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(54) **Stringed musical instrument formed from bamboo plates**

(57) Bamboo fibers uniformly extend in the longitudinal direction of a bamboo stem (20) so as to impart good acoustic properties to bamboo plates (25) formed from bamboo strips (24), and the bamboo plates (25)

are available for a component part (1a/ 1b/ 1c/ 11/ 12) of a body and a neck (2a/ 2b) both forming part of an acoustic guitar, because the bamboo is easily economically obtainable.

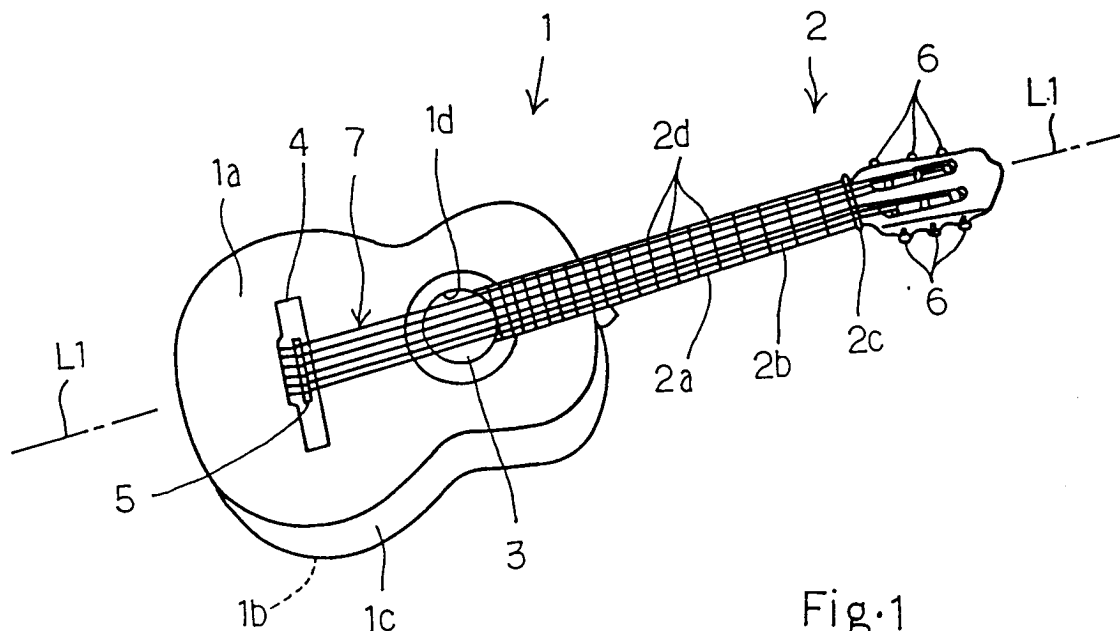


Fig.1

Description**FIELD OF THE INVENTION**

[0001] This invention relates to a stringed musical instrument and, more particularly, to a stringed musical instrument such as, for example, a guitar, an electric acoustic guitar and a Japanese modern two-stringed plucked musical instrument called as "Taishogoto" in Japanese.

DESCRIPTION OF THE RELATED ART

[0002] An acoustic guitar is broken down into a body, a neck, turning keys, a tailpiece, bridges and strings. The body and the neck are usually formed of wood, and wooden boards define a hollow space or a resonator in the body. The large resonator makes the acoustic sound loud, and reverberates low-pitched tones. If the resonator is small, a player appreciates it for high-pitched tones. Thus, the body affects the acoustic sound.

[0003] A front board, a rear board and side boards form in combination the body, and the front board has the strongest acoustic influence on the sound like the sound board of an acoustic piano. For this reason, the front board is usually formed of a kind of wood superior in acoustic properties.

[0004] The thinner the front board is, the more it vibrates. The wide vibrations result in loud sound, and it is desirable to use a thin wooden plate for the front board. Even so, the tailpiece is attached to the front board. The strings are stretched between the turning keys and the tailpiece, and each string exerts the tensile force of the order of 6 - 7 kilograms on the tailpiece. Therefore, the manufacturer is to give appropriate mechanical strength to the front board. Plural wooden sound bars are bonded to the front board in order to propagate the vibrations from the bridge to the entire surface of the front board, and wooden reinforce members increases the mechanical strength. The rear board and the side boards are expected to offer large mechanical strength rather than good acoustic properties. The manufacturer forms the rear board and the side boards from wooden plates harder than the front board.

[0005] A fingerboard is bonded to a reinforcing bar, and the fingerboard and the reinforcing bar form in combination the neck. The reinforcing bar is stiff enough to withstand the bending moment due to the tensile force of the strings. Frets are embedded in the fingerboard at intervals, and the player presses the strings against the fingerboard during the performance. Not only the strings but also the fingers are pressed against the fingerboard, and the fingerboard is liable to be soiled. For this reason, the fingerboard is formed of another kind of wood making the stains inconspicuous and less worn away.

[0006] Thus, the components of the guitar have different duties, and, accordingly, different kinds of wood are used for the components. Typical examples are listed in the following table.

Table

Components	Wood
Front board	Spruce Silver fir Cedar
Rear board & Side boards	Indian rose Maple Mahogany Jacaranda
Reinforcing bar	Mahogany Maple
Fingerboard & Tail piece	Ebony Indian rose
Sound bar & Reinforce member	Spruce Mahogany

[0007] The other components, i.e., the strings, the turning keys, the bridges and the frets are formed of metal or synthetic resin, and the metal and the synthetic resin are easily obtainable. However, the wood such as the spruce, the silver fir and ebony are getting a little, and the manufacturer feels the stable supply difficult in future. For this reason, the manufacturer changes those kinds of wood to the south-sea wood such as lauan and china wood. However, a large amount of south-sea wood is consumed as the building material. For this reason, stable supply is doubtful.

SUMMARY OF THE INVENTION

[0008] It is therefore an important object of the present invention to provide a stringed musical instrument, a part of which is formed of woody material easily economically obtainable and having good acoustic properties. To accomplish the object, the present invention proposes to use bamboo.

