July 11, 1933. J. LEOPOLD 1,917,309

DIAPHRAGM FOR ACOUSTIC APPARATUS

Filed Dec. 23, 1931

Fig. 1

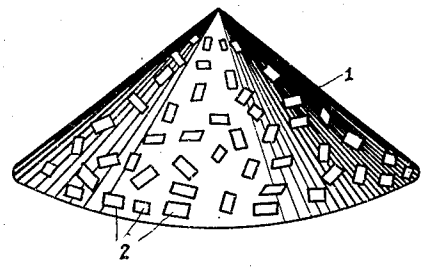


Fig. 2

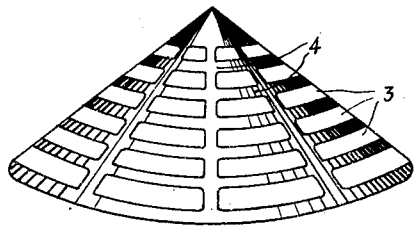
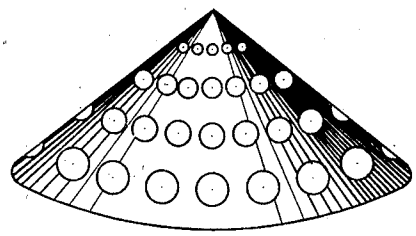


Fig. 3



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DIAPHRAGM FOR ACOUSTIC APPARATUS

Application filed December 23, 1931, Serial No. 582,729, and in Germany April 10, 1931.

This invention relates to a diaphragm for acoustic apparatus. More particularly it relates to a diaphragm for loud speakers which distinguishes itself by a very uniform and regular reproduction over the whole frequency range.

Several ways and means have been suggested to insure uniform reproduction independent of the frequency. One fundamental principle in this direction has been to choose the natural period of the diaphragm very low, say, around 2–3 cycles so that such higher harmonics as may arise will come to lie so close together inside the frequency band that no resonance points will become noticeable any longer. Another solution has been to make the diaphragm so stiff that it would oscillate as a rigid body inside the audible ranges, and to incidentally place the natural frequency of the system which essentially is dependent upon the mass of the diaphragm and the size of the elastic restoring forces, in the neighborhood of 30–70 cycles. In this manner the occurrence of resonance peaks inside the frequency band is reduced to a minimum. Now, the last mentioned problem generally is frustrated because it is technically impossible to make a diaphragm having a diameter of over 10 cm of the requisite lightness so that it will oscillate as a rigid body inside the audible range (below 10,000 cycles). For instance, attempts have been made to attain the desired end by cutting portions of a metallic cone away so that there results a support or skeleton adapted to serve as a support for a cone of thin paper, silk or similar light material. Apart from the fact that it is technically and practically unfeasible to make comparatively large diaphragms which will be rigid inside the audible range, there is the draw-back that because of the special disposition of the recesses or cut-out portions the diaphragm exhibits certain preferential natural periods whereby uniform reproduction and thus sufficient width of the frequency band are unattainable. Another draw back is the relatively great weight which even with the use of light metals renders the sensitiveness of the diaphragm rather low.

The present invention solves the problem in another way. According to the invention the diaphragm is made so non-rigid that it will not exhibit any single outstanding natural period, but that it is divided into a plurality of oscillation regions characterized by partial natural periods dissimilar from each other. The material from which the diaphragm is made consists preferably of paper or some other fibrous substance impregnated with synthetic resins; and in this material gaps are cut out which in contradistinction to known arrangements are irregularly distributed over the whole surface. The resultant holes are closed by a varnish or gelatinous coating. By suitable diaphragm construction in conjunction with proper selection of the holes or cut-outs, it is thus feasible to influence the frequency curve of the loudspeaker throughout the entire frequency range in such a way that the natural periods of vibration will no longer exercise a troublesome effect. Another advantage of the new diaphragm is the reduction of the volume or mass of the diaphragm with the active surface or area being the same. By breaking up the continuity of the diaphragm surface, with the resultant gaps, however, being re-closed by said coating, the diaphragm according to the arrangement of the breaks or cut-outs, is provided with different partial masses and partial elasticities so that certain resonance points which invariably arise in diaphragms of larger dimensions are shifted or diminished by the provision of the gaps. In the case of a cone diaphragm the breaks or gaps could be disposed annularly and concentrically in reference to the base circle of the cone so that they will fulfill a problem and object similar to the ribs or fins concentric and annular in reference to the base circle of the cone and pressed into the diaphragm material. However, the advantage offered by the said gaps or breaks compared with the said annuli is that the mechanically similar construction is obtainable with less diaphragm material or substance when recourse is had to the breaks or gaps. The diaphragm is thus endowed with numerous surface parts which possess different natural periods so

