

Jan. 16, 1940.

B. F. MIESSNER

2,187,612

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

Filed July 22, 1938

2 Sheets-Sheet 1

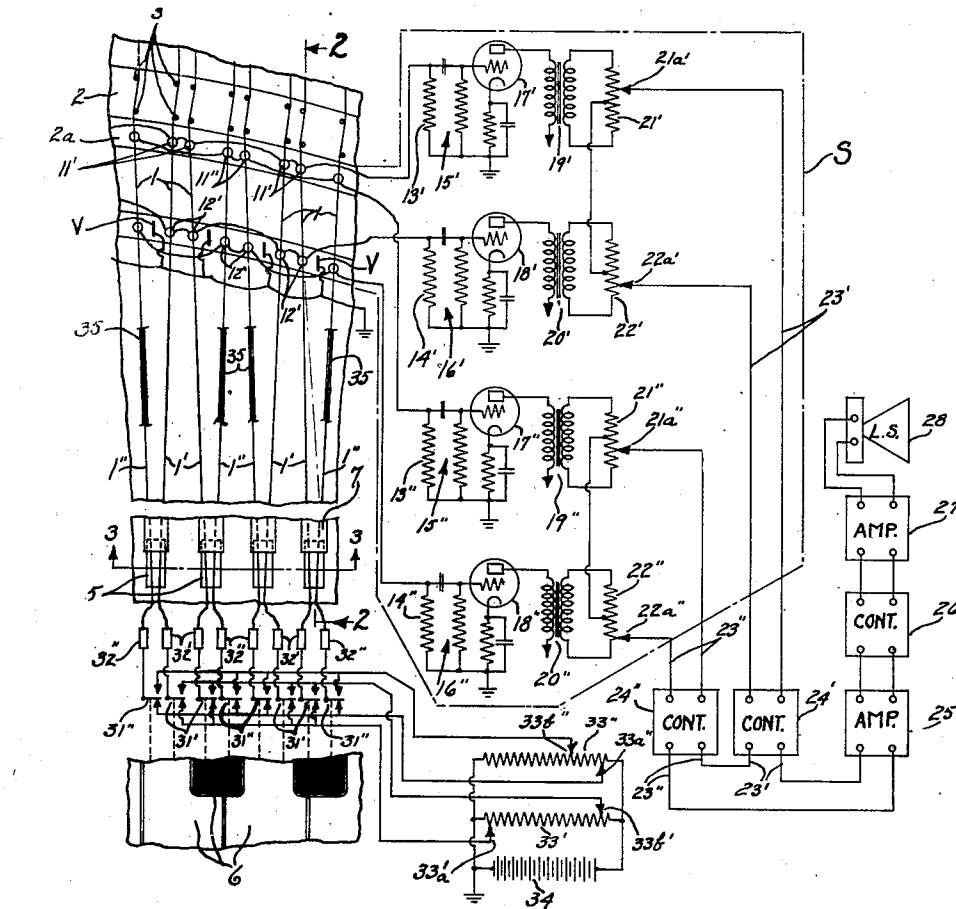


Fig. 1

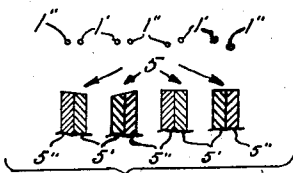


Fig. 3

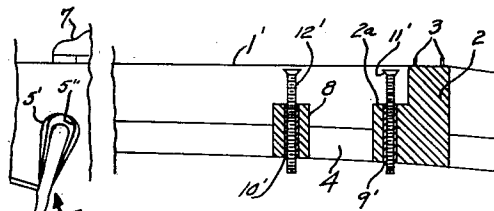


Fig. 2

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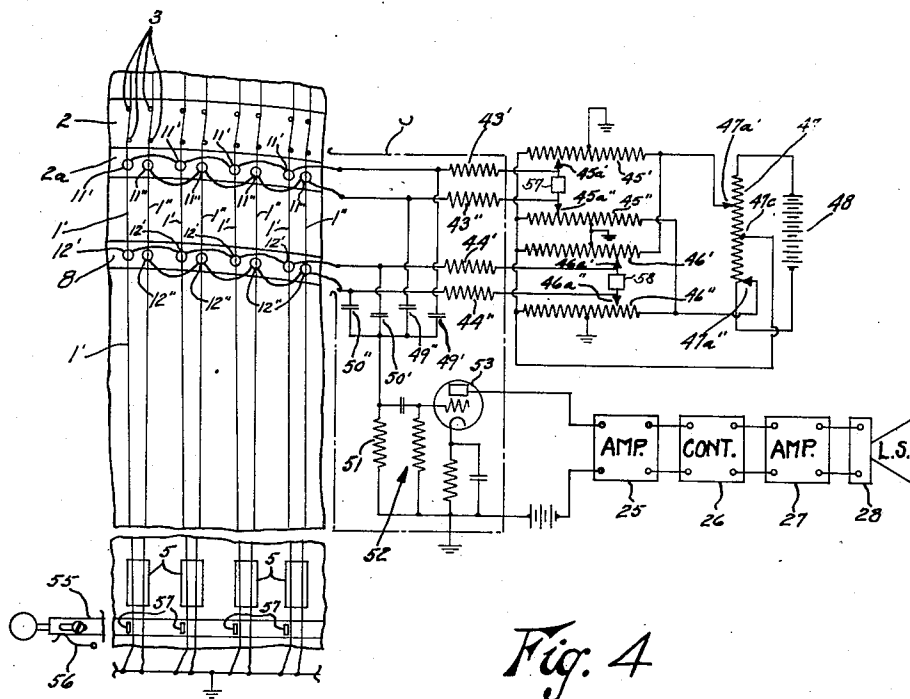


Fig. 4

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UNITED STATES PATENT OFFICE

2,187,612

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

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Application July 22, 1938, Serial No. 220,722

20 Claims. (Cl. 84—1)

This invention relates to the production of music, and more particularly to that production from vibrations of tuned vibrators. The invention has particular utility, and has been illustrated and described, in connection with electronic instruments wherein the vibrations of the vibrators are translated into electric oscillations and thence into sound.

It is well known that by such an instrument there may be produced output tones of a variety of qualities. Many of these qualities may actually represent, or be the equivalent of, the superposition upon each other of two or more other qualities also available from the instrument—yet the sensation of such superposition of separate qualities is ordinarily not impressed upon the hearer, who senses each produced quality as an integral or unitary one.

An important object of the instant invention is the provision of improved methods and apparatus for producing, from a single instrument of the class described, output tones causing the sensation of a plurality of distinct instruments or "voices" playing simultaneously, or superposed on one another.

Another object is the production of such effects particularly by an electronic piano.

Another object is the provision of an instrument having a plurality of vibrator-translation systems suitably differentiated from each other for the preservation of separate identity in the respective outputs of the several systems.

Another object is the provision in such an instrument of especially effective combinations of differentiating means.

Another object is the provision of improved means for differentiating the excitation of the vibrators.

Another object is the provision of improved control means, whereby there may be increased, with little complexity, the range of control of an instrument employing a plurality of vibrators per note.

It is a general object to provide improvements in, and an improved, instrument of the class described.

