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[54] **REED MOUTHPIECE FOR MUSICAL INSTRUMENT WITH PIEZOELECTRIC TRANSDUCER**
9 Claims, 4 Drawing Figs.

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[51] Int. Cl. **G10d 9/02,**
G10h 3/00

[50] Field of Search **84/1.04,**
1.14, 1.15, 1.16, 1.01, (P)

ABSTRACT: A mount for the reed of a musical instrument, in the form of a mouthpiece for instruments such as the clarinet, the mount including a transducer which utilizes piezoelectric material positioned for engagement by the reed to produce electrical signals in response to vibratile movements of the reed.

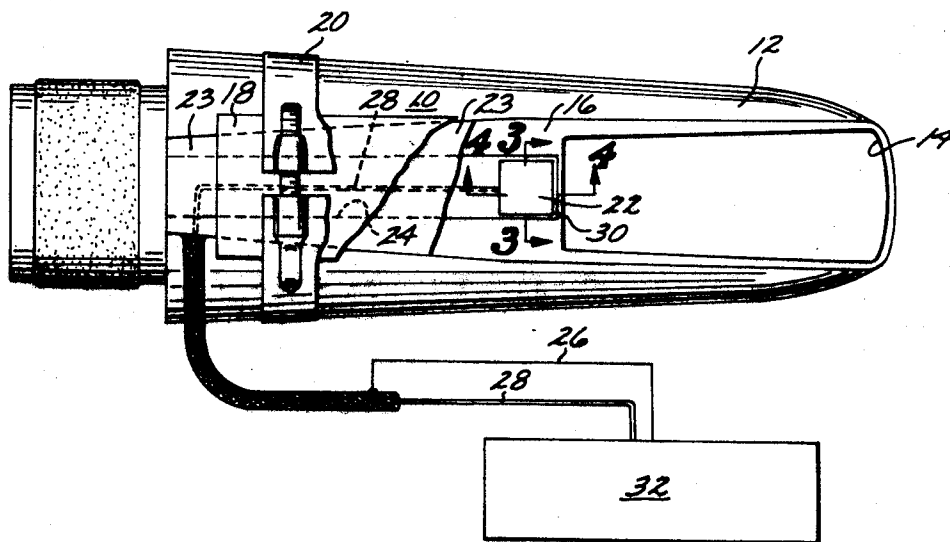


FIG. 1

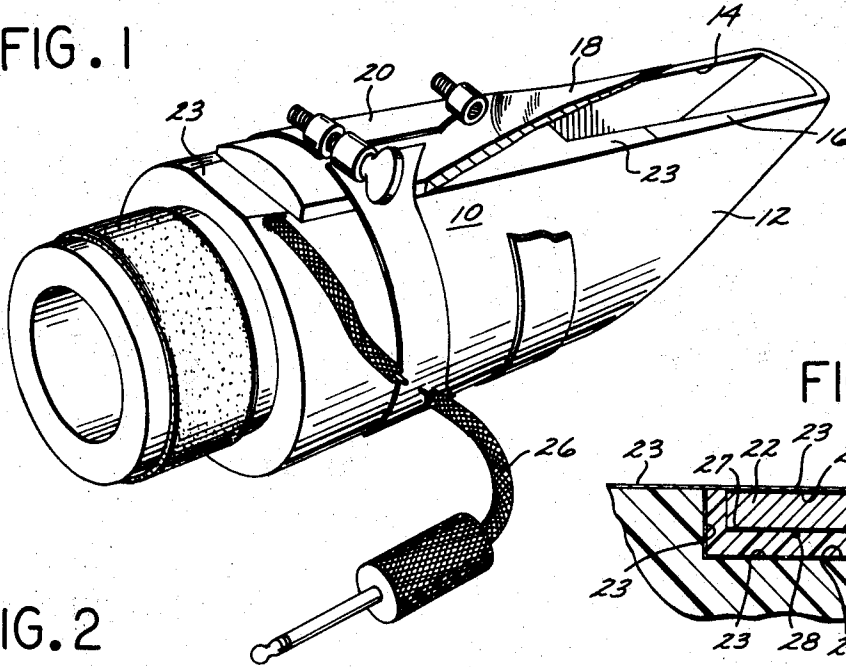


FIG. 2

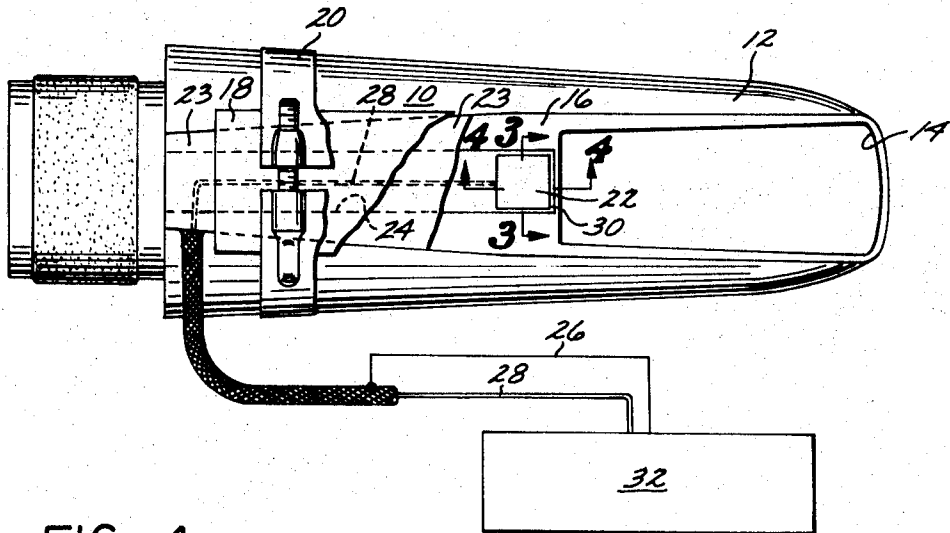


FIG. 4

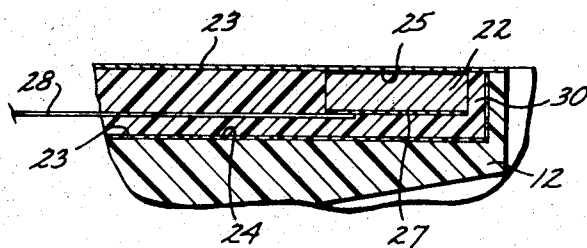
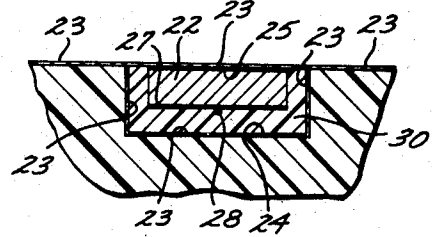


FIG. 3



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REED MOUTHPIECE FOR MUSICAL INSTRUMENT WITH PIEZOELECTRIC TRANSDUCER

Cross References to Related Applications

The present invention is generally related to the subject matter of our copending U.S. Pat. application Ser. No. 716,441, filed Mar. 27, 1968, now U.S. Pat. No. 3,543,629 and entitled MOUTHPIECE FOR MUSICAL INSTRUMENT, and our U.S. Pat. application Ser. No. 717,562, filed Apr. 1, 1968, now abandoned, and entitled TRANSDUCING METHOD AND APPARATUS. The inventions described in these patent applications utilize transducers employing electromechanically sensitive material such as piezoelectric material which is responsive in a particular manner to provide electrical signals corresponding to the character of vibration waves causing deformation of the material.

The mount of the present invention is broadly analogous but utilizes electromechanically sensitive material so constituted and arranged as to be peculiarly adapted for use with musical instruments employing reeds. The piezoelectric material of the present mount is essentially unresponsive to vibrations of the mount itself, but is responsive primarily to vibratile movements of the reed.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to mounts for the reeds of musical instruments and particularly to a mount incorporating a transducer for providing electrical signals corresponding to vibratile movements of an associated reed.

2. Description of Prior Art

The achievement of high-fidelity reproduction or amplification of the sound of musical instruments of the reed family has long been sought in the prior art. Various techniques and designs have been attempted, but with limited success. Previously proposed systems are incapable of isolating the "pure" sound of a clarinet, for example, from accompanying unwanted noises such as valve pad sounds, sounds caused by brushing of exterior objects or materials against the instrument, and the like. Often there was also an unwanted emphasis of certain frequencies because of the location of the microphone or other pickup device, and the placement of a microphone anywhere in the air passages of the instrument undesirably affected the tonal qualities of the instrument.

