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XR 3,453,920 35W

July 8, 1969 R. C. SCHERER 3,453,920

PIEZO GUITAR BRIDGE PICKUP

Filed June 29, 1966

FIG. 1

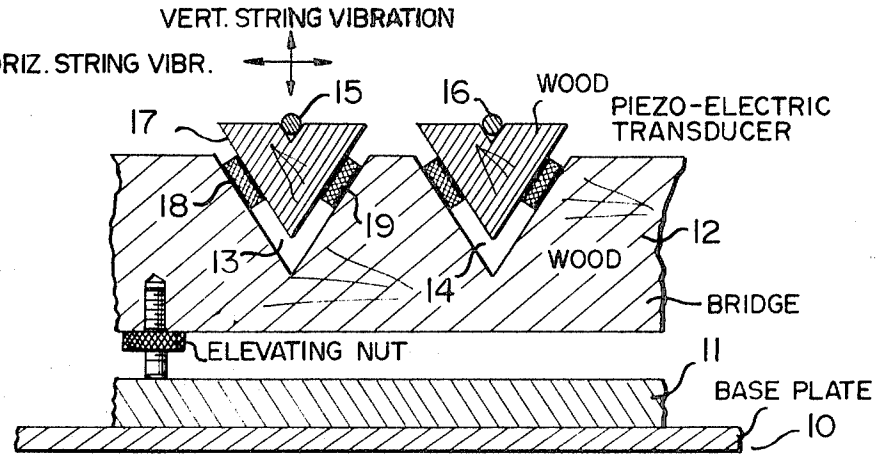


FIG. 2

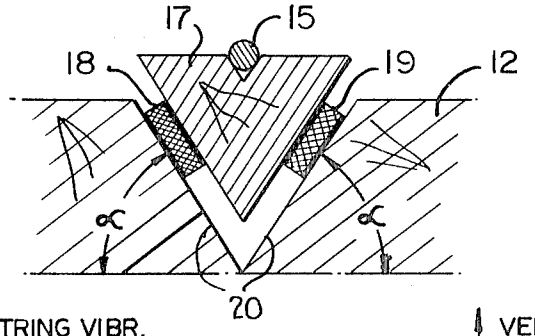


FIG. 3

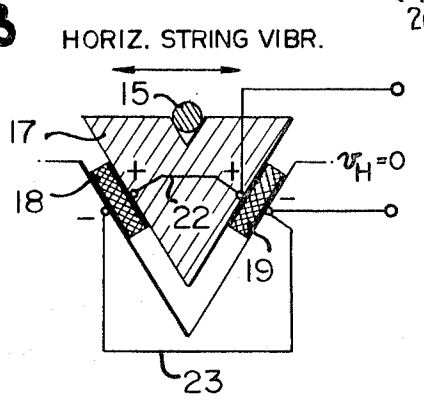


FIG. 4

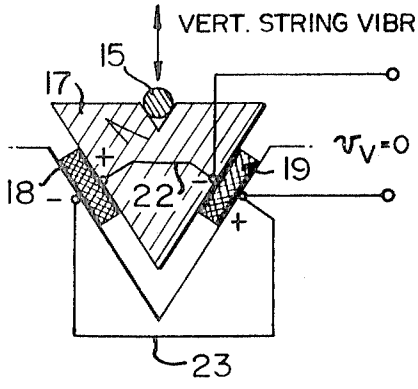
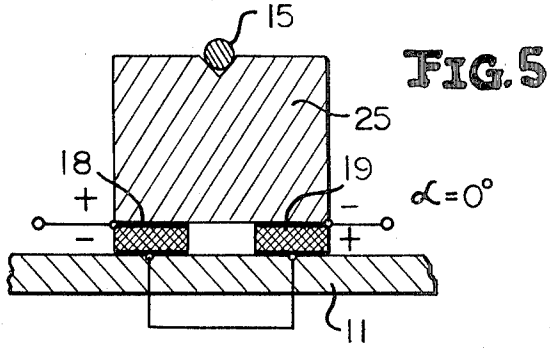


FIG. 5



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PIEZO GUITAR BRIDGE PICKUP

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ABSTRACT OF THE DISCLOSURE

An electric guitar pickup employing two piezoelectric transducers located under the support for each string and interconnected to give a zero joint piezoelectric response to vertical vibrations but normal response to horizontal vibrations.

The present invention relates generally to mechanico-electrical tranducers for stringed instruments and more particularly to piezoelectric transducers capable of providing response to vibrational components in one plane, to the exclusion of vibrational components in a plane orthogonal to the one plane.

The problem exists, in transducing the vibrations of a string, and particularly of a picked or plucked string, that while the steady state vibration of the string subsists in a preferred plane, the initial transient vibration, occurring on picking or plucking, involves a complex vibration in three dimensions. In some types of guitar playing, it is desired to accentuate the sound of the plectrum as it actuates the stirng of the guitar. I have found that this objective can be accomplished by accentuating response of string transducers to horizontal vibrations of the string. At the same time certain types of noise, and microphonics, can be eliminated from the transducer outputs if responses due to vertical string vibrations are reduced, or responses due to horizontal vibrations relatively increased. Microphonics, in guitars, are due to noise-like vibrations of the guitar body. These may occur due to handling of the body, finger movements, and the like. Such vibrations are transmitted from the body of the guitar to the transducers, primarily via the bridge of the guitar, and are largely vertical. Finger noise is noise due to movements of the fingers along the strings. Such movements appear to cause largely vertical string vibrations. Accordingly, by providing a string transducer which responds only, or primarily to horizontal string vibrations, not only do we obtain accentuation of the sounds of the plectrum in actuating the strings, but at the same time there occurs a reduction of microphonics and string noise.

