March 31, 1931. L. LOAR 1,798,212

PIANO

Filed Dec. 24, 1928 3 Sheets-Sheet 1

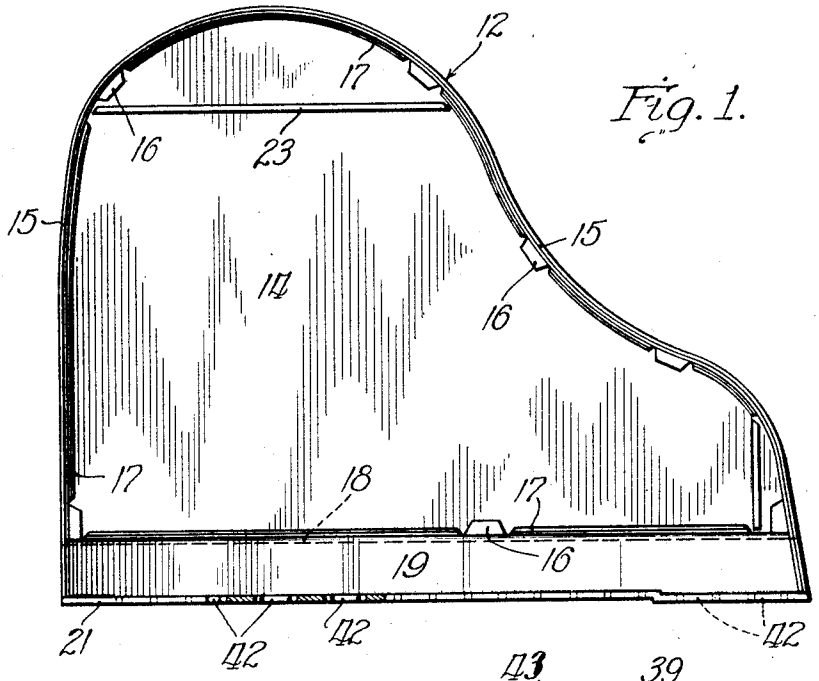

Fig. 1.

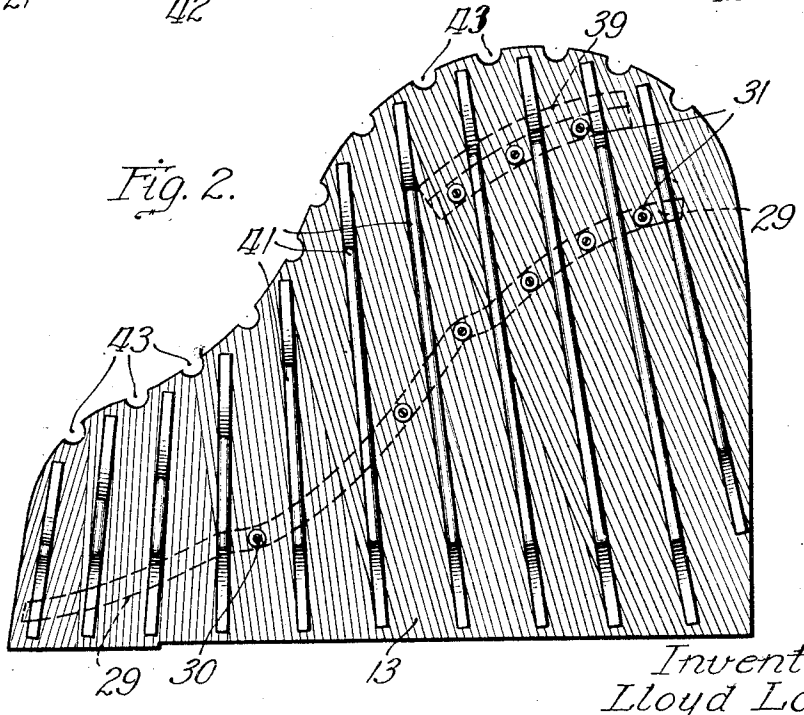

Fig. 2.

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Fig. 3.

