Sept. 26, 1944. R. A. O'CONNOR ET AL 2,358,823

ELLIPTICAL CONE-SHAPED REPRODUCING DIAPHRAGM

Original Filed Dec. 6, 1940

FIG. 1.

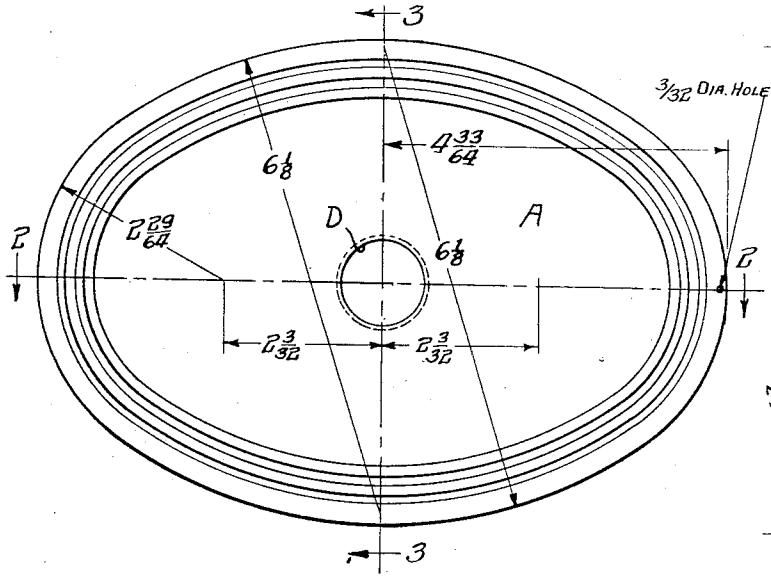
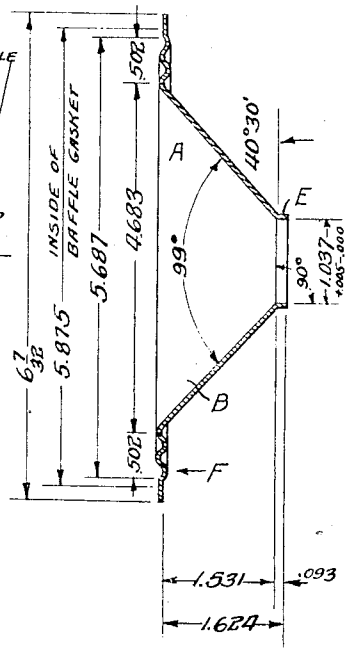


FIG. 3.



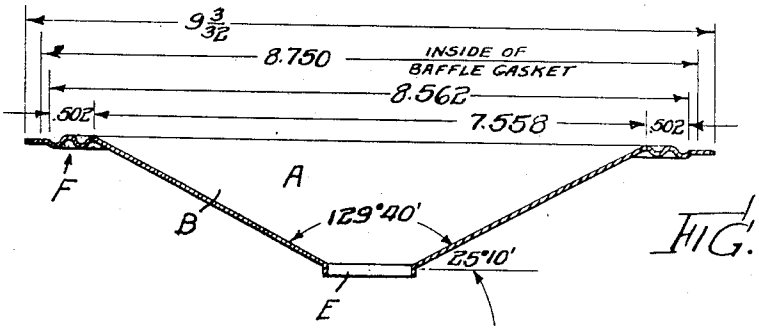
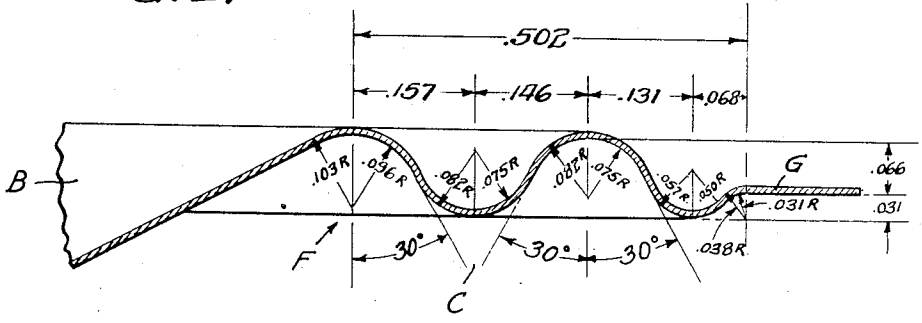


FIG. 2.

FIG. 4.



