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2,325,117

VIBRATION TRANSLATING DEVICE

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FIG. 1

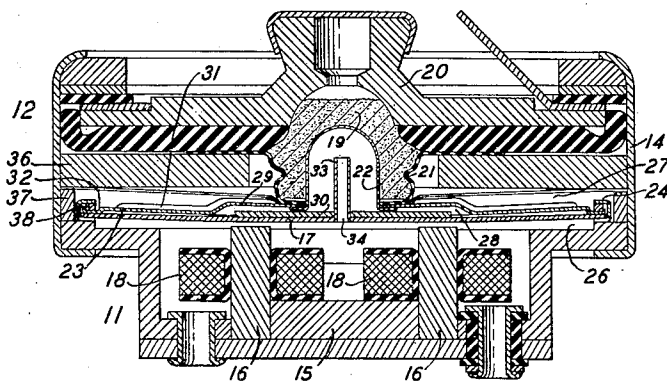


FIG. 2

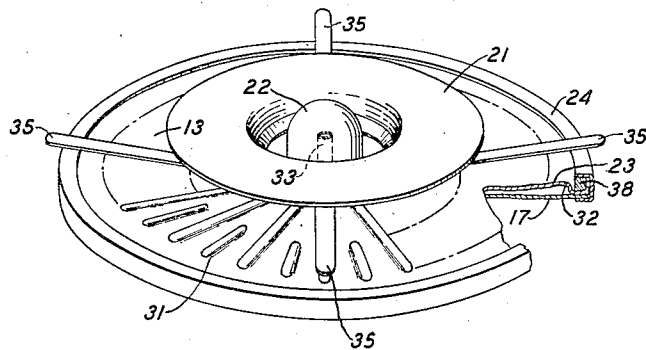
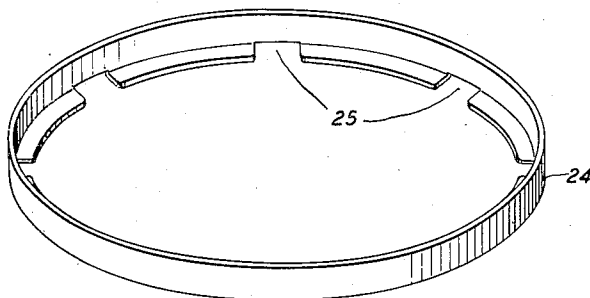


FIG. 3



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VIBRATION TRANSLATING DEVICE

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5 Claims. (Cl. 179-171)

This invention relates to vibratory translating devices and particularly to devices of this type which have acoustically coupled diaphragms.

The object of the invention is a vibratory system for such devices which responds at uniformly high efficiency over a desired frequency range and controls the response outside this range, so as effectively to suppress undesired frequency components.

The advantages of acoustically coupled diaphragms in such devices as microphone amplifiers are well understood and are explained for example in such patents as 1,952,577 to Bennett. It is also well understood in the art that the resonant response of a vibrating member such as a diaphragm may be reduced to any desired degree by associating with the member a suitable acoustic antiresonant network. In the case of acoustically coupled diaphragms, however, the structures suggested heretofore are not directly applicable since damping must be applied to both diaphragms without affecting the operation of the structure as an acoustic coupling.

According to this invention the primary resonance of a double diaphragm vibratory system is eliminated by connecting together the air chambers on opposite sides of the system through slots of suitable acoustic mass and resistance to produce an antiresonance the magnitude and frequency of which are fixed at the proper values by correct proportioning of the acoustic resistance and mass of the slots with respect to the stiffness of the air chambers. With this type of antiresonant acoustic network the slots may be of such low resistance that the chamber stiffnesses are ineffective at frequencies below resonance thus improving the efficiency of the device at those frequencies. At frequencies above resonance, where the mass reactance of the system is controlling, the acoustic mass of the slots is sufficient to make the chamber stiffnesses effective thereby reducing the impedance and extending the range of uniform high frequency response.

According to a further feature of the invention the response of the device below the desired range of response is sharply reduced by venting the acoustic coupling chamber through a tube disposed between the diaphragms, the frequency and rate of cut-off being determined by suitable proportioning of the length and diameter of the tube.

In the drawing Fig. 1 shows a microphone amplifier embodying the features of the invention.

Fig. 2 is a perspective view of the vibratory assembly of the amplifier and Fig. 3 shows the special ring used to clamp the parts of the vibratory structure together.

The amplifier of Fig. 1 comprises a telephone receiver unit 11 and a carbon microphone unit 12, acoustically coupled by the diaphragm assembly 13 and held together in operative relation by an outer casing ring 14. The receiver unit comprises a permanent magnet 15, pole-pieces 16, 16 mounted in spaced relation to the magnetic diaphragm 17 and coils 18, 18 on the pole-pieces for receiving the currents to be amplified.

The microphone unit comprises a carbon chamber 19 defined by an upper electrode 20, a silk retaining wall 21 and a lower electrode 22 secured to the non-magnetic diaphragm 23 and projecting upwardly into the chamber to make the microphone substantially non-positional in accordance with known practice in the art.

