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ELECTRO-ACOUSTIC TRANSDUCER HAVING DAMPING SLOTS

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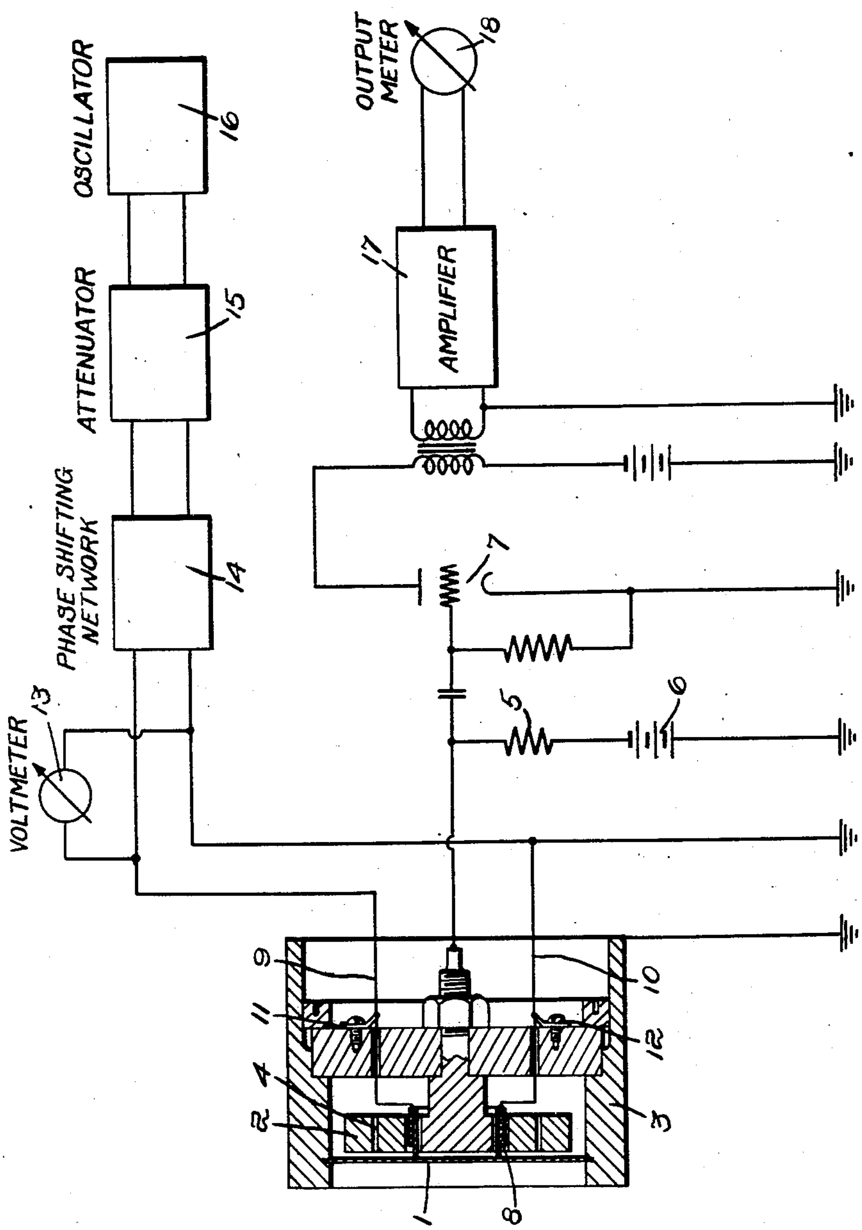

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ELECTROACOUSTIC TRANSDUCER HAVING DAMPING SLOTS

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4 Claims. (Cl. 179—180)

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This invention relates to transducers and more especially to an electro-acoustic transducer for measurement of sound pressure.

It is well known in the art that electro-acoustic transducers which are to be used for measurements of sound pressure in cavities with rigid walls should possess relatively small physical size and relatively high mechanical diaphragm impedance. At present condenser type microphones are largely used for this purpose. As the frequency is increased, the dimensions of the cavity in which the sound pressure may be desired to be measured become increasingly comparable with the wave length of sound, and wave motion in the cavity sets in, which in many cases is modified by the presence of the finite mechanical impedance of the microphone. It is, therefore, desirable to increase the diaphragm impedance of the condenser microphone beyond the present limits dictated by requirements of sensitivity and reliability. Optimum results would be obtained from a small microphone with an infinite diaphragm impedance. Such an instrument would measure the sound pressure in the cavity which would exist if the microphone itself were not present in the cavity.

An object of the invention therefore is to improve electro-acoustic transducers and to provide a device having the desirable characteristics above noted. More particularly an object is to provide means for modifying the diaphragm impedance of a condenser microphone, in order to conduct more efficiently measurements of sound pressures in cavities with rigid walls. Other objects of the invention will appear from the following discussion.

In the accompanying drawings the figure illustrated therein diagrammatically indicates an improved condenser microphone connected to electrical circuits, this assembly constituting the device of the invention.

The condenser microphone is provided with a moving coil member interposed between the diaphragm and back plate of the microphone, and the coil is connected to electrical circuits by which compensating effects may be obtained with resultant increase in diaphragm impedance.