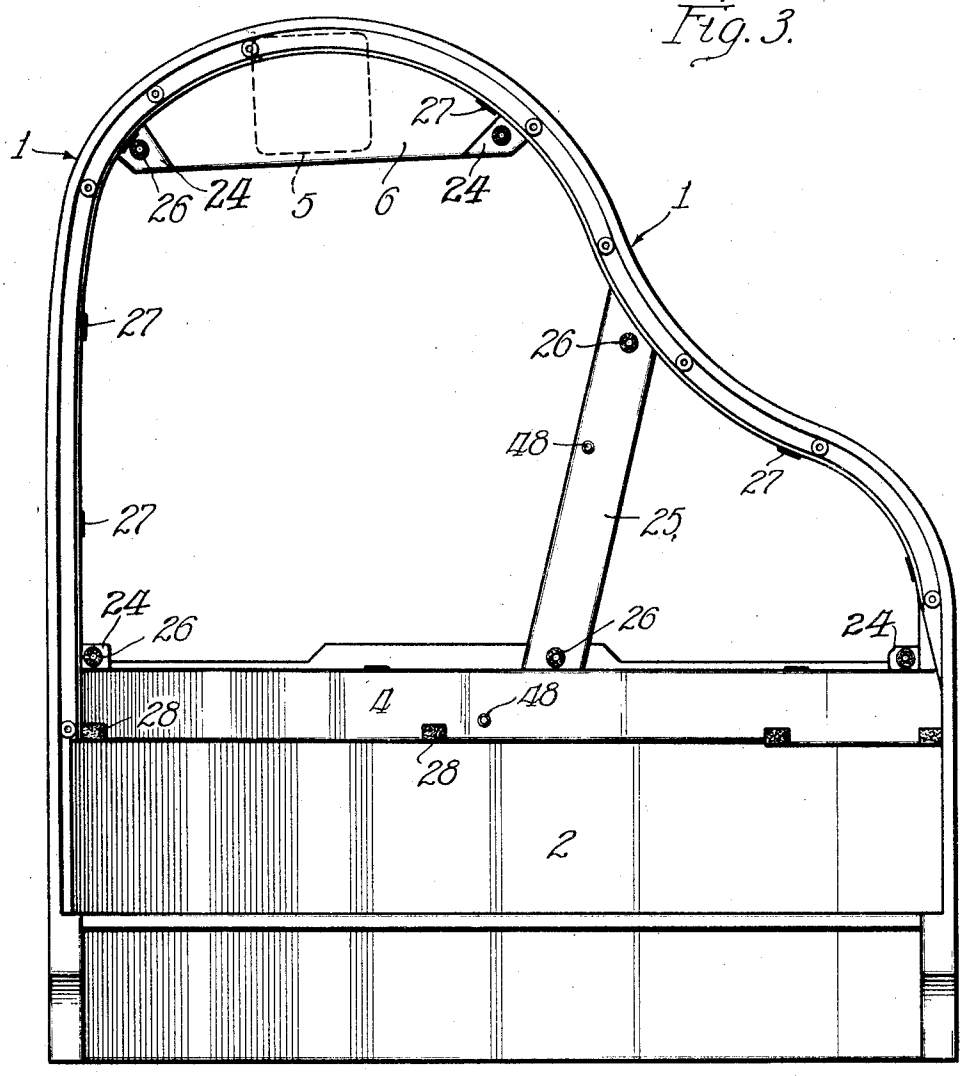

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Fig. 4.