SUMMARY OF THE INVENTION

The present invention is a mount which incorporates a transducer utilizing electromechanically sensitive material, such as piezoelectric material, of a type and in an arrangement such that the material is essentially unresponsive to vibration of the mount, but is engageable by a reed and is responsive essentially only to vibratile movements of the reed.

In a clarinet, for example, the mount would be in the general form of the usual mouthpiece and, since the piezoelectric material is so constituted and mounted that it is essentially unresponsive to vibrations of the mouthpiece, the unwanted valve vibrations, pad noises, and the like, which travel to the mouthpiece are isolated. In addition, for all practical purposes any of the sounds which may emanate from sources located externally of the instrument are isolated from the sensitive piezoelectric material. Thus, the present mount mouthpiece is generally discriminative in its sensitivity to musical versus nonmusical sounds.

Other objects and features of the invention will become apparent from consideration of the following description taken in connection with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a mount according to the present invention and taking the form of a mouthpiece adapted for use with a reed instrument such as a clarinet;

FIG. 2 is a top plan view of the mouthpiece of FIG. 1, diagrammatically illustrating the connection of the piezoelectric material or element to a suitable sound recording or amplification system;

FIG. 3 is an enlarged view taken along the line 3-3 of FIG. 2; and

FIG. 4 is an enlarged view taken along the line 4-4 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is illustrated a mount which, but for its modification to incorporate certain structure according to the present invention, is identical to and takes the general form of a conventional mouthpiece 10 like those presently available for use with instruments of the reed family. This is intended to include, without limitation, a clarinet, a saxophone, an oboe, a bassoon, and some organ pipes. Although the invention is envisioned as having its primary application to the mouthpiece of these musical instruments, it will be apparent that it is equally applicable to any mount for a musical instrument reed which vibrates to excite the air column of the instrument. As is well known, such excitation causes the air column to resonate or vibrate at a constant rate, as determined by its length, and react upon the exciter reed to maintain such constant rate. Such a reed-mount in certain applications simply takes the form of a support having a surface to receive the reed, with the support cantilevering one extremity of the reed across a passage through which a stream of air is directed to vibrate the reed.

The term "reed" is intended to include any vibratile body disposed across such an air passage to induce vibration, such as a thin, elastic tongue of cane, wood, metal, or the like.

The mouthpiece 10 includes a hollow, substantially cylindrical body 12 having a generally circular inner extremity adapted to complementally fit upon the body (not shown) of a musical instrument such as a clarinet. Details respecting the interconnection between the mouthpiece 10 and such an instrument body are well known, and are therefore omitted from this description for brevity. The opposite or outer extremity of the body 12 is tapered to comfortably fit within the mouth of the player and includes a generally rectangular opening 14 in the upper portion thereof. The opening 14 is in communication with the central air passage of the mouthpiece 10 through which air expelled by the player is carried to the body of the musical instrument.

The upper portion of the mouthpiece 10 includes an elongated, generally rectangular surface or lay 16 extending from the inner extremity of the body 12 to the inward margin of the opening 14. Through this area the lay 16 is substantially flat or planar to complementally receive the inner extremity of an elongated, rectangular and generally flat or planar reed 18. The opposite extremity of the reed 18 projects outwardly in cantilever fashion across the opening 14 for the mouthpiece air passage, generally coextensive with the upper portion of the tapered outward extremity of the mouthpiece body 12. As is well known, such outward extremity is not exactly flat in this area, but diverges from the adjacent reed extremity to permit vibration of the reed by air passing opening 14 across the reed 18. The reed 18 is held in position and urged against the lay 16 by any suitable means, such as a clamp or ligature 20.

As thus far described, the mouthpiece 10 and reed 18 are no different from a conventional clarinet mouthpiece and reed against which the player presses his lips to develop vibrations of the reed and consequent condensations and rarefactions of the air column defined by the body of the musical instrument.

According to the present invention, sensing and amplifying the vibratile movements of the reed 18 provides a surprisingly high-fidelity reproduction of the major portion of the tonal structure of the actual instrument. More particularly, a transducer employing electromechanically sensitive material, such as piezoelectric material 22, is located within an elongated recess, groove or channel 24 provided in the lay 16. The lon-

gitudinally oriented channel 24 is simply a depression or cavity to receive the material 22, but for ease of manufacture it is made to extend outwardly from the inward edge of the lay 16 to a point located about one-sixteenth of an inch inwardly of the inward margin of the opening 14.

