July 5, 1955 E. REISZ 2,712,360

MEMBRANE FOR SOUND REPRODUCING DEVICES

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FIG. 1.

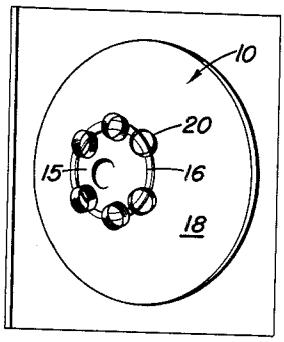


FIG. 4.

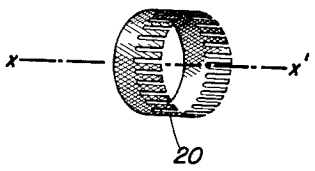
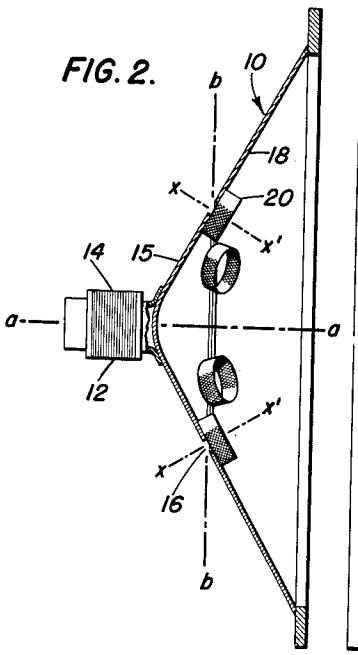


FIG. 2.



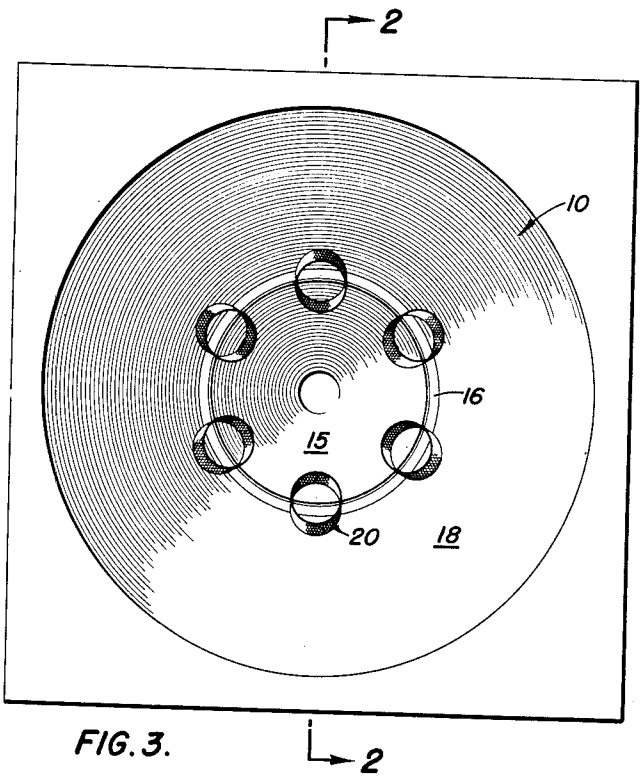


FIG. 3.

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MEMBRANE FOR SOUND REPRODUCING DEVICES

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11 Claims. (Cl. 181—32)

This invention relates to the reproduction of sound with a high degree of fidelity and it has particular reference to electrodynamic speakers with a conical or funnel shaped membrane. The main object of the invention is a material improvement of the quality of the sound produced by speakers having such membranes.

High fidelity reproduction of tones and sounds produced by musical instruments, especially by a plurality of instruments with or without accompanying human voices entails a very close reproduction of complex oscillations covering a wide frequency range without selective preference for single notes or certain frequency ranges and one of the main difficulties in obtaining high fidelity resides in the fact that high frequencies have inherent properties which are sufficiently different from lower frequencies to cause all electromechanical systems to show a marked preference for one group of frequencies while other groups of frequencies are attenuated or suppressed. The high frequencies have to a certain extent the character of beams, propagated in straight lines without bending or spreading, while low frequencies spread easily according to an exponential law and may be guided along surfaces without material loss.

