Aug. 26, 1952 H. ECKARDT 2,608,265

RIBBON-TYPE MICROPHONE DIAPHRAGM

Filed May 28, 1949

FIG. 1

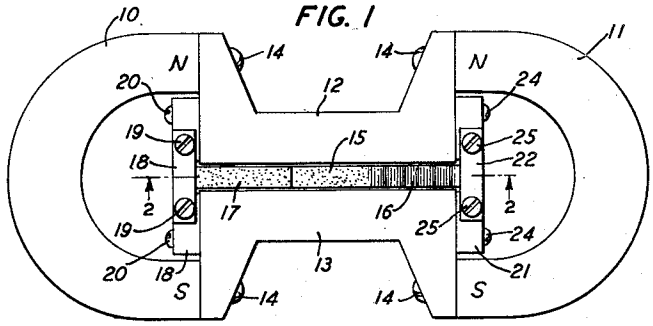



FIG. 2

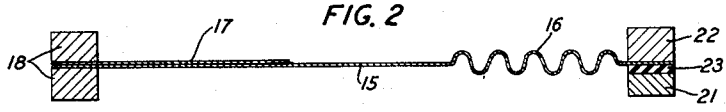



FIG. 3

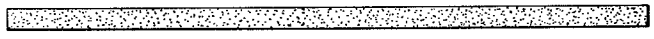


FIG. 4

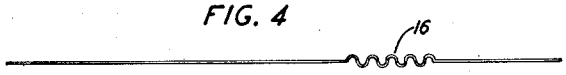



FIG. 5

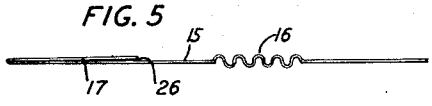
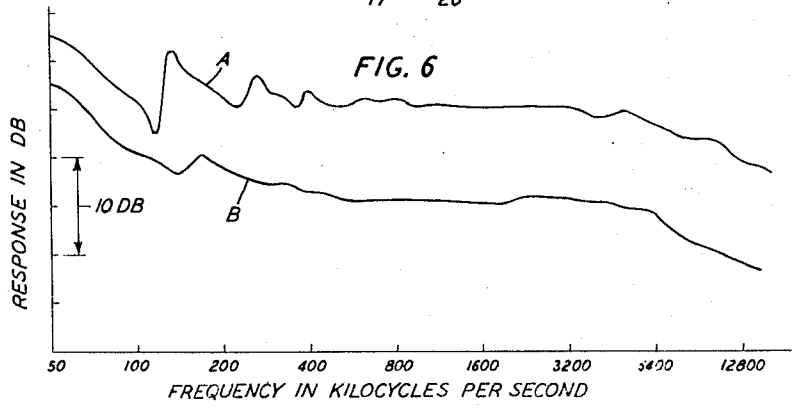



FIG. 6




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## RIBBON-TYPE MICROPHONE DIAPHRAGM

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6 Claims. (Cl. 181—32)

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This invention relates to acoustic diaphragms and more particularly to such diaphragms for ribbon-type microphones.

Microphones of this type comprise, in general, a thin metal, elongated or ribbon diaphragm supported at or adjacent its ends and immersed in a magnetic field the lines of force of which are transverse with respect to the diaphragm and substantially parallel to the faces thereof. In presently known constructions, the diaphragm may be flat or transversely corrugated substantially throughout its length. In response to sound waves effective upon one or both faces thereof, the diaphragm vibrates in the magnetic field whereby potential variations respresentative of the sound waves are developed between spaced points on the diaphragm, specifically between the ends thereof.

In devices of presently known construction, the relationship between diaphragm vibration and developed potential, or the frequency response characteristic, is irregular. Specifically, in devices including diaphragms of the forms above mentioned, the response is quite non-uniform over a range of frequencies at the lower end of the operating range so that distortion or unfaithful translation of the suond waves results.

One general object of this invention is to improve the frequency response characteristic of acoustic devices, such as microphones, including ribbon-type diaphragms, whereby high fidelity translation of sound waves into electrical signals may be realized.

It has been determined that distortion such as mentioned heretofore is definitely associated with the manner in which the elongated or ribbon diaphragm vibrates in response to sound waves effective thereon. Specifically, such a diaphragm flat or transversely corrugated substantially throughout its length, vibrates in several different modes in addition to its fundamental mode. For the latter, the diaphragm vibrates generally as one section with maximum displacement midway between its ends. In the third mode, which occurs at a frequency about triple that of the fundamental, the intermediate portion of the diaphragm vibrates out of phase, substantially 180 degrees, with the two end sections. The combination of resonance and cancellation effects results in marked irregularities in the response particularly in the range of several hundred cycles above the fundamental frequency. In general, because of the low mass of the diaphragm, the resonance frequency is low, for example of the order of 50 cycles. The third mode vibration, together with the fundamental resonance, results in substantial distortion in the range between about 100 and 500 cycles in typical devices.

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In accordance with one feature of this invention, the diaphragm is constructed to substantially suppress spurious vibration and especially vibration in the third mode.