[0009] In accordance with one aspect of the present invention, there is provided a stringed musical instrument comprising a body structure including at least one component part formed of bamboo, an anchor means attached to the body structure and at least one strings anchored at the anchor means so as to be stretched over the body structure

and vibrating for generating sounds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The features and advantages of a stringed musical instrument will be more clearly understood from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view showing an acoustic guitar according to the present invention;
 Fig. 2 is a plane view showing a reverse surface of a front board forming a part of the body of the acoustic guitar;
 Fig. 3 is a plane view showing a reverse surface of a rear board forming a part of the body of the acoustic guitar;
 Fig. 4 is a perspective view showing a bamboo stem available for bamboo plates;
 Fig. 5 is a plane view showing an edge of a bamboo strip cut from an arc piece of the bamboo stem;
 Fig. 6 is a plane view showing a bamboo plate formed from the bamboo strips for a front board and a rear board;
 Fig. 7 is a side view showing the bamboo plate;
 Fig. 8 is a side view showing the side surfaces of the bamboo strips assembled together;
 Fig. 9 is a plane view showing another bamboo plate available for a side board;
 Fig. 10 is a side view showing the bamboo plate;
 Fig. 11 is a side view showing the side surfaces of the bamboo strips assembled together;
 Fig. 12 is a plane view showing yet another bamboo plate available for a sound bar and a reinforce member;
 Fig. 13 is a side view showing the bamboo plate;
 Fig. 14 is a cross sectional view showing the bamboo plate;
 Fig. 15 is a plane view showing still another bamboo plate available for a sound bar and a reinforce member;
 Fig. 16 is a side view showing the bamboo plate;
 Fig. 17 is a cross sectional view showing the bamboo plate;
 Fig. 18 is a plane view showing a bamboo plate available for a neck body;
 Fig. 19 is a side view showing the bamboo plate;
 Fig. 20 is a side view showing a part of the bamboo plate encircled in dots-and-dash line A of figure 19;
 Fig. 21 is a plane view showing another bamboo plate available for a finger board;
 Fig. 22 is a side view showing the bamboo plate;
 Fig. 23 is a side view showing the bamboo plate at large magnification ratio; and
 Fig. 24 is a fragmentary perspective view showing an electric acoustic guitar according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Acoustic Properties of Bamboo

[0011] Bamboo is defined in Webster's Third New International Dictionary as "woody or arborescent grass of *Bambusa*, *Arundinaria*, *Dendrocalamus*, and related genera (tribe Bambuseae) widely distributed chiefly in the tropics and subtropics of both hemispheres". Although bamboo is much lower in price than wood such as spruce, it is not popular in the building industry. Bamboo grows faster than trees. For this reason, bamboo is easily and economically obtainable.

[0012] A bamboo is formed from thin long fibers gathered at high density. The thin long fibers uniformly extend along the longitudinal direction of the bamboo, and are strong and flexible. However, the cohesion between the bamboo fibers is small. When small compressive force is exerted on a bamboo in the longitudinal direction, the bamboo is easily separated into the bamboo fibers. Those properties are appropriate for a kind of plywood.

[0013] The bamboo is cut into bamboo sheets. The reverse surface of one bamboo sheet is, by way of example, bonded to the front sheet of another bamboo sheet so as to form a lamination. The lamination is less warped under a temperature difference. Thus, the bamboo is available for various structures of plywood. Some kinds of plywood have large mechanical strength and/ or good acoustic properties, and are appropriate for the board or boards of the stringed musical instrument.

[0014] In detail, the bamboo offers good propagation characteristics to acoustic waves in the direction of the bamboo fibers. However, the acoustic waves are less propagated across the bamboo fibers. In fact, the acoustic wave velocity in the direction of the bamboo fibers is larger than that of wood, but the acoustic wave velocity in the direction across the bamboo fibers is smaller than that of wood. When the body of a stringed musical instrument is made of bamboo, the bamboo fibers rapidly propagate the acoustic waves over the body, and make the phase difference small. The body rapidly decays the higher harmonics of the acoustic sound, and restricts the sprit vibrations. As a result, the body generates clear acoustic sound. This feature is desirable for an electric acoustic stringed musical instrument. The electric acoustic stringed instrument will be hereinbelow described as an embodiment of the present invention. A pickup is incorporated in the electric acoustic stringed instrument, and converts the acoustic sound to an electric signal. The

acoustic sound generated in the bamboo body is clear, and a preamplifier easily imparts a selected timbre to the electric sound on the basis of the clear acoustic sound. Thus, bamboo is appropriate for a body of a stringed musical instrument.

First Embodiment

[0015] Referring to figure 1 of the drawings, an acoustic guitar embodying the present invention comprises a body 1, a neck 2 projecting from the body 1. The body 1 is constricted, and includes a front board 1a, a rear board 1b and a side board 1c or boards 1c. The front board 1a and the rear board 1b have contours identical with each other, and are symmetrical with respect to a line L1. The front board 1a is spaced from the rear board 1b, and the side boards 1c are connected along the outer peripheries of the front/ rear boards 1a/ 1b. The front board 1a, the rear board 1b and the side boards 1c thus assembled form hollow space serving as a resonator 3. A circular aperture is formed in the front board 1a, and serves as a sound hole 1d. The resonator 3 is open to the air through the sound hole 1d.

[0016] The neck 2 is connected to the body 1, and is elongated along the line L1. The neck 2 includes a neck body 2a bonded to the body 1, a finger board 2a attached to the front surface of the neck body 2a, an upper bridge saddle 2c embedded into the leading end portion of the finger board 2b and plural frets 2d attached to the finger board at intervals. The leading end portion of the neck body 2a is widened, and slots are formed. As will be described hereinbelow, the leading end portion serves as a kind of peg box.

[0017] The acoustic guitar further comprises a bridge 4 attached to the front board 1a, a lower bridge saddle 5 embedded in the bridge 4, turning keys 6 screwed into the leading end portion of the neck body 2a and strings 7 stretched between the bridge 4 and the turning keys 6. The strings 7 are terminated at the turning keys 6, and a player gives appropriate tensions to the strings 7 through rotation of the turning keys 6. The acoustic guitar has the contour similar to that of the prior art acoustic guitar. When the player plucks the strings 7, the strings 7 vibrate, and the vibrations are propagated through the bridge 4 to the body 1. The body 1 generates the acoustic sound from the vibrations, and the resonator 3 makes the acoustic sound loud. The acoustic sound is radiated through the sound hole 3. When the player selectively presses the strings 7 against the finger board 2b, the strings 7 are brought into contact with the frets 2d, and the vibrating strings 7 change the pitches of the acoustic sound.

