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SINTERED TRANSDUCER HOUSING PROVIDING ACOUSTICAL RESISTANCE
AND WATERPROOFING
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3,539,735

Fig. 1.

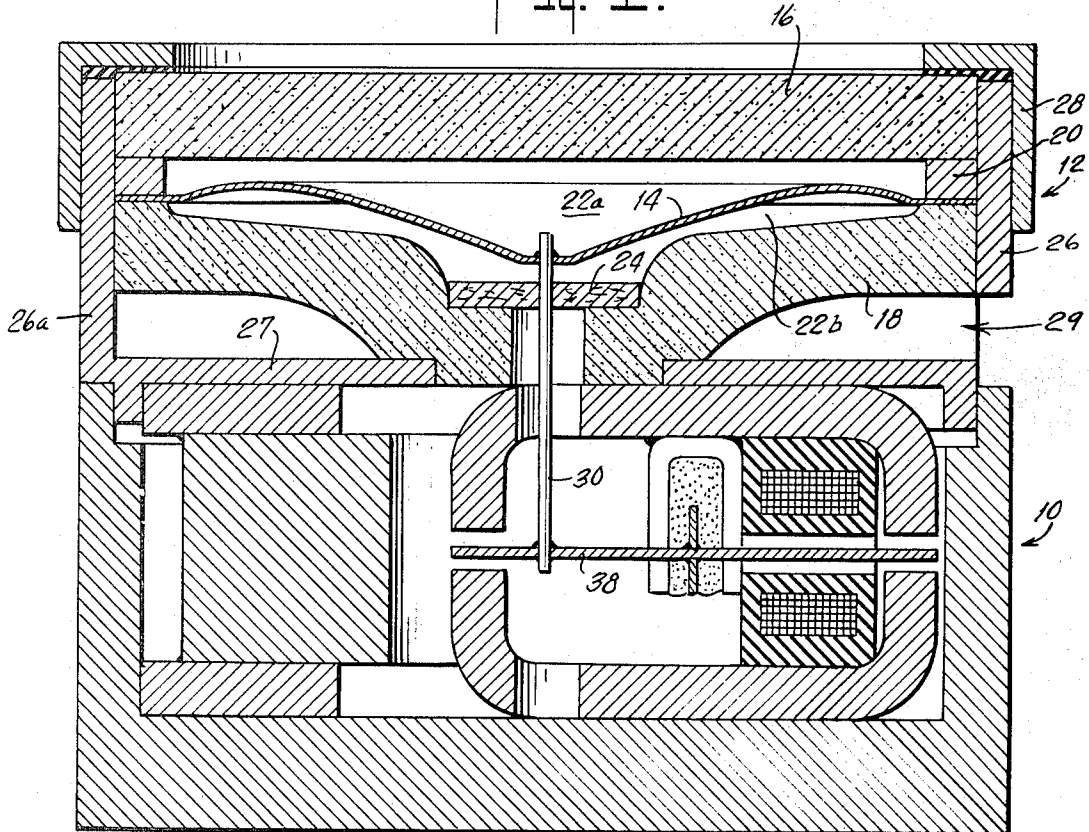


Fig. 2.

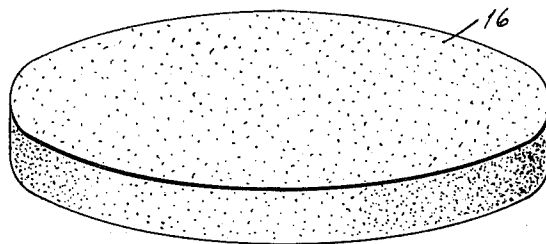
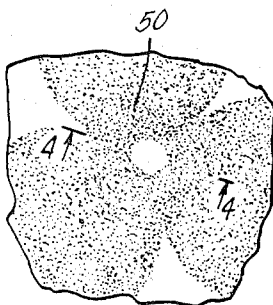


Fig. 3.

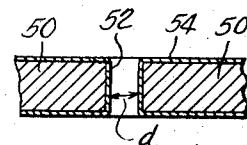


Fig. 4.

