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(54) Contact microphone for cymbals and the like.

(57) The microphone comprises one or more strips (30) of a piezoelectric sheet material secured to the surface of the cymbal (10), each strip having metallised electrodes on its opposed surfaces. The strips are disposed radially of the cymbal. The preferred material is polyvinylidene fluoride in polarized form, the axis of the main uniaxial mode of the material being transverse to the longitudinal axes of the strips.

In an alternative embodiment (Fig. 1), a single radial strip (16) is used in combination with a circumferential strip (18).

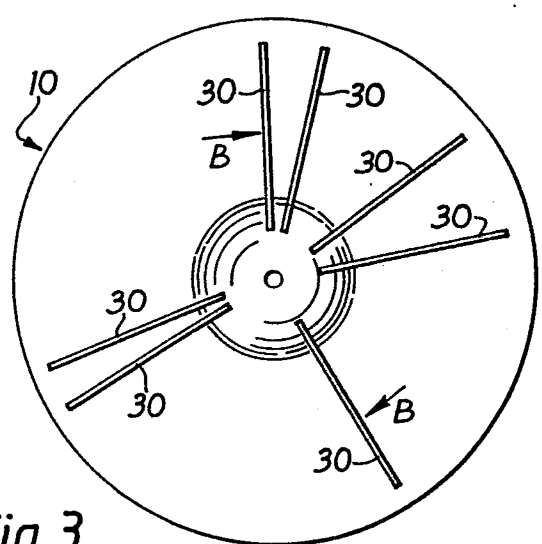

Fig. 3

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"Contact microphone for cymbals and the like"

This invnetion relates to contact microphones for use with cymbals, gongs, and similar resonant percussion instruments, all of which will be referred to hereinafter for convenience as "cymbals".

A cymbal when struck undergoes a complex resonance in a variety of modes. However, some of these modes do not propagate efficiently in air; this applies especially to certain low frequencies. The result is that the sound perceived by a listener more than a few centimetres from the cymbal contains vibrations corresponding to only some of the vibrations in the cymbal.

Hence, there have hitherto been no contact microphones which provide acceptable amplification or recording of the sound of a cymbal, since the electric signal produced has been very different from the sound perceived by a listener. Non-contact microphones have been equally unacceptable since they cannot be used without interference from other instruments in an ensemble or from ambient noise.

One object of the present invention is to provide a novel contact microphone arrangement capable of effective use with cymbals.

Accordingly, the present invention provides a contact microphone for use with a cymbal (as hereinbefore defined), comprising at least one strip of piezoelectric polymeric sheet material secured to the cymbal surface and having its longitudinal axis aligned radially of the cymbal.

Other features and advantages of the invention will be apparent from the following description of embodiments of the invention, given by way of example only, and referring to the accompanying drawings, in which:

Fig. 1 is a perspective view of a cymbal having secured thereto a microphone forming a first embodiment of the present invention;

Fig. 2 is a plan view to an enlarged scale of the embodiment of Fig. 1;

Fig. 3 is an underneath plan view of a cymbal having secured thereto a microphone arrangement forming a second embodiment of the present invention; and

Figs. 4 and 5 are underneath plan views illustrating further embodiments of the invention.

Referring to Figs. 1 and 2, a cymbal 10, as is usual, has a dished, part-spherical central portion 12 and a surrounding skirt portion 14 of shallow conical form. The microphone of this embodiment comprises a first strip 16 and a second strip 18 of a polymeric piezoelectric material, suitably polyvinylidene fluoride (PVDF); preferred forms of this material will be discussed in detail below. The strips 16 and 18 are provided on their major surfaces with metallised electrodes, and they are secured to the surface of the cymbal 10 by any suitable means, such as adhesive or pressure sensitive tape.

