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[54] **PICK UP DEVICE FOR STRINGED INSTRUMENT**

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Related U.S. Application Data

[63] Continuation of Ser. No. 776,547, Nov. 18, 1968, abandoned.

[52] **U.S. Cl.**.....**84/1.14,** 84/1.16, 84/DIG. 24

[51] **Int. Cl.**.....**G10h 3/00**

[58] **Field of Search**.....84/1.04, 1.14–1.16, 84/DIG. 24; 310/8.2–8.6; 179/100.41

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Assistant Examiner—Stanley J. Witkowski
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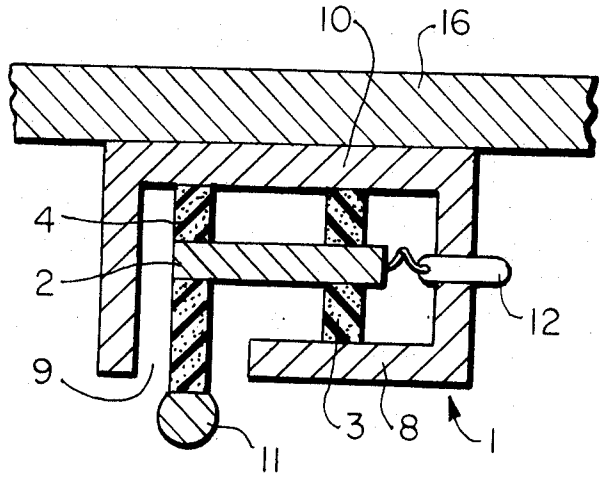
[57] **ABSTRACT**

A piezoelectric pickup for stringed musical instruments comprising a piezoelectric element, a synthetic rubber vibration transmitting material attached to one end of the element, a support for the element at the other end thereof, and a weight attached to the vibration transmitting end of the element, the pickup being mounted in the resonance box of the instrument.