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SINTERED TRANSDUCER HOUSING PROVIDING ACOUSTICAL RESISTANCE AND WATER-PROOFING

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3 Claims

ABSTRACT OF THE DISCLOSURE

A diaphragm housing which is constituted of sintered metallic particles having minute air passages to provide sufficient acoustic resistance, the air passages having a width of the order of .001 inch and being coated with a material which is not wet by water whereby they are additionally capable of preventing moisture penetration.

BACKGROUND, OBJECTS AND SUMMARY OF THE INVENTION

This invention relates to an electro-acoustic transducer in general and, more particularly, to housing means associated with such a transducer that will provide the desired acoustical resistance for the proper operation of the transducer and will also provide resistance to moisture in an environment where the transducer is to be utilized.

The present invention is especially concerned with the notion of combining in a simple housing for electro-acoustic transducer the rigidity required for protection of the sensitive elements forming the transducer with a means for eliminating undesirable resonance peaks. Such means comprising a well calculated value of acoustic resistance inserted in the acoustical circuit for smoothing out the transducer's response characteristics.

It has been discovered by me that the very same housing which provides the above-noted advantages of shock protection and improvement in response can be made capable of preventing penetration of moisture into the interior of the transducer. In other words, it is an underlying principle of the present invention that, in particular, while providing for the elimination of undesirable resonance peaks the housing can be so constituted as to resist a head of water having a value of one foot. Consequently, the housing is completely capable of eliminating the penetration of harmful moisture to the interior of the transducer.

It has been known to provide damping means for electro-acoustic transducer devices where such means has the desirable characteristic of being utilizable in the construction of the transducer housing or casing. For example, in the U.S. patent to Williams et al., 2,444,620, there is described a damping material which is composed of a plurality of sintered-together minute discrete particles. As described therein the particles preferably are metallic spherules and, after sintering is accomplished, the material is sufficiently self-supporting and rigid enough to be utilized to provide the housing for the transducer. In the particular context discussed by Williams et al., the housing is provided for a diaphragm-crystal type of assembly in which sintered plates are placed very close to opposite faces of two diaphragms for the particular purposes to be served therein.

However well the intent and objectives in Williams et al. are satisfied by their particular design it happens to be the case that where the crystal element of their transducer must be protected against moisture, an extra thin, flexible diaphragm of rubber or the like has to be introduced in the interior of the housing to provide this function of immersion prevention. In other words, an addi-

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tional element must be added to the transducer to furnish protection against moisture because the sintered housing itself is not capable of achieving this result.

Accordingly, it is a primary object of the present invention to provide a sintered housing that will not only furnish acoustical resistance but will eliminate the need for adding extra elements to prevent moisture penetration.

Another object is to lower the manufacturing cost in producing a transducer assembly that will have both of the desired attributes, i.e. it will possess satisfactory acoustic response characteristics and will substantially eliminate moisture penetration to the interior of the transducer.

A further object is to avoid the effects of moisture penetration on any of the interior elements of the transducer, including the diaphragm.

The unique feature of the present invention resides in a sintered housing for providing the aforesaid multiple functions. It will be described in greater detail hereinafter with reference to the fabrication of a transducer of the balanced armature type. This type of transducer is thoroughly described in co-pending application Ser. No. 534,572, now Pat. No. 3,451,773, assigned to the assignee of the present invention. More particularly, the novel sintered housing feature will here be described in the particular context of a noise-cancelling microphone application for the balanced armature transducer. However, as the description proceeds, it will become apparent that the present invention is just as applicable to any number of transducers, whether balanced armature or not, and further, is specifically applicable to microphones other than the noise-cancelling variety.

It should be briefly noted that by the term "noise-cancelling" is simply meant a device that is capable of responding to desired sound emanating from a particular direction and sound source proximity, and of discriminating against sound waves from random directions, the latter being typical of ambient noise. In other words, such a microphone provides an output from the desired sound but cancels out the effects due to noise.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawings.

FIG. 1 is a side view in section of a balanced armature transducer embodying the sintered housing feature in accordance with the present invention.

FIG. 2 is a perspective view of the top plate or cover of such sintered housing.

FIG. 3 is an extremely enlarged, fragmentary view of the sintered housing showing the sintered particles and the interstices therebetween.

FIG. 4 is a sectional view showing an air passage defined by interstices and depicting a coating layer applied to the sintered material.

