Jan. 16, 1940. B. F. MIESSNER 2,187,611

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

Filed March 2, 1937 3 Sheets-Sheet 1

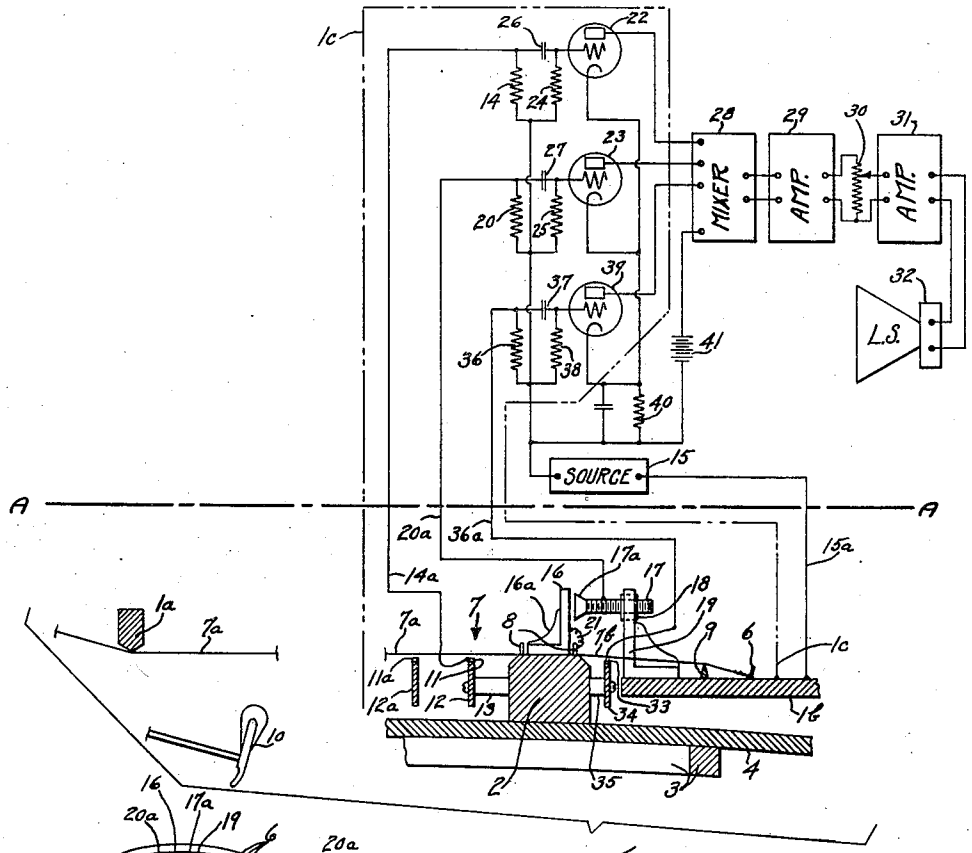


Fig. 1

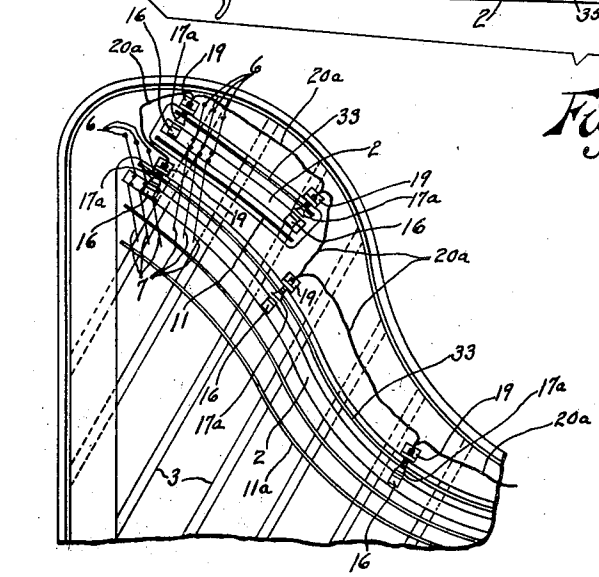


Fig. 1a

