United States Patent [19]

Houtsma

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[54] **SOUNDBOARD-BRIDGE CONFIGURATION FOR ACOUSTIC GUITARS**

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[52] **U.S. Cl.** **84/307**; 84/291

[51] **Int. Cl.** **G10d 3/04**

[58] **Field of Search** 84/291, 298, 307

[56] **References Cited**

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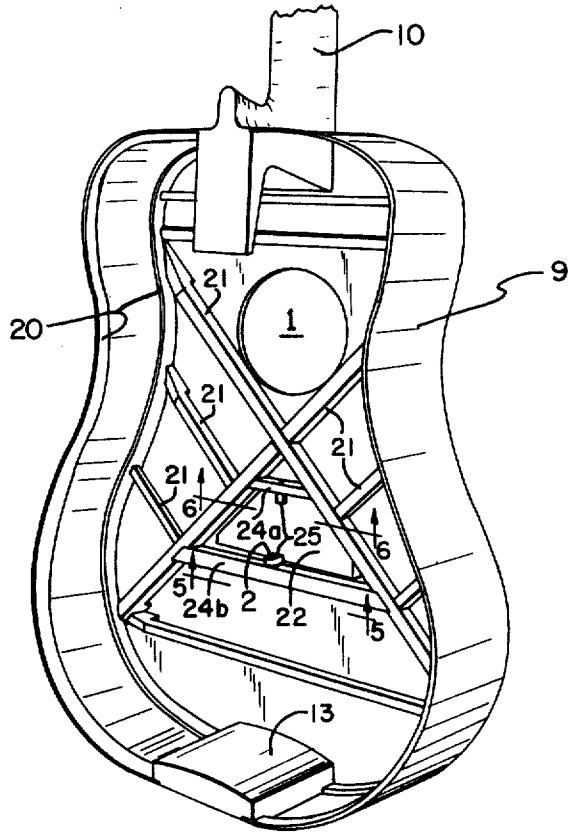
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[57] **ABSTRACT**

The bridge of a lute type instrument, such as a guitar, is supported by a bridge plate under the top of the instrument. The bridge plate is mounted to a stiff, rigid bracing in a manner which allows the plate to rotate about an axis in the direction of the neck of the instrument while preventing it from rotating forward under the tension of the strings. The bracing does not touch the top of the sound chamber except permissibily near the edges of the top. The thickness of the bridge plate varies monotonically transverse to the string direction to achieve optimal sound energy transmission over the frequency range of the instrument.