In this embodiment, the first strip 16 is arranged radially on the central portion and gives an electrical output substantially corresponding to vibrations in the central portion 12 when the cymbal 10 is struck. The second strip 18 is arranged circumferentially on the skirt portion 14 and is of a predetermined length. When the cymbal is struck, one mode of vibration induced is a low frequency wave travelling circumferentially in the skirt portion 14. This wave gives rise to very little perceived sound, but would form a major input to a conventional contact microphone. According to a preferred feature of the invention, the second strip 18 has a length equal to one wavelength of this mode, or to a whole number of wavelengths. The wavelength in question can readily be determined by examination for a given cymbal. The result is that equal and opposite voltages are induced at this frequency in the PVDF material, giving a net output of nil, but permitting higher frequencies to be reproduced.

The transducers formed by the strips 16 and 18 can be connected in series or (preferably, as shown in Fig. 2) in parallel to give a composite electrical output which when amplified and reproduced will be aurally close to the perceived sound of the cymbal to a listener.

As shown in greater detail in Fig.2, connecting wires 20, 22 are attached, e.g. by soldering, to the electrodes on the opposed faces of the strips 16, 18. The electrodes may be formed by any suitable means such as printing with silver ink or vapour deposition of a metal such as silver or aluminium, such techniques being well known per se. The strips 16, 18 may conveniently be formed by cutting from pre-metallised sheets.

Preferably, the strips 16 and 18 are formed from a polarized polymeric piezoelectric material such as polarized PVDF. In the embodiment of Figs. 1 and 2, it is preferred that the main uniaxial mode (D_{31} mode) of the polarized material is aligned axially of the strip, as indicated by the arrows A, for maximum sensitivity.

A preferred material is prepared as follows. A base film is prepared from vinylidene fluoride homopolymer, film grade resin (KYNAR (trade mark) 9816-30 from Pennwalt Corporation) by melt extrusion. The base film is uniaxially stretch oriented at a stretch ratio ranging between about 4 and 5 to 1 to produce a film having a thickness of about 28μ. This thickness is not critical but is preferred for the present use.

The film is then electrically polarized (poled) in known manner by subjecting the film to a pressure of about 300 psi, a temperature of about 65°C, and voltage of 15-18 kV. The temperature is held at 65°C for 10 minutes and the film is then permitted to cool at a rate of about 2°C|min over a period of 18-20 min. At the end of this cooling period, the voltage is decreased to zero and the film is removed and stabilised under a pressure of about 350-400 psi and temperature of 40-60°C. The film is then metallised as described above.

The same material may be used in the other embodiments of the invention which will now be described.

Referring to Fig. 3, the microphone of this embodiment comprises a plurality of strips 30 each arranged radially of the cymbal, but in this embodiemnt having the principal uniaxial mode of the material transverse to the longitudinal axis of the strip as indicated by the arrows B. The strips 30 are positioned at irregular intervals around the circumference of the cymbal 10; in the example shown, there are seven strips 30 at angular spacings of 15°, 40°, 25°,70°, 90°, 10° and 110°. The preferred number of strips is in the range 6 to 12.

It is believed that the fidelity achieved by this embodiment is brought about for the following reasons. When the cymbal is struck, its surface vibration which is rapdly attenuated or is cancelled in air. Moreover, the surface information at any given point on the cymbal surface is essentially single phase, whereas the listener speaced from the cymbal hears a randomised mixture of phase for each characteristic frequency of the cymbal, the phase information being further randomised for the listener by Doppler effects produced by the cymbal oscillating on its support after striking. The irregular, quasi-random distribution of the strips 30 around the cymbal in this embodiment is believed to produce a similar randomising of phase information in the composite electrical output, the strips 30 to achieve this being conencted in parallel.

The strips 30 are suitably of metallised PVDF of the type detailed above. A presently preferred width for the strips 30 is about 3.5 mm; a greater width would produce a larger output but it has been found that wider strips tend to give a signal with too much bass. The strips are preferably as long as is practical. It is in any event preferred that in the case of a crash cymbal, where the skirt consists of a relatively thick tapered inner portion surrounded by a relatively thin annular rim, the strips should extend as far as the transition between the two parts of the skirt.

