May 30, 1933. B. F. MIESSNER 1,912,293

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

Filed May 9, 1932 2 Sheets-Sheet 1

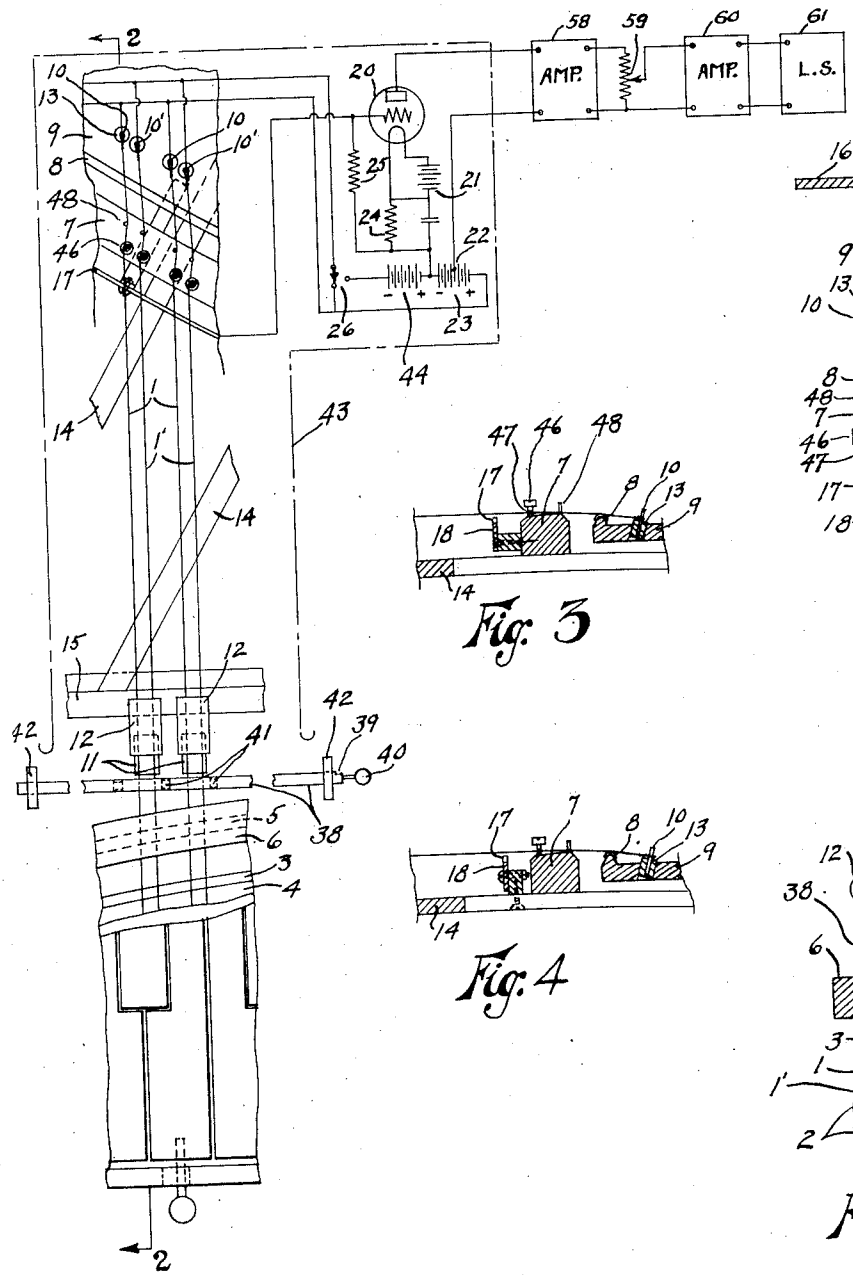

Fig. 1

Fig. 3

Fig. 4

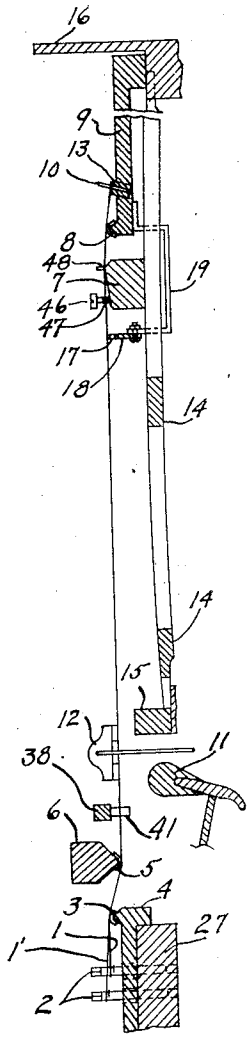

Fig. 2

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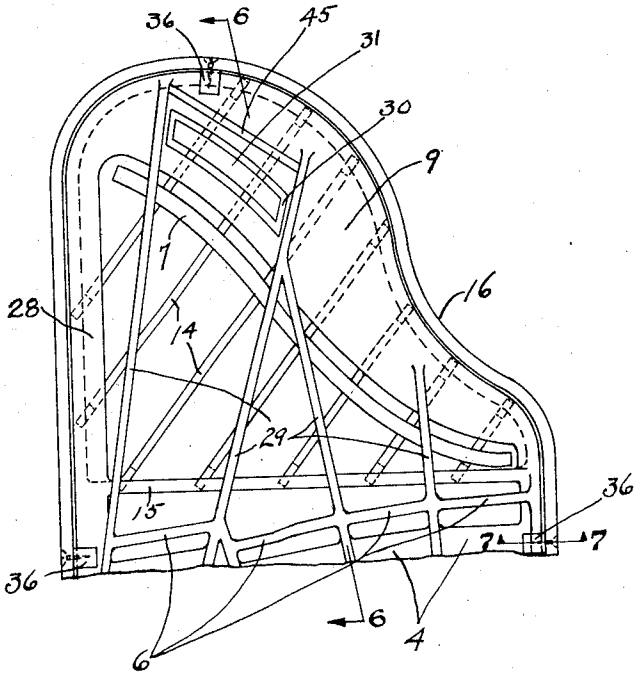

Fig. 5

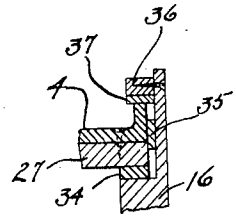

Fig. 7

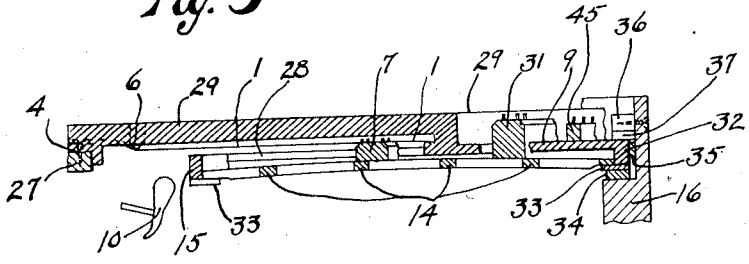

Fig. 6

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

Application filed May 9, 1932. Serial No. 610,124.

This invention relates to the production of music from tuned vibrators, and more particularly to musical instruments in which the vibrations of the vibrators are translated into electric oscillations and these oscillations in turn translated into sound. Instruments of this class have been broadly disclosed and claimed in my co-pending applications Serial Number 512,399, filed January 30, 1931, and Serial Number 528,750, filed April 9, 1931.

In instruments employing tuned vibrators, it is conventional to produce the desired tones, at the desired moments and for the desired durations, by selectively and appropriately vibrating the vibrators. Usually the excitation into vibration of each vibrator, by the application either of a momentary force (as in the piano) or of a vibrating force continuously acting for the duration of the tone, is accompanied by certain transient effects which markedly differentiate the beginning of the tone from the remainder. For the production of tones relatively free of such transient effects, wind pressure has been practically the only exciting force extensively used.

It is an object of my invention to provide improved and novel means and methods for reducing these transient effects in instruments of the class described in which any form of vibrator excitation is employed. It is an allied object to provide means and methods for rendering organ-like the output tones of a piano employing mechanico-electro-acoustic translation.

Another object of my invention is to provide an improved instrument employing such translation by which may be selectively produced piano-like or organ-like tones.

A further object is the provision of means and methods for improving certain tone effects characteristic of the piano.

Another object is the provision of improved mechanico-electric translating systems for use in instruments of the class described. A still further object is the provision of an improved construction for a piano employing mechanico-electro-acoustic translation. Other and allied objects will more fully appear from the following description and the appended claims.

