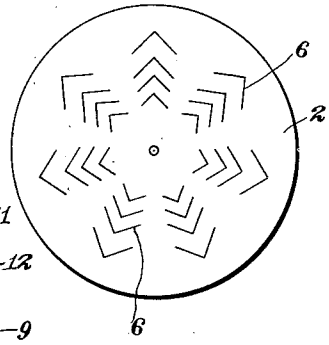

Fig. 5

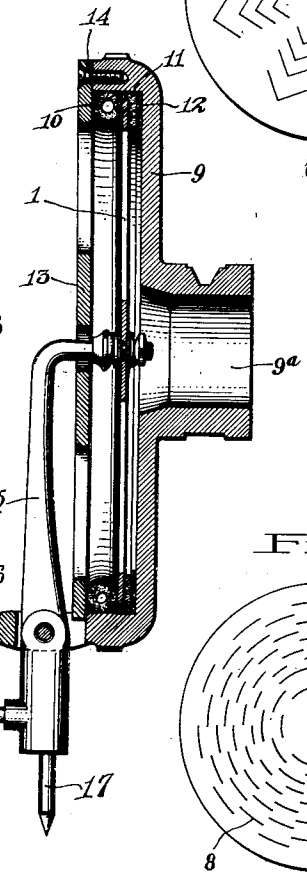

Fig. 3

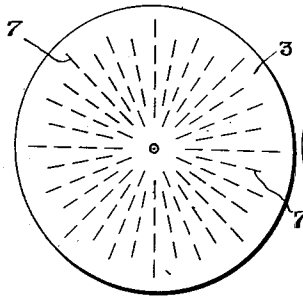

Fig. 4

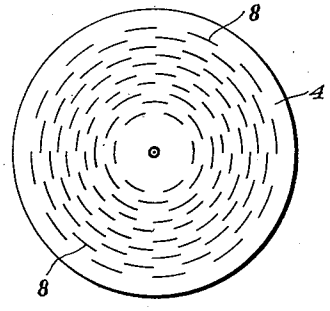

Fig. 6

Fig 7

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Patented May 27, 1924. 1,495,515

UNITED STATES PATENT OFFICE.

FRANK C. HINCKLEY, OF STRATFORD, CONNECTICUT, ASSIGNOR, BY MESNE ASSIGNMENTS, TO COLUMBIA PHONOGRAPH COMPANY, INC., A CORPORATION OF NEW YORK.

DIAPHRAGM FOR SOUND REPRODUCERS.

Application filed April 4, 1921. Serial No. 458,302.

To all whom it may concern:

Be it known that I, FRANK C. HINCKLEY, a citizen of the United States, and residing at Stratford, in the county of Fairfield and State of Connecticut, have invented certain new and useful Improvements in Diaphragms for Sound Reproducers, of which the following, taken in connection with the accompanying drawings, is a specification.

This invention relates to diaphragms such as are used in sound reproducing and recording devices, as, for instance, phonographs, dictaphones, and telephones, and more particularly the former.

One object of the invention is to provide a diaphragm which will accurately and fully respond to the most delicate vibrations irrespective of atmospheric changes, and which will truthfully record and reproduce both the high and low tones and all intermediate ones with equal effect.

Another object is to increase the volume of the sound produced, by increasing the natural flexibility of a metal-disc diaphragm of predetermined dimensions.

Another object is to provide a diaphragm that will eliminate the metallic and superimposed tones so common to phonographs, for which unnatural tones the diaphragm has been proven to be quite largely responsible.

Another object is to provide a diaphragm having these desirable qualities, yet at a fraction of the cost of the mica ones now in common use, and made of a material not so liable to price fluctuations.

Other objects of this invention appear in the specification and claims below:

Referring to the drawings forming a part of this specification, and in which the same reference characters are employed to designate the same parts throughout the various views,

Figure 1 is a plan view of one of the improved diaphragms;

Figs. 2, 3, and 4 are plan views of modified forms of other diaphragms utilizing the same novel constructional features as disclosed in this invention;

Fig. 5 is a semi side elevation and cross-sectional view of a completely assembled reproducer taken along a line parallel and adjacent to the needle-arm;

Fig. 6 is a cross-sectional view of the diaphragm as shown in Fig. 1 and taken through line A—B of Fig. 1, and showing the diaphragm as it appears after the first or shearing operation; and

Fig. 7 is a similar sectional view taken after the final or flattening operation.

An extensive series of tests has been made to find a diaphragm material, much cheaper and more stable in price than the now commonly used mica, impervious to temperature and humidity changes, and yet having vibratory qualities which most perfectly adapt it to natural and complete sound reproduction. The metal aluminum in sheet form was finally found to contain in great measure these desirable attributes. It is inexpensive, fairly constant in price, is practically unaffected by temperature and moisture changes, lends itself readily to manufacturing manipulations, and possesses desirable vibratory characteristics.