4 Claims, 6 Drawing Figures



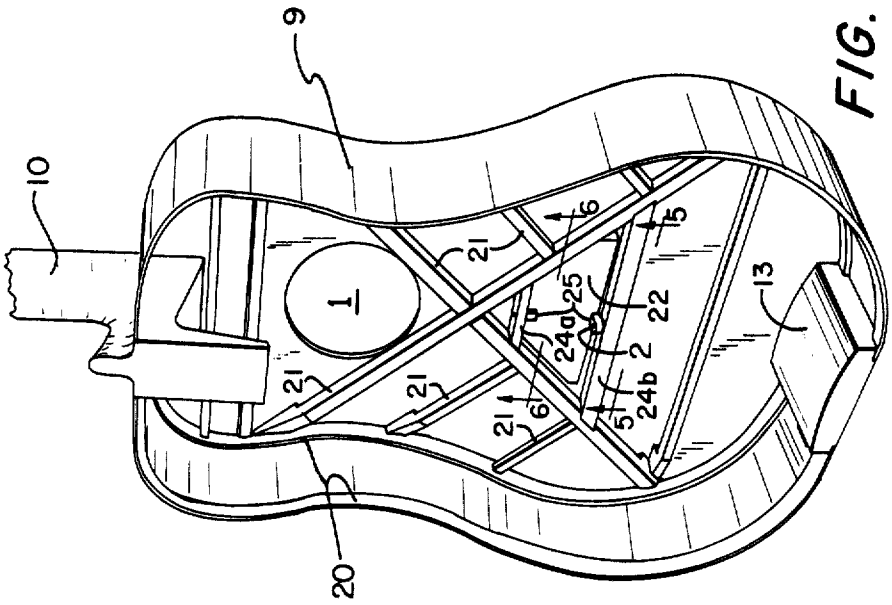


FIG. 2

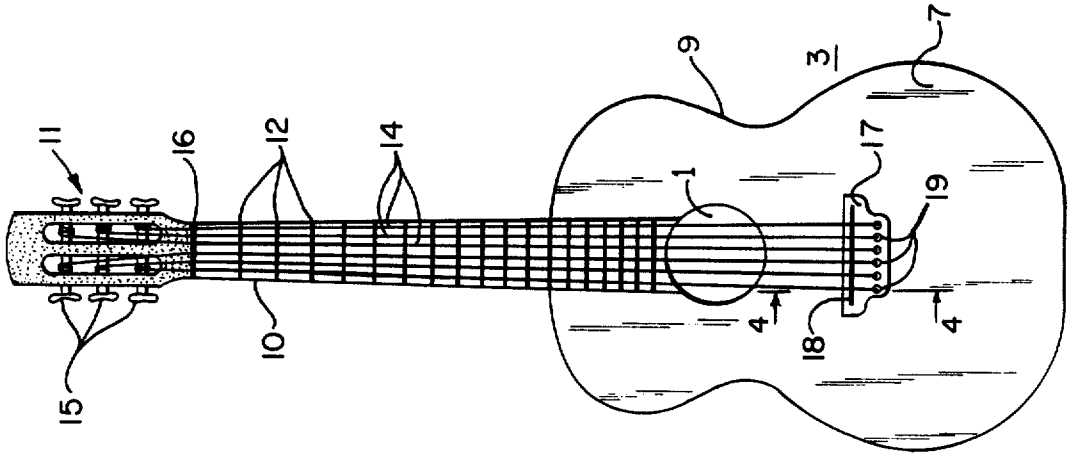


FIG. 1

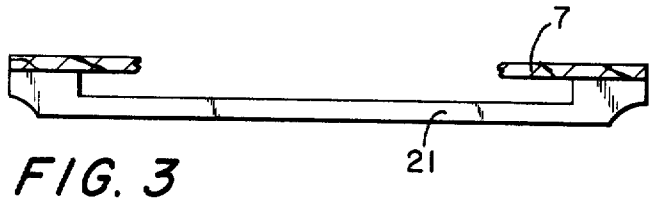


FIG. 3

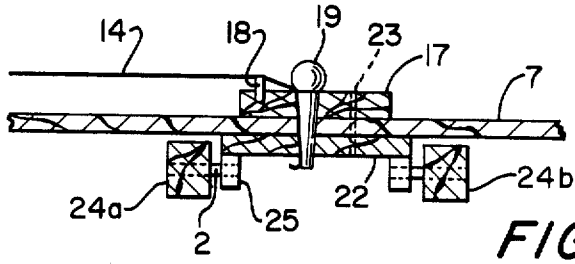


FIG. 4

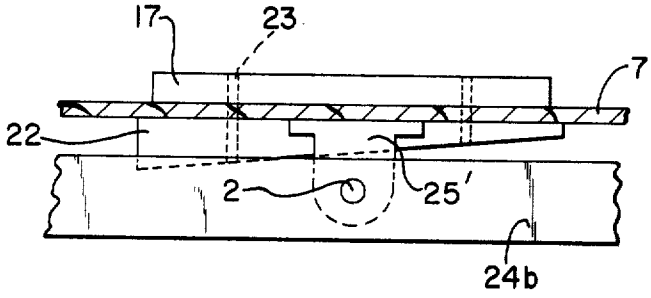


FIG. 5

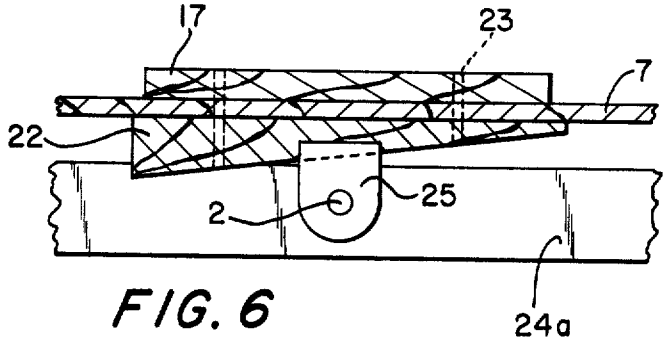


FIG. 6

SOUNDBOARD-BRIDGE CONFIGURATION FOR ACOUSTIC GUITARS

This invention relates to stringed musical instruments of the lute type, having steel, gut or nylon strings, such as the lute, the classical guitar and the folk guitar. In this class of instruments the strings terminate on a device, called the bridge, which is attached to the top or soundboard of the instrument.