5 Claims, 9 Drawing Figures



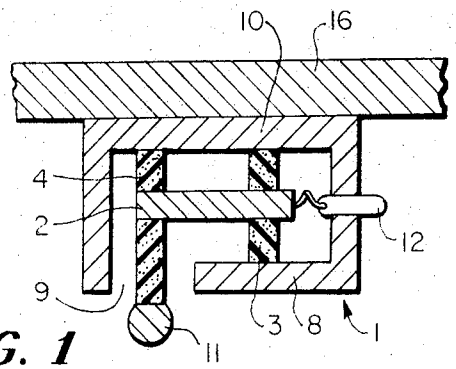


FIG. 1

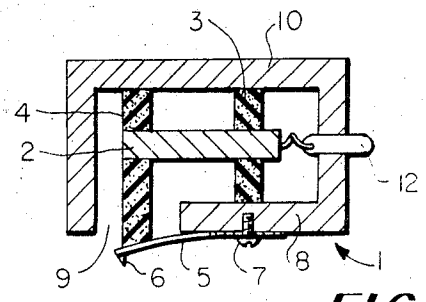


FIG. 2
PRIOR ART

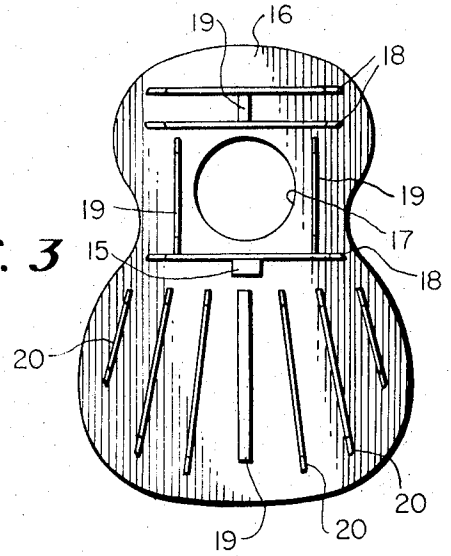


FIG. 3

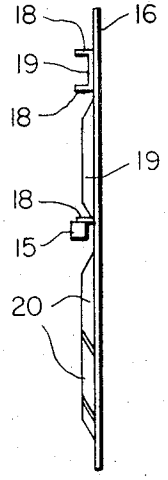


FIG. 4

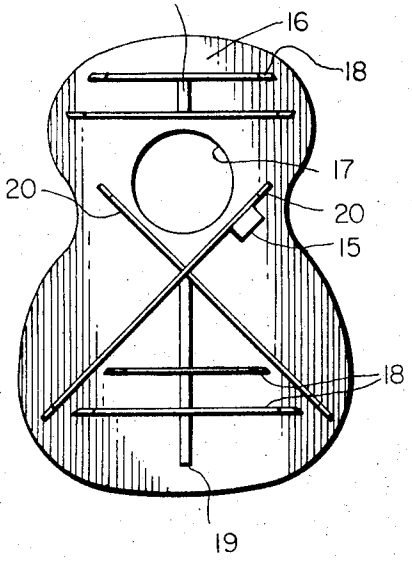


FIG. 5

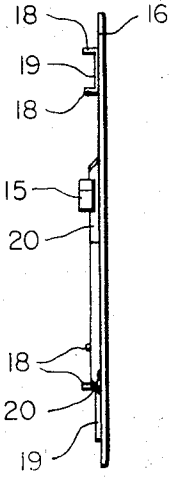


FIG. 6

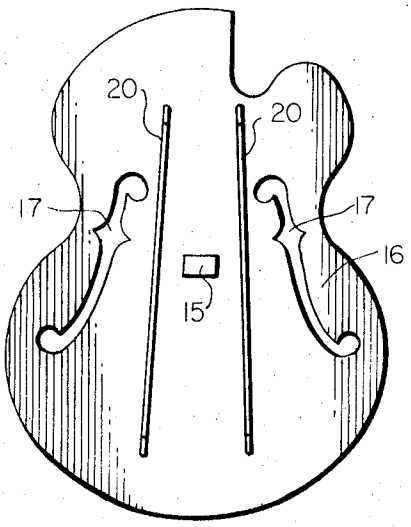


FIG. 7

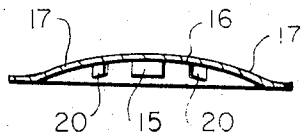


FIG. 8

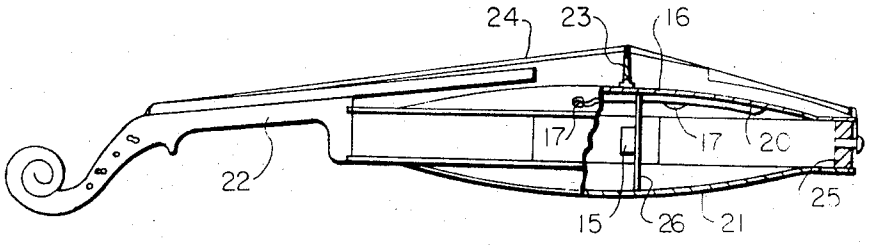


FIG. 9

PICK UP DEVICE FOR STRINGED INSTRUMENT

This is a continuation of application Ser. No. 776,547 filed on Nov. 18, 1968, now abandoned.

The present invention relates to a pickup device for a stringed instrument wherein a piezoelectric element, such as Rochelle salt, has one end secured to a support in a stringed instrument case, and the other end attached to a vibration transmitting medium made of, for example, an elastic synthetic rubber of suitable hardness. The transmitting medium has one end secured to the instrument's case, and a suitable weight attached to the free end thereof in order to transmit the desired frequency of vibrations. The assembly is bonded into the stringed instrument in a position so as to enable a sound similar to the original sound generated from the stringed instrument, or a suitably modulated sound to be selectively reproduced. The sound is generated in response to the pressure waves created by condensation and rarefaction of air in the resonance box or body, the pressure being created in response to the mechanical vibrations of the strings.

The present invention will now be described in connection with the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view of a preferred embodyment of a pickup device in accordance with the present invention;

FIG. 2 is a longitudinal sectional view of a pickup cartridge used in a conventional record player or the like;

FIGS. 3 and 4 are the top plan view and side elevational view, respectively, of the back side of a belly of a gut guitar showing a pickup device of the present invention mounted on the back side of said belly;

FIGS. 5 and 6 are the top plan view and side elevational view, respectively, of the back side of a belly of a folk guitar showing a pickup device of the present invention mounted on the back side of said belly;

FIGS. 7 and 8 are the top plan view and lateral cross sectional view, respectively, of the back side of a belly of a pick guitar showing a pickup of the present invention mounted on the back side of said belly; and

FIG. 9 is a side elevational view, partly in longitudinal section, showing a pickup of the present invention mounted on a stringed instrument having a soundpost such as violin, cello and base.