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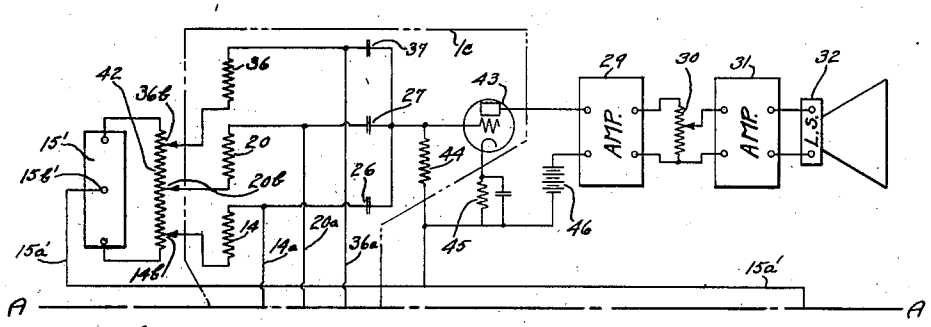


Fig. 2

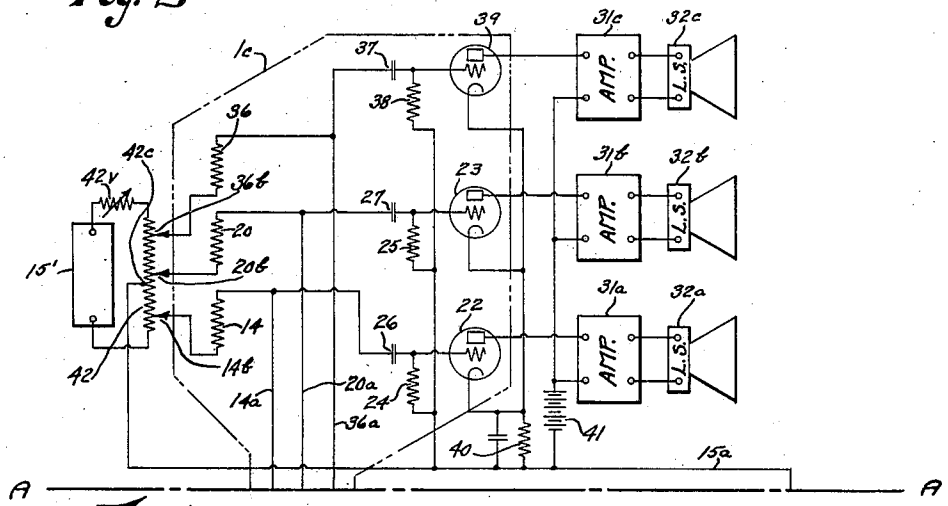


Fig. 2a

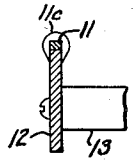


Fig. 3

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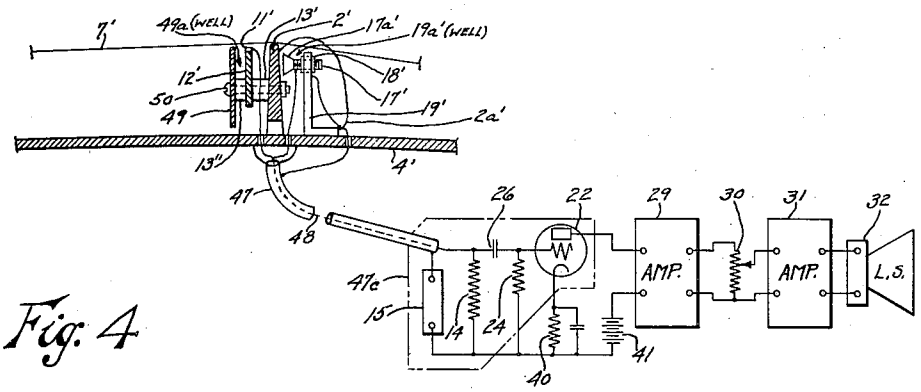