Aluminum has, however, one material disadvantage for this purpose, which is that a diaphragm formed of a solid sheet of aluminum cannot be made to reproduce the full volume and true quality of the sounds transmitted to it, due to its being so stiff, even when reduced to the minimum thickness found practical, that the sound vibrations are not of sufficient strength to vibrate the diaphragm. And yet any previously known method of slitting or cutting the diaphragm, while increasing its flexibility, would allow the sound waves to pass through the diaphragm instead of being projected outwardly therefrom. This invention discloses a simple and effective method of obtaining this increased flexibility while still maintaining an air-tight surface. It is accomplished as follows:

A series of sheared cuts is made entirely through the diaphragm spaced from the center and peripheral edge, by means of an ordinary shearing punch and die, these cuts actually separating the metal, as disclosed in Fig. 6, which shows the sheared edges, 5 of Fig. 1, separated after having been sheared. This sheared diaphragm is next placed in a forming press between perfectly flat dies and its distorted surface flattened into its original plane. In this manner the sheared edges of the various cuts are brought back into such close contact that an air-tight joint results, any minute tearing away of the material being compensated for by slightly squeezing the sheet between the

flat dies. By stating that the cuts are made entirely through the diaphragm "spaced from" the center and peripheral edge, is meant that the cuts do not extend either to or through the peripheral edge, or the center. With such a construction, the diaphragm is maintained as one member, and particularly the parts of its support, namely, the peripheral and the center sections, are kept solid, to prevent the cuts from interfering with the action of the diaphragm where it is mounted on its gaskets, and also where it is connected to the stylus-bar, and from there, operated. Also,—and this is of first importance—the plane of the diaphragm is maintained. Were the structure permitted to be weakened at any section, by the slits piercing entirely through that section, the diaphragm would be thrown out of plane, and its flexing—during normal operation—to both sides of neutral position, would be unbalanced, resulting in little or no sound reproduction.

The sheared cuts produce increased flexibility of the metal disc by diminishing its strength to resist the hammer blows of the vibration without diminishing its tension or the power which keeps it tight and flat. These cuts, when positioned as shown in Figs. 1 and 3, break up the strains along the concentric lines of the disc, thereby permitting the radial segments between said cuts to come directly into free vibratory tension. When the cuts are positioned in any other manner, as for instance, in the diagonal pattern shown in Fig. 2, or in concentric circles as shown in Fig. 4, the principle of operation is the same, only the location and direction of the strained segments being altered. However, this variation in the pattern of the cuts materially affects the acoustical property of the diaphragm, that shown in Fig. 1 having been found preferable.

A mounting, found to be particularly useful in connection with this diaphragm, is shown in Fig. 5, which is a sectional view of the sound box 9, having integral therewith a tubular projection 9^a connecting with the horn or other sound conveying means; a flat rubber washer 11 having a ridge on the outer edge, said washer resting on a flat paper washer 12, which rests on the inside bottom surface of the sound box; a diaphragm 1, positioned on the washer 11, inside the ridge of said washer; a tubular washer 10, positioned over the peripheral edge of said diaphragm; a perforated cover plate 13, extending over the face of the sound box and held in place by means of screws 14; and a needle-arm 15, one end of which is rigidly attached to the center point of the diaphragm, the other end arranged to hold the needle 17, and said needle-arm being pivotally held on a yoke support 16, projecting from and integral with the sound box 9.

Experiment has shown that such a diaphragm mounting as here shown, consisting of a flat washer beneath the diaphragm and a tubular washer above it, possesses peculiarly superior acoustical properties to any other combination, as, for example, two flat washers, or two tubular ones. The outer ridge on the flat washer operates to keep the edge of the diaphragm away from the walls of the sound box, which is a necessary condition for obtaining proper results.

And the flat paper washer 12 not only provides a yielding medium on which gasket 11 rests, but also serves the useful purpose of separating it from the metal of the sound box, thereby preventing the washer 11, when warmed, from adhering to the metal. This has been found particularly advantageous on reproducers used in tropical countries, where it is often desirable to assemble and disassemble them, for trade reasons.

The invention is capable of receiving a variety of mechanical expressions, one of which has been described above and shown in the accompanying drawings. It is to be expressly understood, however, that the particular embodiment disclosed is for the purposes of illustration only, and is not to be construed as a definition of the limits of the invention, reference being had to the appended claims for that purpose.

Having thus described the invention, what is claimed as new, and for which Letters-Patent is desired, is:

1. A method of producing an air-tight sheared-cut metal diaphragm, including shearing through the diaphragm by means of a suitable shearing press, and returning the distorted diaphragm to its original plane by pressing it flat between dies, and finally slightly squeezing the diaphragm between the flat dies to assure the sheared cuts being air-tight.

2. A diaphragm for sound-boxes, having a series of radially disposed air-tight sheared cuts extending entirely through the diaphragm spaced from the center and periphery.

3. A diaphragm for sound reproducers and the like, including a disc having a series of substantially air-tight straight cuts sheared entirely through its section spaced from the periphery and center.

4. As a new article of manufacture, a diaphragm for sound-boxes, having a series of elongated air-tight cuts formed therein spaced from the periphery and center.

5. As a new article of manufacture, a diaphragm, having a sheared cut spaced from the peripheral edge and center, adapted to make it more flexible and maintain it air-tight.

6. As a new article of manufacture, a diaphragm, having a cut therethrough spaced from the peripheral edge, the walls of which contact to render the diaphragm substantially air-tight.

7. A diaphragm for sound-boxes, consisting of a flat metal disc having a concentric series of elongated cuts formed therein, the walls of the cuts contacting to render the diaphragm flat and air-tight.

8. A metal diaphragm having a series of equally spaced cuts extending entirely therethrough to render the diaphragm more flexible, and said cuts being rendered air-tight solely by the use of the material of the diaphragm.

Signed at Bridgeport in the county of Fairfield and State of Connecticut this 17th day of November 1920.

FRANK C. HINCKLEY.