In such description, reference is had to the accompanying drawings, of which:—

Figure 1 is a plan view of a portion of an instrument of the grand piano type in which my invention is embodied, certain electrical and electro-acoustic apparatus appearing schematically therein;

Figure 2 is a cross-sectional view taken along the line 2—2 of Figure 1;

Figures 3 and 4 are each alternative views of a portion of Figure 2, illustrating a modification of my invention in respect of the mechanico-electric translation;

Figure 5 is a plan view of a grand piano rim and frame or plate, and Figures 6 and 7 each cross-sectional views thereof, illustrating a preferred method of construction and assembly.

In Figures 1 and 2 I show a plurality of strings 1 and a plurality of strings 1′, strung from tuning pins 2 over insulation 3 on front frame portion 4, under insulation 5 on capo 6, over bridge 7, over insulation 8 on rear frame portion 9, and to hitch pins 10 and 10′, respectively. One string 1 and one string 1′ may be tuned to each note to be produced, and for each such pair of strings may be provided a hammer 11 and a damper 12, actuated in conventional manner. Front frame portion 4, capo 6 and rear frame portion 9 may of course form an integrally cast frame or plate, as customarily (excepting that this frame may if desired include an additional member hereinafter described). In order that the insulation of the strings from the frame may be complete, hitch pins 10 and 10′ may be set in insulating bushings 13 and these in turn into rear frame portion 9. Tuning pins 2 should of course pass into wrest-plank 27 through over-size holes in front frame portion 4.

While bridge 7 may be rigidly mounted, I have found it preferable when piano tones are at times desired to couple the strings together vibrationally by mounting the bridge to a plurality of strips or ribs 14, which may be similar to those customarily employed for reinforcement of the piano soundboard,

although the latter itself may be omitted. These ribs 14 may be slightly arched toward the strings, the better to resist their downward pressure. The forward ends of the right-shown ribs may be secured to cross-member 15. All other ends of the ribs and the ends of cross-member 15 may be secured to the rim 16 of the piano, or in such alternative manner as is hereinafter described. Coupling together of the vibrators in an instrument of the class described is generally shown and claimed in my co-pending application Serial Number 573,319, filed November 6, 1931.

For translating the vibrations of the strings into electric oscillations I show an electrically conductive strip 17 underneath points on the several strings which are preferably at a similar fractional distance from the ends of respective strings. Strip 17 may be cemented to the top of insulating strip 18, which may be mounted to the frame as by brackets 19, being positioned vertically as close to the strings as possible without causing contact of conductive strip 17 with any string under conditions of maximum vibration of the latter. The strip 17 may be connected to the grid of thermionic vacuum tube 20, whose filament or cathode may be energized in any suitable manner, as for example by battery 21. Anode current for tube 20 may be derived from a tap 22 on high voltage battery or other source 23. The cathode of tube 20 may be maintained at a potential slightly positive with respect to the negative terminal of battery 23 by the flow of its anode current through condensively by-passed resistor 24; and the grid of the tube may be biased to the potential of such negative terminal by connection thereto through high resistance 25. All the strings 1 may be connected together and to the positive of battery 23; and all the strings 1′ may be connected together and to switch 26, in one of the positions of which (as shown) the strings may be electrically paralleled with strings 1. The operation of the system will first be described with switch 26 in this position.

It will be seen that between each string and strip 17 a small electrostatic capacity exists. These capacities in parallel form a total capacity between strings and strip. This total capacity is charged to the potential of battery 23 through resistance 25; and by virtue of the high value of this resistance this charge cannot change rapidly. If now any string 1 or 1′ be vibrated, its capacity to the strip will be varied oscillatorily, in accordance with the frequency and waveform of the point of the string directly above the strip, and the total string-strip capacity will be likewise varied, though in reduced degree. By virtue of the inability of this capacity to change its charge rapidly, there will be produced across the capacity an oscillatory voltage variation corresponding in frequency and waveform to those of the string point vibration abovementioned. These voltage variations appear as A. C. voltages across resistance 25 and hence are applied to the grid of tube 20. Amplified by this tube, they may be supplied to amplifier 58, controlled in respect of amplitude by volume control 59, further amplified by amplifier 60, and translated into sound by loudspeaker or other electro-acoustic translating device 61. Electrostatic shielding, shown schematically as 43, may advantageously be provided at least partially about the tube 20, its immediately associated circuits, and the mechanico-electric translating apparatus.