Other and allied objects will more fully appear from the following description and the appended claims.

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

Figure 1 is a view, partly in plan and partly diagrammatic, of an electronic piano wherein my invention has been incorporated in one form;

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

Figure 3 is a partial vertical cross-sectional view taken along the line 3—3 of Figure 1; and

Figure 4 is a view, partly in plan and partly diagrammatic, of an electronic piano wherein my invention has been incorporated in a modified form.

Reference being had to Figures 1, 2 and 3, there will be seen a fractional illustration of an instrument basically of the piano type. In this instrument there are employed for each note a plurality of tuned strings 1, maintained under tension between tuning pins and hitch pins not herein necessary to show; it may be mentioned, however, that the strings are maintained electrically insulated from each other and from common conductive elements, when the variable polarizing voltage hereinafter mentioned is employed. Near their rear extremities the strings may pass over and bear on a bridge 2 of wood or other insulating material, engaging respective pairs of bridge pins 3 in the top of the bridge in the usual manner. While the bridge may be variously supported, it is preferably disposed transversely of a plurality of vibratile ribs therebeneath; one such rib appears as 4 in Figure 2, which illustrates a desirable extension of the bridge downward to the bottoms of the ribs so that it may be secured not only to the rib tops but also to the rib sides. By way of simple illustration the strings for each note have been shown as two in number, one of them being designated as 1' and the other as 1''. Near their front extremities the two strings for each note, which may at least here be relatively close together, may be struck, typically from beneath, by a hammer 5 respective to that note. Each hammer may be actuated by depression of a respective key 6, and depression of the key for any note may also lift from the strings of that note a damper 7; these effects may be produced through conventional piano action mechanism not herein necessary to show.

With the several strings there are associated means for translating their vibrations into electric oscillations, which after control and amplification are translated into sound; and while it will be obvious that my invention may be carried out with translating means of any of a variety of types, I have particularly illustrated translating means of an electrostatic type, hereinafter more fully described.