Piezoelectric material in the form of a thin slab measuring three-sixteenths of an inch square by 0.025 to 0.030 inches thick has operated satisfactorily in conjunction with the clarinet application here described. The width and depth of the channel 24 are made such that the material 22 fits within the channel 24 in spaced relation to the sides and base of the channel. In addition, the outward edge of the material 22 is arranged in spaced relation to the portion of the mouthpiece body 12 separating the channel 24 from the opening 14. Consequently, no portion of the piezoelectric material 22 is in physical contact with the body 12 of the mouthpiece 10.

The inner walls and base surfaces of the channel 24 are coated with an electrically conductive layer 23 of material such as silver paint or the like, the layer 23 also extending out of the channel 24 and covering the surface of the lay 16.

The piezoelectric material 22 includes usual electrode surfaces 25 and 27 on its opposite faces which are electrically coupled, respectively, to electric conducting ground and signal leads 26 and 28. The particular connection to the ground lead 26 will be described in more detail below.

The channel 24 is filled with electrically nonconductive filler material such as an epoxy resin or any suitable casting resin 30. This embeds the piezoelectric material 22 with its upper surface preferably flush with the surrounding surface of the resin 30 and the lay 16, as best illustrated in FIG. 3. In addition, the layer 23 covering the lay 16 adjacent to channel 24 is also applied to the upper surface of the resin 30 so that an electrical grounding shield completely surrounds the piezoelectric material 22.

The signal lead 28 electrically connected to the electrode face 27 of the piezoelectric material 22 is extended inwardly through the channel 24 to its outer end, and is embedded in the resin 30 along with the piezoelectric material 22. The ground lead 26 is electrically coupled to the electrode surface 25 by connection to the inner extremity of the electrically conductive layer 23 which is electrically coupled to the surface 25. The ground lead 26 is arranged, in conventional fashion, as a coaxial shield surrounding the lead 28, the combined leads being connected to any suitable external electrical circuit or system 32. The nature of the system 32 is not a part of the present invention and it will therefore not be described, other than to indicate that it could be a recording system, a radio or television broadcast system, an amplification system or the like, any of which could also include formant filters or the like for modifying the character of the output signals of the material 22, as desired.

The clamping action of the ligature 20 upon the reed 18 provides firm engagement between the inward extremity of the reed 18 and the exterior face of the piezoelectric material 22 underlying the thin layer 23. It has been found that the electrically conductive layer 23 does not adversely affect the response of the material 22 to vibrations of the reed 18. The relatively thin electrically conductive metal plating or layer 23 not only provides the desired electrical continuity between the ground electrode 25 and the ground lead 26 without affecting the response of the material 22, but it also seals off the material 22 from moisture and dirt. Moreover, the layer 23 tends to smoothly fair together the adjacent surfaces of the resin 30, lay 16, and material 22 in a manner closely simulating the smooth surface or lay of the conventional clarinet mouthpiece.

The material 22 is selected for sensitivity to pressure fluctuation or waves acting generally normal to its outer face so as to thereby be essentially responsive to the generally perpendicularly or normally directed forces exerted by the vibrating reed 18. Accordingly, the material 22 is preferably a thickness expander plate or element of polycrystalline electromechanically sensitive dielectric material such as barium titanate or

lead-zirconate-titanate ceramic. Such a material produces electrical signals in response to varying pressures or mechanical vibrations applied in the thickness mode. Preferably, the material 18 is productive of such a signal directly upon its compressive deformation, although it is contemplated that piezoresistive materials could be used whose deformation in a thickness mode merely affects its electrical resistivity and consequently the character of the electrical signals applied to it by an external circuit (not shown), as will be apparent to those skilled in the art.

The theoretical operation of the present piezoelectric material 22 in the environment described is not entirely developed. Although it is believed that the material 22 effects the unusual clarity of reproduction experienced during operation of the present mouthpiece 10 primarily by reason of its responsiveness to vibrations applied by the reed in the thickness mode, it is also believed that the material 22 may be responsive to transverse waves of vibration traveling in directions generally in the plane of the reed 18. Such transverse waves may be effecting an undulating deformation of the piezoelectric material 22 by reason of the mechanical coupling of the material 22 to the reed 18 provided by the ligature 20.