Fig. 4

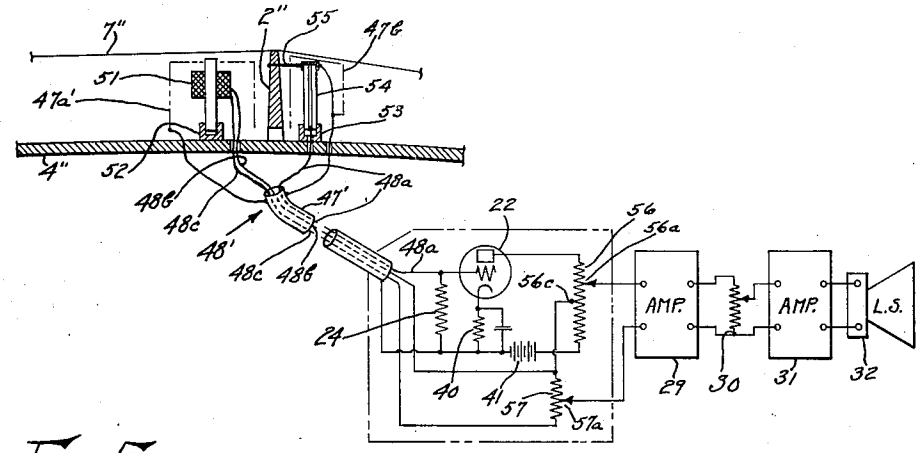


Fig. 5

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UNITED STATES PATENT OFFICE

2,187,611

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

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Application March 2, 1937, Serial No. 128,611

14 Claims. (Cl. 84—1)

This invention relates to the production of music, and more particularly to that production from the vibrations of tuned strings or other vibrators through the medium of mechanico-electric (and electro-acoustic) translation.

It is frequently desired, in the use of instruments involving the translation above mentioned, to effect a close duplication or approximation of the tonal output of the more conventional instruments which operate by simple mechanico-acoustic translation; and it is an object of this invention to facilitate that duplication or approximation.

An independent object is to increase the flexibility of control of tonal output of an instrument of the type described, particularly in respect of harmonic structure.

It is another object to increase the inter-dependence of harmonic structure and instantaneous amplitude of the output tones, and still another object is to control this inter-dependence.

Another object is to provide improved means for translating higher-order oscillations from the vibrations of tuned strings or other vibrators.

Still another object is to provide improved arrangements for controllably translating both first- and higher-order oscillations from such vibrations.

Yet another object is to provide means for suppressing certain objectionable output effects occasionally produced in instruments involving electrostatic mechanico-electric translation.

A still further object is the provision of generally improved and simplified stringed instruments operating by mechanico-electro-acoustic translation.

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 cross-sectional and partly schematic, of a piano in which my invention has been embodied;

Figure 1*a* is a plan view further illustrating such an instrument as shown in Figure 1;

Figure 2 is a schematic view of a modification of a portion of the instrument of Figure 1;

Figure 2*a* is a schematic view of a further modification of the same instrument portion;

Figure 3 is an enlarged cross-sectional view of a small portion of Figure 1;

Figure 4 is a view, partly cross-sectional and partly schematic, of a violin or like instrument in which my invention has been embodied; and

Figure 5 is a like view of a stringed instrument, for example a fretted one, in which my invention has been embodied in modified form.

Figure 1 illustrates an embodiment of my invention, applied for example to a piano operating by mechanico-electro-acoustic translation. In this figure will be seen the rear portion *1b* of the metallic plate or frame of the instrument; the capo *1a* forming a more forward portion of that frame; and a bridge 2 slightly forward of the rear plate portion *1b* and vibratily supported on wooden or other vibratile ribs, one of which appears as 3. While there may be included between the bridge and ribs a soundboard 4, it will be understood that for purposes of the present invention this inclusion is not necessary.

Stretched under tension from still more forward plate portions, under capo *1a* and over the bridge 2 to a hitch-pin 6 on the plate portion *1a*, is seen a tuned string 7; this in passing over the bridge may engage the bridge pins 8, and preferably makes a slight angle in a vertical plane to provide the usual down-bearing on the bridge. Additionally the string may pass slightly angularly over a small metallic ledge 9 just forward of the hitch-pin 6, to form a rear string section *7b*; this may have a length which is some integral fraction of the length of the main string section *7a* from capo to bridge, to provide a harmonically vibrating section according to well understood practise. While for vibrating the string no limitation to any particular means is contemplated in the broader aspects of my invention, I have illustrated a hammer 10 arranged to strike the string section *7a* near its front extremity, according to conventional piano practise.