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ELLIPTICAL CONE-SHAPED REPRODUCING DIAPHRAGM

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Continuation of application Serial No. 368,780, December 6, 1940. This application May 7, 1943, Serial No. 486,004

4 Claims. (Cl. 181—31)

This invention relates to a dynamic speaker, elliptical cone-shaped reproducing diaphragm.

One of the objections inherent in elliptical cone-shaped reproducing diaphragms prior to this invention was their failure to adequately generate sound output at extremely low frequencies and at the same time provide satisfactory middle and high frequency response.

It is an object of the present invention to provide an elliptical cone-shaped sound reproducing diaphragm which adequately generates sound output at extremely low frequencies and concurrently therewith provides satisfactory middle and high frequencies.

A further object of the invention is to provide an elliptical diaphragm which, in itself, affords a large amount of apparent extreme low frequency bass where adequate baffling to reinforce such frequencies is not possible—for example, in automobile, table model, and portable radio sets.

A still further object is to provide a practical construction of elliptical cone-shaped diaphragm for sound reproducers which may be inexpensively manufactured on a commercial basis.

The desirable frequency response or result is attained according to the present invention by properly coordinating certain characteristics or features of the diaphragm.

In carrying the invention into effect it was found that entirely satisfactory results could be obtained by constructing a diaphragm so that:

(1) The ratio of the major and minor axes at the base of the cone falls within the limits of 1.5 to 1.7.

(2) The included angle of the minor axes falls within the range of 95 degrees to 105 degrees.

(3) The included angle along the major axes falls within the range between 125 degrees and 135 degrees.

(4) The sections as cut by a plane parallel with the base of the conical section approximate an ellipse.

(5) The skiver has two complete rolls having decreasing radii outwardly from the cone, substantially as shown in the drawing.

The accompanying drawing illustrates a commercial embodiment of the invention from which highly satisfactory results have been obtained, in which:

Figure 1 is a reproduction of the working drawing of about one-half scale, showing the diaphragm in plan view;

Figure 2 is a cross section along the line 2—2 of Figure 1;

Figure 3 is a cross section along the line 3—3 of Figure 1; and

Figure 4 is a cross section on an enlarged scale, showing the details of the corrugations of the diaphragm.

All of the measurements of the particular diaphragm illustrated, with, of course, the exception of the angles, are given in inches, and from these it will be seen that the overall dimensions of the diaphragm A at the base of the conoidal section are 7.558 inches in the major or longitudinal direction and 4.683 inches in the minor or transverse direction, whilst the included angle of the major axes is 129° 40′, that of the minor axes is 99°, the cone angle of the former 25° 10′ and that of the latter axis is 40° 30′.

The additional numerals appearing on Figures 1 to 3 of the drawing will be readily understood by those skilled in the art and hence it does not appear to be necessary to describe or explain them in detail here. The same is true with respect to the dimensions of the corrugations C shown in Figure 4.

The diaphragm A may be made from any material well known in the art and such as from the usual paper stock.

It is, of course, to be understood that the particular diaphragm shown in the drawing is only one example of the carrying of the present invention into effect and variations in any of the dimensions or figures therein shown may be made provided always that substantially the ranges and relationships hereinbefore set forth are followed. If such ranges and relationships are substantially disregarded, the desirable results aimed at are not possible of attainment. For example, if the same diaphragm as to size and ratio of minor and major axes is used but the angles are increased or decreased materially, say on the order of 25 percent one way or the other, satisfactory results are not obtainable. Again, if the same angles are used but the major and minor axes are changed on the same order the desirable characteristics will not be present. In the case of a decreased included angle on the one hand a shifting of the high frequency response to a higher frequency outside of the useful range will result as will be appreciated, whilst, on the other hand, an increase in the included angle of the order mentioned would shift the frequency response to a lower frequency which would not only be objectionable from a listening standpoint but would also limit the useful range of the speaker as far as frequency characteristics are concerned. By the employment of greater

cone angles through the minor axis region and relatively smaller or lower cone angles through the major axis region, proper control of the directional response as well as of the range of the high frequency response is secured.

In the case of the major axes or the larger included angle due to the shallower cone angle and the longer path of radiation, an improved response characteristic in the lower high frequency range is obtained as well as an increased piston diameter for the low frequency range. This shallow angle and larger dimension along this axis also furnishes the beam effect so desirable for automotive application.