Referring now to the drawing, a preferred embodiment of the present invention is exemplified by the balanced armature transducer shown as comprising two basic parts, i.e. the electro-magnetic system designated 10 and the acoustic device 12. The acoustic device 12 is in the form of a diaphragm 14 which is disposed in a separate enclosure entirely outside the enclosure containing the magnetic elements.

Movement between the diaphragm and the armature of the transducer is transmitted by way of a linkage in the form of a drive rod 30 which is attached at one end to the center of the diaphragm by means of an epoxy cement or similar material, and at its other end is soldered to the armature 38. The armature 38 is a rocking armature, that is to say, it is pivotally mounted at its center and has its ends extending between respective pairs of

pole tips. This type of operation has been described fully in co-pending application Ser. No. 534,572, supra, and such description is not repeated here since it is not considered necessary for an understanding of the basic feature of the present invention, which is not confined or limited in any way to the precise transducer as illustrated.

The enclosure or housing for the diaphragm 14 essentially consists of the front and rear plates 16 and 18 which are formed of sintered material. Such sintered material is, for the purposes of the present invention, preferably stainless steel. By reason of this sintered construction for the plates 16 and 18, minute openings are provided for the passage of sound waves. In other words, the sintered material is sound-permeable but it is sufficiently rigid to withstand impacts and other rough treatment. In the particular microphone illustrated in FIG. 1 which is of the noise-cancelling variety, the design is such that sound can enter into either the front or the rear chamber, that is, into either the chamber 22a formed by the upper plate 16 and the diaphragm 14 or into the chamber 22b formed by the lower plate 18 and the diaphragm 14. Of course, the chamber 22b, as shown is also defined by a separate acoustic damping element 24 having its vertical axis coincident with the axis of the transducer.

It will be appreciated that it is only through the minute openings in the sintered material of the plates 16 and 18 that there is air flow into the interior. This is so because the annular sealing ring 20 abuts the periphery with the diaphragm 14 to form a moisture-proof and air-proof joint between the diaphragm 14 and the plates 16 and 18. In addition, a clamping ring 26 entirely surrounds the peripheral edges of the diaphragm 14 as well as plates 16 and 18, and by suitable means (not shown) clamps all of these elements to insure air tightness. Furthermore, the clamping ring 26 includes a portion 26a which connects with a horizontal diaphragm seating ring 27. The seating ring fits tightly against the lower end of the plate 18 and also fits tightly against the inner surfaces of the lower enclosure for effective sealing. A cap or cover 28 fits over the diaphragm housing and has a suitable opening for desired entry of sound waves so that they may penetrate the plate 16. Correspondingly, entry of sound waves from the back side is enabled by virtue of the opening 29 to the atmosphere.

As noted previously, the material preferably utilized according to the invention for the combined functions of microphone housing-damping-moisture proofing is metallic in character and most preferably is stainless steel. In order to provide the essential function of protecting against moisture, the plates 16 and 18 must be capable of resisting pressures of the order of one foot of water.

To realize the above stated objective of moisture elimination while at the same time providing the required acoustic resistance, very fine metallic particles are sintered together to form the material for the plates 16 and 18, which together constitute the housing for the diaphragm. The plate 16, which is the upper plate for the housing, is shown in the form of a disc in FIG. 2. In the particular example being considered, that is, with a diaphragm housing such that the volume of the chamber 22a is of the order of .06 cubic inch and with the thickness for the plate 16 of approximately $\frac{1}{16}$ of an inch, it turns out that the acoustic resistance will be of the order of 200-600 acoustical ohms c.g.s.

Preferably to achieve the ends desired, the particles (such as particles 50 in FIG. 3) should have an average diameter of the order of .006 inch or less. Most preferably, in the case where it is desired to achieve the elimination of moisture solely by the sintering of particles, i.e. without any further treatment, the particles should have an average diameter of the order of .002 inch. However, the essential criterion is not the size of the particles, per se, but rather the constitution of the ma-

terial of the acoustic plates so that the air passages defined by the interstices between particles are of proper size, on the average, both to obtain the necessary acoustic resistance and to provide proper moisture repellency. Thus, the forming of the material of plates 16 and 18 is carried out so that the requisite air passages are formed. These passages 52 have a width d , as shown in FIG. 4, of the order of .0010 inch or less.