Referring now to the FIG. 1, there is shown one form of pickup in accordance with the present invention wherein numeral 1 designates a casing for protecting a piezoelectrical element such as Rochelle salt, made of plastic or metal, and 2 designates a piezoelectrical element of rectangular shape, which is supported near its base portion (right end in the drawing) in a space within the casing 1 by a support 3 of hard synthetic rubber so that it is not brought into contact with casing 1.

A vibration transmitting medium 4 having its base end secured or bonded by a binding agent to the inner surface of one side (upper side in the drawing) of the casing 1 supports a free end of the piezoelectrical element 2 to hold the same in position.

The vibration transmitting medium 4 is made of synthetic rubber of suitable hardness (elasticity), and its free end projects slightly beyond the casing 1 from one side 8 (under side in the drawing) thereof in which an opening 9 is provided.

At the end of the medium 4 projecting from the opening 9 of the casing 1 a weight 11 of proper weight (mass) is secured or bonded.

Numeral 12 in the drawing designates a lead wire connected to the piezoelectric element 2 and extending out of the casing 1. FIG. 1 shows an operating position in which the pickup of the present invention, thus assembled, is secured, e.g., by bonding, at a surface 10, on which the opening 9 is not provided, to the back side of the belly 16 of a stringed instrument.

FIG. 2 shows a structure of a pick up device with a piezoelectric element such as Rochelle salt or the like which is commonly used in a record player. Numerals 1, 2, 3, 4, 8, 9, 10 in FIG. 2 designate the similar parts to those in FIG. 1.

In such a conventional pick up, there is a needle 5 secured by a small bolt 7 on one side 8 (under side in the drawing) of the case 1 in which the opening 9 is provided. At a chip end of the needle 5 is provided a needle chip 6 adapted to be press-contacted with the track groove of a record disc.

In the conventional pickup, the chip 6 of the needle 5 is brought into press-contact with the track groove of the record disc under a proper pressure, and a vibration of the needle 5 as the record disc is rotated is conveyed to the piezoelectric element 2 which in turn produces an electric signal one response to the music recorded in the disc, which signal is passed to an electric amplifier to actuate a loudspeaker.

The instance (hereinafter referred to as B) in which chip 6 of a conventional pickup as shown in FIG. 2 is mounted in contact with the belly of a stringed instrument is now compared with the instance (hereinafter referred to as A) in which the pickup of the present invention is directly attached to the belly 16 of the instrument as shown in FIG. 1. It has been found that in instance A it is possible to produce sound corresponding to a mechanical vibration of strings as well as sound corresponding to a wave of condensation and rarefaction of air in a resonance box.

In instance B, when the strings are made of metal, metallic sound is exaggerated and the reproduced sound becomes poor, while in instance A such a metallic sound of high vibration frequency inherent in metal strings is attenuated and a sound inherent to the instrument, that is, a sound inherent to the resonance box is produced.

It is possible to explain the present invention as follows:

Sound is sensed by the human ear from a biological standpoint and it is a sound wave from an objective standpoint. The sound is sorted into treble or bass, strength, and tone. Our ears can distinguish these three elements when we listen to music. From a physical standpoint, these elements are characterized by sound waves generated from a sound source. Namely, the treble or bass sound depends upon the frequency of the sound wave, the strength of the sound depends upon the amplitude of the sound wave, and the tone depends upon the sound wave-form.

It is generally agreed that a musical instrument should have such a structure that it expresses these three elements as much as possible.

Now, considering stringed instruments, they consist of strings, a neck and a resonance box. The strings serve to vibrate themselves to generate sound and provide physical vibration to the entire instrument. The neck serves to vary the string length by being touched by fingers to modulate treble and bass conditions. The resonance box serves to enhance the vibration move-

ment of the air, which is an elastic medium within the resonance box, in response to the transmitted string vibrations and the forced physical vibration of the resonance box due to the string vibrations. Thus, the wave of condensation and rarefaction of the air generated in the resonance box serves to strengthen or weaken the sound and modulates the tone with the aid of the tuning fork action of the front belly and back.

In order to electrically amplify the sound of the musical instrument, the sound wave from the sound source is picked up and its energy is converted to electrical energy which is reproduced as acoustic energy by an amplifier, or mechanical vibration generated by the sound source is converted into electrical energy which is in turn reproduced as acoustic energy by an amplifier.