[0018] Figure 2 shows the reverse surface of the front board 1a, and figure 3 shows the reverse surface of the rear board 1b. Sound bars 11 and reinforce members 12 are bonded to the reverse surfaces. The reinforce members 12 enhance the mechanical strength of the boards 1a/ 1b, and the sound bars 11 propagate the vibrations of the bridge 4 over the front/ rear boards 1a/ 1b. Thus, various parts are assembled into the acoustic guitar, and are formed of woody material except the strings 7, the bridge saddles 2c/ 5, the turning keys 6 and the frets 2d. In this instance, the front board 1a, the rear board 1b, the side boards 1c, the sound bars 11, the reinforce members 12, the neck body 2a, the finger board 2b and the bridge 4 are formed of bamboo. The other parts, i.e., the front board 1a, the rear board 1b, the side boards 1c, the sound bars 11, the reinforce members 12, the neck body 2a, the finger board 2b and the bridge 4 are similar in configuration to those of the prior art acoustic guitar.

[0019] The bamboo is formed into bamboo plates available for the other parts as follows. Figure 4 illustrates a bamboo stem 20. The bamboo stem 20 belongs to a species of thick-stemmed bamboo. Of course, other species such as grown in Asian countries, African countries and North/ South American countries is available for the other parts. The bamboo has a subterranean stem and a terrestrial stem. The terrestrial stem is appropriate for the bamboo plates.

[0020] The manufacturer firstly selects bamboo stems that are close in age and color to one another. The manufacturer checks the bamboo stems to see whether stains and scratches are serious or not. When the bamboo stems are acceptable, the manufacturer cuts the bamboo stem 20 into cylindrical parts 21. If there is a node 22, the manufacturer grinds the node 21, and makes the outer surface smooth.

[0021] Subsequently, the manufacturer cuts the cylindrical part 21 into arc pieces 23. In this instance, the cylindrical part 21 is cut into eight arc pieces along broken lines. Of course, the cylindrical part 21 may be cut into more than eight arc pieces depending upon the diameter of the bamboo stem 20. The corners 23a and a curved outer surface portion 23b are removed from the arc piece 23, and a bamboo strip 24 is formed from the arc piece 23. Although most of the epidermis is removed from the bamboo strip 24, residual epidermis 24a is seen as indicated by dots.

[0022] The bamboo strips 24 are arranged as shown in figure 6. Only four bamboo strips are labeled with reference 24 for the sake of simplicity. The bamboo strips 24 form a bamboo plate 25, and the bamboo plate 25 has length L1 of 550 millimeters, width W1 of 420 millimeters and thickness T1 of 3 millimeters. When the manufacturer intends to use the bamboo plate 25 for a wide part, the bamboo plate 25 may have different dimensions. Every other bamboo strip 24 is turned the inside 24b out, and the remaining bamboo strips keep the outside 24c out as shown in figure 8. The bamboo strips 24 are bonded to one another without gap therebetween. This feature is desirable, because the bamboo plate 25 is less warped under temperature difference. The residual epidermis 24a is periodically seen on the outer surface of the bamboo plate 25 like the grain of wood. The manufacturer shapes the bamboo plates 25 into the front board 1a and the rear board 1b.

[0023] Figures 9 and 10 illustrate another bamboo plate 26 for the side board 1c. The bamboo plate 26 has length

L2 of 850 millimeters, width W2 of 120 millimeters and thickness T2 of 2.5 millimeters. The bamboo strips 24 are prepared as similar to those for the bamboo plate 25. The manufacturer puts the bamboo strips 24 side by side, and the inner surface 24b is alternated with the outer surface 24c as shown in figure 11. The bamboo strips 24 are bonded to the adjacent bamboo strips 24 without gap, and are formed into the bamboo plate 26. The bamboo plate 26 is shaped

into the side board 1c.

[0024] Figures 12 and 13 illustrate a bamboo plate 27 available for the sound bars 11 and the reinforce members 12. The bamboo plate 27 has length L3 of 500 millimeters, width W3 of 20 millimeters and thickness T3 of the order of 10 millimeters. The manufacturer prepares the bamboo strips 24 as similar to those of the bamboo plate 25. A pair of bamboo strips 24 is used for the bamboo plate 27, and the inner surface 24b of one bamboo strip 24 is bonded to the inner surface 24b of the other bamboo strip 24 without gap. For this reason, the outer surfaces 24c serve as both surfaces of the bamboo plate 27 as shown in figure 14. The bamboo plate 27 is less warped under temperature difference.

[0025] Figures 15 and 16 illustrate another bamboo plate 28 also available for the sound bars 11 and the reinforce members 12. The bamboo plate 28 has length L4 of 500 millimeters, width W4 of 20 millimeters and thickness T4 of the order of 20 millimeters. Thus, the bamboo plate 28 is twice thicker than the bamboo plate 27.

[0026] The manufacturer firstly forms the bamboo strips 24 as similar to those for the bamboo plate 25. Two pairs of bamboo strips 24 are used for the bamboo plate 27. The bamboo strips 24 are alternately laminated in such a manner that inner surface 24b and the outer surface 24c of one bamboo strip 24 are respectively laminated on the inner surface of an adjacent bamboo strip 24 and the outer surface of another adjacent bamboo strip 24 as shown in figure 17. The outer surfaces 24c serve as both surfaces of the bamboo plate 28. Two bamboo plates 27 may be bonded to one another without gap. The bamboo plate 28 is less warped under temperature difference.

[0027] Figures 18, 19 and 20 illustrate yet another bamboo plate 29 available for the neck body 2a. The bamboo plate 29 has length L5 of 630 millimeters, width W5 of 95 millimeters and thickness T5 of 110 millimeters.

