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VIOLIN SOUNDING BOARD CONSTRUCTION

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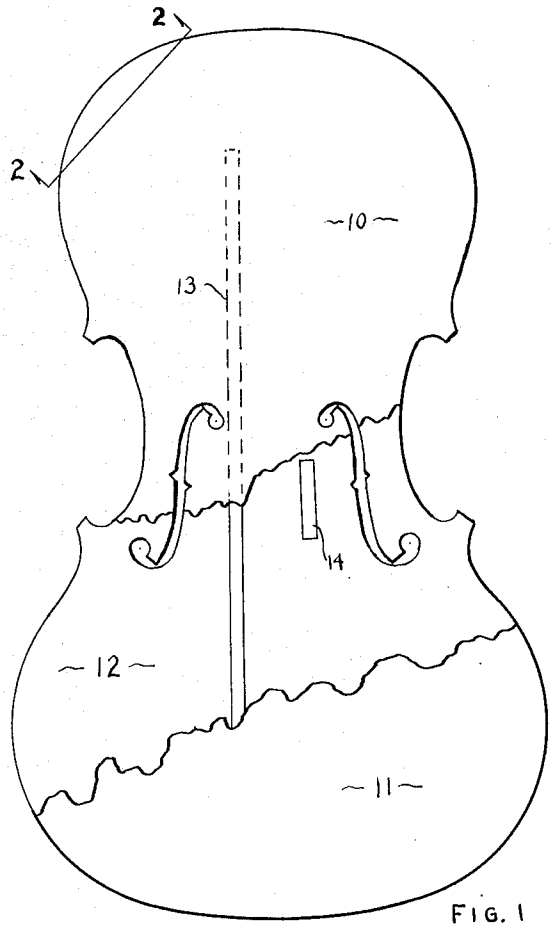


FIG. 1

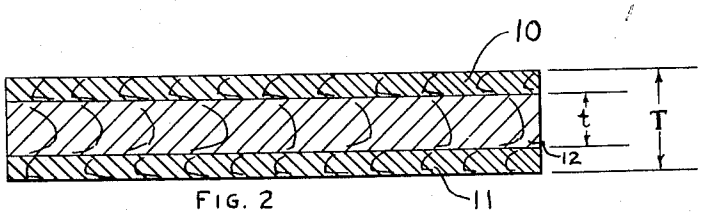


FIG. 2

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VIOLIN SOUNDING BOARD CONSTRUCTION

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3 Claims. (Cl. 84—291)

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The invention relates to improvements in sounding board and diaphragm construction.

One of the objects of the present invention is to provide a sounding board or diaphragm with a large ratio of stiffness to weight so as to decrease the damping characteristics of the diaphragm.

Another object of the present invention is to provide a laminated sounding board or diaphragm made of at least two different materials and having a larger ratio of stiffness to weight than a similar sized solid diaphragm made of either of the materials.

Other features of this invention reside in the arrangement and design of the parts for carrying out their appropriate functions.

Other objects and advantages of this invention will be apparent from the accompanying drawings and description and the essential features will be set forth in the appended claims.

In the drawings,

Figure 1 is a fragmentary elevational view of a violin having a laminated sounding board with some of the laminae of the sounding board broken away to show more clearly its construction while

Fig. 2 is a fragmentary vertical sectional view through the sounding board taken on the line 2—2 of Fig. 1.

While this sounding board invention can be adapted to various types of instruments, I have chosen to show the same as applied to a violin. The best sounding board or vibrating diaphragm has a high ratio of stiffness to weight. A high ratio gives a high resonant frequency for a given thickness of material. A light-weight diaphragm or sounding board reduces the effect of inertia and damping. A most satisfactory material for sounding boards is Sitka spruce wood because it has a high ratio of stiffness to weight and is a heavy fibrous wood having little resin.

The present application discloses a sounding board or diaphragm having a higher ratio of stiffness to weight than the conventional diaphragm or sounding board made from Sitka spruce wood. Since the outer fibers of the sounding board or diaphragm add more to the stiffness than the inner ones, a composite sounding board having outer layers made of material with relatively high stiffness such as Sitka spruce wood, and having an inner layer made of a relatively light-weight material within definite limits, will have a higher ratio of stiffness to weight than Sitka spruce wood, and therefore the composite sounding board will be more satisfactory than

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the solid Sitka spruce. The outer plies or laminae are of relatively stiff wood which is relatively heavy while the inner ply or lamina is made of light-weight wood which is generally not as stiff as the wood in the outer plies.