It has therefore been proposed to provide separate sound producing elements and separate sound channels for the higher and lower frequency ranges. This has been partly successful, but entails great complications of the structure and introduces many additional problems of sound distribution. If sound reproducers with two sound reproducing elements for two different ranges of frequencies are used without separate channels, for instance two conical membranes radiating in the same direction, either driven by the same voice coil or by separate voice coils, the success is much less marked as the two concentric sound reproducing elements are of different efficiency either because one of the elements lacks means for preventing pressure equalization between its two sides or because the double suspension for the two elements interferes with the transmission of the excursions of the voice coil to at least one sound reproducing element.

It has also been proposed to treat the membrane in different ways in different zones so as to produce a different rigidity in the central and in the peripheral zone, using one zone mainly for the higher and the other for the lower frequencies. This entails the formation of a pliable zone between the two zones of different rigidity impairing the transmission of the larger excursions (the base tones) to the outer zone.

According to the invention, the single funnel shaped or conical membrane of a loud speaker is completely divided into two separate parts, separated by a small gap along a plane which intersects its axis, said parts or sections being joined and coupled in a novel manner. The coupling consists preferably of tube like symmetrical bodies, arranged astride of the gap separating the two sections of the membrane and projecting from the surface of the membrane substantially at right angles thereto, which bodies are attached to the membrane sections.

The tube like bodies may consist of an open mesh textile fabric, such as gauze, or of another fibrous material, stiffened to such an extent that the free oscillations of the tube like bodies or of the elements of which they consist are not within the range of audible frequencies.

The gap must be of such narrow size that pressure equalization between the front and the back of the membrane through the gap, especially for the lower frequencies is prevented, while it must be sufficiently wide to permit independent movement of the high frequency reproducing section relatively to the low frequency section.

The term "cone" or "conical membrane" used throughout this specification is intended to include not only frusto conical membrane shapes, but all flaring or funnel shaped bodies which are centro symmetrical and are formed by or contained within a body of rotation with a generatrix formed by a straight or curved line, one end of which is closer to the axis of rotation than the other end.

From the above it is seen that one object of the invention consists in obtaining a major improvement of the quality of the reproduction of musical and other sounds by using different sections of the same membrane for the reproduction of different frequencies, high fidelity being thus obtained without the complication due to the arrangement of multiple reproducing elements or devices.

A further object of the invention consists in an improved distribution of the different frequencies which are emitted by the same membrane.

A still further object of the invention consists in using a sectionalized membrane which is sufficiently rigid for the transmission of frequencies in the lower range from one section connected with the voice coil of the device to the other section, but which permits the separate use of a small stiffened section of the membrane for the reproduction of frequencies of the higher range.

A still further object of the invention consists in a divided membrane whose parts or sections are coupled with each other in a special manner, permitting the transmission of one group of frequencies from a first section of the membrane to a section section thereof, while the said first section may oscillate independently and radiate another group of frequencies.

Further objects of the invention will be best explained in the following detailed specification.

The invention is described with reference to the accompanying partly diagrammatic drawings illustrating one embodiment thereof. It is however to be understood that the embodiment of the invention which has been illustrated is shown by way of example only, in order to be able to explain the principle of the invention and the best mode of applying said principle. The shape and the constructional details illustrated are to be considered as illustrative and are not limitative, and a departure from the illustrated example of a speaker membrane is therefore not necessarily a departure from the principle of the invention.

In the accompanying drawings:

Fig. 1 is a perspective view of a loud speaker membrane according to the invention.

Fig. 2 is a diagram representing a section through the membrane along a plane of symmetry passing through the axis.

Fig. 3 is an elevational side view of the membrane looking towards the large opening of the membrane.

Fig. 4 is a perspective of a detail.