[0028] The manufacturer firstly forms the bamboo strips 24 as similar to those for the bamboo plate 25. The manufacturer laminates the bamboo strips 24, and bonds the bamboo strips 24 without gap so as to obtain two kinds of bamboo sub-plates 30/ 31. The bamboo strips 24 are laminated in such a manner that the inner surface 24b and the outer surface 24c are held in contact with the inner surface 24b of one adjacent bamboo strip 24 and the outer surface 24c of the other adjacent bamboo strip 24, and are bonded without gap. The bamboo sub-plate 30 exposes the inner surfaces to both sides thereof, and the bamboo sub-plate 31 exposes the outer surfaces to both sides thereof as shown. The bamboo sub-plates 30 are alternated with the bamboo sub-plates 31, and are bonded without gap. The inner surfaces 24b and the outer surfaces 24c are alternately exposed to each of the side surfaces of the bamboo plate 29, and the bamboo plate 29 is less warped under temperature difference.

[0029] Figures 21, 22 and 23 illustrate a bamboo plate 32 available for the finger board 2b. The bamboo plate 32 has length L6 of 500 millimeters, width W6 of 60 millimeters and thickness T6 of 6 millimeters. The manufacturer forms the bamboo strips 24 as similar to those for the bamboo plate 25. In this instance, three pairs of bamboo strips 24 are used for the bamboo plate 32. The first pair has the bamboo strips 24, the outer surfaces of which are bonded to one another. As a result, the inner surfaces 24c are exposed to both surfaces of the first pair. On the other hand, the bamboo strips 24 of the other pairs have inner surfaces 24b bonded to one another, and, accordingly, the outer surfaces 24c are exposed to both sides of the second/ third pair. The second pair and the third pair are placed on both sides of the first pair, and are bonded to the first pair without gap. The bridge 4 is also formed from the bamboo strips 24.

[0030] As will be understood from the foregoing description, the body 1, the neck 2 and the bridge 4 are formed from the bamboo strips 24. Any scarce wood such as spruce, cedar and Indian rose is never required for the acoustic guitar according to the present invention. The bamboo is economical. The bamboo is rapidly grown, and is constantly supplied to the manufacturer. The manufacturer does not need a large amount of stock. Moreover, the bamboo strips 24 are easily assembled into the plates 25/ 26/ 27/ 28/ 29/ 32, and the manufacture does not need special machines. For this reason, the manufacturer reduces the production cost of the stringed musical instrument.

[0031] The bamboo has constant cellular texture, and the cellular texture is straightly continued. Moreover, the bamboo plates 25/ 26/ 27/ 28/ 29/ 32 are less warped under temperature difference. For this reason, the stringed musical instrument according to the present invention is stable, and constantly generates the acoustic sound. In fact, the present inventor fabricated the acoustic guitar according to the present invention, and compared the acoustic sound with the acoustic sound of the prior art acoustic guitar. The difference of timbre was ignoreable.

[0032] In the first embodiment, the body 1, the neck 2 as a whole constituted a body structure.

Second Embodiment

[0033] Turning to figure 24 of the drawings, an electric acoustic guitar embodying the present invention largely comprises an acoustic guitar 41 and an electric sound generating system 42. The acoustic guitar 41 is similar to the acoustic guitar implementing the first embodiment, and component parts are labeled with the same references designating

corresponding component parts of the first embodiment without detailed description. At least three holes 1f are formed in the side board 1c.

[0034] The electric sound generating system 42 includes a pickup assembly 43, a pre-amplifier assembly 44, a battery holder assembly 45 and cord 46/ 47. The bridge 4 is replaced with the pickup assembly 43. The pickup assembly 43 is attached to the front board 1a, and converts the vibrations to an electric signal. The electric signal is supplied through the cord 47 to the pre-amplifier assembly 44. The pre-amplifier assembly 44 includes a circuit board 44a, and the electric signal is processed by an electric circuit of the circuit board 44a. The electric circuit processes the electric signal, and controls the timbre of electric sound to be produced. The electric signal is supplied from the pre-amplifier assembly 44 through the cord 46 to a sound system (not shown), and the sound system generates the electric sound.

[0035] As described hereinbefore, the bamboo rapidly decays the high-order harmonics of the vibrations, and restricts split vibrations. For this reason, the high-order harmonics and noise components in the electric signal is little, and the pre-amplifier assembly 44 well controls the timbre.

[0036] Though not shown in figure 24, a battery unit is held by the battery holder assembly 45, and the battery holder assembly 45 is inserted into the resonator 3 through the first hole 1f. The battery unit energizes the pickup assembly 43 and the pre-amplifier assembly 44. The second hole 1f is assigned to the pre-amplifier assembly 44, and the cords 46/ 47 are connected through the hole 1f to the pre-amplifier assembly 44 attached to the side board 1c. The cord 46 passes through the third hole (not shown), and projects from the resonator 3 to the outside of the body 1.

[0037] As will be appreciated from the foregoing description, the bamboo plates 25/ 26/ 27/ 28/ 29/ 32 have good acoustic properties, and are appropriate for the component parts of the body 1. The bamboo is economical and easy to shape into component parts. For this reason, the manufacturer can reduce the production cost without sacrifice the quality of sound.

[0038] Although particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the present invention.

[0039] For example, the bamboo plates are available for a body of another stringed musical instrument such as, for example, the Taishogoto and other kinds of stringed musical instrument already known.

[0040] Only the body or neck may be formed from the bamboo plates. A part of the body 1 such as, for example, the side board may be formed of wood. Similarly, either neck body or finger board may be formed of wood.

Claims

1. A stringed musical instrument comprising:

a body structure (1/ 2);
an anchor means (4/ 5/ 6) attached to said body structure; and
at least one string (7) anchored at said anchor means so as to be stretched over said body structure and vibrating for generating sounds,

characterized in that

said body structure includes at least one component part (1a/ 1b/ 1c/ 11/ 12/ 2a/ 2b/ 4) formed of bamboo.

2. The stringed musical instrument as set forth in claim 1, in which said body structure includes a body (1) and a neck (2) projecting from said body.

