

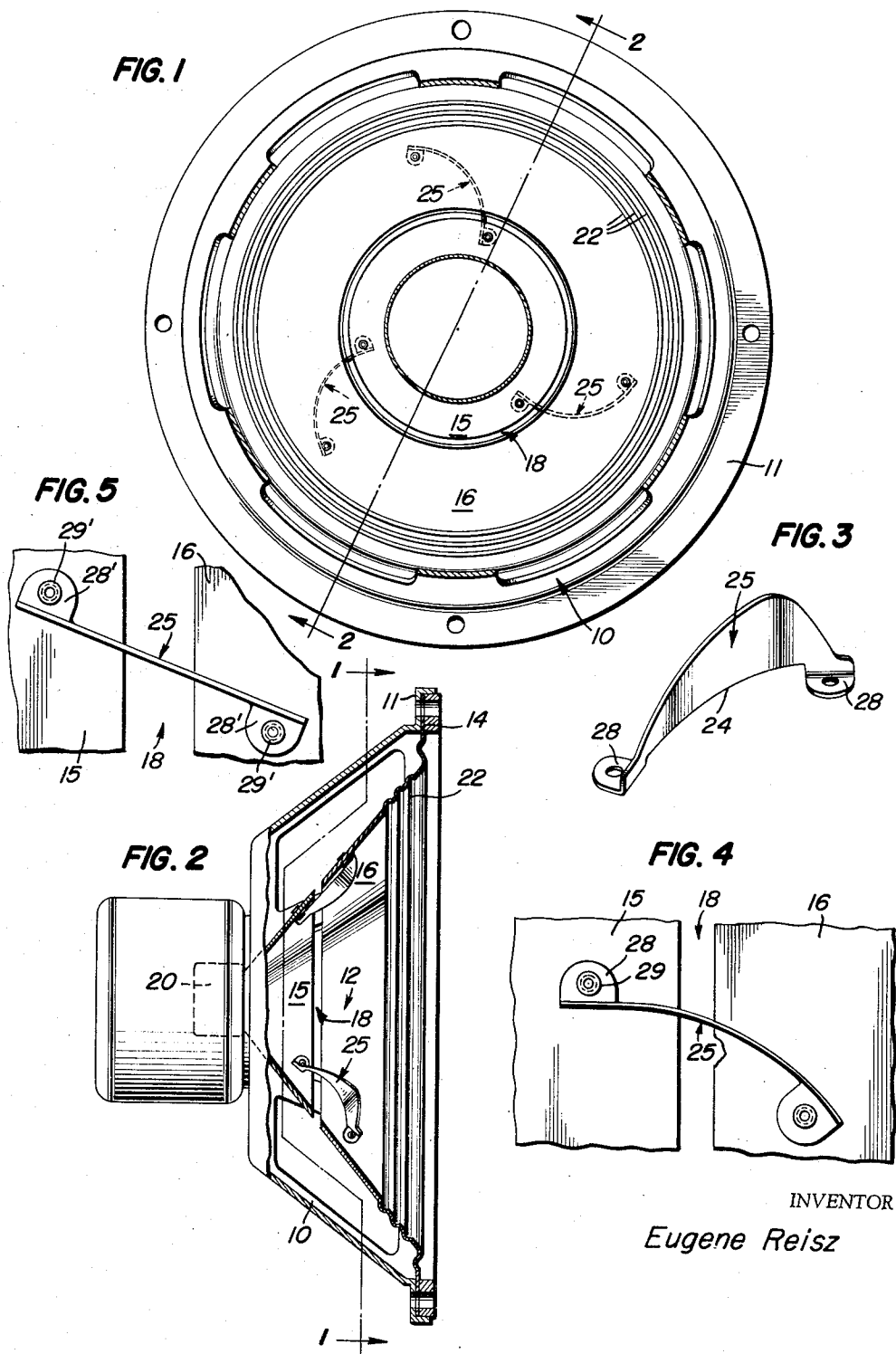
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MEMBRANES FOR SOUND REPRODUCING DEVICES

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MEMBRANES FOR SOUND REPRODUCING DEVICES

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This invention relates to sound reproduction and it has particular reference to high fidelity speakers of the type disclosed in my earlier application Ser. No. 428,070, now Patent No. 2,712,360.

My earlier invention was based on the principle of using a substantially conical or funnel shaped speaker membrane, divided longitudinally into sections spaced along the axis of the speaker cone and separated by a gap, said sections being joined by suitable coupling members. The inner or central section connected with the voice coil radiates the higher frequencies, thus forming the treble speaker or tweeter section, while the lower frequencies are transmitted to and radiated from the frusto-conical outer section forming the bass speaker or woofer section.