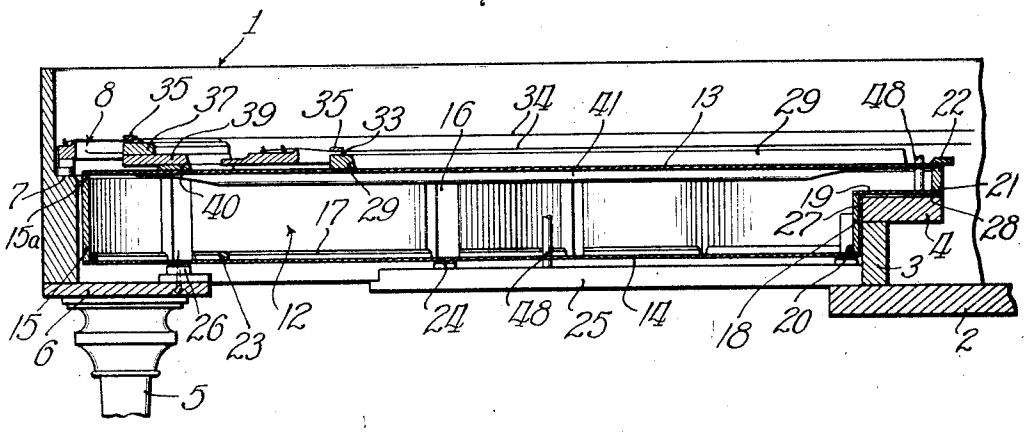


Fig. 5.

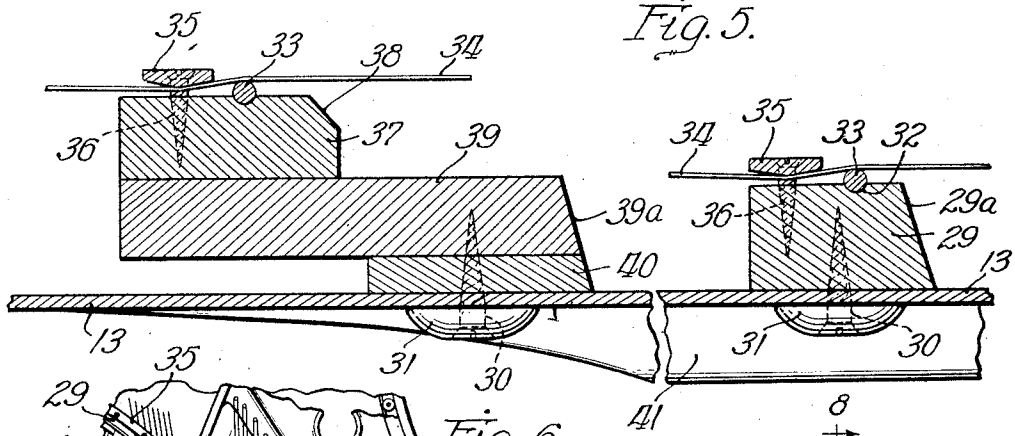


Fig. 6.

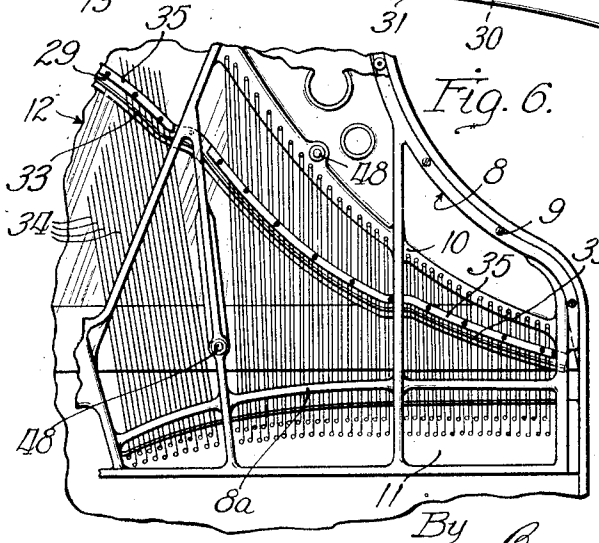
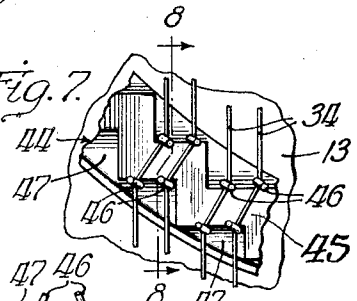


Fig. 7.



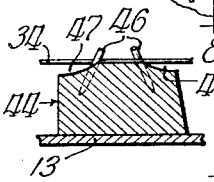


Fig. 8.