According to a principal aspect of my invention, I employ a plurality of translating systems, suf-

ficiently separate from each other so that each may provide individual qualitative control over the output tone components produced by it; each translating system is accordingly capable of supplying a respective one of the plurality of voices to be produced by the instrument. Were these translating systems associated in common with the same vibrators, however, there would occur, in large measure if not completely, a fusing or integration of these voices into a single composite voice—which, while actually representing the superposition of the plurality, would not be sensed as such by the hearer. According to the invention I associate each translating system with a respective vibrator or string for each of the several notes—e. g., I associate a translating system with the several strings 1', and another translating system with the several strings 1''. This produces a plurality of distinct vibrator-translation systems wherein not only are the translation portions qualitatively differentiated from each other, but also the vibrator portions are inherently differentiated from each other—at least to a slight extent by unavoidable minute differences between the strings of each note, and preferably to a greater extent by virtue of an actual slight detuning of those strings from each other. The effect of these two differentiations, when jointly effected, is to largely preserve the separate identity of the separate voices—or, in reverse terms, to suppress the sensation of their integration. A structure broadly involving a plurality of vibrators per note and separate translations therefrom was disclosed in U. S. Patent No. 1,933,294 to Jacobs; but that structure, being directed primarily to the selective production of different types of tone and not to the preservation of voice individuality, contemplated neither deliberate slight detunings of the vibrators for each note from each other, nor respective qualitative controls for the several translating systems, nor various other features of the instant invention hereinafter defined.

It will of course be understood that the showing of only two strings per note and two translating systems—i. e., of the strings 1' with their respective translating system and of the strings 1'' with their respective translating system—is only in the interest of simplicity of illustration, and obviously implies no limitation to only two vibrator-translation systems.

In the instrument of Figures 1, 2 and 3 each translating system is arranged for the control of its voice in the qualitative respects of harmonic structure as influenced by particular partial components of each tone, of harmonic structure as influenced by absolute frequency, and of tone envelope shape (i. e., manner of inception and continuance of the tone), as well as in the quantitative respect of simple volume.

The control of harmonic structure as influenced by particular partial components has been illustrated as effected by pick-up, or mechanico-electric translation, from each string at a plurality of points (purely by way of simple example, two points) along its length, and the variable mixing of the pick-up outputs. Thus beneath a rear portion of each string 1' will be seen a respective pick-up electrode 11', while beneath a more forward portion of each string 1' will be seen a respective pick-up electrode 12'. The electrode 11' may for example pass through insulating bushings 9' held in a forward extension 2a of the bridge 2, while the electrodes 12' may pass through insulating bushings 10' held in an auxiliary bridge

8 secured across and between the ribs 4; such electrode mountings have been disclosed and claimed in my co-pending application Serial No. 187,646, filed January 29, 1938.

The several electrodes 11' are connected together and to the upper extremity of a charging or polarizing resistance 13', while the several electrodes 12' are connected together and to the upper extremity of a charging or polarizing resistance 14'. To simplify the electrode interconnections in the illustrated case of the use of two strings per note, the string 1' for one note may be made the righthand one, the string 1' for the next note the lefthand one, and so on in an alternated or staggered arrangement; and toward their rear extremities the strings for each note may be fanned apart, to bring the strings 1' for successive notes relatively close together and the strings 1'' for successive notes likewise relatively close together.

The lower ends of the resistances 13' and 14' may be grounded (i. e., established at a reference potential), while the strings 1' may be suitably established at a potential difference from ground. Particular means for establishing this potential difference are hereinafter described; but it will be understood that however established, this potential difference during its continuance will polarize the minute capacities between the strings 1' and the electrodes 11' through the resistance 13', and the minute capacities between the strings 1' and the electrodes 12' through the resistance 14'. When these minute capacities are so polarized, their oscillatory variations by string vibration will cause substantially corresponding small oscillatory voltages to appear across the charging resistances, the waveform of the voltage across 13' substantially corresponding to the string vibrational waveform above electrodes 11', and the waveform of the voltage across 14' substantially corresponding to the string vibrational waveform above electrodes 12'.

The harmonically distinct voltages from the two resistances 13' and 14' are applied through respective input circuits 15' and 16' (each comprising for example series capacity and shunt resistance) to the respective repeater tubes 17' and 18', in the output circuits of which are connected the primaries of respective transformers 19' and 20'. Across the secondaries of these transformers are connected respective center-tapped potentiometers 21' and 22', with center-taps connected together. The variable contacts 21a' and 22a' of these potentiometers are connected to a circuit or pair of conductors 23'; and it will be understood (as disclosed in U. S. Patent No. 1,906,607 to Jacobs) that by adjustment of the contacts 21a' and 22a' the oscillations in circuit 23', translated from string 1' vibration, may be controlled in respect of harmonic structure as influenced by particular partials of each tone.