It will be seen that by switch 26 the strings 1′ may be connected, instead of in parallel to strings 1, to the negative terminal of a battery or source 44, preferably of equal potential to that of battery or source 23. Thus these strings are rendered opposite to strings 1 in their mean potential with respect to strip 17. When the strings 1 and 1′ for any note are of the same potential, both the mechanical and electrical transient effects resulting from excitation—i. e., impact of hammer 11 therewith—are similar and the electrical effects cumulative. When switch 26 is thrown to connect strings 1′ to a potential opposite to that of strings 1 as abovementioned, however, the mechanical transient effects are still similar; but such electrical effects produced by the two respective strings, though similar, are opposite in phase to each other, and therefore cancel—i. e., their algebraic addition is actually or sensibly zero. Thus the momentary initial high amplitude of a typical piano tone is eliminated from the output tones of the instrument described when strings 1′ are of opposite potential to strings 1.

For the more desirable tone characteristics following the initial moment, I prefer to cause the vibration of one of the two strings for each note—shown as 1′—to damp out quickly. This obviates any tendency toward cancellation of the effects of one string by that of the other in the later tone characteristics, eliminates the possibility of beats resulting from slight lack of unison between the two strings, etc. Thus in Figures 1 and 2 I show damping pads 41 carried by the bottom of rod 38. The latter is schematically shown as being slidable to the left, as by handle 40, to press dampers 41 against strings 1′, in which position they may be held by engagement of slot or notch 39 in rod 38 with one of the rod supports 42. Thus the strings 1′ will be damped between the point of striking by hammers 11 and their forward extremities. This is a desirable point for the damping, which should not be effected anywhere on the string between the points of striking and translation.

Thus by translating oscillations from each of two strings whose vibrations are at least in their beginnings in phase and of which the vibration of one preferably dies away rapidly, and by combining these oscillations to oppose each other at least as respects their initial peaks, I am enabled to secure organ-like tones. Although I prefer to damp one of the strings as just described, I do not wish to limit my invention by invariable specification of such damping, since I have found in practical cases with tuned strings that it may be dispensed with and the organ-like effects still obtained. I further do not wish to limit my invention to use with strings and an electrostatic form of translation, since the invention obviously is applicable to other vibrators and may be carried out with other forms of translating apparatus, such for example as separate electromagnetic translating devices for each vibrator, with opposing series or parallel connections between the devices.

It will be appreciated that I may employ selective means—e. g., switch 26—for changing the translation phase relations from opposition to similarity, as for obtaining organ-like or piano-like tones at will. It will be further appreciated that if one of the strings—as 1′—for each note be damped, as above described, when strings 1 and 1′ are at the same potential (for piano-like tones), an emphasis on the early part of the tone with relation to later portions will be obtained. This effect I have found useful as either a permanent piano arrangement, or an optional one selectively available by manipulation of the damper control.

For the best effects of the character described—particularly in eliminating initial transients from the tones—it is desirable that the excitation of the two vibrators be not only coincident but similar. Thus, while adjacent strings have been shown as slightly different in length, the hammers 11 may strike each at the same fractional distance from the end of its vibratory portion. Likewise it is desirable that the translating device, e. g., strip 17 be positioned adjacent corresponding points on the vibrators.

In the co-pending application of myself and Charles T. Jacobs, Serial Number 558,207, a means and method for adjusting the positions of the strings relative to the translating devices was shown and claimed; and I have found it convenient to employ the same in carrying out the instant invention. Thus each string 1 and 1′ may be secured to bridge 7 by being passed around screw 46 in a circumferential groove 47 therein, and thence around bridge pin 48 to the hitch pin. The vertical position of groove 47 and therefore the distance of the string from strip 17 may then be adjusted by turning of screw 46. As shown in the co-pending application last mentioned, such adjustment may provide a satisfactory means of voicing the instrument for uniform volume of different tones. In the instant invention it may further be employed to render similar the electrical transient effects from a string 1 and its associated string 1′. The adjustment of the relative spacings of any such two associated strings is best made with the two strings at opposite potentials, the criterion of proper adjustment being greatest freedom from abruptness of inception of the output tone from loudspeaker 61 upon excitation of the two strings.

In Figure 2 I have shown the translating strip 17 mounted to the rigid rear frame portion 9. Under these conditions, and when a vibratile bridge such as 7 is employed, the translated oscillations will include not only the component translated from the vibrations of the point of the excited string opposite the strip, but also a component generally corresponding to the vibration of bridge 7. This results from the fact that the bridge is vibrated by the directly excited string, and in turn produces a slight similar vibration of all the strings as a group. This bridge-like string vibration, while of low amplitude compared to the vibration of the point on the excited string, is translated from all the strings instead of from only one, and therefore, may produce an appreciable component in the translated oscillations.