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Patented Mar. 31, 1931 1,798,212

UNITED STATES PATENT OFFICE

LLOYD LOAR, OF CHICAGO, ILLINOIS, ASSIGNOR TO GULBRANSEN COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

PIANO

Application filed December 24, 1928. Serial No. 328,238.

This invention relates to pianos and similar musical instruments, and has to do more particularly with the resonator of such an instrument.

It is the present practice in piano construction to arrange the sounding board in such manner that the grain thereof is disposed in substantial parallelism with the bridge. This relation of the grain of the sounding board to the bridge is inefficient both from the standpoint of acoustics and of construction.

From the structural standpoint, disposing the grain of the board parallel to the bridge renders the board unable to sustain the pressure exerted thereon by the strings through the bridge. This pressure may be from a minimum of approximately 750 pounds to 1200 pounds.

A sounding board with its grain disposed in the direction of the bridge would break under a pressure of less than 750 pounds on the bridge, and it is necessary, therefore, to provide the face of the board opposite to the bridge with reenforcing members or ribs which extend transversely of the bridge and, therefore, transversely of the grain of the board. These ribs are, of necessity, of considerable width to withstand the stresses to which they are subjected and are not readily vibrated with the board. As a result, the sounding board is inefficient and it is the common practice to employ three strings for each note to obtain the proper unisons and produce the desired volume of tone.

I have found that by properly constructing the sound board and disposing the grain thereof in the proper relation to the bridge, the above noted objection to the present construction of pianos can be avoided and better tonal qualities can be obtained, with the use of but two strings to each note, than is possible under the present practice referred to. In wood and other materials having a grain, waves propagated by vibration will travel in the direction of the grain with less resistance, and, consequently, less loss of energy, than such waves will travel across the grain. Also, in a piano, the vibrations of the string travel in the direction of the length thereof, and these vibrations are transmitted to the sound board through the bridge by transverse vibration or rocking movement of the latter.

In order to obtain maximum efficiency of the sounding board, the grain of the board should, therefore, be disposed at right angles to the length of the bridge and the string should be disposed at right angles to the bridge, also, that is, parallel to the grain. While it is not practicable to arrange the grain of the board at right angles to the bridge, and the strings parallel to the grain, due to the necessity of arranging the strings at different angles across the frame, the theoretical condition for maximum efficiency of the sounding board can be closely approached in a piano of present day construction. By disposing the grain of the board at approximately right angles to the length of the bridge, and arranging the strings in approximately the direction of the grain of the board, the volume and quality of the tone of the instrument is greatly improved over that of instruments of present type in which the grain of the board is parallel to the bridge, the improvement being so great that better results can be obtained by employing but two strings for each note than can be obtained on pianos of present construction using three strings for each note to produce unison. In accordance with my invention, I employ a sound box, the top or cover of which constitutes the sounding board, and this sounding board cooperates with the air body or column within the box in such manner as to greatly enhance the benefits above referred to obtained by the use of the board constructed and arranged in accordance with my invention. I also provide the sounding board with elements, which I term "tone bars", which primarily increase the efficiency of the board and also serve to reenforce the same mechanically.

Further objects and advantages of my invention will appear from the detailed description.

In the drawings:—

Fig. 1 is a plan view of a sound box in accordance with my invention, with the sounding board removed;

Fig. 2 is an underneath view of the sounding board;

Fig. 3 is a plan view of a piano case to which a sound box in accordance with my invention is to be applied, the sound box being removed;

Fig. 4 is a vertical sectional view through a piano with a sound box applied thereto, in accordance with my invention, taken from front to back of the instrument, the keyboard, action and associated parts being omitted;

Fig. 5 is a fragmentary sectional view through the sounding board and bridge structures, on an enlarged scale;

Fig. 6 is a fragmentary plan view of a piano with a sound box applied thereto in accordance with my invention, the frame and case being shown fragmentarily and in plan;

Fig. 7 is a fragmentary plan view of the sound box showing a different form of bridge applied thereto;

Fig. 8 is a section taken substantially on line 8—8 of Fig. 7.