The translating system for the strings 1', continuing into circuit 23' as above described, is duplicated by a translating system for the strings 1'', the components of the latter being designated by respectively similar numerals but with double-prime marks. Thus underneath the strings 1'' there are provided electrodes 11'' in the bridge extension 2a and electrodes 12'' in the auxiliary bridge 8. The several electrodes 11'' are connected together and to the upper extremity of a charging resistance 13'', while the several electrodes 12'' are connected together and to the upper extremity of a charging resistance 14'', the lower extremities of these resistances being

grounded. Oscillatory voltages from across these resistances are applied to the respective repeater tubes 17' and 18', in the output circuits of which are provided the transformers and potentiometers 19'—21' and 20'—22' respectively. This translating system continues into a pair of conductors or circuit 23'; and it will be understood to function with respect to the strings 1'', and to provide an independent harmonic structure control for the oscillations translated therefrom, as was described above for the translating system for the strings 1'.

Shielding, from external fields, of electrostatically sensitive portions of the translating systems is of course desirably provided, and has been schematically indicated by the grounded enclosure S in Figure 1. It may also be desirable to provide some electrostatic shielding between electrodes of one of the translating systems and those of the other; this has been schematically indicated in Figure 1 as to the electrodes 12' and 12'' by small grounded metal vanes V interposed therebetween, though it will of course be understood that no limitation to use only with these electrodes is intended.

For the separate control, for the two translating systems, of harmonic structure as influenced by absolute frequency, there are schematically shown as interposed, in the circuits 23' and 23'' of the respective translating systems, the respective control circuits 24' and 24''; these may operate independently to control the transmission-frequency characteristics of the circuits 23' and 23''. Beyond the control circuits 24' and 24'', the circuits 23' and 23'' may be connected together, serially for example, to merge the differentiated oscillation outputs of the two vibrator-translation systems for common final amplification and common control. Thus these here-interconnected circuits may feed into a cascade of appropriate apparatus schematically shown as amplifier 25, control circuit 26 (which may effect volume control, and if desired transmission-frequency control, for the combined oscillations), further amplifier 27, and loudspeaker 28.

For separate control of the tone envelope shape in connection with the respective translating systems, there may be employed with each a respective system for the control of translation efficiency—for example, a polarizing voltage control system of the type disclosed in U. S. Patent No. 2,071,649 to Miessner et al. Such a system for the translating system associated with the strings 1' may include a plurality of single-pole double-throw switches 31', each having a pole which is mechanically connected with the respective key 6 to be thrown from its lower contact to its upper contact upon key depression. The lower contacts of all the switches 31' are connected together and to the variable contact 33a' of a potentiometer 33', while the upper contacts of all the same switches are connected together and to the variable contact 33b' of the same potentiometer; the potentiometer is connected across a battery or other source of high potential 34, one extremity of which is grounded. The strings 1' normally have the potential which is established by the adjustment of contact 33a'; but upon depression of any key 6, the throwing of the associated switch 31' will cause the associated string 1' to take on the potential established by the adjustment of the contact 33b'. The change of string potential is rendered slightly gradual, rather than wholly abrupt, by an electrical time-delay system 32', an individual such system being

serially interposed between each string 1' and the associated switch pole, as schematically indicated in Figure 1.

Details of the construction and operation of a typical such polarizing-voltage control system may be ascertained by reference to the mentioned Patent No. 2,071,649; but it will be understood that since it regulates the polarization of the minute string-to-electrode capacities, and hence the translation efficiency, in predetermined relationship to key depression and hence to string excitation, it will provide a regulation of the tone envelope. Purely by way of example, if the contact 33a' be adjusted to the grounded extremity and the contact 33b' to the ungrounded extremity of the potentiometer 33', the strings 1' will normally be kept at no potential difference from the electrodes 11' and 12', and translation efficiency for those strings is normally zero; but as depression of any key is completed and the associated string 1' excited, the potential difference and translation efficiency as to that string will rise at a rate determined by the associated time-delay system 32', and the produced tone will have a generally organ-like inception in spite of the impulse excitation of the string.