The drawings disclose a sounding board for a violin composed of three laminae, layers or plies extending along the lengths and widths of the sounding board. The outer two laminae 10, 11 are of substantially equal thickness made of the same kind of wood. They are generally made of Sitka spruce or Swiss pine because of its high stiffness. However, they need not be of equal thickness or be made of the same kind of material if they have the same or similar characteristics. An inner lamina 12 is made of wood lighter in weight than the wood in laminae 10 and 11. The material in lamina 12 need not have as large a stiffness as the material in laminae 10 and 11. However, since the stiffness of lamina 12 adds to the stiffness of the sounding board, it is desirable to have as much stiffness in lamina 12 as possible. Balsa wood could very well be used for lamina 12.

In a violin sounding board, there are certain areas of maximum stress which require additional support. These areas 13 and 14 in Fig. 1 have a solid thickness of the material making up the laminae 10 and 11. No inner lamina 12 exists in these areas.

The laminae 10, 11 and 12 are secured together preferably by gluing. It is desirable to use as little glue as possible since any excess glue will add to the weight of the sounding board and increase the inertia effect and damping effect. Here is one method of gluing the laminae together. A thin, tough and porous paper may be selected and then glue may be applied to both sides of the sheet of paper. The excess glue may be wiped off so that only a very thin film remains on both sides of the paper, and the glue permeates the paper. Then, one lamina is placed on each side of the paper, and the laminae are firmly pressed together.

There is a definite relationship between the thickness of the three laminae making up the laminated sounding board or diaphragm for obtaining better results than with the standard spruce wood diaphragm or sounding board. The mathematical relationships hereinafter set forth apply when the outer laminae 10 and 11 are of equal thickness and are made of the same material. Of course, both laminae need not be of the same material or thickness if each has the same physical characteristics. The best sounding

board is obtained when the ratio of the thickness of the inner lamina 12 to the thickness of the three laminae substantially bears the following relationship:

$$\frac{t}{T}=\frac{2-2K_s-\sqrt{(2K_s-2)^2-4(K_sK_w-K_s-K_w+1)(1-K_w)}}{2(K_sK_w-K_s-K_w+1)}$$

wherein

t=thickness of the inner layer or lamina 12

T=thickness of the three laminae or of the whole diaphragm or sounding board

$K_s=\frac{\text{stiffness of the material in the inner lamina 12}}{\text{stiffness of the material in the outer laminae 10, 11}}$

$K_w=\frac{\text{density of the material in the inner lamina 12}}{\text{density of the material in the outer laminae 10, 11}}$

Stiffness is defined as the resistance to deflection in a standard sized specimen and is expressed in units of force required to produce a unit bend in a standard sized (unit thickness and area) specimen of a selected wood. When balsa is used for the inner layer and Sitka spruce for the outer layers and the outer layers are of equal thickness, K_w and K_s are approximately 0.365 and 0.322 respectively and the thickness of the inner layer is approximately 0.568 times the thickness of the composite diaphragm or sounding board. Satisfactory results have been obtained with a violin when T=0.215 inch. Of course, the above values of K_w and K_s are for only the selected wood samples. These values will vary with the quality, growing conditions and seasoning of each sample.

A diaphragm or sounding board which is superior to the conventional solid sounding board has also been found. The mathematical relationships hereinafter set forth apply when the outer laminae 10 and 11 are of equal thickness and are made of the same material. Of course, both laminae need not be of the same material or thickness if each has the same physical characteristics. The relative thicknesses of the laminae of this sounding board may also be expressed by a formula:

$$R\frac{1-\left(\frac{t}{T}\right)^2+K_s\left(\frac{t}{T}\right)^2}{1-\frac{t}{T}+K_w\frac{t}{T}}$$