In certain cases, especially with small cymbals, it is possible to use a single radial strip without a circumferential strip. This is illustrated in Fig. 4, wherein a cymbal 10 is provided with such a strip at 16'. In a small cymbal, the influence of the circumferential travelling wave is small and the radial disposition of the strip 16' minimises pick-up from it.

Fig. 5 illustrates an embodiment similar to those of

Figs. 1 and 2 and Fig. 4, in that a single PVDF film transducer 50 is used, this being of L-shape to provide a radial portion 52 and a circumferential portion 54.

The materials used in the embodiments of Figs. 4 and 5 are suitably the same as in the previous embodiments. The electrical signals produced by the embodiments of Figs. 4 and 5 and similar embodiments may not be truly representative of the sound of the actual cymbal on which the microphone is mounted, but they would reproduce as cymbal-like sounds.

The microphone may in principle be mounteed either on the upper surface of the cymbal, as in Figs. 1 and 2, or on the lower surface, as in Figs. 3 - 5. In practice, however, it would be preferred to mount it on the lower surface where it cannot be struck by the striking implement.

CLAIMS

1. A contact microphone for use with a cymbal (as hereinbefore defined), characterised in that it comprises at least one elongate strip (16; 16'; 30; 50)of piezoelectric sheet material secured to the surface of the cymbal (10), the longitudinal axis of the strip being aligned radially of the cymbal, said strip being provided on its major surfaces with electrodes for providing an electrical output.

2. The microphone of claim 1, further comprising a second elongate strip (18) of piezoelectric sheet material provided on its major surfaces with electrodes, said second strip being secured to the outer portion (14) of the cymbal (10) with its longitudinal axis aligned circunferentially of the cymbal.

3. The microphone of claim 2, in which the second strip (18) is of a length approximating a whole number of wavelengths of vibration propagating circumferentially in said outer portion (14).

4. The microphone of claim 2 or claim 3, in which the piezoelectric sheet material is a polarized polymeric material, the material of each strip (16, 18) being oriented such that the principal uniaxial mode of the material is transverse to said axes.

5. The microphone of claim 1, further comprising at least one additional elongate strip of piezoelectric sheet material (30) provided on its major faces with electrodes and secured to the surface of the cymbal with its longitudinal axis aligned radially of the cymbal.

6. The microphone of claim 5, in which there are a number of said strips (30) disposed around the cymbal surface at irregular angular spacings.

7. The microphone of claim 6, in which said number is in the range six to twelve.

8. The microphone of any of claims 5 to 7, in which the piezoelectric sheet material is a polarized polymeric material, the material of each strip (30) being oriented such that the principal uniaxial mode of the material is aligned with said axes.

9. The microphone of claim 4 or claim 8, in which said material is polarized polyvinylidene fluoride, and each strip is about 3.5 mm wide.

10. The microphone of claim 1, in which said strip (50) is provided at its outer end with a circumferentially-extending portion (54) to form an L-shaped transducer.

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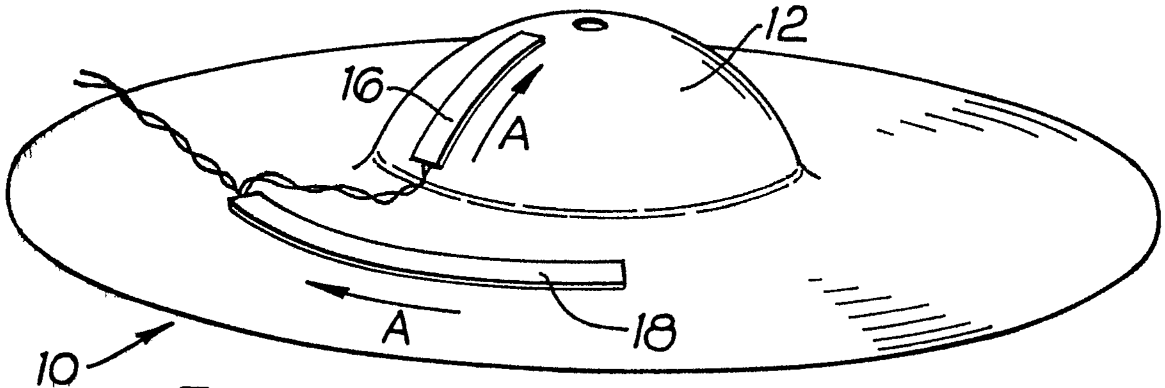