The speaker membrane **10** according to the invention may be approximately conical, as illustrated in the drawing, or may have the shape of a hyperboloid, or of any other body of rotation or of any other more complex body with a flaring mouth and a narrow end or apex **11**, to which narrow end portion the cylindrical

carrier 14 for the voice coil 12 is attached in any well known manner. The membrane consists in most cases of a cellulosic material, like paper, or of other fibrous material, selected in accordance with the effects to be obtained, using approved principles. The membrane is held by a sound board in a manner not specifically shown.

This membrane 10, as shown in Figs. 1–3, is completely divided into two sections 15 and 18 along a plane, indicated at *b—b* in Fig. 3 in dots and dashes, which plane in the example illustrated, is perpendicular to the main axis *a—a* of the conical membrane. The two sections 15 and 18 are separated by a small gap 16, the section 15 extending from the apex to the gap 16, while the section 18 extends from the gap outwardly.

The gap 16 is as small as possible, and it need only be wide enough to allow the central section 15 to perform high frequency oscillations independently of and relatively to the outer section 18. Its width must however be so small that the passage of pressure equalizing sound waves, especially of the lower frequencies, from the front to the rear of the membrane through the gap is blocked. Pressure equalization between oscillations produced at the front and at the back of the membrane respectively, which show a phase difference of 180° and therefore cancel each other out and reduce the efficiency materially is thus prevented.

To transmit the oscillations imparted to the voice coil 12 which is merely connected with the section 15 to both sections of the membrane, the section 15 of the membrane is coupled with the outer section 18 by means of a number of tubular coupling members 20, cylindrical tubes being shown by way of example. These coupling members may consist of any fibrous material, for instance of textile material, preferably a woven fabric such as fine gauze, or any other open mesh fabric. While the material in itself is not of primary importance, the stiffness of the coupling members in various directions must be carefully selected and this is best possible by selecting as a material a suitable open mesh woven fabric like gauze which is available with any number of threads per square unit. Careful selection is necessary because any free oscillation which may occur within such a coupling member should be entirely outside the limits of audible frequencies.

Tests have shown that oscillations of the threads of the gauze relatively to each other are best suppressed by providing the threads of the gauze or the entire coupling member with a coating consisting essentially of a fine granular material, with very fine grains, such as starch, as the friction of the fine grains prevents such oscillations practically completely.

A suitable number of these coupling bodies 20 are spaced along the gap 16, their number being dependent on the length of the circumference of the gap and on the size which is thought to be best for the coupling members 20.

The coupling members 20 may be provided with axial slots or cuts of limited length, as indicated in Fig. 4, on the free end projecting inwardly to reduce rigidity at this end and the teeth or strips between the cuts may be bent outwardly or inwardly or in different directions to minimize directional effects.

The coupling members 20 are placed astride the gap 16 in such a manner that their axes are preferably intersecting the small gap. The tubular members are then approximately at right angles to the surface of the membrane and approximately one half of the coupling member 20 extends outwardly and one half inwardly from said gap.

The coupling members 20 are fastened to the two sections 15, 18 of the membrane and hold these sections together. Preferably the coupling members are fastened to the sections 15, 18 directly without any intermediate member and even without bending or turning over of the edges which abut the surface of sections. The attachment is produced by means of an elastic adhesive. Wax or a rubber solution have both been found to be most suitable, but other elastic adhesives will perform as well.

The tubular coupling bodies 20, when attached to the inside or front side of the membrane, as illustrated, in addition to their other functions, also act as a distributing and directing means for the sound and more especially for the high frequencies.

The two sections 15, 18 of the membrane may be given different inherent rigidity, but this will, as a rule not be required, as the stiffening of the two sections by the coupling members 20, on account of their different positions on the sections, produces a sufficient difference in their rigidity.