As shown more clearly in Fig. 2 the diaphragms 17 and 23, the silk piece 21 and the gold plated dome-shaped electrode 22 are all secured together to form a unitary vibratory assembly by means of the clamping ring 24. Gold plated phosphor bronze strips 35 extending from the electrode 22 and clamped between the plate 36 and the spacing ring 37 are provided to insure good electrical connection between the electrode and the casing. The bottom flange of the clamping ring 24 has a plurality of slots 25 and, when the assembly is held in place by the magnetic attraction between the pole-pieces 16 and the diaphragm 17, these slots and the clearance between the rings 24 and 37 form an air path between the receiver chamber 26 and the microphone chamber 27 but the whole acoustic system is sealed against dust in the outer air. The use of the thickness of the ring material to form the slots in this way provides a convenient means of holding the critical slot depth dimension to close limits when the amplifier is made by mass production methods. With the diaphragms in position on the lower flange of the ring as shown in Fig. 3 the top portion is folded over and against a washer 38 to clamp the diaphragms with enough pressure to seal the air chamber 28 between them against leakage at this point and yet leave them sufficiently free to move radially with temperature changes so as to avoid excessive bowing of the diaphragms.

The number of dimensions of the slots required will depend, of course, on the constants of the particular vibrating system to be damped but for a given structure they will be determined by the

stiffnesses of the chambers 26 and 27 to be interconnected. Since the slots must have appreciable acoustic resistance the width, that is the ring thickness, will always be small. In general, the acoustic mass of such slots varies directly with the length and number of slots and inversely with the ring thickness whereas the acoustic resistance varies inversely with the number of slots and inversely with the cube of the ring thickness. It will, therefore, be apparent that by proper choice of the number and size of the slots it is possible to obtain any values of mass and resistance required. In the structure shown the ring 24 is .0023 inch thick and about .327 inch in diameter and satisfactory results were obtained by using eight slots 25 each .090 inch long.

The diaphragm 23 has a high region 29 at its center to clear the magnetic slug 30 on the diaphragm 17 and yet be close enough to the latter diaphragm to provide the required air stiffness in the chamber 28. A number of radial ribs 31 are provided to stiffen the diaphragm so that it vibrates as a whole about its outer edge 32 and the section between this outer edge and the high central region 29 is preferably sloped or coned slightly toward the receiver diaphragm 17. When the device is put into operation and its temperature rises the dome electrode 22 expands slightly thereby tending to pack the carbon in the chamber 19 but the slight coning of the diaphragm counteracts this tendency by insuring that the diaphragm will always move downwardly with increasing temperature.

If the chamber 28 between the diaphragms is completely sealed the chamber stiffness is an effective coupling down to very low frequencies. For audiophone applications this is undesirable for several reasons. Low frequencies below about 500 cycles per second are not essential for intelligibility of speech and when an audiphone transmits efficiently in this range the reproduction is marred by low rumbling noises due to various causes such as walking pulses or other body movements. The normal position of the receiver diaphragm will of course depend on the value of the direct current in the receiver coils and, with an acoustic coupling effective at low frequencies, changes in position of this diaphragm, due for example to fluctuations of battery voltage, will produce corresponding changes in the normal position of the microphone diaphragm and its electrode 22 with the result that the average conductivity and efficiency of the microphone carbon changes with the receiver current.

To avoid these undesirable operating features the acoustic coupling at low frequencies between the diaphragms of such a structure has been reduced heretofore merely by providing a hole in one of the diaphragms. While this expedient is effective, the low frequency cut-off is gradual with the result that transmission is impaired for a portion of the band which should be transmitted. Applicant therefore provides a tube 33 extending upwardly from a hole 34 in the diaphragm 17 into the dome electrode 22 where it is protected from injury and does not interfere with other parts of the unit. The frequency and rate of cut-off can be controlled by proportioning the length and diameter of the tube with respect to the stiffness of the air within the chamber 28 so that the very low frequencies are prop-

erly attenuated and yet the response is maintained substantially constant down to frequencies low enough to insure good intelligibility.

The dimensions of the tube in a given case will, of course, vary with the other constants of the particular structure and with the frequency and rate of cut-off desired. In general, the sharpness and frequency of cut-off are proportional to the tube diameter and inversely proportional to the length of the tube. In the structure shown very good results are obtained with a tube .015 inch inside diameter and .10 inch long which produces a rather sharp cut-off below 500 cycles per second.

While the invention has been described for purposes of illustration with reference to a microphone amplifier it will be understood that the novel features are equally applicable to any other vibratory device using an acoustic coupling of the double diaphragm type.

What is claimed is:

1. A vibratory element for acoustically coupling vibratory translating devices comprising two diaphragms, a thin, U-shaped clamping ring holding the diaphragms together in spaced relation and radial slots in the ring for producing a leakage path around the vibratory element.

2. A vibratory element for acoustically coupling vibratory translating devices comprising a magnetic diaphragm and a non-magnetic diaphragm, a clamping ring holding the diaphragms together in spaced relation, a dome-shaped electrode on the central portion of the non-magnetic diaphragm and a region in the non-magnetic diaphragm surrounding the electrode coned in the direction to compensate for expansion of the electrode with increasing temperature.

3. A vibration translating device comprising two vibration translating units each having a diaphragm and an air chamber sealed against dust in the outer air, means for holding the diaphragms together in closely spaced relation to form an acoustically coupled vibratory system and a path between the chambers forming therewith an acoustic antiresonance at the resonant frequency of the vibratory system.

4. A vibratory element for translating devices comprising two diaphragms, means for clamping the diaphragms together in spaced relation to form an acoustic coupling between them and means for determining the rate and frequency of the cut-off of the coupling comprising a hole in one of the diaphragms and a tube extending from the hole into the space between the diaphragms.

5. A vibration translating device comprising two vibration translating units each having a diaphragm and an air chamber, means for holding the diaphragm together in spaced relation to form an acoustically coupled vibratory system and means for giving the device a substantially flat transmission characteristic over a limited frequency range comprising an air path between the chambers forming therewith an acoustic antiresonance at the resonant frequency of the vibratory system and an air path between one of the chambers and the air confined between the diaphragms of such dimensions as to give the vibrating system a sharp cut-off at low frequencies.

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