I have illustrated my invention, by way of example, as applied to a grand piano. It is to be understood, however, that it is susceptible of use with other instruments, such as upright pianos, and I do not, therefore, intend to in any way limit myself to the one use of my invention illustrated and herein described.

The piano case 1 is of known construction and comprises a key bed 2 and rails 3 and 4. This case is supported by three legs, two front legs (not shown) and a back leg 5 secured to a cross piece 6 which is, in turn, suitably secured to the lower edge of the wall portion of case 1. The case 1 is provided with an interior shoulder 7 extending about the periphery thereof and providing a support for a frame 8 suitably secured to the shoulder, as by means of screws 9. This frame comprises a string plate 10 to which the ends of the strings are fastened by suitable pins, a wrest plate 11 which receives the tuning pins to which the strings are fastened, and suitable ribs and cross braces connecting these plates. The frame is of known construction and is commonly referred to simply as the "plate". The piano case and the string frame are, in general, of known construction. The strings are arranged on the frame in overstrung relation, that is, they are arranged in several sets or series disposed in different horizontal planes, the angles of the strings of the different sets or series varying somewhat relative to the front of the frame. This arrangement of the strings on the frame is well known in the art and may be considered as standard.

In conjunction with the case and frame, I provide a sound box 12 of special construction. This box comprises a top member constituting a sounding board 13, a bottom member 14, and a peripheral wall 15 connecting the sounding board 13 and bottom board 14. Blocks 16 are suitably secured to the wall 15, at the inner face thereof and in spaced relation. The boards 13 and 14 are secured to the ends of these blocks by being glued thereto and a molding strip 17 is preferably provided at the juncture of wall 15 and board 14, this strip being glued to the wall and to the board. The upper edge of wall 15 is preferably beveled downwardly and inwardly at 15*a* to provide a small area of contact between the sounding board 15 and this wall. The forward portion of the sound box 12 is preferably of L-shape, and comprises the vertical transverse strip 18 and a horizontal strip 19 disposed parallel to the rails 3 and 4, respectively. Strip 18 is preferably secured to board 14 by being glued thereto, a molding strip 20 being provided at the juncture of strip 18 and board 14. Strip 19 is glued, at its rearward edge, to the upper edge of strip 18, and the forward edge of strip 19 is glued to a relatively thick cross strip 21 to the upper edge of which is glued the forward edge portion of sounding board 13. A guide strip 22 is suitably secured to strip 21 and the forward portion of board 13 and is suitably bored for reception of the damper rods (not shown). I also preferably provide a cross brace strip 23 which extends across the upper face of board 14, adjacent the rearward end thereof, and is glued to this board.

A sound box, constructed as above set forth, is disposed within the lower portion of frame 1 in spaced relation thereto. This box is supported upon blocks or spacing members 24 secured to case 1 at the forward corners thereof and to cross brace 6, certain of these members being secured upon the upper face of a cross brace 25 which is suitably secured to the case.

The upper faces of the members 24 are covered by felt cushion members 26 suitably secured thereon, and the peripheral wall 15 of the sound box is held spaced away from the peripheral wall of the case 1 by felt spacing members 27 suitably secured to the inner face of the case, as by gluing, and spaced about the same so as to effectively hold the sound box out of contact with the case of the instrument. The sound box is thus supported in the case in such manner as to be capable of vibrating freely in all directions, it being noted that felt spacing members 28, secured on the upper face of rail 4, hold the strip 19 of the box out of contact with this rail. The sound box is thus effectively insulated from the case 1 so as not to have its vibration damped thereby.

The construction of the sounding board 13 and the disposition of the grain thereof relative to the bridge is highly important. This board is constructed of spruce and is formed in two or more sections suitably secured together, as by gluing. The board 13 is so constructed that the grain thereof is disposed substantially radially from a point

outside of and in rear of the board. This disposition of the grain is indicated in Fig. 2. Referring more particularly to Figs. 2 and 6, the main bridge 29, in the form of a compound curve, which is the usual form of the main bridge in a piano, seats upon the upper face of sounding board 13. This bridge is secured to the board by screws 30 which pass through wooden heads or buttons 31 bearing against the under face of board 13.

