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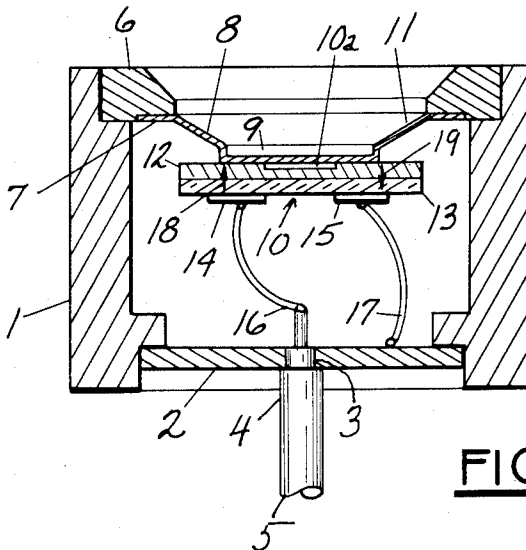


FIG. 1

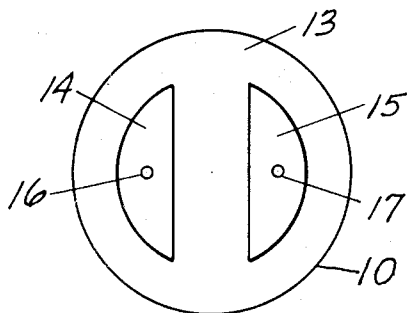


FIG. 2

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This invention is a microphone for outdoor applications requiring waterproof or splashproof protection. This protection is obtained by a thin diaphragm which is cemented at its center directly to a piezoelectric bender element to transfer a maximum of sonic energy.

In the accompanying drawing, FIG. 1 is a section through a microphone and FIG. 2 is a plan view of the piezoelectric element.

The housing 1 of the microphone has its back closed by a metal ground plate 2 electrically connected at 3 to the ground sheath 4 of a cable 5. The front end of the housing is closed by a metal ring 6 having its inner surface 7 cemented to the rim of a thin diaphragm 8. The diaphragm 8 is dished inward from the rim and at the center of the diaphragm is a depressed circular section 9 the underside of which is cemented to the center of the piezoelectric bender element 10. The section 9 provides a sharply defined area over which the diaphragm is cemented to the piezoelectric element. The element is tuned before attachment of the diaphragm by milling a recess 10a beneath the section 9. The element may also be tuned by reducing the total thickness or reducing the diameter. Between the section 9 of the diaphragm 8 and the rim 7 of the diaphragm, there is an unsupported annular section 11 of the diaphragm preferably having a radial width equal to or less than one-half the wave length of the operating frequency to which the piezoelectric element is tuned.

Sonic energy impinging on the diaphragm is transmitted through the center section 9 to the bender type piezoelectric element 10. The diaphragm is so thin and flexible as compared to the piezoelectric element 10 that it is effectively decoupled from the piezoelectric element and does not enter into the resonant response. When the frequency of the sound energy falls within the band of frequencies to which the piezoelectric element is tuned, the piezoelectric element is excited to resonant vibration which, in this case, consists of bending about the center section. That is, the outer edges or rim of the piezoelectric element 10 move up and down relative to the center section which remains relatively stationary.

There are a number of designs of piezoelectric elements which function as benders in the manner of the piezoelectric element 10. The bender type element may be made with a metal plate and piezoelectric element or with two piezoelectric elements. The shape may be round, elliptical or rectangular. Electrodes may be on one side, as illustrated, or both sides if necessary for frequency and capacitance requirements. The particular piezoelectric element illustrated comprises a rigid metallic disc 12 having its upper sides cemented to the center section 9 of the diaphragm and having its lower side cemented to a disc 13 of polarized piezoelectric ceramic. On the underside of the ceramic disc 13 are spaced electrodes 14 and 15. The electrode 14 is connected to the center conductor 16 of the cable and the electrode 15 is connected to the ground shield 2 of the microphone. At the electrode 14 the ceramic is polarized in the direction of arrow 18 while at the electrode 15 the ceramic is polarized in the direction of arrow 19. Upon bending of the piezoelectric element

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10 about its center, the voltage produced between the electrode 14 and the metal disc 10 is in the opposite direction to the voltage produced between the electrode 15 and the metal disc 10. These voltages are connected in series by the conductor 16 and 17 so that the output equals the sum of the two voltages appearing at the electrodes 14 and 15.

What is claimed as new is:

1. A microphone comprising a housing closed at one end by a flexible diaphragm and at the other end by a ground plate, said diaphragm having a rim fixed to the housing and an annular section inclined inwardly from the rim and a depressed circular center section, a bender type piezoelectric element within the housing and having its central part fixed at one side to said center section of the diaphragm with the balance of the element unsupported and projecting radially outside and overhanging the center section, said diaphragm being so flexible as compared to the piezoelectric element that it is effectively de-coupled and does not enter into the resonant response of the piezoelectric element, two electrodes on the piezoelectric element, and a two conductor cable having one conductor connected to each electrode, and one of the cable conductors being connected to said ground plate.

2. A microphone comprising a housing closed at one end by a flexible diaphragm and at the other end by a ground plate, said diaphragm having a rim fixed to the housing and a center section dished inwardly from the rim, a bender type piezoelectric element within the housing and having its central part fixed at one side to said center section of the diaphragm with the balance of the element unsupported and projecting radially outside and overhanging the center section, said diaphragm being so flexible as compared to the piezoelectric element that it is effectively de-coupled and does not enter into the resonant response of the piezoelectric element, the radial distance between the center section and the rim of the diaphragm being less than half the wave length of the operating frequency to which the piezoelectric element is tuned, two electrodes on the piezoelectric element, and a two conductor cable having one conductor connected to each electrode, and one of the cable conductors being connected to said ground plate.

3. A microphone comprising a housing closed at one end by a flexible diaphragm and at the other end by a ground plate, said diaphragm having a rim fixed to the housing and a center section dished inwardly from the rim, a bender type piezoelectric device within the housing comprising a metal plate having one side fixed to one surface of a piezoelectric element which expands and contracts in a direction along said surface, a depression in the center of the opposite side of the plate adapted to be cut away to tune the resonant frequency of the device, the depression being presented to the diaphragm and the portion of the plate around said depression being fixed to said center section of the diaphragm, two electrodes on the piezoelectric element, and a two conductor cable having one conductor connected to each electrode, and one of the cable conductors being connected to said ground plate.

4. A microphone comprising a support, a bender type piezoelectric device comprising a metal plate having one side fixed to one surface of the piezoelectric element which expands and contracts in a direction along said surface, a depression in the center of the opposite side of the plate adapted to be cut away to tune the resonant frequency of the device, a flexible diaphragm, said diaphragm

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having a rim fixed to the support and a center section dished inwardly from the rim fixed to the portion of the plate around said depression, and two electrodes on the piezoelectric element.

5. A microphone comprising a support, a bender type piezoelectric device comprising two discs fixed together, one of the discs expanding and contracting radially, the other disc having a central despression remote from the first disc and adapted to be cut away to tune the resonant frequency of the device, a flexible diaphragm, said diaphragm having a rim fixed to the support and a center section dished inwardly from the rim, and fixed to the portion of the other disc around said depression, and two electrodes on the piezoelectric device.

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