Fig.1

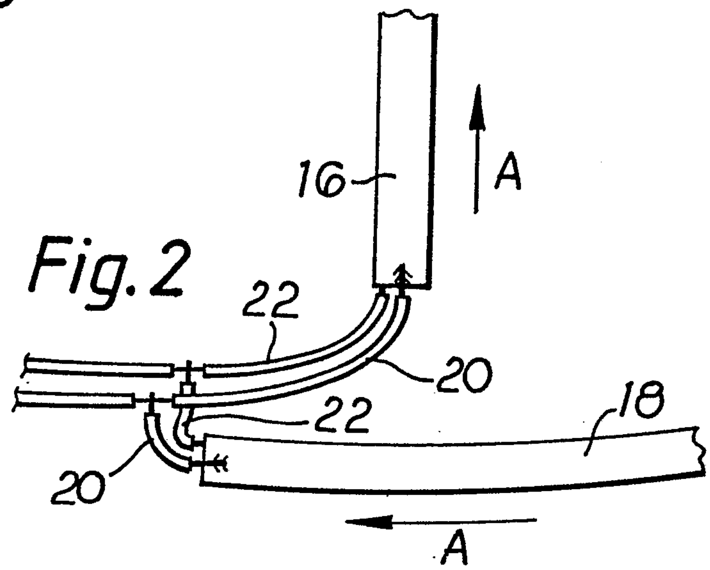

Fig. 2

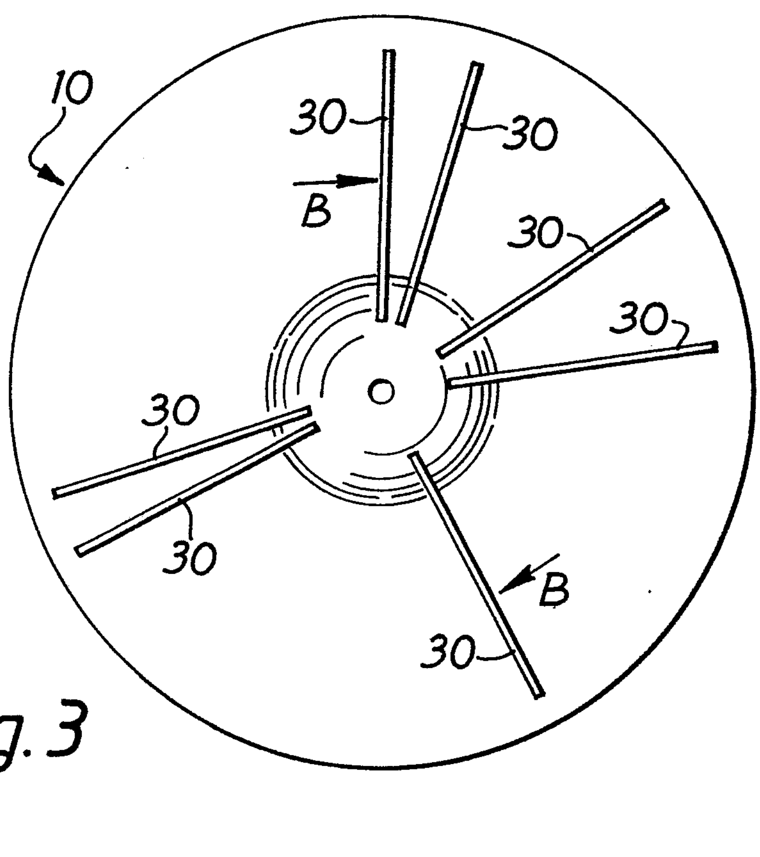

Fig. 3