For the reduction or elimination of this bridge vibration component I show in Figure 3 an alternative mounting of the translating device—i. e., of strip 17 by its insulat- strip support 18. This mounting is to the bridge 7 instead of to the frame. In cases where a translating device is positioned at an appreciable distance from the bridge 7, and in other cases where desired, the translating device may be mounted to the ribs 14 instead of to the bridge, since these ribs tend to vibrate similarly with the bridge. This second alternative mounting I show in Figure 4.

Whether the translating device be mounted to frame, bridge or ribs, I have found it decidedly convenient, particularly from the point of view of construction and assembly of an instrument of this character, to have the frame, wrest-plank and tuning pins, bridge, ribs, strings etc., an integrally supported unit, removable from the piano rim and case without unstringing of the instrument. Such construction has other advantages, including the opportunity which it affords to insulate vibrationally all the strings and the translating system from the rim and case, which are subjected to external shocks from time to time, and to repeated shock upon the bottoming of each key in the playing of the instrument. Accordingly in Figures 5, 6 and 7 I have shown an assembly of a suitable frame, with bridges, ribs etc., having these advantages.

In Figure 5 will be seen an integrally

formed plate or frame 28, which may include all the portions normally possessed by a piano frame, such as reinforcing struts 29, capos 6 (some of which may of course be replaced with agraffes), front portions 4, rear portion 9, etc. In conventional opening 30 in plate 28 may be seen bass bridge 31, supported by some of the same ribs 14 which support the treble bridge 7. The forward extremities of the right-shown ribs 14 may be secured to cross-member 15; but this cross-member is shown in these figures as an integral portion of the frame 28. The other extremities of the ribs may be secured to frame 28, underneath and near the periphery of the latter. The vertical position of cross-member 15, a manner of securing ribs 14 to the frame, and other details will better appear by reference to Figure 6, a vertical cross-section taken along the line 6—6 of Figure 5—i. e., principally through one of the reinforcing struts 29.

Herein may be seen a flange 32, which may extend downwardly around the periphery of plate 28 and be continuous for example with cross-member 15. Ribs 14 may be retained, in longitudinal compression if desired, between points on the flange 32, and between points respectively on the flange and on cross-member 15, each rib end being secured in its respective position as by a plate 33 affixed to the bottom of the rib and to the bottom of flange 32 or cross-member 15, as the case may be.

A cross-sectional view taken along the line 7—7 of Figure 5 shows the wrest-plank 27 affixed to the bottom of the front portion 4 of the plate. The entire assembly of plate, wrest-plank, ribs, bridges and strings (which latter may now be strung while the plate is out of the piano case) may rest through rubber pads 34 on horizontal portions of rim 16. The plate may be spaced from the inside upper vertical surface of the rim by rubber strip 35; and it may be held down as retaining blocks 36, underneath which may be provided further rubber pads 37. Thus the whole assembly is provided with vibration insulation from the rim and case and hence, of course, from the hammer action.

While I have illustrated various elements and sub-combinations of my invention in separate figures for the sake of clarity, it will be understood that they are capable of coincident employment in a single instrument. It will further be understood that while I have shown and described my invention in the form of particular embodiments thereof, no limitation is thereby intended, and the scope of my invention is rather to be determined in accordance with the following claims.

I claim:—

1. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators and into audible tones, the method of producing such tones relatively free of initial transient effects, which includes coincidentally and similarly exciting two substantially similarly tuned said vibrators; translating electric oscillations from the vibrations of each of said two vibrators; and combining said oscillations in opposition to each other as respects their initial peaks.

2. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators and into audible tones, the method of producing such tones relatively free of initial transient effects, which consists in coincidentally and similarly exciting two substantially similarly tuned vibrators; in damping one only of said two vibrators; in translating electric oscillations from the vibrations of a corresponding point on each of said two vibrators; and in combining said oscillations in opposition to each other as respects their initial peaks.

3. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators, the combination of two substantially similarly tuned vibrators; means for coincidentally exciting said two vibrators; means for translating electric oscillations from the vibration of each of said two vibrators; and means for combining said oscillations in opposition to each other as respects their initial peaks.

4. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators, the combination of two substantially similarly tuned vibrators; means for similarly and coincidentally exciting said two vibrators; means for translating electric oscillations from the vibration of a corresponding point on each of said two vibrators; and means for combining said oscillations in opposition to each other as respects their initial peaks.

5. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators, the combination of two substantially similarly tuned vibrators; means for coincidentally exciting said two vibrators; means for damping one only of said two vibrators; means for translating electric oscillations from the vibration of each of said two vibrators; and means for combining said oscillations in opposition to each other as respects their initial peaks.

6. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators, the combination of two substantially similarly tuned vibrators; means for similarly and coincidentally exciting said two vibrators; means for damping one only of said two

vibrators; means for translating electric oscillations from the vibration of a corresponding point on each of said two vibrators; and means for combining said oscillations in opposition to each other as respects their initial peaks.

7. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators, the combination of two substantially similarly tuned vibrators; means for coincidentally exciting said two vibrators; means for translating electric oscillations from each of said two vibrators; means for combining said oscillations; and selective means controlling the relative phases of the oscillations translated from said two respective vibrators to render the initial peaks of said oscillations similar or opposite in phase.

8. In a musical instrument of the type wherein electric oscillations are translated from the vibrations of tuned vibrators, the combination of two substantially similarly tuned vibrators; means for similarly and coincidentally exciting said two vibrators; means for damping one only of said two vibrators; means for translating electric oscillations from the vibration of a corresponding point on each of said two vibrators; means for combining said oscillations; and selective means controlling the relative phases of the oscillations translated from said two respective vibrators to render the initial peaks thereof similar or opposite in phase.

9. In a musical instrument, the combination of two substantially similarly tuned strings; common means for similarly exciting said two strings; an electrically conductive member in spaced relation to a corresponding point on each of said two strings and forming an electrical capacity with each of said strings; and means for maintaining relatively constant, opposite electrical charges on said two strings respectively, with respect to said conductive member.

10. In a musical instrument, the combination of two substantially similarly tuned strings; common means for similarly exciting said two strings; damping means operative on one only of said strings; an electrically conductive member in spaced relation to a corresponding point on each of said two strings and forming an electrical capacity with each of said strings; and means for maintaining relatively constant, opposite electrical charges on said two strings respectively, with respect to said conductive member.

11. In a musical instrument, the combination of two substantially similarly tuned strings; common means for similarly exciting said two strings; damping means operative on one only of said strings; an electrically conductive member in spaced relation to a corresponding point on each of said two strings and forming an electrical capacity with each of said strings; means for maintaining relatively constant electrical charges on said two strings respectively, with respect to said conductive member; and selective means for reversing the sign of one of said charges.

12. In a musical instrument, the combination of a plurality of tuned vibrators; means for vibrating said vibrators; means for coupling said vibrators together, comprising a vibratile system engaging all of said vibrators; and a mechanico-electric translating system having at least a portion in spaced relation to said vibrators and operative in accordance with vibratory variation of such spacing, said portion being mounted to said vibratile system.

13. In a musical instrument, the combination of a plurality of tuned strings; means for vibrating said strings; a vibratily supported bridge engaging all of said strings; and a mechanico-electric translating system having at least a portion in spaced relation to said strings and operative in accordance with vibratory variation of such spacing, said portion being mounted to said bridge.

14. In a musical instrument, the combination of a plurality of tuned strings; means for vibrating said strings; a bridge engaging all of said strings; a plurality of vibratile ribs supporting said bridge; and a mechanico-electric translating system having at least a portion in spaced relation to said strings and operative in accordance with vibratory variation of such spacings, said portion being mounted to said ribs.

15. In a piano of the type wherein the vibrations of the strings are translated into electric oscillations, the combination of a plate supporting said strings; a bridge engaging said strings; and a plurality of vibratile ribs supporting said bridge and terminally secured to said plate; whereby at least said strings, plate, bridge and ribs are removable as a unit from further portions of said piano.

16. In a piano of the type including a rim, and wherein the vibrations of the strings are translated into electric oscillations, the combination of an integral assembly including at least a plate, strings supported by said plate, and mechanico-electric translating apparatus for translating the vibrations of said strings into electric oscillations; and vibration insulation between said plate and said rim, whereby at least said plate, strings and translating apparatus are insulated from said rim and portions of said piano therewith in contact.

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