These screws pass through suitable openings in the board 13 and screw into bridge 29 from the under face thereof. The bridge is of substantially rectangular cross-section, but has its front surface inclined downwardly and forwardly at 29*a*. The bridge is provided, in its upper face and adjacent the front thereof, with an arcuate groove 32 in which seats a bearing member 33 in the form of a rod or wire of steel or other suitable material one-eighth of an inch in diameter. The diameter of this rod is not, however, essential and may be varied within limits. The strings 34 extend across the bridge 29 and bear upon the member 33, these strings passing beneath a pressure plate or bar 35 adjustably secured to the rearward portion of bridge 29 by screws 36. This bar has its under face inclined downwardly from each edge to its center (Fig. 5) so as to exert pressure upon the strings 34 throughout an appreciable area and avoid corners or sharp edges in contact with the strings. The height of the bridge 29 is such that the bearing member 33 is disposed slightly below the upper rearward edge of plate 10 upon which the strings bear, and the strings are inclined downwardly and forwardly of frame 8, passing beneath element 8*a* thereof and being then inclined upwardly and forwardly from element 8*a* to the tuning pins. This mounting of the strings on the frame or plate is well understood in the art and need not be illustrated nor described in detail. The pressure exerted by the strings on the bearing member 33 is transmitted to the bridge at the forward portion thereof. The pressure plate 35 serves to depress the strings immediately in rear of the bearing member 33 and, due to the resistance of the strings, exerts a lifting effect at the rearward portion of the bridge. The bridge is, therefore, subjected to a downward pressure at its forward portion and a lifting effect at its rearward portion being thus mounted in such manner as to readily respond to vibration of the strings. The bass bridge seats upon the upper face of the rearward portion of the sounding board 13 and comprises a bridge member 37 of substantially rectangular cross-section, the inner upper corner of this member being beveled at 38. Member 37 is provided, in its upper face, with an arcuate groove in which seats a bearing member 33, and a pressure bar or strip 35 is adjustably secured to the rearward portion of member 37 by screws 36. The bass bridge member 37 is secured to a supporting member or strip 39, in a suitable manner, the forward portion of member 39 being secured to a spacing strip 40, members 39 and 40 being secured by screws 30 and buttons 31 to board 13. The forward edge of member 39, as well as the forward edge of the spacing member 40, is inclined downwardly and forwardly at 39*a*. The bass bridge 37 is subjected to a combined lifting effect at its rearward portion and downward pressure at its forward portion so as to be capable of readily responding to vibrations of the strings 34. The bridge member 37 acts through the member 39 with a lever effect to transmit the vibrations to board 13.

The sounding board 13, by having the grain thereof disposed in the manner illustrated and described, possesses sufficient mechanical strength to support the bridge structures and to resist the downward pressure exerted thereon by the strings.

This pressure may vary from a minimum of approximately 750 pounds to a maximum of approximately 1200 pounds. The main bridge extends substantially the full width of the sounding board so that this pressure is distributed throughout the board and, by having the grain thereof disposed transversely of the bridge, this sounding board is capable of withstanding the string pressure. To obtain maximum efficiency of the sounding board as a resonator, the entire area of the board should respond instantaneously to the vibrations of the strings. To accomplish this, I provide tone bars 41 which are glued or otherwise suitably secured to the under face of sounding board 13. Referring more particularly to Fig. 2, these bars are disposed in the general direction of the grain of the sounding board, but at a slight angle thereto, and are so related that a portion at least of the grain which is intercepted by a bar is also intercepted or crossed by a succeeding bar. In this manner, the grain of the board is connected or tied together by the tone bars throughout substantially the entire area of the board. Upon a string above a portion of the board being vibrated, these vibrations are transmitted through the bridge to the board and are then distributed by the tone bars throughout the entire area of the board. As a result, the board responds instantaneously to the string vibration throughout its whole extent. By disposing the tone bars in the general direction of the grain of the board, vibration of the board is not interfered with to any material extent, so that the loss of energy is reduced to a minimum and the board has maximum efficiency as a resonator.

