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DIAPHRAGM AND IMPEDANCE MEANS

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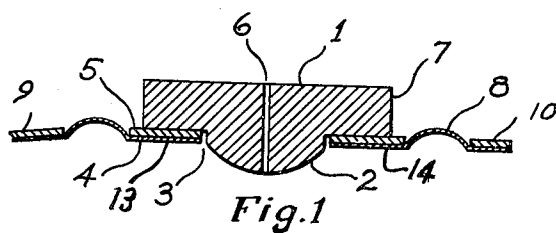


Fig. 1

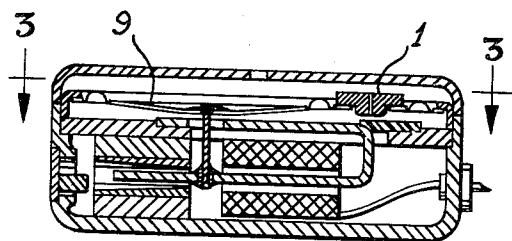


Fig. 2

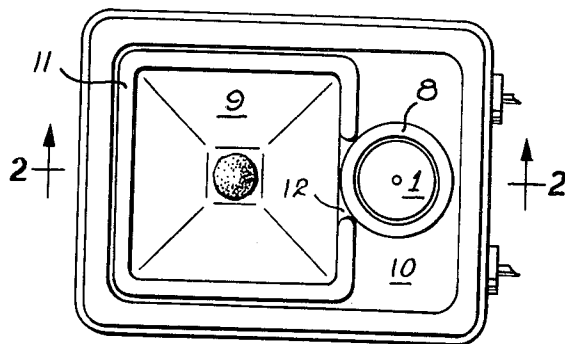


Fig. 3

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DIAPHRAGM AND IMPEDANCE MEANS

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17 Claims. (Cl. 181—32)

This invention is concerned with acoustic impedance means which may be utilized in microphones and receivers or other acoustic translating devices.

Accordingly, it is an object of this invention to provide an impedance element acting essentially as an acoustic inductance with substantially no acoustic resistive component, enabling utilization in highly miniaturized translating devices.

It is a further object to provide a very small impedance element which may be employed as an improved substitute for the impedance tube commonly utilized with acoustic translating devices, thus enabling greater miniaturization of such devices while providing increased sensitivity and flatness of response.

Thus it is an object of the invention to provide an acoustic impedance means, for an acoustic translating device, comprising a laminate sheet providing an outer support portion and a highly compliant surround intermediate said portion and a mass, so that the compliance of the surround may be made sufficiently large to place the self-resonant frequency of the impedance means below the lower cutoff frequency of the translating device.

Another object is to provide an impedance means adjacent an acoustic diaphragm on a single sheet also supporting a diaphragm reinforcement.

A further object of the invention is to provide an impedance means adjoining an acoustic diaphragm comprising respective flexible surrounds in contact, or coextensive at least partially, so as to provide an optimally compact structure.

These and further objects of the invention will be apparent from the accompanying specification and drawings in which:

FIGURE 1 is an enlarged view of the flopper of the present invention;

FIGURE 2 is a section along line 2—2 of FIGURE 3 showing the flopper in conjunction with the acoustic diaphragm of a complete acoustic transducer; and

FIGURE 3 is a plan view along line 3—3 of FIGURE 2.

In the particular embodiment of the invention shown in FIGURE 1, the flopper comprises a mass element 1 and the flexible surround 8, which are supported by the outer laminate portion 10. The mass may have one or more projections or bosses such as 2 extending into association with the portion 13 of the sheet 14 within the flexible surround, as through an aperture 3. The laminate sheet 14 comprises at least two materials of different elastic moduli, for example a flexible sheet of film 4 such as a fluorocarbon resin and foil 5 such as aluminum. Preferably a portion of the foil 5 underlies the mass for convenience in bonding the mass to the sheet, as by an adhesive, while the surround is restricted to the material of lower elastic modulus, in this case the film 4. An aperture 6 may be provided to compensate for changes in atmospheric pressure, or in addition to provide a desired value of acoustic resistance as an additional impedance element.

The mass has a peripheral edge 7, which may define the contour of the surround. The latter may take various configurations such as a rectangle, an oblong shape with rounded ends in the shape of a race track, an ellipse, or otherwise. Preferably however the contour is defined by smooth continuous curves which may include straight

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line portions. The highly compliant surround 8 provided by the film 4 permits oscillation of the mass in response to pressure difference between opposite sides of the sheet.

FIGURES 2 and 3 show the flopper adjacent an acoustic diaphragm between air spaces in the casing of a translating device such as a hearing aid microphone or receiver. In those figures the sheet defining the flopper also carries a diaphragm reinforcement 9, a region of the foil portion 5 of the laminate sheet, and a surround 11, defined by a part of the film portion 4 of the laminate sheet. The diaphragm reinforcement 9 is attached to the drive pin of a translating device such as the one more fully disclosed in copending application Serial No. 168,183, filed January 23, 1962. FIGURE 3 shows the arched portion of the diaphragm surround 11 in contact with the arched portion of the flopper surround 8. Since in this particular embodiment the flat portions 12 are also restricted to the film 4, they form small portions of the surrounds 8 and 11, so that the flopper and diaphragm surrounds are in this case partially coextensive. This structure provides a compact arrangement of the elements, while still permitting the mass surround, the mass, the diaphragm surround, and the diaphragm reinforcement to be respectively exterior one to the other along a direction extending laterally outward from the center of the diaphragm reinforcement to and through the center of the adjacent mass and mass surround, so that the mass is not superimposed on the diaphragm or vice-versa.