3. The stringed musical instrument as set forth in claim 2, in which a resonator (3) is formed in said body (1).

4. The stringed musical instrument as set forth in claim 3, in which a front board (1a), a rear board (1b) and at least one side board (1c) form in combination said body (1), and at least one of said front board (1a), said rear board (1b) and said at least one side board (1c) is formed of said bamboo.

5. The stringed musical instrument as set forth in claim 3, in which said neck (2) includes a neck body (2a) attached to said body (1) and a finger board (2b) attached to an upper surface of said neck body, and at least one of said neck body and said finger body is formed of said bamboo.

6. The stringed musical instrument as set forth in claim 2, in which said anchor means includes a bridge (4) attached to said body (1) and formed of bamboo, a first bridge saddle (5) attached to said bridge (4), at least one turning

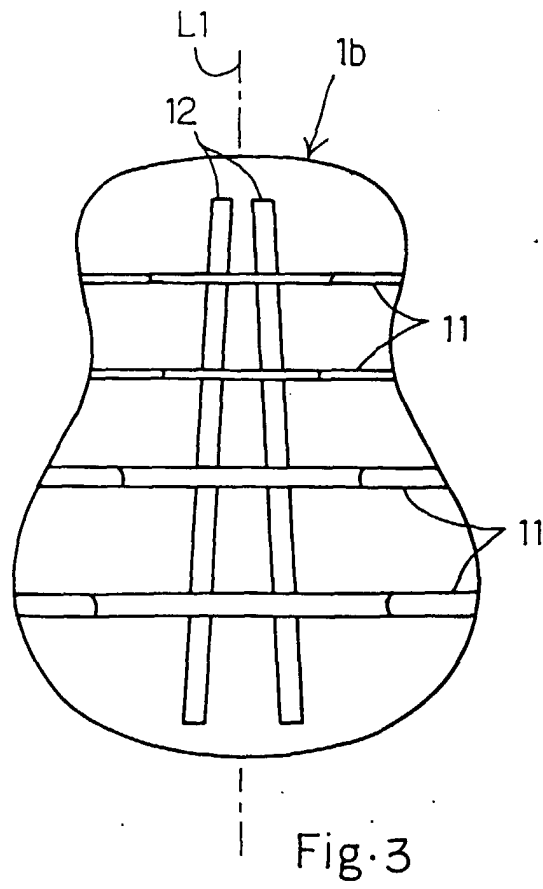
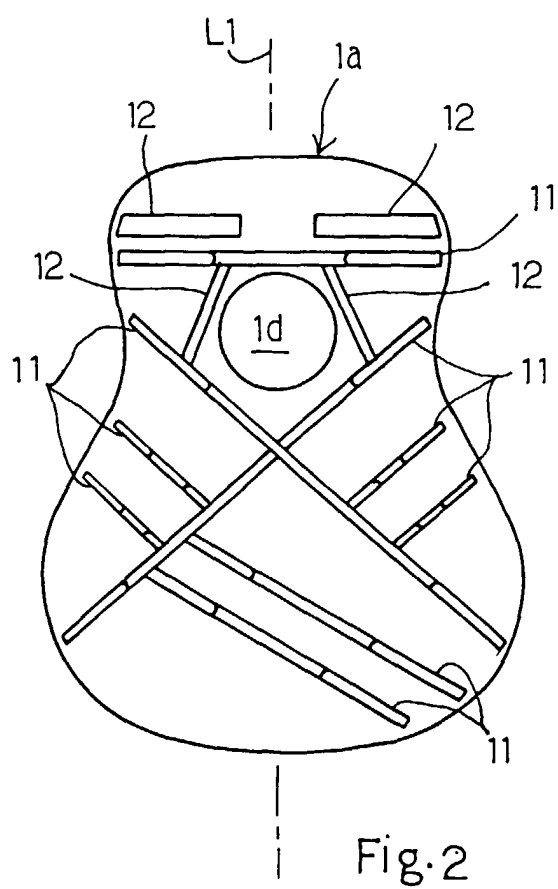
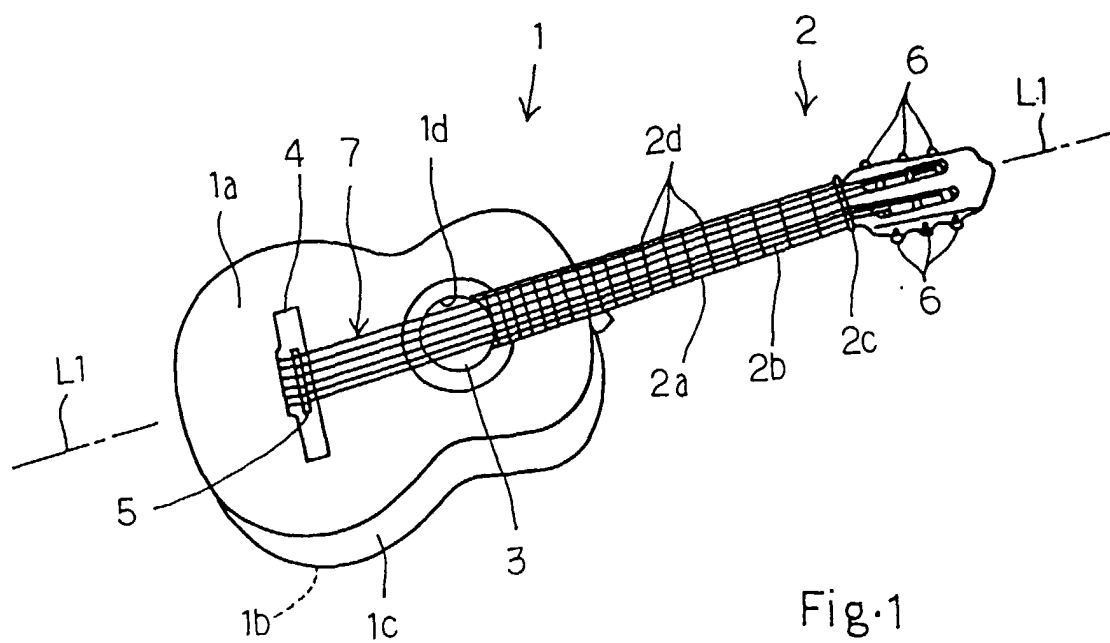
key (6) connected to a leading end portion of said neck and a second bridge saddle (2c) attached to said neck between said bridge and said at least one turning key, and said at least one string (7) is stretched between said bridge and said turning key (6).