The tone envelope control system for the strings 1' is duplicated by a similar system for the strings 1'', the components of the latter system being designated by respectively similar numerals but with double-prime marks. Thus the switches 31'' are provided, each having a pole mechanically connected with a respective key 6 and electrically connected, through a respective time-delay system 32'', to the respective string 1''. The lower contacts of the switches 31'' are connected to the variable contact 33a'', and the upper contacts of the same switches to the variable contact 33b'', of the potentiometer 33'', which potentiometer may be parallel with the potentiometer 33'. By way of example of an adjustment for different tone envelope from the strings 1'' and their associated translating system than from the strings 1' and their associated translating system, the variable contact 33a'' has been shown adjusted to the high-potential extremity of the potentiometer 33'' and the variable contact 33b'' to an intermediate point on that potentiometer. With this adjustment the translation efficiency for the strings 1'' is normally high but will be reduced to a partial extent, at a finite rate, immediately after tone inception; accordingly there is produced a tone having an impulsive or pianistic inception characteristic, that characteristic being especially emphasized by the immediately ensuing partial reduction above mentioned. It will be understood, of course, that the particular adjustments in which the several contacts 33a'—33b' and 33a''—33b'' have been illustrated are exemplary only, and that each pair is intended to be adjusted as desired, to produce for example any of a range of effects such as described in the Patent No. 2,071,649 abovementioned.

In addition to the qualitative differentiations between the voices, provided by the separate controls in the translating portions of the several vibrator-translation systems, differentiations may be effected in the vibrator portions of those systems. One such differentiation may be in respect of the rate of damping—the strings of one of the groups 1' and 1'' being for example subjected to higher damping influences than those of the other. This has been schematically illustrated in the instrument of Figures 1, 2 and 3 by the

fractional showing of coatings 35 surrounding the strings 1''. These coatings may be of felt dust or similar light and fluffy material, held in a thin layer of lacquer or other cementitious material

5 preferably itself characterized by internal resistance to deformation; in this way both air damping and internal-resistance damping may be obtained, though it will be understood that either alone may be found sufficient to produce a
10 marked differentiation in damping rate between the two groups of strings. Such coatings of strings have themselves been disclosed and claimed in my co-pending application Serial No. 187,646 abovementioned.

15 Another such differentiation may be effected by differently exciting the strings of the two groups 1' and 1''; in Figures 2 and 3 I show two general ways in which such different excitation may be caused. One way is by a differentiation
20 of the hardness or sharpness, or both, of each hammer in its two portions which strike its respective two strings 1' and 1''. In Figure 3 the different materials indicated in the two portions 5' and 5'' of each hammer, respectively under
25 strings 1' and 1'', illustrate a manner of carrying out the hardness variation; and in Figure 2 the different elevational shapes of the hammer portions 5' and 5'' illustrate a manner of carrying out the sharpness variation.

30 Another way of causing the different excitation is by arranging the hammers and strings so that the striking of the strings 1' and 1'' is progressive, in point of time or of strength or of both. In Figure 3 the bevelling of the tops of the
35 lefthand two hammers, and the arrangement at different elevational levels of the two strings of each of the righthand two notes, illustrate two manners of causing the excitation or striking of the strings 1'' to be progressively earlier and
40 stronger than that of the strings 1'. It may be pointed out that the differentiation by progressive excitation has the further effect of increasing the touch-responsivity of the instrument, and that by the touch on the individual keys the
45 contribution of the voice from strings 1' may be especially effectively controlled—it being noted that while for very weak striking the strings 1'' will be moderately excited, the strings 1' will be excited negligibly or not at all.

50 In Figure 4 I illustrate my invention in a modified embodiment, again by way of example employing translating systems of an electrostatic type, but with those systems arranged in materially different circuits and without tone envelope control. In this embodiment each string
55 1' is shown as the lefthand one, and each string 1'' as the righthand one, of its respective note; and the strings of each note have been shown as fanning only slightly apart rearwardly. In this
60 embodiment all the strings may be electrically connected together, in any convenient manner, and to ground. The usual key-hammer-damper system has been fractionally illustrated by the showing of a respective hammer 5 under the pair
65 of strings for each note.