In prior art instruments, the top was reinforced by braces glued to the top resulting in an instrument which was inefficient for the bass frequencies. Reinforcing was required to make the instrument sufficiently strong to hold the tension of the strings.

Accordingly, the objects of this invention are:

First, to increase the instrument's efficiency of sound radiation without making the instrument overly fragile.

Second, to provide a soundboard that radiates equally efficient at all audible frequencies, resulting in a better balanced tone quality.

Third, to support the bridge assembly and prevent it from tilting in the direction of the force exerted on it by the strings, resulting in a much better tuning stability.

Fourth, to provide virtually unlimited structural stability to the instrument without adversely affecting its sound quality.

For an understanding of the nature and objects of the invention, reference should be had to the following detailed descriptions, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a top plan view of a stringed instrument in which the invention has been incorporated.

FIG. **2** is a perspective view from the rear side of the instrument with the back removed.

FIG. **3** is a detailed side view of one of the large cross braces shown in FIG. **2.**

FIG. **4** is a fragmentary sectional view of the bridge and its suspension, taken on the line **4** — **4** in FIG. **1.**

FIGS. **5** and **6** are sectional views of the bridge suspension taken on lines **5** — **5** and **6** — **6** in FIG. **2** as seen from the tailblock.

Referring to the drawings, FIG. **1** shows an acoustical musical instrument of the lute type, in this case a guitar. The guitar has a body **3** consisting of a top **7**, a back (not shown), sides **9**, and a neck **10** which ends on a head **11** and is covered with a fretted fingerboard **12.** At the bottom end, the sides top and back are held together by a tailblock **13.** Strings **14** are stretched from the head where they are fastened to tuning machines **15,** over the nut **16,** approximately parallel to fingerboard **12,** terminating on bridge **17** where they pass over saddle **18** and are secured by bridge pins **19.** Linings **20** are glued along the top and bottom of sides and form the main connection between sides, top and back. Braces are anchored in the top linings **20,** providing structural support for sides **9** and additional bonding between top **7** and sides **9,** as shown in FIG. **2.** The particular brace pattern shown in this figure is not of very great importance; other equally effective layouts are possible. The braces are cut away at the top, entirely or partially, as shown in FIGS. **2** and **3,** so that only a small part of the bracing network, near lining **20,** are attached to the top **7.** Referring to FIG. **2,** the top clears most of the bracing network **21** by at least **4** mm and is glued only to the extremes of braces **21,** linings **20**

and tailblock **13.** The bridge **17** and bridge plate **22,** both made from a strong hardwood, are glued on either side of top **7** as shown in FIG. **4,** and are pinned together by two or three small dowels **23.** The bridge plate **22** is connected to braces **24***a*, 24*b* at top and bottom center by two metal or plastic brackets **25, 25'** and pins **2,** as shown in FIGS. **2, 4, 5** and **6.** Although these brackets should generally be in the center of the bridge plate to obtain tone and mechanical balance, they may in some cases be off center. The top bracket **25,** the one closest to sound hole **1,** is notched into the bridge plate **22** to form a compression joint (FIG. **6**), while the bottom bracket **25'**, shown in FIG. **5,** is anchored as a tension member. Both brackets are connected with braces **24***a*, 24*b* by plastic or metal pins **2.** Both pinjoints (brackets and pins) should be sufficiently strong to withstand the bending movement produced by the tension on the strings.