The operation of the device is as follows. The mass 1 is acted upon directly by pressure difference between the two sides of the sheet, and indirectly via the surround 8 acted upon by such pressure difference, and is thereby accelerated, producing a volume displacement between the two spaces separated by the sheet. In this fashion the flopper acts essentially as an acoustic inductance. The resistive component of its impedance is negligible relative to that of a Thuras tube of equal inductance if the volume available for the tube is very small as in highly miniaturized translating devices. The energy loss due to the resistive component of a Thuras impedance tube has been a limiting factor in the performance of such translating devices as size has been progressively reduced.

By means of the laminate sheet structure and the support provided by the outer portion 10, it has proved practical to make the thickness and hence the stiffness of the surround 8 low enough, while maintaining mechanical positioning and stability of the mass 1, to provide a sufficiently low self-resonant frequency of the flopper. This must be less than the lower cutoff frequency of the translating device if a severe dip in the frequency response is to be avoided over the desired pass-band. The thicknesses of the surround 8 which may be employed range typically from .00025" to .00012" and less.

It is apparent that the present invention provides a very small substitute of improved performance for the bulky and relatively inefficient impedance tube commonly utilized with acoustic translating devices, thereby enabling greater miniaturization of such devices than was heretofore possible. Furthermore the use of the flopper enables increased sensitivity and flatness of response to be achieved whatever the degree of miniaturization of the device in which it is employed. It has also the advantage of being readily fabricated in a variety of configurations to fit the particular acoustical and mechanical requirements of the translating device. The invention obviously can be modified in many ways such as the provision of more or less locating boss or none, changes in orientation or location on the sheet, one or more apertures through portions other than the mass such as the outer portion 10, and the like. For example the mass may be located about a portion or all of the periphery of the diaphragm reinforcement, such

that respectively a portion or all of the diaphragm surround is intermediate the mass and the diaphragm reinforcement. The mass may be solely a portion of the laminate sheet within the mass surround, when the desired impedance causes weight element 1 to be not present, or may be considered as including or comprising such a portion of the laminate sheet within the mass surround when the desired impedance causes element 1 to be so light that the weights of the foil 5 and film 4 portions inwardly of the mass surround must be taken into account. It may be desirable in a particular case to provide the combination of a flopper and an impedance tube or other acoustical impedance element in a single translating device. However the scope of the invention is to be limited only by the following claims.

I claim:

1. An acoustic impedance element comprising a laminate sheet including two materials of differing elastic moduli, having an outer support portion comprising said materials, an intermediate portion forming a flexible surround restricted to the material of lower elastic modulus, and an inner portion comprising a mass supported by said surround.

2. The impedance element of claim 1 wherein said mass comprises a portion of the laminate sheet within the surround.

3. The impedance element of claim 2 wherein said mass further comprises a weight element located on said portion of the laminate sheet within the surround.

4. The impedance element of claim 1 wherein said mass comprises an element located on a portion of the laminate sheet inwardly of the surround.

5. The impedance element of claim 4 further comprising a boss projecting out from the mass into association with a portion of the laminate sheet.

6. The impedance element of claim 5 wherein the boss is seated in an aperture through the sheet.

7. The impedance element of claim 6 wherein the boss and mass have an aperture therethrough.

8. The impedance element of claim 1 wherein the contour of the surround is defined by smooth continuous curves.

9. The combination of acoustic diaphragm and impedance means comprising a flexible sheet defining a diaphragm surround, a diaphragm reinforcement supported thereby, and a mass, said sheet also defining a mass surround supporting said mass.

10. The combination of acoustic diaphragm and impedance means comprising a laminate sheet including two materials of differing elastic moduli, having one portion

defining a diaphragm reinforcement, another portion restricted to the material of lower elastic modulus defining a diaphragm surround, a mass, and a further portion of said sheet restricted to the material of lower elastic modulus defining a mass surround supporting said mass.

11. The combination of claim 10 wherein the mass comprises a portion of the laminate sheet within the mass surround.

12. The combination of claim 11 wherein the mass further comprises a weight element located on said portion of the laminate sheet within the surround.

13. The combination of claim 10 wherein the mass surround, the mass, the diaphragm surround, and the diaphragm reinforcement are respectively exterior one to the other.

14. The combination of claim 12 wherein the diaphragm surround is exterior of the diaphragm reinforcement, the mass is adjacent to and exterior of the diaphragm surround, and the mass surround is exterior of the mass, along a direction extending laterally outward from the center of the diaphragm reinforcement to and through the center of the adjacent mass and mass surround.

15. The combination of claim 10 wherein the diaphragm and mass surrounds are in contact.

16. The combination of claim 10 wherein the diaphragm and mass surrounds are at least partially co-extensive.

17. The combination of acoustic diaphragm and impedance means comprising a laminate sheet including two materials of differing elastic moduli, having one portion defining a diaphragm reinforcement, a mass, and another portion of said sheet restricted to the material of lower elastic modulus defining a surround portion for the mass and diaphragm reinforcement.

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