The translating system for the strings 1' again includes, under those strings, the interconnected electrodes 11' in bridge extension 2a and the interconnected electrodes 12' in auxiliary bridge
70 8; while the translating system for the strings 1'' again includes, under those strings, the interconnected electrodes 11'' in bridge extension 2a and the interconnected electrodes 12'' in auxiliary bridge 8. In view of the string arrangement
75 abovementioned, the single- and double-primed

electrodes are of course wholly alternate. The translating system for the strings 1' further includes a charging or polarizing resistance 43' connecting the electrodes 11' with the variable contact 45a' of a potentiometer 45', and a charging or polarizing resistance 44' connecting the electrodes 12' with the variable contact 46a' of a potentiometer 46'; while the translating system for the strings 1'' further includes a charging or polarizing resistance 43'' connecting the electrodes 11'' with the variable contact 45a'' of a potentiometer 45'', and a charging or polarizing resistance 44'' connecting the electrodes 12'' with the variable contact 46a'' of a potentiometer 46''. Each of these four potentiometers may be provided with a grounded center-tap, and its variable contact may be taken as normally freely adjustable, independent of the position of the like contacts on any of the other potentiometers.

Direct voltages are maintained across these four potentiometers as hereinafter more fully described. It will be understood that by adjustment of the contacts 45a' and 46a' there may be differentially adjusted (as to both amplitude and polarity) the polarizing voltages for the minute capacities between strings 1' and the two sets of therewith associated electrodes; likewise that by adjustment of the contacts 45a'' and 46a'' there may be differentially adjusted the polarizing voltages for the minute capacities between strings 1'' and the two sets of therewith associated electrodes. These minute capacities being varied by string vibration, there are developed across the resistances 43' and 44', considered as a pair, oscillations translated from the strings 1' and having a controlled harmonic structure (as influenced by particular partials); likewise there are developed across the resistances 43'' and 44'', considered as a pair, oscillations translated from the strings 1'' and having an independently controlled harmonic structure. These oscillations may be merged for common amplification and further control, by application through condensers 49', 50', 49'', 50'' to a common load resistance 51; from this they may be applied through input circuit 52 to a repeater tube 53, in the output circuit of which may be connected the cascade 25—26—27—28 as in Figure 1. It will be obvious that there is thus provided an instrument wherein vibrators excited in common, but slightly detuned or otherwise differentiated from each other, are translated from by systems independently adjustable as to harmonic structure of their produced tones, so that the effects of distinct, controlled voices are again obtained.

The control by contacts 45a' and 46a' of simple volume and phase of the contribution from the strings 1', or the control by contacts 45a'' and 46a'' of that from the strings 1'', would in either instance require a careful joint adjustment of those two contacts. To obviate the necessity of this I have shown the direct voltage impressed across the potentiometers 45' and 46' by the connection of these potentiometers between the center-tap 47c and the variable contact 47a' of a potentiometer 47 shunted across a high voltage source or battery 48, and the direct voltage impressed across the potentiometers 45'' and 46'' by the connection of those potentiometers between the center-tap 47c and the variable contact 47a'' of the potentiometer 47. Control of simple volume and phase of the contributions from the two sets of strings may accordingly be effected simply by adjustment of the respective contacts 47a' and 47a''.

In the instrument of Figure 4 there has been schematically illustrated a means for effecting at will a qualitative differentiation, in respect of damping rate, between the vibrator portions of the two vibrator-translation systems. Thus transverse of and beneath the strings, near their forward extremities, there may be disposed a rail 55, arranged for limited rightward and leftward sliding, and constrained as by spring 56 pressing thereagainst to remain in any position to which it may be adjusted; and from this rail there may extend upwardly at the left of each string 1' a respective small pad 57 of felt or other soft material. By a sliding of the rail 55 the several pads 57 may be brought into or out of light contact with the respective strings 1', to provide at will an adjustable damping of those strings; it is to be understood, however, that this particular adjustable damping means is shown purely by way of example and in no sense as limitatively.

At times it may be desired to suppress the effect of separate voices from the instrument, while retaining the activity of all the vibrator-translation systems. In the instrument of Figure 4 I have schematically illustrated two mechanical coupling devices 57 and 58, operable at will to couple the variable contact 45a' on potentiometer 45' to the contact 45a'' on the potentiometer 45'', and the variable contact 46a' on potentiometer 46' to the contact 46a'' on the potentiometer 46'', respectively. It will be understood that when these coupling devices are in operation each pair of the coupled contacts will be adjusted as a unit, rendering entirely similar the harmonic structures of the oscillations produced by the two vibrator-translation systems and thus unifying the voices.

When these coupling devices are in operation the instrument of Figure 4 may be employed in the general manner of operation disclosed in U. S. Patent No. 1,912,293 to me, but with features of improvement thereover. This general manner of operation involves the simultaneous excitation of two vibrators, one preferably having a higher rate of damping than the other, and translations therefrom with similar harmonic structures but respectively opposite phases. Thereby two series of oscillations are produced, of which at first one substantially wholly cancels the other; but as the one dies away the cancelling effect decreases, and the overall effect is of a gradually or smoothly beginning—rather than an impulsively or pianistically beginning—tone. The mentioned patent showed that this action could be eliminated at will, and the tone rendered pianistic, by making the two translations of additive rather than of opposite phase, and preferably eliminating the damping of the one vibrator.