Referring more in detail to the drawings, I have illustrated in cross section a condenser microphone having a stretched metal diaphragm 1 and a fixed back plate 2 which is mounted so that it is insulated from the casing 3. The back plate 2 is preferably formed with annular slots 4 which provide for proper damping and more desirable response characteristics. As sound impinges on

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the diaphragm it executes corresponding motion and changes the capacitance between the diaphragm and the back plate. A constant D. C. bias voltage is applied through a high resistor 5 from the battery 6. The change in capacitance produces a resultant change in voltage which may be conveniently amplified by a vacuum tube 7 connected to the high side of the resistor 5.

In accordance with the invention I provide a moving coil 8 which is solidly secured to the diaphragm 1 of the transducer at some convenient point such as is indicated in the drawings. The coil extends inwardly from the diaphragm and is received in one of the annular damping slots of the back plate 2. The back plate 2 is made of a ferro-magnetic material magnetized as a permanent magnet to permit the device to function properly.

Numerals 9 and 10 denote conductor wires connected to terminals 11 and 12 and then to opposite ends of the moving coil 8. These conductor wires 9 and 10 are connected to a circuit which includes a voltmeter 13, a phase shifting network 14, an attenuator 15 and an oscillator 16.

In operation, the diaphragm 1 is set in motion by sound of any given frequency, generating an alternating voltage across the resistor 5. This output voltage of the condenser microphone is passed through an amplifier 17 and read on an output meter 18.

It is possible to induce a compensating force by energizing the moving coil from the oscillator 16 on the same frequency, utilizing the attenuator 15 and the phase-shifting network 14. By appropriate adjustment of these two controls, it becomes possible to compensate the output voltage of the condenser microphone to a minimum value, observed on the meter 17.

In practice, it may be desired to use the oscillator 16 to drive the electro-acoustic transducer generating the sound field in the cavity to be measured. In a typical instance, this transducer will be a telephone receiver, whose response is to be measured when acoustically terminated in a cavity with rigid walls.

As a result of this operation and under these conditions, the diaphragm motion is controlled and rendered extremely small. The result of thus controlling the diaphragm motion is to produce a correspondingly high mechanical impedance. The microphone can be calibrated in terms of the voltage applied to the voice coil and read by the voltmeter 13, or by other convenient means at balance by applying known sound pressures of varying frequencies to the diaphragm and compensating as described above.

There is thus obtained an increase in diaphragm impedance which is not limited by sensitivity and reliability which enables a small microphone to approach a condition where it may measure pressure in the cavity with an infinite diaphragm impedance such as would exist at the point of insertion of the microphone if it were not present. The moving coil and its association with the diaphragm may be readily carried out and provides a simple, convenient and efficient controlling means for modifying diaphragm impedance when connected to the control circuits described.

In addition, an electro-acoustic transducer with very high mechanical diaphragm impedance may also be superior to conventional condenser microphones for measurements of sound pressure in open air. In determining what is known to the art as the free field calibration of the microphone, the obstacle effect caused by the finite size of the microphone must be known. Although no definite data are available to the art as yet, it is highly probable that said obstacle effect is a function of the diaphragm impedance. Theory as developed to date gives expressions for this obstacle effect only for rigid obstacles.

In many cases, facilities for determining experimentally the free field correction, which includes the obstacle effect, are not available and calculations have to be resorted to. These calculations are expected to be in better agreement with reality for transducers with very high diaphragm impedance of the type described here as compared with conventional instruments.

While I have shown a preferred embodiment of my invention, it should be understood that various changes and modifications may be resorted to, in keeping with the spirit of the invention as defined by the appended claims.

Having thus described my invention, what I claim is:

1. An electro-acoustic transducer comprising a condenser microphone having a back plate, a diaphragm arranged in spaced relation to said back plate, said back plate magnetized as a permanent magnet and being formed with damping slots, a moving coil member affixed to the diaphragm and received in the said damping slots, electrical control means connected to the coil, said control means including a voltmeter, a phase-shifting network, an attenuator and an oscillator, a battery member connected to the back plate through a high resistor adapted to apply a constant D. C. bias voltage, a vacuum tube connected to the high side of the resistor, an amplifier for amplifying signals passed through the vacuum tube, and a meter for indicating the output from the amplifier, said phase-shifting network and oscillator being adapted to compensate the voltage of the condenser microphone and provide a high mechanical impedance.

2. In an electro-acoustic transducer, the combination comprising a casing, a back plate, a diaphragm rigidly secured to said casing and arranged in spaced relation to said back plate, said back plate magnetized as a permanent magnet and formed with annular damping slots, a moving coil member secured to said diaphragm and arranged to move in and out of one of said annular slots.

3. In an electro-acoustic transducer, the combination comprising a casing, a back plate, a diaphragm rigidly secured to said casing and arranged in spaced relation to said back plate, said back plate magnetized as a permanent magnet and formed with annular damping slots, a moving coil member secured to said diaphragm and arranged to move within one of said annular slots, and means for electrically inducing movement of said coil to provide a high mechanical impedance.

4. In an electro-acoustic transducer, the combination comprising a casing, a back plate, a diaphragm rigidly secured to said casing and arranged in spaced relation to said back plate, said back plate magnetized as a permanent magnet and formed with annular damping slots, a moving coil member secured to said diaphragm and arranged to move within one of said annular slots, and electrical control means including an oscillator and a phase shifting network connected to said coil for providing a high mechanical impedance.

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