As will be clear, the central or inner section 15 of the membrane is intended to radiate the higher and highest frequencies, corresponding to the treble tones, while the outer or peripheral section 18 of the membrane radiates the lower frequencies, corresponding to the bass tones. The high frequencies thus may radiate from a relatively small surface which may oscillate, when moved by the high frequency component of the voice coil oscillations, without being impeded by the large surface of the remainder of the membrane. Moreover this small surface section 15 is not only more rigid because it is the central section, but it is also braced to a much higher extent than the outer section by the coupling bodies 20, which surround it and form part of its periphery. The coupling is sufficiently elastic to permit such high frequency oscillations of the inner section without transmission to the outer section. This elimination of outer section of the membrane from participation in the high frequency oscillations eliminates the disturbances due to phase differences which always occur when the radiating surface for high frequencies is large.

The voice coil, on the other hand, can transmit all its low frequency excursions directly to the outer section of the membrane, as the coupling is sufficiently stiff for such transmission.

The arrangement of a divided membrane joined by coupling members excludes, as already above explained, pressure reduction by partial equalization of the pressure produced at the two sides of the membrane and provides a multidirectional guide for the high frequencies which are thus better distributed through space.

Further advantages will be readily understood by those skilled in this art. It will also be clear that unessential details may be changed without departing from the essence of the invention which is defined in the annexed claims.

Having described the invention, what is claimed as new is:

1. A high fidelity sound reproducing device comprising a voice coil, a central substantially conical membrane section closed on one side and attached to said voice coil, a separate membrane section, open on both sides and having the shape of a truncated cone which is co-axial with and substantially forms a continuation of the conical surface of the central membrane section, the central membrane section and the coaxial truncated membrane section being separated by a gap, a plurality of peripherally spaced coupling members arranged astride of and bridging said gap, said coupling members being attached to the membrane sections, arranged substantially along a continuous conical surface, the sound oscillations of the voice coil being thus transmitted to the truncated cone section of the membrane through the said coupling members.

2. A high fidelity sound reproducing device, comprising a substantially conical membrane, axially divided into an inner central section and an outer peripheral section, separated by a gap, coupling members, rigid in one direc-

tion and resilient in another direction, bridging said gap at predetermined spaced points, said coupling members being arranged astride of said gap and being attached both to the inner central and to the outer peripheral section, said inner central section being attached to a voice coil transmitting its oscillations to the outer peripheral section through said spaced coupling members.

3. A device as claimed in claim 2, wherein the coupling members are tubular members of fibrous material.

4. A device as claimed in claim 2, wherein the coupling members are tubular members of open mesh woven fabric.

5. A device as claimed in claim 2, wherein the coupling members are tubular members of woven fabric, the fabric being covered with a coating of fine granular material, preventing oscillation of parts of the fabric.

6. A device as claimed in claim 2, wherein the coupling members are tubular substantially symmetrical bodies placed with their axes intersecting the gap, said coupling members projecting from the surface of the sections of the membrane substantially at right angles.

7. A device as claimed in claim 2, wherein the coupling members are tubular substantially symmetrical bodies so placed that their axes intersect the gap, said coupling members projecting from the surface of the sections of the membrane substantially at right angles, and being attached to the said sections of the membrane at the edges abutting the surfaces of said sections by means of an elastic adhesive.

8. A device as claimed in claim 2, wherein the coupling members are tubular substantially symmetrical bodies so placed that their axes intersect the gap, said coupling members projecting from the surface of the sections of the membrane radially towards the inside of the membrane.

9. As an article of manufacture, a substantially conical membrane, divided along a plane at right angles to the axis of the said membrane, into two separate sections, separated by a gap, said sections being held together by substantially tubular coupling members of textile fabric, approximately one half of each tubular coupling member being attached to each section of the membrane on the inner side of the said membrane, said coupling members being placed astride the said gap and regularly spaced along said gap.

10. A device as claimed in claim 2, wherein the coupling members are tubular members of woven fabric, stiffened by a coating and provided with axially directed cuts dividing the cylindrical surface near the free end of the members, to reduce rigidity at this end.

11. A device as claimed in claim 10, wherein the strip shaped uncut portions between the cuts are bent so as to be inclined with respect to the axis of the cylinder, in order to minimize directional effects.

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