The preferred technique of providing the necessary resistance to moisture penetration is to coat the material of which the plates 16 and 18 are formed with a substance which has the desirable characteristic that it is not wet by water. Thereby, a large contact angle will be obtained and, consequently, a large hydrostatic pressure will be necessary to overcome surface tension. To provide the moisture imperviousness desired a substance such as a commercially available silicone compound is utilized as the coating material. In this particular case, as illustrated in FIG. 4, a coating is obtained within the air passages 52. This results from the fact that the silicone compound has been forced under pressure in forming the material of the plates and has been caused to penetrate the interstices between metallic particles. The silicone compound is then baked leaving the very thin coating 54 on the external surfaces as well as within the air passages 52.

It should be noted that the sintered material must be capable of meeting the requirements for an air flow of one $\text{cm}^3/\text{sec.}/\text{cm}^2$ of area at 1000 dyne/ cm^2 and still hold a one foot minimum head of water. In actual practice it has been found that such criteria can be satisfied where the sintered material has particle sizes, as noted before, ranging as high as .006 inch but with the air passages themselves being restricted to .0010 inch or less.

Although emphasis has been placed above on the fabrication of plates 16 and 18 by the sintering of stainless steel particles, it will be manifest to one skilled in the art that other metallic particles can also be utilized. For example, copper particles alone may be molded and sintered to form the desired material, or various mixtures of copper and tin, or of nickel or nickel alloys or the like, may also be employed.

It should be made clear that the particular material for the plates 16 and 18 may be varied by one skilled in the art pursuant to the broad teaching of the present invention. This is another way of saying that the present invention resides primarily in the recognition that those acoustic housing materials which have been known to serve the purpose of introducing acoustical resistance into the system can, unexpectedly, and in the particular ambience considered here, be made capable of resisting moisture penetration. Thus, the scope of the present invention is not limited to any particular material or set of materials. Moreover, it should be appreciated that the present invention is not limited to a type of microphone as illustrated in FIG. 1, since it is manifestly applicable to a variety of transducers operating on other principles than the one illustrated.

It should also be especially noted that the advantage of the construction of the diaphragm housing is increased by the fact that it provides a moisture proof barrier without the use of thin membranes. Such thin membranes, as they have been used before in noise cancelling microphones, are difficult to balance. The balancing of the thin membranes is required in order to permit the cancellation of the noise signal. A moisture proof vent would still be a necessary element to permit pressure equalization, thereby to compensate for changes resulting from barometric pressure and temperature variations.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to the preferred embodiments, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art

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without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. An electro-acoustic transducer comprising a vibratory diaphragm; a housing for said diaphragm, including a rigid but porous member clamped to the periphery of said diaphragm, said member being formed of discrete metallic particles such that a plurality of air passages extend through said member; means sealing said rigid member to the periphery of said diaphragm so as to form with said diaphragm a chamber which is air tight except for the passages between said particles; said air passages being characterized by having a width of the order of .001 inch and being coated with a material which is not wet by water whereby, in addition to acoustic resistance, the air passages provide resistance to moisture penetration into the interior of said chamber.

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2. A device as defined in claim 1, in which the average diameter of said metallic particles is less than .003 inch.

3. A device as defined in claim 2, in which said member is constituted of sintered particles of stainless steel.

References Cited

UNITED STATES PATENTS

2,444,620	7/1948	Williams et al.	179—110
3,439,128	4/1969	Sobel et al.	179—110
2,453,192	11/1948	Bryant	179—179

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U.S. Cl. X.R.

179—184

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,539,735 Dated November 10, 1970

Inventor(s) Gaston A. Marchand

It is certified that error appears in the above-identified pater and that said Letters Patent are hereby corrected as shown below:

Column 2, lines 22 and 23, change "Ser. No. 534,572, now Pat. No. 3,451,773" to -- Ser. No. 634,572, now Pat. No. 3,460,080--.

Column 3, line 2, change "Ser.No. 534,572" to -- Ser. No. 634,572 --.

SIGNED AND
SEALED
NOV 16 1971

(SEAL)

Attest:

Edward M. Fletcher, Jr.
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