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DIAPHRAGM UNIT AND METHOD OF FABRICATING SAME

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Fig. 1

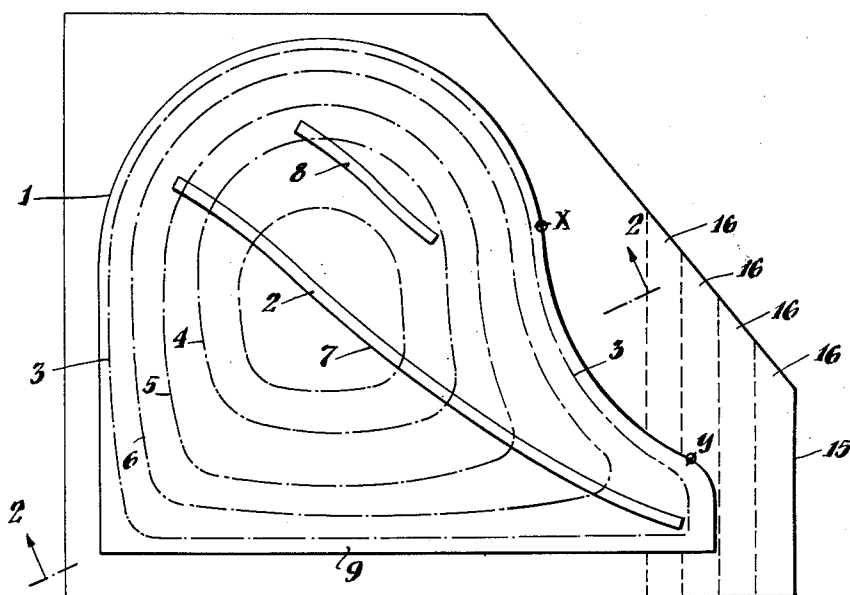


Fig. 2

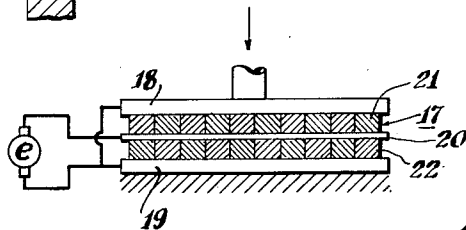
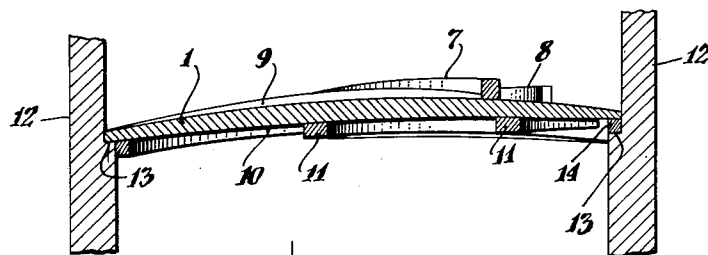


Fig. 3

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FABRICATING SAME

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1 Claim. (Cl. 84—192)

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This invention relates to vibrating diaphragm units for musical instruments such as piano soundboards, violin sound boxes, reeds of woodwind instruments and the like and relates more particularly to certain new and useful improvements in vibrating diaphragm units of the nature aforesaid and in methods of fabricating such units.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the processes, steps, articles and combinations pointed out in the appended claims.

The invention consists in the novel steps, processes, combinations, articles and improvements herein shown and or described.

The accompanying drawing, referred to herein and constituting a part hereof, illustrates one embodiment of this invention and apparatus for carrying out the process of the invention and together with the description serves to explain the principles of the invention.

Objects of this invention are to provide an improved diaphragm unit for pianos or other wood string or wood wind musical instruments and to provide an improved method of fabricating such units; to provide an improved method of conditioning wood, particularly wood to be fabricated into diaphragm units for musical instruments, to render the same less hygroscopic; to provide a piano soundboard which is a more homogeneous structure, which is less hygroscopic and hence will be less subject to cracking, shrinking, warping, buckling, swelling and such form of deterioration with changes in atmospheric conditions which impair the quick speaking properties of a soundboard; which will have a lower density for a given modulus of elasticity and strength; which will have less inertia and so possess an improved tone and enable the instrument to "speak" more quickly; and, to provide a new and improved method for manufacturing piano soundboards and like diaphragm units which will effect material economies in materials, in manufacturing cost, in manufacturing time and equipment and through the use of which soundboards having a more favorable ratio of elasticity to density can be produced from a given material stock without case-hardening or discoloration of the material.