As shown in Figure 4, the integral undulations or corrugations C at the outer periphery of the diaphragm are of decreasing radii and decreasing radial spacing outwardly from the cone to the edge or flange of the cone. Actual tests have shown that loud speakers, having diaphragms with corrugations, as shown in this application, have an extremely low, natural resonance frequency which results in extremely desirable reproduction of the low or bass frequencies, and that such diaphragms with such corrugations smooth out the middle register of frequencies and attenuate or hold down the extreme, high frequencies. It has been established by such tests that diaphragms of this corrugated skiver construction have substantially greater amplitudes of excursion or travel at exceptionally low frequencies, hence in effect aurally reinforcing the low fundamental frequencies through generations of harmonics which differing by the fundamental frequency are interpreted by the ear as the fundamental frequency. The composite tensions on the elliptical diaphragm of the relative dimensions shown, and having the integral relations of corrugations as disclosed, have been shown by such tests to have great effect in smoothing out the middle register of frequencies, and rendering the reproduction of these middle frequencies markedly more uniform, and at the same time those tests have shown that such diaphragm holds down the extreme, high frequencies and thus more truly reproduces the high frequencies in their generated relation to the middle and low frequencies.

The diaphragm A, as clearly shown in Figs. 2 and 3, is provided with a centrally located, circular opening D having a collar or circular flange E for attachment in the usual fashion to the voice coil of a dynamic speaker.

This invention is designed, intended and adapted as before stated for a dynamic speaker, and due to the combination and arrangement of parts of the diaphragm with a skiver F having undulations or corrugations C of gradually reducing radii from the cone proper to its outer rim G solves certain problems in connection with dynamic speakers, and afford the advantages heretofore pointed out in connection with dynamic speakers.

Based on applicant's experience from testing a large number of the dynamic speaker diaphragms herein described in use in the well-known type dynamic speaker, and the manufacture and sale of such structures on a very large scale, they have found that by maintaining substantially the prescription heretofore specified for the cone of the diaphragm in combination with an integral skiver having corrugations or undulations of gradually decreasing radii outwardly from the cone proper to the flange which secures the diaphragm in place in the well-known type of dynamic speaker that they have obtained the advantages heretofore pointed out to the fullest extent.

This application is a continuation of my application Serial No. 368,780 filed December 6, 1940.

What we claim is:

1. In an elliptical conoidal dynamic speaker diaphragm, a skiver comprising a plurality of corrugations the valleys and peaks of which are arranged at successively lesser distances outwardly from the diaphragm, said corrugations having a curvature of substantial radius and extending between two parallel planes parallel to the base of the diaphragm so as to be of substantially equal amplitude, the tangents to said corrugations at the points of the reversal of the curvatures each being at substantially constant angles with respect to said planes, the corrugation adjacent said diaphragm having the greatest radius of curvature, the corrugation adjacent the outer edge of said skiver having the smallest radius of curvature, and the remaining corrugations having radii intermediate the radii of said inner and outer corrugations.

2. In a dynamic speaker diaphragm of the type described, a skiver comprising a plurality of corrugations and a mounting edge, said corrugations being of substantially equal amplitude so as to be substantially tangent to two parallel planes extending in a direction parallel to the base of the diaphragm, said parallel planes being spaced apart a distance in excess of 2% of the value of the minor axis of the diaphragm, the tangents to said corrugations at the points of the reversal of the curvatures each being at a substantially constant angle with respect to one of said planes, each curvature of said corrugations being at decreasing spacing outwardly from said diaphragm towards said mounting edge, said corrugation adjacent said diaphragm having the greatest radius of curvature, said corrugation adjacent said mounting edge having the smallest radius of curvature, and the remaining corrugations each having a radius of curvature intermediate the radii of said inner and said outer corrugations.

3. In an elliptical conoidal dynamic speaker diaphragm of the type described, a skiver comprising a plurality of corrugations and having at least two corrugations whose amplitude is substantially the same and whose tangents to the points of reversal of curvature are at substantially constant angles to a reference line, but whose distances between the apex and the valley of successive corrugations along the center line thereof successively decrease outwardly from the diaphragm, the corrugation adjacent the diaphragm having the greatest radius of curvature.

4. In an elliptical, conoidal, dynamic speaker diaphragm of the type described, a skiver comprising a plurality of corrugations and having at least two corrugations whose amplitude is substantially the same and whose tangents to the points of reversal of curvature of said corrugations are at substantially constant angles to a reference line, but whose distances between the apex and the valley of successive curvatures of said corrugations in a longitudinal direction successively decrease outwardly from the diaphragm.

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