According to my earlier invention the coupling members consisted of peripherally spaced small cylindrical tubes made of fabric or fibrous material, straddling the gap between the sections on the inside of the membrane. They were fastened to the membrane sections by adhesives.

Experimentation has shown that frequency separation and the transmission of the energy of the lower frequencies to the outer or woofer section of the membrane to the desired extent depends on a proper selection of the dimensions, stiffness, elasticity etc., of the cylindrical coupling bodies. Further, the attachment of the coupling bodies by means of adhesive proved to be of disadvantage, as most adhesives deteriorate under the influence of constant vibrations.

My present invention has for its main object to provide a greatly improved coupling between the two cone sections of the speaker, using coupling members which are easy to manufacture, can be joined to the cone sections without adhesive, provide a perfect frequency separation and transmit substantially the full power of the lower frequencies to the outer or woofer section, permitting the latter to oscillate with the large amplitudes corresponding to said frequencies.

According to the invention these coupling members consist of thin flat blades or strips of considerable width relatively to their thickness, so disposed that an edge of each of the said blades points toward the cone, the remaining portions of the said blades point away from the cone, and the flat blade surfaces are substantially at an angle to the cone surface. These strips or blades are provided with laterally projecting ears at or near their ends which serve to fasten each end of the blade to one of the membrane sections. Preferably the blades are fastened mechanically by means of screwbolts, rivets, staples or the like. The blades are fastened to the inner membrane section, connected with the voice coil by a stiff and rigid connection, using for instance metal washers or the like where a screw connection is made, while the connection with the outer membrane section is of a more pliable type.

The contour of the blade surface may follow straight lines or curves. Preferably the width of the blade is not the same all over, but is smallest at the end fastened to the inner membrane section and increases until it reaches a maximum. If curved the contour of the outer edge of the blade may have a camel back shape.

The blades are peripherally spaced along the zone con-

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taining the gap and bridge the gap. They form frequency selective coupling members transmitting only the lower frequencies from the inner to the outer membrane section. While the inner membrane section thus radiates the high frequencies, the lower frequencies are transmitted to the outer or woofer section of the membrane. Blades of this type permit the large excursions of the membrane section which occur at low frequencies without distortion and even at high sound intensities they transmit the low frequencies at a sound energy level which corresponds closely to the energy distribution over the frequencies in the input.

The range of undistorted reproduction with blades of this type is thus a multiple of the range which is obtainable with conventional membranes of the same size and general type.

The invention is illustrated in the accompanying drawing by way of example. It is, however, to be understood that the illustration is diagrammatical and that the example illustrated intends to serve as a base for the explanation of the principle of the invention and of the best mode of applying the said principle. As will be clear to those skilled in the art, the speaker construction and the shape and size of the diaphragm or membrane may vary without departing from the principle of the invention.

In the drawings:

FIG. 1 is a sectional elevational rear view of a speaker provided with a membrane according to the invention, the section being taken along line 1—1 of FIG. 2.

FIG. 2 is a sectional elevational view of the speaker such as illustrated in FIG. 1, the section being taken along line 2—2 of FIG. 1.

FIG. 3 is a perspective view of one of the blades.

FIG. 4 is a fragmentary plan view of part of the speaker membrane, showing one of the blades and their attachment to the membrane sections.

FIG. 5 is a view similar to FIG. 4 showing a modification of the blade attachment.

FIG. 1 shows a conventional speaker frame 10 with an annular flange 11 to which the flange 14 of the speaker cone or diaphragm 12 is fastened. The speaker cone 12 is divided into the high frequency or tweeter section 15 and the low frequency or woofer section 16 which are separated by a gap 18. Preferably the two sections are so arranged that they form part of the same continuous geometrical surface. The central or tweeter section 15 is connected with a conventional voice coil 20 (not shown in detail) while the outer or woofer section 16 is connected with the annular flange 14 by means of the conventional corrugations 22 which permit large membrane excursions. As very large amplitudes occur at the low frequencies, especially at high sound intensities, the pliability of the corrugated portion or of the marginal portion of the cone in general, must be higher than that of a conventional speaker membrane. This may be obtained by thinning the material of the membrane in the marginal zone or in the zone provided with the corrugations, either during the manufacturing process or afterwards, using abrasives.

The sound energy is transmitted from the tweeter section to the woofer section by means of drive or coupling blades 25 peripherally spaced around the gap 18 and bridging the same. As seen in FIG. 3 the drive blades are thin flat strips preferably made of paper, paper pulp, synthetic plastics or the like, or of any other material having pliability while simultaneously having a sufficient stiffness. The drive blades 25 are preferably mounted on the inside of the membrane sections with an edge 24 pointing toward the cone and the remaining portions of the said drive blades 25 pointing away from the cone, the blade surface being at an angle to the surface of the cone, approximately a right angle.