I have found, however, that with such a circuit as that of the instant Figure 4 (employed with the coupling devices 57 and 58 operative) I am able to obtain a far wider range of useful effects. The variable contacts 47a' and 47a'', being adjustable progressively (i. e., continuously or at least to a plurality of voltage values) make it possible to obtain not only the two types of tone last abovementioned, but also tones of accentuated percussiveness and tones of reduced percussiveness. For each of these types of tone the dampers are rendered active on the strings 1'; the contact 47a'' is adjusted to a first voltage value; and the contact 47a' is adjusted to that voltage value, of the same or opposite polarity according to which of the tone types is wanted,

which produces just the degree of the effect desired. It may be pointed out that not only may the contact 47a' (associated with the damped strings 1') be adjusted to voltage values which are smaller than that to which 47a'' is adjusted, but also (with 47a'' adjusted to a less-than-maximum value) contact 47a' may be adjusted to higher voltages of the same polarity, to produce tones of particularly accentuated percussiveness which yet have a long continuance at low amplitude (due to the undamped strings 1'').

While in connection with the instruments abovementioned I have disclosed the several strings for each note as substantially similarly tuned or only slightly detuned from one another (for example, to the extent of the general order of 1% or less), it may be pointed out that various special effects may be obtained by tuning the several strings for each note to respective frequencies harmonically or harmoniously related to each other—for example in the case of two strings, in the frequency ratio of 1:2 or 1:3 (a harmonic relationship) or in the frequency ratio of 1:1½ or 1:1½ (a harmonious relationship), or the like.

While I have disclosed my invention in terms of particular embodiments thereof, it will be understood that as to its broader aspects I intend no unnecessary limitations by virtue of the details of those embodiments, which obviously may be widely varied without departing from the spirit and scope of the invention. In many of the appended claims I undertake to express that scope broadly, subject however to such proper limitations as the state of the art may impose.

I claim:

1. A musical instrument for the production of a series of notes, having for each note a plurality of slightly detuned vibrators; means associated with the vibrators of each note for exciting the same; mechanico-electric translating means, comprising a plurality of translating systems each associated with a respective vibrator of each of the several notes; and means, connected with said translating means, for differentially controlling qualitative characteristics of the oscillations translated by the respective said systems.

2. A musical instrument for the production of a series of notes, having for each note a plurality of slightly detuned vibrators; means associated with the vibrators of each note for exciting the same; mechanico-electric translating means, comprising a plurality of translating systems each associated with a respective vibrator of each of the several notes; and means, connected with said translating means, for differentially controlling the harmonic structures of the oscillations translated by the respective said systems.

3. A musical instrument for the production of a series of notes, having for each note a plurality of slightly detuned vibrators; means associated with the vibrators of each note for exciting the same; mechanico-electric translating means, comprising a plurality of translating systems each associated with a respective vibrator of each of the several notes; and means, connected with said translating means, for differentially controlling the envelope characteristics of the oscillations translated by the respective said systems.

4. A musical instrument for the production of a series of notes, having for each note a plurality of slightly detuned vibrators; means associated with the vibrators of each note for exciting

the same; mechanico-electric translating means, comprising a plurality of translating systems each associated with a respective vibrator of each of the several notes; and electrical means for differentially controlling qualitative characteristics of the oscillations translated by the respective said systems.

5. An electronic piano for the production of a series of notes, having for each note a plurality of substantially similarly tuned strings; means associated with the strings of each note for exciting the same; a plurality of mechanico-electric translating systems each associated with a respective string of each of the several notes; and a plurality of means, respectively connected with the several said systems, for individually controlling qualitative characteristics of the oscillations translated by the respective said systems.

6. An electronic piano for the production of a series of notes, having for each note a plurality of substantially similarly tuned strings; means associated with the strings of each note for exciting the same; a plurality of mechanico-electric translating systems each associated with a respective string of each of the several notes; and a plurality of means, respectively connected with the several said systems, for individually controlling the harmonic structures of oscillations translated by the respective said systems.

7. An electronic piano for the production of a series of notes, having for each note a plurality of substantially similarly tuned strings; means associated with the strings of each note for exciting the same; a plurality of mechanico-electric translating systems each associated with a respective string of each of the several notes; and a plurality of means, respectively connected with the several said systems, for individually controlling the envelope characteristics of the oscillations translated by the respective said systems.