It is also theorized that the location of the material 22 immediately adjacent the opening 14 effectively damps vibratile movements or vibrations of the mouthpiece 10 passing longitudinally and outwardly of the instrument body extremity of the mouthpiece. That is, the material 22 is not significantly deformed since it has no appreciable mass against which to react. It is further theorized that vibrations of the mouthpiece passing radially outwardly, through the material 22 toward the reed 18, do not significantly deform the member 22 since the mass of the reed 18 is too flexible to serve as an abutment against which the material 22 can be deformed. It is also theorized that vibrations of the mouthpiece 10 traveling toward the opposite side margins of the member 22 are essentially identical in character and therefore offset one another to an extent that there is no significant deformation of the member 22. The foregoing theories are offered to assist those skilled in the art, it being understood that applicants do not thereby intend that the scope of the present invention be limited by reference to such theories. The structures described have operated extremely satisfactorily.

Thus, it has been found that the piezoelectric material 22 tends to be responsive essentially only to the vibratile movements of the reed 18, effectively rejecting such unwanted non-musical sounds as instrument pad noises and the like. Vibration of the reed 18 presses the material 22 against the relatively unyielding abutment provided by the resin 30, thereby deforming the material 22 to provide the desired electrical output signals corresponding in character to the character of the reed vibration, so that only the desired musical sounds are converted into the signals which are applied to the circuit 32.

Mouthpieces of the type herein described are reliable in operation and economical to construct. No change in playing technique is required for their use and such mouthpieces can be effectively employed for both sound reinforcement or amplification, and for recording purposes.

Various modifications and changes may be made with regard to the foregoing detailed description without departing from the spirit of the invention or the scope of the following claims.

We claim:

1. A mouthpiece for a musical instrument, said mouthpiece comprising:
 - a vibratile reed;
 - means including an air passage, and further including a surface for engaging one extremity of said reed for projection of the opposite extremity of said reed across said air passage for development of vibratile movements of said reed by a stream of air moving past said reed;
 - transducer means having a portion in said surface for engagement by said reed, said portion being deformable to

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provide electrical output signals corresponding to the character of the deformation; and

means for urging said reed toward said surface and into engagement with said portion whereby said portion is deformable essentially only by said reed during said development of said vibratile movement of said reed.

2. A mouthpiece according to claim 1 wherein said surface is the lay of said mouthpiece.

3. A mouthpiece according to claim 1 wherein said portion includes a face mounted generally flush with said surface of said first-mentioned means.

4. A mouthpiece according to claim 1 wherein said portion of said transducer means is piezoelectric material compressible in a thickness mode in response to said vibratile movements.

5. A mouthpiece according to claim 4 wherein said surface includes a recess, said piezoelectric material is disposed in said recess in spaced relation to the edge margins and in spaced relation to the base of said recess, and including filler material disposed within the space between said piezoelectric material and said base and between said piezoelectric material and said edge margins.

6. A mouthpiece according to claim 5 wherein said filler material in said space between said piezoelectric material and said base is relatively unyieldable to afford an abutment against which said piezoelectric material is compressible by said vibratile movements.

7. A mouthpiece according to claim 5 wherein said piezoelectric material is relatively thick and thereby relatively unbending and unresponsive to any bending of said surface of said first-mentioned means.

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8. A mouthpiece for a musical instrument, said mouthpiece comprising:

a vibratile reed;

a body adapted for attachment to a musical instrument and including an air passage, a recess defined by walls and a base, and further including a surface for engaging one extremity of said reed for projection of the opposite extremity of said reed across said air passage for development of vibratile movements of said reed by a stream of air moving past said reed;

piezoelectric material located in said recess in spaced relation to said walls and said base and having a face substantially flush with said surface of said body for subjection of said face to deformations by said reed during said vibratile movements, said material being deformable to provide electrical output signals corresponding to the character of said deformations, said material being relatively highly deformable in compression compared to bending whereby said material provides said signals responsive primarily only to said deformations;

filler material disposed in the space between said piezoelectric material and said walls and said base of said recess; and

a ligature for clamping said reed against said surface of said body.

9. A mouthpiece according to claim 8 and including electrical leads connected to said piezoelectric material and terminating externally of said body for connection to an external electrical circuit for utilization of said electrical output signals.

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