In one specific construction illustrative of this invention, a diaphragm comprises a thin metallic ribbon supported at its ends and having one end portion corrugated transversely to increase its flexibility, the opposite end portion formed to increase its mass and stiffness and an intermediate or central planar portion.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a face view of the magnet and diaphragm assembly in a ribbon-type microphone illustrative of one embodiment of this invention;

Fig. 2 is a side view, partly in section, of a diaphragm constructed in accordance with this invention, and illustrating the manner of supporting the diaphragm;

Figs. 3, 4 and 5 illustrate several steps involved in the formation of a diaphragm such as illustrated in Fig. 2; and

Fig. 6 is a graph illustrating the improvement in response effected by diaphragms constructed in accordance with this invention.

Referring now to the drawing, the microphone unit assembly illustrated in Figs. 1 and 2 comprises a pair of similar, horseshoe permanent magnets 10 and 11 having their like poles in opposed relation and connected by U-shaped pole-pieces 12 and 13 affixed thereto as by screws 14. The base faces of the two pole-pieces are plane and parallel and define an elongated magnetic gap in which the diaphragm is suspended.

The diaphragm is in the form of a metallic ribbon and, as shown clearly in Fig. 2, comprises a planar intermediate portion 15, a transversely corrugated portion 16 at one end and a double thickness portion 17 at the other end. One end of the ribbon diaphragm is clamped between a pair of metallic bars or blocks 18 secured together by screws 19 and affixed to the pole-pieces by screws 20. The other end of the diaphragm is clamped between a metallic block 21 and a terminal 22, the terminal and diaphragm being insulated from the block 21 by an insulating strip 23. The block 21 is affixed to the pole-pieces by screws 24 and the terminal 22 is secured to this

block by screws 25. Electrical connection to opposite ends of the diaphragm may be established by leading-in conductors, not shown, connected to the block 21 and terminal 22.

The diaphragm may be fabricated in one way as illustrated in Figs. 3, 4 and 5. Specifically, a thin metal strip, for example of 0.00017 inch by 0.187 inch pure aluminum, is pebbled as by pressing it between two sheets of sandpaper. Next, as illustrated in Fig. 4, a series of transverse corrugations are formed in the strip in a region near one end thereof. Then, as illustrated in Fig. 5, the other end portion of the strip is folded upon itself, and the end of the folded section is secured to the body of the strip, as by a suitable cement indicated at 26 in Fig. 5. The ribbon is mounted between the supports 18 and 21, 22, tensioned to produce a prescribed resonance frequency therefor, for example of 50 cycles per second, and the excess portions beyond the supports cut away.

In a specific construction, the intermediate portion 15 may be 5/8 inch in length, the corrugated portion 16 may be 5/8 inch long and the unclamped part of the double thickness portion 17 may be 3/4 inch long.

It will be appreciated that the completed diaphragm comprises three distinct sections of different mass and stiffness per unit length. Specifically, the section 17 has the greatest mass and stiffness, the sections 15 and 16 have about the same mass, and the section 16 has the lowest stiffness. Thus, considered as a vibratory system, the composite strip tends to have three different and relatively minor resonances whereas a strip of uniform mass and stiffness throughout has a single pronounced resonance and, as has been pointed out heretofore, for vibration in the third mode involves out of phase effects with consequent degradation of the response characteristic. Because of its construction, the composite diaphragm suppresses spurious vibrations and particularly vibration in the third mode.

The improvement in response realized with diaphragms constructed in accordance with this invention will be appreciated from a consideration of Fig. 6. In this figure, curve A depicts the response of a microphone including a ribbon diaphragm corrugated transversely over substantially its entire length. The pronounced irregularities in the range between about 50 and 900 cycles are clearly evident. Curve B portrays the response of the same microphone but including a diaphragm of the construction illustrated in Fig. 2 and described hereinabove. Particularly to be noted are the relative smoothness of the response over the frequency range wherein curve A is decidedly irregular. The falling off of the response indicated in curve B in this range can be compensated for easily by design of the electrical circuit into which the microphone operates, thereby to obtain a uniform response over this range and consequently over the entire operating range of the device.

Although a specific embodiment of this invention has been shown and described, it will be understood that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention.

What is claimed is:

1. An acoustic diaphragm comprising a thin metal strip having a transversely corrugated flexible portion adjacent one end thereof, means on said strip for increasing the mass and stiffness of a portion adjacent the other end thereof, and means mounting said diaphragm at its ends.

2. A ribbon diaphragm having a transversely corrugated flexible portion adjacent one end thereof, a stiffened portion adjacent the other end thereof and an intermediate planar portion, and means mounting said diaphragm at its ends.

3. A ribbon diaphragm having a flexible section at one end thereof, an intermediate section and a section at the other end of greater mass and stiffness per unit length than said flexible and intermediate sections, and support means engaging said diaphragm at its ends.

4. A ribbon diaphragm comprising a metallic strip having a portion adjacent one end thereof transversely corrugated and a second strip overlying and secured to a portion of said first strip adjacent the other end thereof, and means mounting said diaphragm at its ends.

5. A diaphragm comprising a metallic ribbon having an intermediate portion of single thickness, a transversely corrugated flexible portion at one end and a double thickness portion at the other end, and means mounting said diaphragm at its ends.

6. A diaphragm in accordance with claim 5 wherein the lengths of said intermediate, flexible and double thickness portions are in the ratio of substantially 5:5:6 respectively.

HELMUTH ECKARDT.

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