The tone bars are relatively narrow and thin as compared to the reenforcing ribs used on sounding boards of present construction, and are primarily designed and arranged to

assist in the instantaneous vibration of the board throughout its entire area in response to vibration of the strings of the instrument, instead of preventing or damping the vibration of the board as occurs when relatively thick and wide reenforcing ribs are used substantially at right angles to the grain of the board as in present day piano construction. The tone bars 41 also serve to impart additional mechanical strength to the board, though this function of the tone bars is to be considered as supplemental to the function of assisting in the instantaneous vibration of the board throughout substantially its entire extent.

As will be noted more clearly from Figs. 2 and 6, the strings are disposed in the general direction of the grain of the board and transversely of the bridge structures. I thus produce an assembly in which the strings and the grain of the sounding board are disposed transversely of the bridge, the strings extending in the general direction of the grain of the board, and the tone bars 41 are also disposed transversely of the bridge and in the general direction of the grain of the board. It is not possible, due to practical considerations of construction, to dispose the grain of the board at right angles to the bridge, though in my construction the grain is disposed at approximately right angles and the strings are disposed approximately parallel to the grain.

When a string is struck, the resulting vibrations travel lengthwise of the string and serve to vibrate the bridge transversely. These vibrations of the bridge are transmitted to the sounding board and travel in the direction of the length of the grain thereof, this board responding instantaneously and throughout its entire extent to such vibrations. I thus provide a sounding board construction which possesses maximum efficiency both from the standpoint of construction and acoustically. The tone produced by the use of this board in a piano which is, in all other respects, of known construction, results in a tone of much greater volume and better quality than it is possible to obtain from a piano employing a sounding board of present day construction.

The body of air within air chamber or sound box constitutes an air column which has an individual pitch or natural rate of vibration. The function of this air column or body is to add resonance to the notes emitted by the piano. An air body cannot resonate a tone lower in pitch than its own pitch. In constructing the sound box the air column enclosed thereby is given a definite pitch, by its size and suitably disposed openings or outlets, as nearly as possible within the deepest octave of the bass clef and yet not so far below the last octave of the treble clef but what the notes of the treble clef will be resonated by the air body. Referring more particularly to Fig. 1, front strip 21 of the sound box is provided with suitably disposed slots 42 establishing communication between the sound box and the surrounding atmosphere.

Sounding board 13 is provided with a plurality of openings 43 extending inwardly from the periphery thereof, the size, number, and disposition of these openings depending to a great extent upon the size and shape of the air body or column within the sound box. By means of these openings the air column within the sound box is tuned so that its pitch or natural period of vibration is between F and G of the lowest octave of the bass clef. I have found that the air column, tuned to the pitch stated, is highly efficient for all notes higher in pitch than such air column, and is also efficient for notes lower in pitch than the air column, since these low notes possess numerous overtones which are readily resonated by the air column. When a note is struck on the piano corresponding in pitch to the pitch of the air column of the sound box, this air column tends to respond to the vibration of the note, due to sympathetic vibration, to its fullest extent and would resonate this particular note out of all proportion to the other notes of the instrument in the absence of means to prevent this. In order that all of the notes of the instrument may be resonated equally and an even scale in sound produced, the sounding board 13 and the bottom board 14 of the sound box are so constructed as to be of different pitches than the pitch of the air column. As a result, the natural period of vibration of the sounding board and of the bottom board of the box are different from the natural period of vibration of the air column in the sounding box, and when the note is struck which corresponds in pitch to the pitch of this air column, excessive resonance, due to sympathetic vibration of the air column is prevented by the sounding board and the bottom board of the box which are of different pitch than the air column and, therefore, are antagonistic to vibrations thereof at its natural pitch or rate of vibration. The box, as a whole, including the air column and the sounding board, is thus capable of greatly amplifying all of the notes of the instrument while avoiding excessive resonance when any one note is struck. The scale is, therefore, even and the tone produced is rich in quality and of great volume. The openings 43 in the sound board 13, in addition to serving as means for tuning the air column of the sound box, also facilitates vibration of the board. The improvement in tone and volume, as compared to pianos of present day construction, is so great that I employ but two strings to each note. I am able to obtain greater volume and better tone quality

than is possible in pianos of present day construction employing three strings to each note. This is, from a practical standpoint, a decided saving in construction of the instrument.