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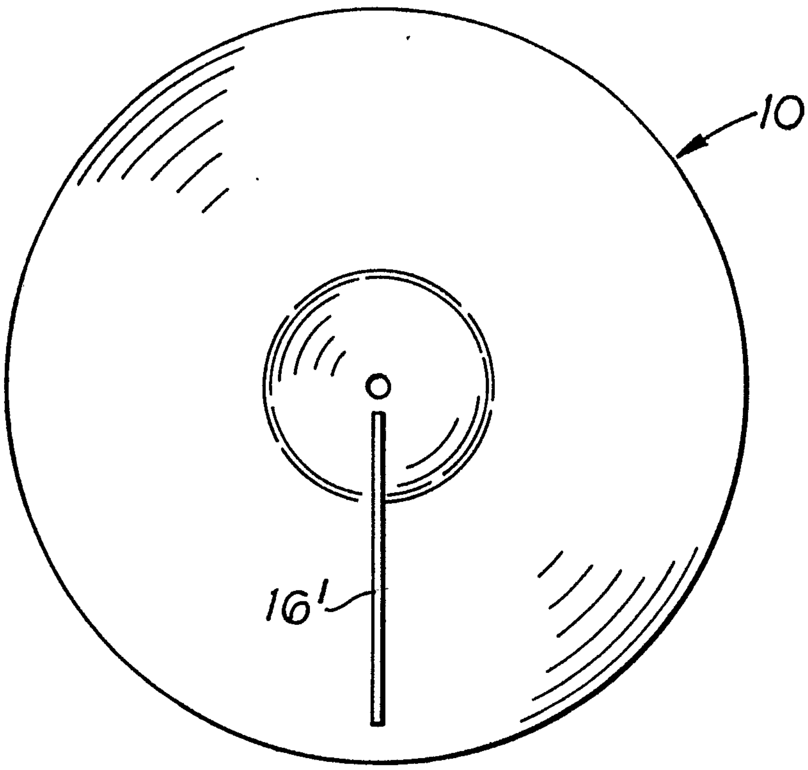

Fig. 4

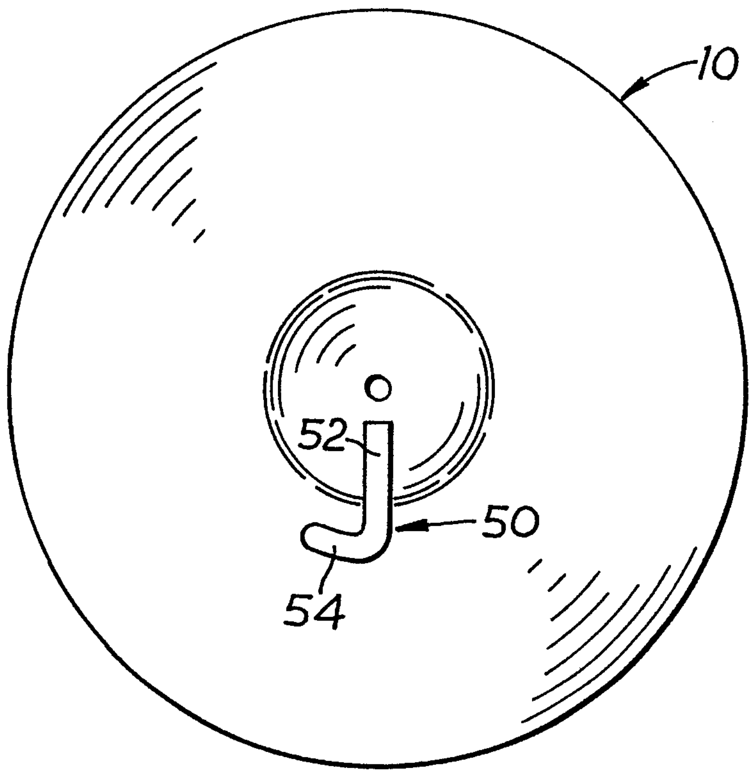

Fig. 5