This sounding board has a greater ratio of stiffness to weight than the conventional solid one. After the above formula is solved for

$$\frac{t}{T}$$

the range of the thickness of the inner lamina 12 to the thickness of the sounding board for improved results bears the relationship:

$$\frac{t}{T}=\frac{R(1-K_w)\pm\sqrt{R^2(K_w-1)^2-4(R-1)(1-K_s)}}{2(1-K_s)}$$

wherein T, t, K_w, K_s have the same meaning as before. R is any factor greater than one which will give a real, positive solution for the above equation within the extreme limits of 0 and

$$\frac{1-K_w}{1-K_s}$$

For a diaphragm composed of an inner lamina

of balsa and outer laminae of Sitka spruce, the above formula would give a value for

$$\frac{t}{T}$$

approximately between 0 and 0.937 if K_w and K_s are approximately 0.365 and 0.322 respectively. However, these are the extreme outer theoretical limits since the above formula is a theoretical one obtained by mathematical derivation. In actual practice, there are factors nullifying the benefits obtained in the zones adjacent each of the limits set forth above. In actual practice, it has been found that good results are obtained if the lower limit is half way between the lower limit (0) and the best sounding board value, as set forth in the previous paragraph and if the upper limit is half way between the upper limit

$$\frac{1-K_w}{1-K_s}$$

and the best sounding board value. Hence, the lower limit is

$$\frac{t}{T}=\frac{2-2K_s-\sqrt{(2K_s-2)^2-4(K_sK_w-K_s-K_w+1)(1-K_w)}}{4(K_sK_w-K_s-K_w+1)}$$

while the upper limit is

$$\frac{\frac{1-K_w}{1-K_s}+\frac{2-2K_s-\sqrt{(2K_s-2)^2-4(K_sK_w-K_s-K_w+1)(1-K_w)}}{2(K_sK_w-K_s-K_w+1)}}{2}$$

The practical limits for

$$\frac{t}{T}$$

in an actual diaphragm made of Sitka spruce outer laminae and balsa inner lamina are 0.284 and 0.753. Any thickness of the inner lamina relative to the total thickness of the sounding board bearing a value within this range will give satisfactory results better than a solid diaphragm or sounding board.

Various changes in details and arrangement of parts can be made by one skilled in the art without departing from the spirit of this invention or the scope of the appended claims.

What I claim is:

1. A laminated sounding board for a violin comprising three laminae secured together and extending approximately the full width and breadth of the sounding board, the outer laminae being Sitka spruce having a high ratio of stiffness to weight while the inner lamina being balsa, the thickness of the sounding board comprising the composite thickness of the three laminae, the outer laminae being of equal thickness while the inner lamina comprising between 0.284 and 0.753 of the sounding board thickness.

2. A laminated sounding board for a violin comprising three laminae secured together wherein the outer laminae are of equal thickness and made of a different material than the inner lamina and the thickness of the inner lamina to the total thickness of the three laminae bears the relationship

$$\frac{R(1-K_w)\pm\sqrt{R^2(K_w-1)^2-4(R-1)(1-K_s)}}{2(1-K_s)}$$

wherein K_w is the relative density of the inner lamina material to the outer laminae material, K_s is the relative stiffness of the inner lamina

material to the outer laminae material, the material of the outer laminae has a greater density and stiffness than the inner lamina material has, and R is any value greater than 1 which gives real, positive solutions for the above equation between the limits

$$\frac{2-2K_s-\sqrt{(2K_s-2)^2-4(K_sK_w-K_s-K_w+1)(1-K_w)}}{4(K_sK_w-K_s-K_w+1)}$$

and

$$\frac{1-K_w}{1-K_s}+\frac{2-2K_s-\sqrt{(2K_s-2)^2-4(K_sK_w-K_s-K_w+)(1-K_w)}}{2(K_sK_w-K_s-K_w+1)}$$

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3. A laminated sounding board for a violin comprising three laminae secured together and extending along the length and width of the sounding board wherein the outer laminae are

of equal thickness and made of the same material but made of a different material than the inner lamina and the thickness of the inner lamina to the thickness of the three laminae substantially bears the relationship

$$\frac{2-2K_s-\sqrt{(2K_s-2)^2-4(K_sK_w-K_s-K_w+1)(1-K_w)}}{2(K_sK_w-K_s-K_w+1)}$$

wherein K_w is the relative density of the inner lamina material to the outer laminae material, wherein K_s is the relative stiffness of the inner lamina material to the outer laminae material, and wherein both K_w and K_s have values less than one.

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