The difference between these two processes lies in whether acoustic energy is picked up from a wave of condensation and rarefaction of the air generated by the musical instrument or it is picked up from a mechanical vibration generated by the musical instrument. In either case, it is impossible to produce an electrical signal which has the same components as those of the original sound of the musical instrument.

The reason is that the sound originally generated by the musical instrument is a combination of a wave of condensation and rarefaction of the air generated from the resonance box and mechanical vibration of a component of the musical instrument, whereas when a microphone is used to convert the wave of condensation and rarefaction of the air into an electric signal and a piezo-electric element is used to convert a mechanical vibration into an electric signal, both of these can pick up only a part of the wave of condensation and rarefaction of the air or the mechanical vibration.

The weight **11** provided in the pickup of the present invention vibrates freely when the musical instrument vibrates. Namely, besides the vibration of the musical instrument itself, another vibration may be applied to the piezoelectric element **2** depending upon the mass action of the weight **11.**

Although it is apparent that the piezoelectric element **2** senses the vibration of the entire musical instrument intensively, it is possible, by a proper selection of the mass of the weight **11,** to make the piezoelectric element **2** sense a tone very similar to the original sound.

Therefore, the weight **11** serves to cause the piezoelectric element **2** to generate an electric signal similar to the tone which is the combination of the mechanical vibration of the musical instrument itself and the wave of condensation and rarefaction of the air from the resonance box.

According to the experimental data, the optimum balance of tone was obtained when the mass of the weight **11** was so selected that it resonates with the vibration of the entire musical instrument, and the best result was observed in reproducing the original sound.

Further, it has been found that the following relationship exists between the mass of the weight and the mass of the air within the resonance box of the musical instrument and the density of the belly of the resonance box of the musical instrument:

Mass of weight ~ mass of the air within the resonance box of the musical instrument

Mass of weight ~ 1/density of the front belly of the resonance box

Thus,

Mass of weight

$$= K \frac{\text{mass of the air within the resonance box}}{\text{density of the front belly of the resonance box}}$$

wherein: K = a constant.

Furthermore, it has been found by experimentation that the electrical output of the piezoelectric element depends upon the location at which the pickup is attached to the body of the stringed instrument, the proportion of the mechanical vibration of the stringed instrument, and the wave of condensation and rarefaction of the air in the resonance box. This electric energy output produced by the piezoelectric element varies over a wide range.

The pickup device of the present invention is shown in FIG. **1** as being mounted on a back surface of the belly **16** which is a part of the resonance box of the stringed instrument. According to the experiments, the sound could be heard as if there were another sound source behind a real sound source, and the mechanical vibration of the resonance box was picked up well to generate an electrical signal in the piezoelectric element **2.** By a proper selection of the mass of the weight **11,** as described above, taking into consideration of the mass of the air within the resonance box and the density of the belly of the resonance box, it is possible to enhance the tone inherent to the particular stringed instrument.

Now, the pickup of the present invention is shown in FIGS. **3** and **4** as being attached to one of bass-bars mounted on the back surface or under side of the belly **16** which is a part of the resonance box of the stringed instrument.

Numeral **17** in FIGS. **3** and **4** designates an opening of a suitable size provided in the belly **16, 18** designates bars mounted on the back surface of the belly **16** extending traversely to a longitudinal direction thereof, **19** designates similar bars extending in parallel to the longitudinal direction, and **20** designates similar bars extending diagonally to the belly **16.** The pickup **15** of the present invention is mounted on a bar **18** which in turn is mounted traversingly to the longitudinal direction of the belly **16.**

The belly **16** in combination with the back belly and outer periphery plates (peripheral side walls) forms the body or resonance box of the musical instrument which resonant with the string vibration. The vibrating elements are not always identical to each other over an entire area of the belly, differ somewhat with the location.

Accordingly, the provision of the bars on the back surface of the belly **16** serves not only to enhance the mechanical vibration of the belly but also to improve the resonance function of the belly as one sheet.