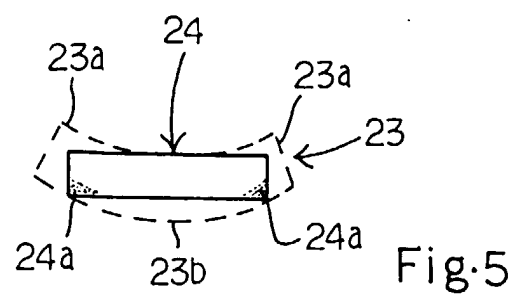
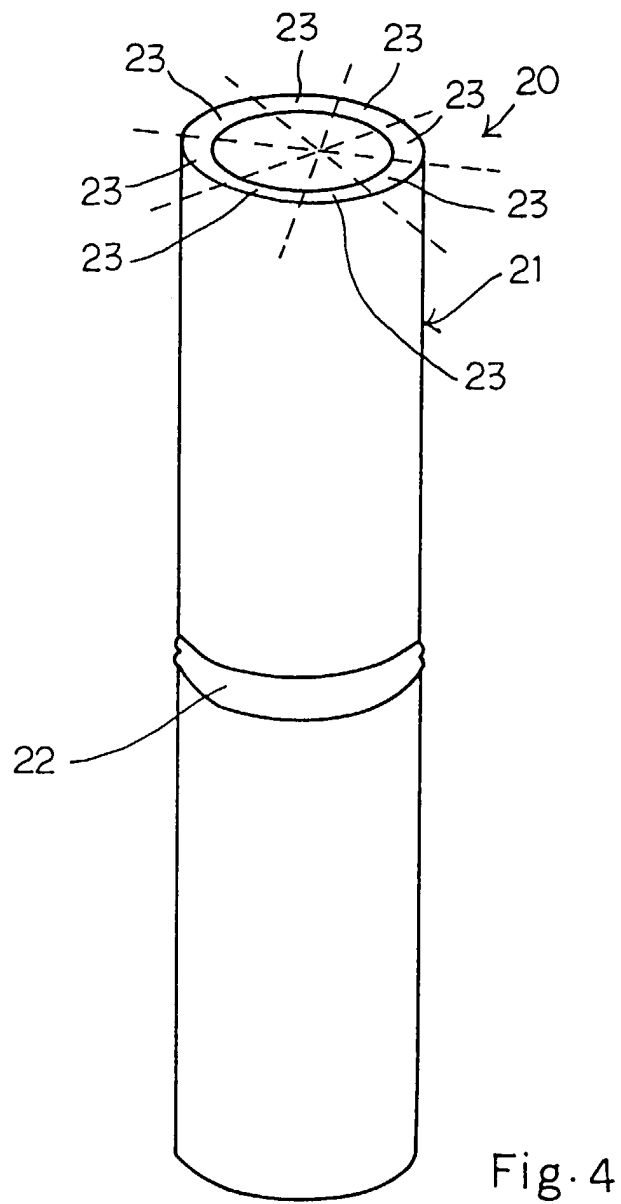
7. The stringed musical instrument as set forth in claim 1, in which said at least one component part is formed from a mosaic bamboo plate (25).

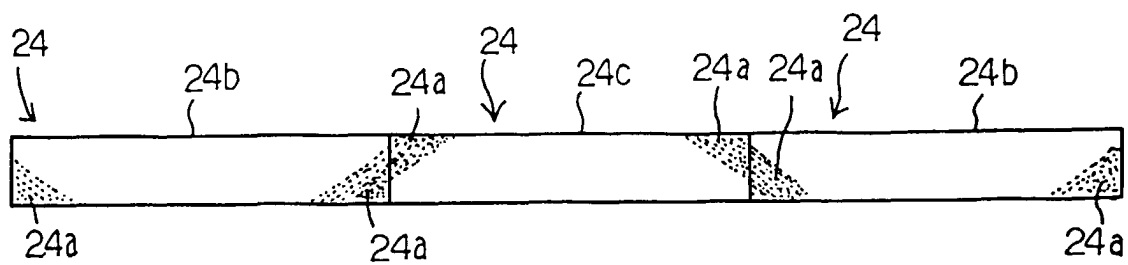
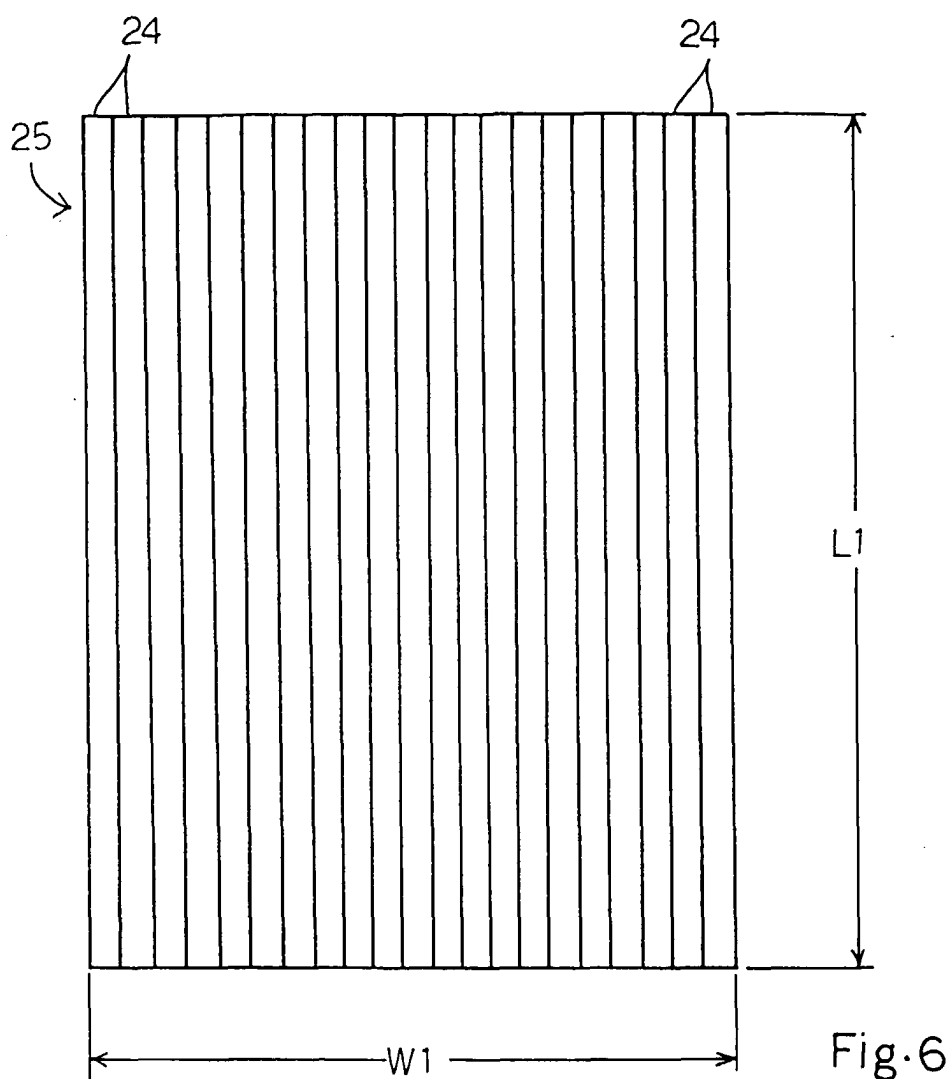
8. The stringed musical instrument as set forth in claim 7, in which plural bamboo strips (24) are assembled into said mosaic bamboo plate (25), each bamboo strip (24) forms a part of a bamboo stem (20) so as to have an inner surface forming a part of an outer peripheral surface of said bamboo stem and an inner surface forming a part of an inner peripheral surface of said bamboo stem, and side surfaces of one of said bamboo strips are connected to side surfaces of adjacent bamboo strips so that said inner surface of said one of said bamboo strips forms a major surface of said mosaic bamboo plate together with the outer surfaces of said adjacent bamboo strips.