8. A musical instrument comprising a plurality of vibrator-translation systems, each system comprising a plurality of vibrators respectively slightly detuned from corresponding vibrators in each other system and mechanico-electric translating means associated therewith and responsive to the vibrations thereof; a plurality of vibrator-exciting means, a respective one of said exciting means being associated with corresponding vibrators in the several said systems; and means included in at least one of said systems for differentiating qualitative characteristics of the oscillations produced thereby from those produced by other of said systems.

9. A musical instrument comprising a plurality of vibrator-translation systems, each system comprising a plurality of vibrators respectively slightly detuned from corresponding vibrators in each other system and mechanico-electric translating means associated therewith and responsive to the vibrations thereof; a plurality of vibrator-exciting means, a respective one of said exciting means being associated with corresponding vibrators in the several said systems; means influencing the vibrators of at least one of said systems for differentiating qualitative characteristics of their vibrations from those of the vibrators of other of said systems; and means associated with the translating means of at least one of said systems for differentiating qualitative characteristics of the oscillations produced thereby from those produced by other of said systems.

10. A musical instrument comprising a plurality of vibrator-translation systems, each system

comprising a plurality of vibrators respectively substantially similarly tuned to those of each other system and mechanico-electric translating means associated therewith and responsive to the vibrations thereof; a plurality of means, a respective one of which is associated with corresponding vibrators in the several said systems, for differently exciting corresponding vibrators; and means associated with the translating means of at least one of said systems for differentiating qualitative characteristics of the oscillations produced thereby from those produced by other of said systems.

11. In a musical instrument, the combination of a plurality of substantially similarly tuned vibrators; means for translating sound of different qualitative characteristics from said vibrators respectively; a movable key; and impulse exciting means, operated by said key in a single movement thereof, for exciting said vibrators progressively in point of time.

12. In a musical instrument, the combination of a plurality of substantially similarly tuned vibrators; means for translating sound of different qualitative characteristics from said vibrators respectively; a movable key; and impulse exciting means, operated by said key in a single movement thereof, for exciting said vibrators progressively in point of excitation strength.

13. In a musical instrument, the combination of a plurality of substantially similarly tuned vibrators; means for translating sound of different qualitative characteristics from said vibrators respectively; and a hammer movable to strike said vibrators, the striking surface of said hammer being bevelled to strike one of said vibrators prior to the other.

14. In a musical instrument, the combination of a plurality of substantially similarly tuned vibrators; means for translating sound of different qualitative characteristics from said vibrators respectively; and a hammer movable to strike said vibrators, one of said vibrators being nearer than other of said vibrators to said hammer to be earlier struck.

15. In a musical instrument, the combination of a plurality of substantially similarly tuned vibrators adjacent each other; means for translating sound of different qualitative characteristics from said vibrators respectively; and a hammer movable to strike said vibrators, the portions of said hammer striking said vibrators respectively being substantially different in hardness.

16. In a musical instrument, the combination of a plurality of substantially similarly tuned vibrators adjacent each other; means for translating sound of different qualitative characteristics from said vibrators respectively; and a hammer movable to strike said vibrators, the portions of said hammer striking said vibrators respectively being substantially different in sharpness.

17. In a musical instrument, the combination of two substantially similarly tuned vibrators; means for damping one of said vibrators; means for translating electric oscillations from the vibrations of each of said vibrators; and progressively adjustable means for opposing regulable amplitudes of the oscillations translated from one of said vibrators against oscillations translated from the other.

18. In a musical instrument, the combination of two substantially similarly tuned vibrators; means for damping one of said vibrators; means

for translating electric oscillations from the vibrations of each of said vibrators; and progressively adjustable means for selectively opposing and adding regulable amplitudes of the oscillations translated from one of said vibrators against and with oscillations translated from the other.

19. In a musical instrument, the combination of a tuned vibrator; a plurality of electrodes in spaced relation thereto and forming therewith a respective plurality of capacities; means for applying polarizing voltages across said capacities; means for differentially controlling the relative values of said voltages; and means, electrically connected with said last mentioned means, for varying the absolute values of said voltages while maintaining their relative values.

20. A musical instrument for the production of a series of notes, having for each note a plurality of substantially similarly tuned vibrators; means associated with the vibrators of each note for exciting the same; a plurality of mechanico-electric translating systems each associated with a respective vibrator of each of the several notes; a plurality of means for individually controlling qualitative characteristics of the oscillations translated by the respective said systems; and means, interposed between said controlling means, for interlinking said control means at will, to control said oscillation characteristics in common for said plurality of systems.

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