Of the drawings:

Figure 1 is a view in top plan of a piano soundboard constituting a typical and illustrative embodiment of this invention;

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Figure 2 is a view in section taken along the line 2—2 of Figure 1 showing the soundboard with its bridge and ribs, applied to the frame of a piano; and,

Figure 3 is a diagrammatic view of one form of high frequency electrostatic apparatus for use in the carrying out of the method of this invention.

In accordance with the invention, the wood from which the diaphragm unit is to be fashioned or fabricated, is conditioned by subjecting the wood to a short time, high temperature electrostatic baking operation. The operation serves to reduce the mass (density) of the wood appreciably, to render the wood less hygroscopic thereby substantially preventing subsequent swelling, cracking, checking or warping of the wood and enables the accomplishment of these results without reducing the modulus of elasticity of the wood, or its strength (except for possibly a reduction in impact strength) and without objectionable discoloration or case-hardening of the material.

The wood to be processed is preferably in the form of strips or elements from one or more of which the diaphragm unit such as a piano soundboard, a violin box, or a reed of a wood wind instrument is subsequently to be cut, fashioned, shaped or assembled, as the case may be.

In accordance with the invention and as applied to the fabrication of a piano soundboard, wood strips of a length, width and thickness preferably in the range 2' to 9', 3" to 8" and $\frac{5}{8}$ " to $1\frac{1}{4}$ ", respectively, are placed between, and preferably in contact with, the electrodes of high frequency electrostatic heating apparatus such, for example, as is shown in Figure 3.

The strips may be stacked or piled one upon the other, but preferably are arranged in side-by-side relation so as to provide a single thickness of wood between each pair of electrodes. In such case twelve to twenty strips in each layer provide a convenient number although this may be varied to suit the capacity of the apparatus depending upon the strip dimensions.

The power supplied to the electrodes should be sufficient, having regard to the dielectric constant (e. g. 2.5 to 7.7) of the wood as a measure of its capacity to absorb power and be heated electrostatically, to establish within a practically useful time a temperature substantially uniformly internally of the wood, at which in addition to free moisture such constituents as oleo resins, e. g. rosin, pine oil, terpenes; acids, e. g. formic acid and acetic acid; and, particularly water-of-constitution of the cellulose, will be driven off.

A temperature in the range approximately 375° F. to approximately 425° F. preferably about 400° F., will, for most woods, be found suitable for effecting the removal of an optimum quantity of the constituents of the nature aforesaid. An ultra high frequency electrostatic field of about six to eight megacycles at an inner-electrode potential of about 5000 to 6000 volts per inch of spacing will in general be found suitable for the obtainment of the desired temperature. At this temperature, the quantity of constituents driven off in the short time required, for example, 10 to 30 minutes depending upon the wood, including its free moisture content, and the rate of energy input, will be such as to achieve a reduction in density appreciably greater, that is to say, greater by from about 4% to 10%, than is possible of obtainment by the customary relatively slow kiln drying operations (3 to 14 days) conventionally employed in the preparation of wood for use in soundboards and normally serving to drive off only free moisture.

Through the application of the electrostatic baking operation with its relatively short time, internal heating of the wood, excessive surface heating is avoided and discoloration due to scorching, which generally accompanies convective heat baking, is prevented. In consequence, there is avoided the planing of the wood surface required to remove scorched areas usually caused by convective baking which planing is ordinarily followed by painting of the planed surface as with aluminum paint, to cover discolored areas. The added mass of the aluminum coat substantially nullifies mass-reduction achieved by convective baking. In addition, radial cracking from tangential stresses induced by the relatively rapid surface drying and slower internal drying characterizing the usual kiln drying operations is avoided, so that stock loss is minimized with concomitant manufacturing economies. The combination of air drying and the conditioning of the wood in accordance with this invention minimizes the stock losses consequent upon normal kiln drying operations. Moreover, wood which has been processed in accordance with this invention possesses the definite advantage that reabsorption of moisture is held to a low percentage because the wood is less hydroscopic than either unprocessed wood or kiln dried wood.

In order further to minimize any possibility of discoloring the wood surface by scorching during the electrostatic baking operation, it may be found desirable to accentuate the normal surface cooling action of the relatively cold electrodes by continuously circulating therein a cooling liquid to maintain them at a relatively low temperature of, for example, 32° F. Or, the baking operation may be made intermittent in nature by interrupting the power input for short intervals so as to establish a hot interior and a relatively cooler exterior of the wood, a suitable temperature differential being, for example, in the order of 15° to 30° F., to prevent scorching. For example, the wood may be heated for 5 to 15 minutes, the current interrupted for 2 to 10 minutes, with or without cooling of the electrodes, and heating resumed for another 5 to 15 minutes.