9. The stringed musical instrument as set forth in claim 8, in which said bamboo strips form plural bamboo sub-plates (30/ 31) laminated on one another, and each of said plural bamboo sub-plates is assembled in such a manner that the inner surfaces of adjacent two bamboo strips and the outer surfaces of next adjacent two bamboo strips alternately form the boundaries between the bamboo strips, wherein the outer surfaces of the outermost bamboo strips are exposed to both side surfaces of one of said plural bamboo sub-plates, and the inner surfaces of the outermost bamboo strips are exposed to both side surfaces of another of said plural bamboo sub-plates laminated on said one of said plural bamboo sub-plates.

10. The stringed musical instrument as set forth in claim 1, further comprising an electric sound generating system (42) for generating electric sounds.







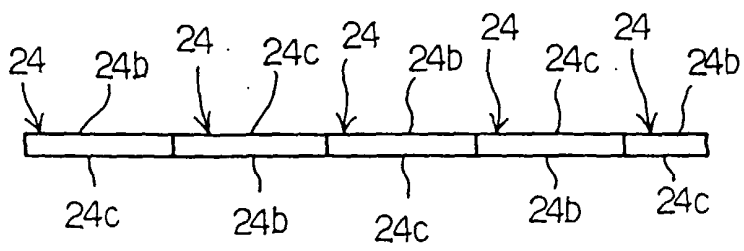


Fig. 11

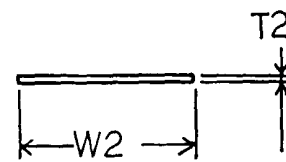
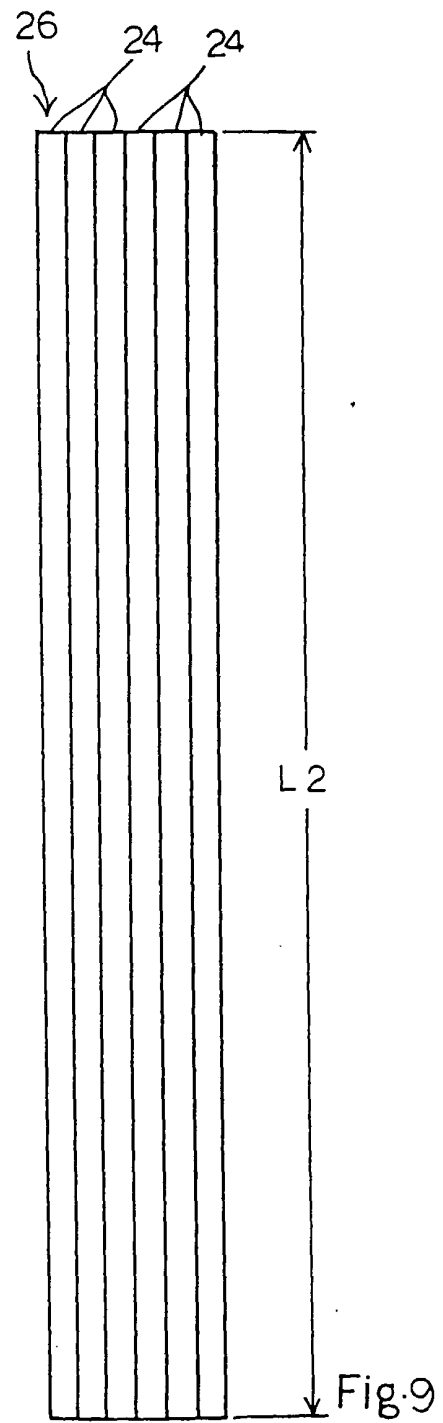