The pick up **15** of the present invention was placed at various locations on the front and back sides of the belly **16** of the instrument. In case of a gut guitar, when the pickup **15** is mounted on one of bars **18** which traverse the belly in the longitudinal direction near the opening **17,** the portion of the piezoelectric element output corresponding to the mechanical vibration of the strings is substantially larger than the portion of the piezoelectric element output corresponding to the wave of condensation and rarefaction of the air, and can provide an electric signal including components corresponding to the tone inherent in the gut guitar. For the other stringed instruments including bars **18** which traverse in the longitudinal direction near opening **17** in the belly **16,** such as Lekint guitar, Flamenco

guitar, ukulele, mandolin and so on, it was possible to provide electric signals of the tone inherent to the particular musical instrument used, as in the gut guitar.

For a folk guitar, as shown in FIGS. **5** and **6**, when the pickup **15** is mounted on one of the bars **20** diagonal in the longitudinal direction of the belly **16** near the opening **17**, the same effect as in the gut guitar is obtained. That is, the part of the piezoelectrical element output corresponding to the mechanical vibration of the strings themselves is substantially larger than the portion of the piezoelectric element output corresponding to the wave of condensation and rarefaction of the air from the resonance box. The unit can produce an electric signal including the tone inherent to the folk guitar.

For the other stringed instruments having bars **20** diagonally across in the longitudinal direction of the belly **16**, such as Western guitars, the same effect as in the fork guitar may be obtained.

For a pick guitar, as shown in FIGS. **7** and **8**, when the pickup **15** is attached near the center of the back surface of the belly **16**, the part of the piezoelectric element output corresponding to the mechanical vibration of the strings becomes substantially larger than the portion of the piezoelectric element output corresponding to the wave of condensation and rarefaction of the air from the resonance box. Thus the unit can produce an electric signal of a tone, the major part of which is a steel tone inherent to the pick guitar.

As for the experiments on the pick guitar, the belly **16** is thicker than other stringed instruments at the center portion, and has an S-shaped, relatively small opening **17** with respect to round openings of the other instruments. Hence bars **20** serve to enhance a basic vibration to suppress the wave of condensation and rarefaction of the air in the resonance box.

In FIG. **9** the pickup **15** of the present invention is shown as being mounted to a sound-post which constitutes a part of the resonance box of the stringed instrument. In the drawing, **17** designates *f*-holes or sound holes, **20** bass bars, **21** a back belly, **22** a neck, **23** a bridge, **24** strings, **25** a rib or outer peripheral plate, and **26** a sound-post.

According to the experiments vibration transmitting medium **4** of pickup **15** receives a vibration of sound-post **26**. That is, a combined vibration of a mechanical vibration having a vibration frequency distribution in which a part of a range of vibration generated by the strings **24** is emphasized by a characteristic vibration of the belly **16** and a mechanical vibration having a vibration frequency distribution in which a part of the range of vibration generated by the strings **24** is emphasized by a characteristic vibration of the back belly **21**, although the intensity of the latter is smaller than the former. Since the weight **11** is attached to the vibration transmitting medium **4**, it presents an impedance to a relatively high frequency component of the mechanical vibration transmitted thereto, so that the high frequency component is attenuated and the piezoelectric element **2** produces an electric energy, in response to the mechanical vibration, of a frequency distribution including a relatively low frequency bared as major parts.

Thus, it became possible to reproduce the characteristic tone of the particular musical instrument.

In the preferred embodiments illustrated, since the pickup according to the present invention is accommodated inside the musical instrument, that is, in a space within the resonance box, it is not observed from the outside and it does not disturb the operation by the player.

What is claimed is:

1. In a stringed musical instrument containing strings, a body and neck, said body containing a resonance box, and one side of the resonance box being the belly of the instrument, the improvement comprising a signal transmitting piezoelectric unit mounted in said body having:

a. at least one piezoelectric element attached at one end thereof to the inside of said unit by a synthetic rubber mount and having signal transmitting means;

b. an elastic synthetic rubber vibration transmitting medium attached to the other end of said element and to said unit, said medium being separate from mount; and

c. a weight attached to said vibration transmitting medium at said other end.

2. The stringed musical instrument of claim **1** wherein said unit is mounted on the inner surface of said belly.

3. The musical instrument of claim **1** wherein said weight has a mass which is both proportional to the mass of the air within said resonance box and inversely proportional to the density of said belly.

4. The stringed instrument in accordance with claim **1** wherein said belly has a sound post mounted on the inner surface thereof and said unit is mounted on said sound post.

5. The stringed instrument of claim **2** wherein said belly has a bar mounted on the inner surface thereof and said unit is mounted on said bar.

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