The shape of the blade may be that of a rectangular, triangular or polygonal flat strip. According to a preferred modification shown in the figure the outer edge of the blade may be so curved that the width of the strip increases from the end attached to the inner or tweeter section of the membrane to a maximum and then decreases again towards the other end, giving the blade a camel back shape. The inner edge of the curve may also be curved.

At each end the coupling or drive blade is provided with a lug or ear 28 projecting laterally from the blade approximately at right angles thereto when in operative position. This lug or ear may be provided with an eye 29 through which small screwbolts, rivets or similar fastening means may be passed with which the blades are attached to the cone sections. These sections may be provided with peripherally spaced holes near the gap 18 at a certain distance therefrom, for receiving the attachment means. Preferably the attachment of the blade to the inner or tweeter membrane section 15 is stiffened so as to be nearly rigid by means of metal washers or the like, while the attachment to the outer or woofer membrane section 16 is more pliable and soft; this may be obtained by using soft washers at this end.

Preferably the attachment of the coupling or drive blade to the inner or tweeter section is closer to the gap than the attachment of the outer or woofer section and the points of attachment on the two sections are located in radial planes which are angularly spaced (FIGS. 4 and 5).

The blades 25 attached to the cone sections 15, 16 cross the gap 18 either in a radial plane passing through the axis of the cone or preferably in a plane somewhat inclined with respect to the radial plane (FIG. 5). It has been found that good results are obtained if the flat blade surface is curved as indicated in the drawing (FIGS. 1 and 4).

The sectionalizing of the speaker cone and the coupling of the sections by means of the blades according to the invention offer several basic advantages, which are important for a high fidelity speaker, and which permit to utilize the full potentialities of a speaker using separate elements for high and low frequency reproduction. One of these advantages consists in a transmission of the lower frequencies to the outer section at their full energy level, the blades offering no elastic resistance in one direction and only a negligible elastic resistance in the other direction. The oscillations are thus neither attenuated nor distorted by the coupling elements. A further basic advantage consists in the relative freedom of the woofer section which can perform excursions which are quite large at low frequencies and at high sound intensities. On account of these large excursions this cone section can reproduce low frequency sounds practically at the energy level of the sounds fed to the speaker. This is especially a notable advantage at high sound intensities.

Oscillographic tests show that a nearly perfect frequency separation may be obtained and that, in addition, the sound energy distribution over the frequencies corresponds very nearly to the distribution of energy over the frequencies of the exciting currents.

These tests have especially shown that the range of

completely distortion free reproduction when compared with an identical speaker with a membrane of the same size and character is a multiple (2.5-2.7 times) of the latter when the connection of the membrane sections by means of the above described blades was used, at average sound intensity, the figures being higher at high sound intensity.

It will be understood that, while the invention has been described in connection with an electrodynamic speaker with a speaker cone, it is not limited to any particular type of speaker or speaker membrane. As will be clear to those skilled in this art, the principle of the invention may be applied to diaphragms or membranes of different type, shape or size. Changes or variations in the speaker or membrane construction do therefore not affect the principle of the invention as defined in the annexed claims.

Having described the invention, what is claimed is:

1. In a high fidelity sound reproducing device with a conical speaker membrane, divided along a plane intersecting the axis of the conical membrane into sections separated by a gap, coupling elements bridging the gap and connecting the membrane sections comprising blades made of flexible and pliable sheet material of a length exceeding the width of the said gap, mechanical fixation means at each end of each blade, holding the blade in a position in which an edge of the blade of sheet material points towards the membrane section surfaces, while the remaining portions of the blade project outwardly away from the membrane section surfaces, said fixation means joining each blade to the membrane sections on both sides of the gap at a distance which leaves a portion of each membrane section surface adjacent the gap free of fixation means.

2. A sound reproducing device as claimed in claim 1 wherein the blades are provided with projecting ears at their ends, laterally bent and substantially at right angles to the blade surface for attaching said blades to said membrane sections.

3. A sound reproducing device as defined in claim 1, in which the width of the said blades varies between the fixation means.

4. A sound reproducing device as claimed in claim 1 wherein the outer edge contour of a blade is curved and is of camel back shape, the apex of the curve being at a point intermediate between the ends.

5. A sound reproducing device as claimed in claim 1 wherein the blades are so positioned relatively to the membrane sections that they cross the gap at an angle to a radial plane through the axis of the conical membrane sections, the ends of each blade being thus located in different radial planes through the said axis.

6. A sound reproducing device as claimed in claim 1 wherein the blade has a flat surface which is curved and the ends of the blade are located in different radial planes passing through the axis of the conical membrane sections.

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