The structural demands on string instruments of the lute type are very particular because the strings terminate on the bridge. Especially when steel strings are employed, the force exerted on the bridge by the strings can be as high as **400** pounds. Referring to FIG. **1,** the tension in strings **14** causes a shear force and a forward bending moment on the joint between bridge **17** and top **7.** If the total string tension is **400** pounds and the strings clear the top by **0.3** inches (these figures are typical for a **12** string folk guitar), the shear force is **400** pounds and the bending moment is $400 \times 0.3/12 = 10$ ft-pounds. The shear force causes an equally large tension force in the wood fibers of the top **7** between bridge **17** and tailblock **13.** Wood fibers are usually strong enough to hold such a tensile force. The bending moment, however, would cause severe distortion of the top, leading to stress concentrations and eventually breakage, if the top were not properly reinforced with braces.

Acoustically the guitar top **7** is the principal sound radiating element. Mechanical energy stored in the vibrating strings causes the bridge **17** to move in a variety of possible modes, e.g., up and down, forward and backward, and rocking from side to side. The amount of motion is determined by the vibration frequencies, and the mass and stiffness of the bridge - bridge plate assembly **17, 22.** Generally speaking, vibration frequencies that coincide with natural mode frequencies of the top **7** will cause relatively much motion, resulting in a strong sound. At other frequencies the top is less willing to oscillate, and these tones will sound weaker.

Conventional lute type instruments have the braces glued over their entire length to the underside of the top. In such designs acoustical and structural considerations always interfere. For a well balanced response of the lower frequencies, the top needs to be much more compliant than structural requirements allow. Hence one always ends up with an instrument that may be structurally strong but has little or no bass response, or an instrument with a well balanced tone that is too fragile.

The present invention allows one to satisfy and optimize both structural and acoustical requirements without interference. When the guitar is strung up, the bending moment on the bridge caused by the strings is counterbalanced by reaction forces in pinjoints **2.** Braces **24a, 24b** and the entire bracing network **21** can be made sufficiently strong to withstand such reaction force. Because the braces are not touching the top **7** ex-

cept in a limited area very near linings **20**, they will not cause any stiffness effect on the top and render sufficient compliance for maximum acoustical efficiency at low frequencies. Because of pinjoints **2** the bridge and bridgeplate assembly **17, 22** is free to rock from side to side, and due to the special bracing the entire bridge and top assembly **17, 7, 22** can also move up and down to a large degree. Other modes of motion play a role only at higher frequencies where stiffness is an asset rather than a liability. Extra stiffness braces may still be applied locally to top **7** for optimum high frequency response, but in the present invention their proper sizes and locations are derived entirely from acoustical considerations and they play no structural role. Stiffness braces have been omitted from the drawings.

Another critical factor which determines the efficiency of sound radiation is the mass or weight distribution of the bridge - bridge plate assembly **17, 22.** Because the bridge is the only visible part of this assembly, its size and shape can be determined largely using aesthetical considerations; the thickness of bridge plate **22** can be tapered, as shown in FIGS. **5** and **6,** so that the total mass distribution of the entire assembly will be optimal for best balanced sound transmission over the entire frequency range of the instrument.

What is claimed is:

1. A stringed musical instrument of the lute type having a hollow body consisting of a top, a back and sides, a neck, strings tuned to increasing pitches from low on one side to high on the other side running generally parallel to said neck and terminating on a bridge attached to the top, the improvement comprising said bridge being also flexibly attached to a structure of at least one brace extending between said sides, neck or tailblock, said brace structure being separate from said top leaving a space between said brace structure and said top over the entire, or nearly entire, surface area of said top.

2. The invention as claimed in claim **1** in which a bridge plate is rigidly attached to said top underneath said bridge and in addition said bridge plate is rotatably attached to said brace structure at least two points which are along the intersection of said bridge plate and the plane bisecting the instrument, so that the bridge plate is free to rotate about an axis extending between said two points.

3. The invention as claimed in claim **2** in which some of said braces are attached to both said top at their extremes near said sides and to said sides in order to obtain a better bond between said top and said sides.

4. The invention as claimed in claim **2** in which the thickness of said bridge plate varies monotonically from side to side in a direction perpendicular to said strings so that its mass is largest at the side where the lowest tuned string terminates and smallest where the highest tuned string terminates.

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