In pianos of present construction, the strings are held in position by pins set into the bridge. There are two pins for each string. This means that there are two holes drilled, two notches cut, and two pins set into the bridge for each string of the instrument. This is all hand work and there are from 225 to 230 strings on a piano of ordinary construction. By utilizing the tension bar 35, I avoid the use of pins, thus effecting a material saving in construction of the bridge member.

The pressure plate 35 is also of assistance in regulating the pressure and the direction thereof exerted upon the bridge, as previously described. This pressure plate also regulates, to a certain extent, the amount of pressure exerted by the strings and the tension thereof. It is thus possible, by adjusting the plate, to alter or correct the tone of the instrument, to a certain extent, after it has been completed and assembled and without involving any change in any of the main constructional features thereof.

While I prefer to employ the form of bridge construction illustrated in Fig. 5, a sounding board constructed in accordance with my invention can also be used to advantage with a bridge of ordinary construction. In Figs. 7 and 8 I have illustrated a bridge 44 of known construction mounted upon the sounding board 13, this bridge having a bearing surface 45 for the strings and being provided with pins 46 which are inclined oppositely to the pressure of the strings. The bridge is notched out at 47 beneath the strings 34 in a known manner and for a purpose well understood in the art. The strings 34 being under tension, in conjunction with the pins 46, exert a lifting effect at the rearward portion of the bridge and a downward pressure at the forward portion thereof in a manner somewhat similar to the forces acting upon the bridge 29 in Fig. 5. In using either form of bridge, the grain of the sounding board is so related to the bridge and the strings and tone bars as to obtain maximum efficiency in vibration of the sounding board, as previously described.

It will be noted that by my construction I have provided a sounding board in which the bridge is mounted upon the intermediate portion of the board, that is, remote from the periphery thereof, the grain of the board being disposed transversely of the bridge and the strings being connected to the bridge in such manner as to vibrate the board in accordance with vibration of the strings. More specifically, the grain of the board is disposed at approximately right angles to the bridge and the strings of the instrument and the tone bars are disposed in approximate parallelism with the grain of the board, the tone bars serving to connect the grain of the board throughout the greater portion thereof.

Two tie bolts 48 are secured through the cross-brace 45 and extend upwardly through the sound box and the sounding board 13 thereof, these bolts being suitably secured through the frame 10. The keyboard, action, and other mechanisms for operating the instrument are well understood and need not be shown nor described.

What I claim is:—

1. In a piano, a sound box comprising a sounding board, a bridge structure seating upon the board, strings bearing on the bridge structure, the grain of the board being disposed transversely of the bridge structure, and means supplemental to the board and connecting the fibres thereof throughout the greater portion of the board, said connecting means being disposed in the general direction of the grain of the board.

2. In a piano, a sound box comprising a sounding board, a bridge structure seating upon the board, strings bearing on the bridge structure, the grain of the board being disposed transversely of the bridge structure, and tone bars secured to the board and disposed in the general direction of but in angular relation to the grain thereof, said bars being disposed to continuously connect the grain of the board throughout the greater portion thereof.

3. In a piano, a sound box comprising a sounding board having spaced openings in its periphery, a bridge structure seating upon the board, and strings bearing on the bridge structure, the grain of the board being disposed transversely of the bridge structure.

4. In a piano, a sound box comprising a sounding board, a bridge structure seated upon said board and extending across the board substantially midway between the ends thereof, and strings bearing upon the bridge structure, the grain of the board being disposed transversely of said bridge throughout the entire length thereof.

5. In a piano comprising a case, a sounding board mounted within the case and spaced therefrom, a string frame within the case and spaced from the board, said board being free from both the case and the frame, a bridge structure seating upon the sounding board, and strings strung upon the frame and bearing upon said bridge structure.

In witness whereof, I hereunto set my hand this 20th day of December, 1928.

LLOYD LOAR.