It is, accordingly, a broad object of the invention to provide a novel piezoelectric mechanico-electric transducer for the string vibrations of stringed instruments, which shall be selective of one mode of vibration to the exclusion of others.

It is a more specific object of the invention to provide a mechanico-electrical transducer system employing two piezoelectric crystals mounted at an angle to each other under a vibrating element, such that vibratory modes of the vibratory element in a horizontal plane are additive while vibratory modes in the vertical plane are subtractive, or vice versa, in respect to the electrical responses of the crystals.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a view in transverse section through a bridge and transducer arranged in accordance with the invention;

FIGURE 2 is a view in transverse section of a portion of the transducer system of FIGURE 1, including one vibratory element;

FIGURE 3 is a view in transverse section, according to FIGURE 2, but showing interconnections of two piezoelectric transducer elements, which result in zero electrical response to the horizontal vibratory mode;

FIGURE 4 is a view in transverse section of a modification of the system of FIGURE 3, showing interconnections of transducer elements which result in zero response to the vertical vibratory mode; and

FIGURE 5 is a view of a modification of the system of FIGURE 3 employing a zero angle between the piezoelectric transducers.

Referring now to the accompanying drawings, in FIGURE 1, **10** represents a portion of the body of a stringed musical instrument, specifically a guitar. On the body portion **10** rests a base plate **11** for supporting the usual bridge **12**, of the instrument. The bridge **12** includes at its upper edge, V notches as **13**, **14** for each string, as **15**, **16**. Interposed between each string and notch, considering string **15** as exemplary, is an interposer of triangular cross section, **17**, conforming in shape geometrically to the notch **13**, and a pair of piezoelectric crystals **18**, **19** having the usual electrodes and responsive in the thickness mode. The crystals **18**, **19** are each laid on a different side of the notch, symmetrically thereof, and the interposer **17** rests on the crystals **18**, **19** and supports string **13** centrally of its upper surface.

The vibrations of string **15** are transmitted to the body portion **10** of the guitar, in the usual fashion except for the interposition of the transducer system.

The angle α, FIGURE 2, which exists between the horizontal plane and a side **20** of the interposer can have a wide range of values, i.e., from zero degrees to an angle approaching 90°. However, the amplitude of response of the piezoelectric crystals, for either mode of vibration, is a function of α, vertical and horizontal modes providing equal response for $\alpha=45°$.

Piezoelectric crystals possess polarity, i.e., indentical crystals provide output voltage of one sign for a positive increment of compression and of the opposite sign for a negative increment of compression, for one orientation of the crystal, which are reversed if the crystal is turned over, i.e., one plate of the crystal is positive going and the other negtaive going in response to compression.

If it is desired to suppress horizontal mode responses, as in FIGURE 3, the crystals are identically oriented, for example, with their positive faces in contact with interposer **17**, and positive electrodes are interconnected by lead **22**, and negative electrodes by lead **23**. Vertical movement of interposer **17** then generates cophasal outputs from the crystals. For horizontal vibrations of interposer **17**, the outputs of the crystals **18**, **19**, being one in compression and one in decompression, are out of phase and equal in amplitude, and therefore cancel.

In FIGURE 4, one, **19**, of the crystals **18**, **19** has its negative electrode, i.e., that electrode which responds with production of negative voltage to compressive force, adjacent to interposer **17**, while the other, **18**, has its positive electrode adjacent to interposer **17**. Thereby, the voltages generated by the crystals **18** and **19** are out of phase by 180° for compression, and the connections previously recited for the embodiment of FIGURE 3 provide zero response for vertical vibrations of interposer **17** and maximum response for horizontal vibrations. The latter is the configuration usually desired in guitar transducers.

In the limit one may use a value of $\alpha=0$, as in FIGURE 5. In such case a pair, **18**, **19**, of piezoelectric crystals, having oppositely poled electrodes rest on base **11**.

Vertical vibrations of string **15** then produces zero output, by addition of the outputs of the crystals. Horizontal vibration of string **15** produces strains in the crystal which are differential, because horizontal movement of string **15** tends to produce a torque on interposer **25**, thus releasing the strain on one crystal while increasing the strain on the remaining crystal.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variation of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A mechanico-electric transducer for a vibrating string, comprising:

a support for said string, said support permitting vibration of said string in at least two orthogonal modes,

a first piezoelectric crystal underlying said support,

a second piezoelectric crystal underlying said support, and

means connecting said piezoelectric crystals to provide substantially zero joint piezoelectric response to vibration of said string in one of said modes and a relatively large joint response to vibration of said string in the other of said modes.

2. The combination according to claim **1** wherein said support is wedge-shaped, having two surfaces terminating in a common line, said piezoelectric crystals underlying said surfaces, said string overlying said common line on said support.

3. The combination according to claim **2** wherein said surfaces make an angle of approximately 90° to each other.

4. The combination according to claim **1** wherein said piezoelectric crystals occupy a substantially common plane under said support,

said support having a flat surface contacting said piezoelectric crystals, and

wherein said string is arranged to compress said support against said piezoelectric crystals and to apply torque to said support during vibration of said string in a direction parallel to said common plane.

References Cited

UNITED STATES PATENTS

3,137,754 6/1964 Evans ..... 84—1.16

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U.S. Cl. X.R.

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