that a wide frequency band will be reproduced at satisfactory efficiency.

By a number of experiments and by calculation the required partial masses and partial elasticities are ascertainable with comparative ease. Inasmuch as it is worth while making the diaphragm weather-proof recourse is had to a sort of varnish which possesses weather-proof properties and which will be stable also to chemical actions such as produced by acid fumes.

By the use of the idea underlying the invention it is possible to manufacture a diaphragm the production of which is free from any technical difficulties while yet offering extremely good conditions as regards faithful reproduction. The mass of the diaphragm, and the requisite stiffness are governed by the size, number and disposition of the cut-outs or breaks.

The drawing shows embodiments of the basic idea of the invention by way of example, the figures relating more particularly to cone type diaphragms, though it will be evident that the idea could be applied also to any other diaphragm. Fig. 1 illustrates one embodiment of the invention. Figs. 2 and 3 illustrate modifications.

Fig. 1 clearly shows the arrangement of the recesses. The material of the cone 1 consists of paper impregnated with synthetic resin; the gaps or cut-out portions 2 are covered with weather and acid-proof varnish. In this manner the weight of the new diaphragm compared with a diaphragm having the same active surface of material such as paper, is diminished. At the same time the advantage of a more uniform reproduction throughout the entire frequency band is attained.

Fig. 2 shows a cone diaphragm with annular concentric gaps 3. In order that the form of the diaphragm may be preserved in this case it is advisable to make the annuli or cut-out portions not entirely annular, but to leave some material at certain points designated by 4 in the drawing.

In the embodiment Fig. 3 the same purpose is obtained by round recesses or cut-outs disposed annularly while the distances between the rings may increase in the direction of the margin or border.

The gaps may be so arranged that the partial masses grow toward the edge, a feature that is desirable and advantageous for better reproduction of the low pitches. This end is attained, for instance, if in annular and concentric arrangement of the breaks their distance and their width remain constant from the inside toward the outside, or else if this distance is increased from the inside toward the outside.

The yieldingness of the diaphragm is increased if the angle of opening of the cone is larger than 90 degrees seeing that the rigidity of the cone increases as the angle of the aperture decreases, a property that is to be avoided according to the invention.

What I claim is:

1. A diaphragm comprising a sheet of non-rigid material in which a plurality of irregularly sized and irregularly distributed gaps are cut out over the entire surface.

2. A diaphragm of fibrous substance impregnated with synthetic resins and provided with a plurality of irregularly distributed openings covered with a hardened weather-proof and acid-proof solution.

3. A diaphragm comprising a sheet of fibrous material impregnated with a stiffening material, a plurality of irregularly distributed and irregularly sized openings in said diaphragm material and a substance different from that of the diaphragm material for closing said opening, said substance being of less mass than the material removed from said openings and being substantially weather and acid proof.

4. A diaphragm comprising a sheet of perforated material, said perforations being of different sizes and shapes and irregularly distributed over the diaphragm surface and a gelatinous coating closing said perforations.

5. A conical diaphragm provided with a plurality of angularly and concentrically disposed openings and a substance of different material from that of the diaphragm for filling said perforations, said substance being of a gelatinous nature and of less mass than the material removed in forming said openings.

In testimony whereof I affix my signature.

JOACHIM LEOPOLD.