The conditioned wood strips after removal from the electrostatic baking apparatus, are carefully graded so as to select therefrom those having substantially similar physical properties particularly as regards equivalency of density and modulus of elasticity. These strips are assembled in side-by-side relationship and adhesively

bonded together in accordance with practices well known in the art, to provide a soundboard blank of suitable dimensions from which the piano soundboard is cut and fashioned in a manner known to those skilled in the art.

The soundboard may be sized with a suitable lacquer followed by varnishing, preferably with an elastic varnish, thus sealing the wood against moisture absorption and at the same time improving its appearance.

Referring now more particularly to the accompanying drawings, there is depicted in Figure 1 a crown shaped piano soundboard 1 of the type disclosed in United States Patent No. 2,070,391 granted February 9, 1937, having its greatest thickness at 2. The thickness decreases toward its rim portion and is smallest at the rim portion indicated by the curved dot-dash line 3. Intermediate contour lines 4, 5 and 6 serve geographically to depict the crown shape of the soundboard whose greatest thickness, at the point 2, is at the geographical center of the soundboard.

Bridges 7 and 8 are secured to the upper convex preferably parabolic surface 9 of the soundboard with the larger bridge 7 of the two preferably passing over substantially the geographic center.

The lower concave surface 10 of the soundboard has secured thereto ribs 11 which together with the bridges 7 and 8 serve to hold the soundboard in its crown shape with the fibres of the upper convex surface 9 in tension and of the lower concave surface 10 in compression.

The soundboard is supported as shown in a piano frame 12 on the shoulder 13, a shim 14 being provided between the soundboard and shoulder between the points X and Y of Figure 1 so as to furnish equalized support with the remaining parts of shoulder 13 of the piano frame, not covered by shim 14.

The soundboard 1 is cut from a blank 15, depicted in outline form in Figure 1, comprising an assembly of grated strips 16 each carefully selected from stock electrostatically baked in the manner previously described so as to have substantial equivalency of physical properties, particularly as regards density and modulus of elasticity, and assembled in edge-joined relationship. Because of this prior conditioning and careful selection, the soundboard 1 is a more homogeneous structure and hence provides quicker response in its diaphragm action in use so that the instrument "speaks" more quickly. The soundboard is highly resistant to swelling, cracking, warping, checking and such forms of deterioration from climatic conditions.

In Figure 3 there is depicted in diagrammatic fashion a form of high frequency electrostatic apparatus for use in carrying out the method of this invention. As there shown, a press 17 has its top and bottom relatively movable platens 18 and 19 respectively connected as one electrode to one terminal of an electrical high frequency generator *e*. The other terminal of the generator is connected to a plate 20 forming the other electrode. Wood strips are positioned between the plate 20 and the press platens in upper and lower layers 21 and 22 respectively, to be subjected to the high frequency field generated by the generator *e* in the manner and for the purpose described. The electrodes 18, 19, and 20 may be hollow and provided with nozzles (not shown) for circulating cooling liquid in the electrodes.

It will be understood that the discoloration or scorching which woods undergo in convection

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baking operations is more pronounced with some woods than with others. Spruce of the Sitka, Engelmann, Rumanian, Rubra, White or Black variety preferred for piano soundboards discolors most easily, and hence may be operated on with advantage in accordance with this invention. Other conifers desirably employed for soundboards, such for example, as Noble Fir, Western Hemlock, Redwood and Cypress are less difficult in this respect but are advantageously operated on in accordance with this invention. Pine whether of the White, Ponderosa or Sugar variety also discolors easily and may be operated on with similar advantages as may Yellow Poplar although the latter is not subject to too ready discoloration.

The invention in its broader aspects is not limited to the specific steps, processes, combinations articles and improvements shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What I claim is:

The method of conditioning wood to be fabricated into a diaphragm unit for a musical instrument which comprises electrostatically baking the wood in an ultra high-frequency electrostatic field of about six to eight megacycles for a time and at a temperature in the range approximately 375° F. to approximately 425° F. so as to remove

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oleo resins and at least some of the water of constitution from the wood while cooling at least a portion of the wood surface so as to maintain a temperature differential in the order of 15° to 30° F. between the inside and outside of the wood and thereby avoid discoloration of its surface.

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