Fig. 10

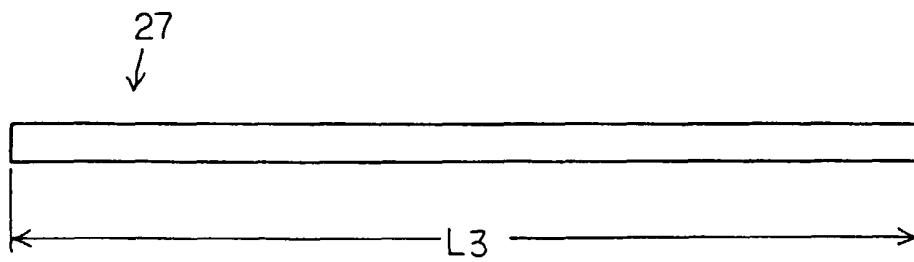


Fig. 12

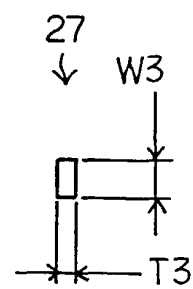


Fig. 13

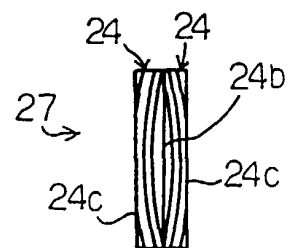


Fig. 14

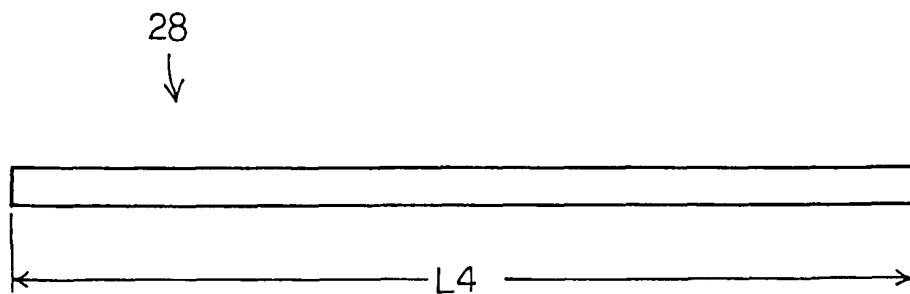


Fig. 15

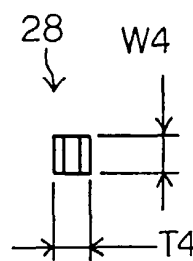


Fig. 16

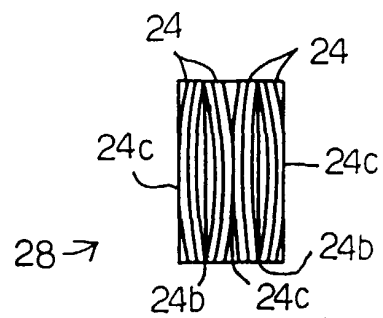


Fig. 17

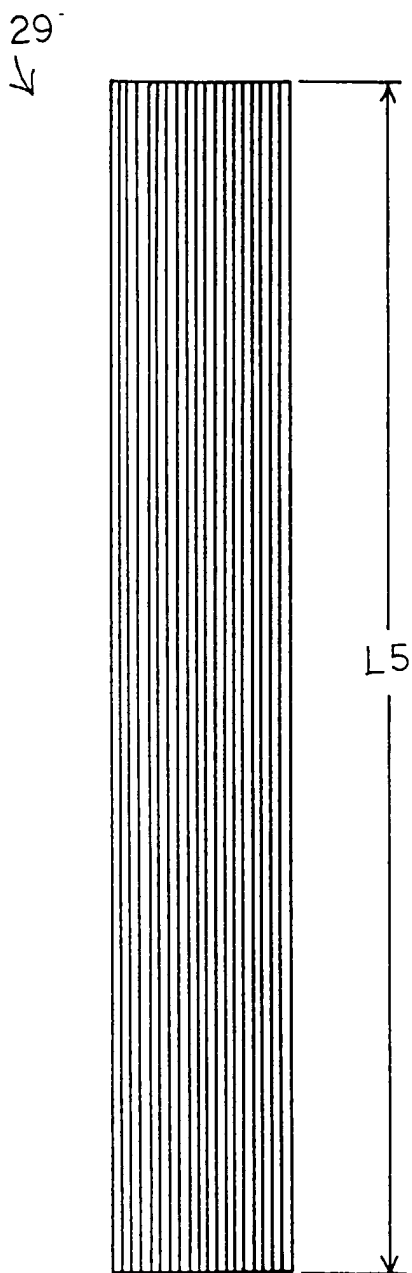


Fig. 18

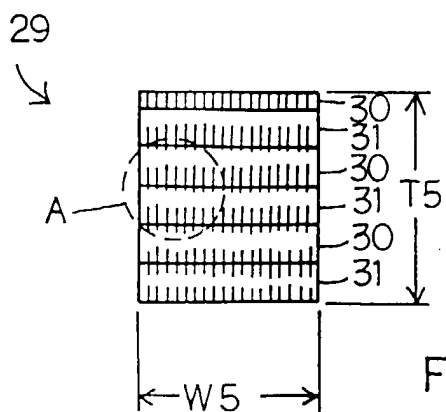


Fig. 19

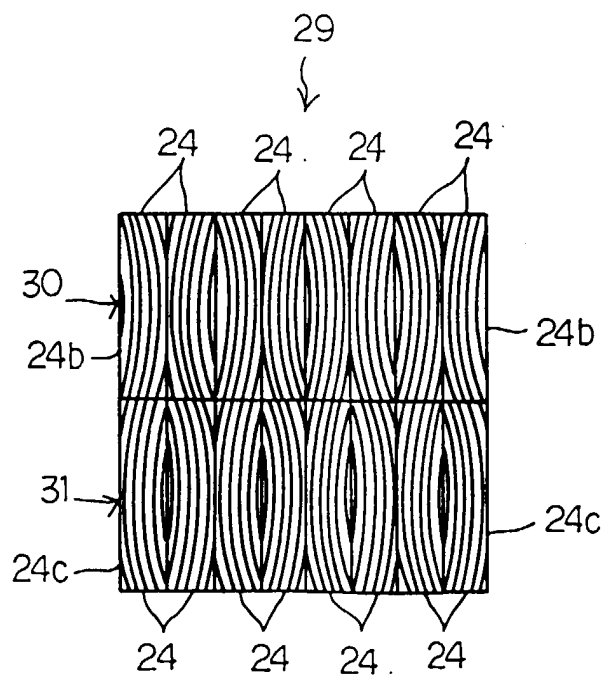


Fig. 20