For translating the simple transverse (e. g., vertical) string vibrations into electric oscillations I may employ any convenient form of mechanico-electric translating device, spacedly above or below the string for example. In Figure 1 I have shown such a device of electrostatic character, and I have preferred to arrange it according to the teachings of prior U. S. Patent No. 1,912,293 to me—i. e., to support it to the vibratile system, for example to the bridge. Accordingly Figure 1 shows in cross section the copper or other conductive strip 11, of small cross-section, spaced slightly below the string 7 and secured to the top edge of a vertically arranged strip 12 of insulating material—and the strip 12 secured, through spacing means such as 13, at a distance forward of the bridge.

To render the conductive strip 11 active as a translating device, I have shown it electrically connected (as through lead 14a) to the top extremity of a resistor 14 of high value, the lower extremity of which is connected to one terminal of an electric energy source 15, of which in turn the other terminal is connected to the string 7, as by lead 15a to the plate portion 1b. Thus there is provided a series circuit comprising the resistor 14, the source 15, and the small capacity between string and conductive strip 11. Assuming the source 15 to be a high potential direct current source, it serves to polarize the capacity in question, so that upon oscillatory variation of that capacity (produced by string vibration) an oscillatory voltage corresponding to or representing the vertical string vibration will appear across the capacity and hence across the resistor 14. On the other hand if the source 15 be a high frequency alternating current source, current will flow therefrom through the series circuit above mentioned and will be modulated by the oscillatory capacity variation, so that across the resistance 14 will appear a high frequency voltage modulated in correspondence with the vertical string vibration. In either event the system translates the vertical string vibration into corresponding electric oscillations across resistor 14.

This translation is of the principal (vertical) first-power vibrations of the string; it is, among other things, essentially cyclic with respect to each of the harmonic components of the string vibration. In the simple mechanico-acoustic translation of the conventional piano or other stringed instrument, however, there is a very appreciably second-power effect of string vibration; this results from the bi-cyclic longitudinal pull of the main string portion on the bridge, causing a bi-cyclic rocking of the bridge which bi-cyclically influences the soundboard and gives rise to second-power sound output. (While principally second-power and bi-cyclic, this action may extend slightly to powers and cyclic relationships of higher order than second. Also it is to be noted that the second-power effects are characterized not only by doubling of frequencies, but also by amplitude dependence essentially on the square of the string vibration amplitude.)

In U. S. Patent No. 1,933,296 to Jacobs there is disclosed a means of translating second-power oscillations, or of jointly translating first- and second-power oscillations, from vibrating strings; in that disclosure, however, the translating means for the second-power oscillations was associated directly with the strings. According to the instant invention I associate second-power translating means with the bridge, in manner to be influenced by its rocking motion above described—an arrangement which I find to have advantages of simplicity, faithfulness of duplication of conventional mechanico-acoustic translation effects, and the like.

Desirably, though not indispensably, the bridge rocking motions may be mechanically amplified by utilizing in the second-power translating means an upward extension from the bridge. Accordingly on top of the bridge 2 I may secure a rigid metallic upward extension 16, desirably in the form of a bracket rigidified with a web 16a; this extension is in its function a member for forward and backward vibration in amplified representation of the bridge rocking. Behind the extension 16, for picking up its vibration, may be provided a stationary mechanico-electric translating device; and while such device may be of any variety, I have illustrated it in Figure 1 as electrostatic, for correspondence with the translating means shown for first-power translation. Thus the device may take the form of an enlarged flat head 17a of a conductive screw 17 mounted in an insulating bushing 18, which is in turn set in a rigid bracket 19 secured to the plate portion 1b.

To render the screw head 17a active as a translating device, I have shown it electrically connected (as through lead 20a) to the top extremity of a resistor 20 of high value, of which the lower extremity is connected to that terminal of source 15 to which resistor 14 was connected. Connection between the other source terminal and the extension 16 may be effected in any convenient manner, as by a connection of 16 through a lead 21 to one of the string-engaging bridge-pins 8 (this contacting the string 7, the string contacting the plate portion 1b, and that portion being connected to the terminal in question). In analagous manner to the appearance of first-power oscillations across resistor 14, there will appear, from the oscillatory variation of the capacity between 16 and 17a, second-power oscillations across resistor 20.

It is of course to be understood that I may employ, particularly in an instrument having a long bridge such as a piano has, a plurality of mutually connected second-power translating devices; and that in an instrument wherein, as frequently in the piano, the bridge is subdivided into mutually coupled bass and treble sections or otherwise into a plurality of sections, I may employ second-power translating devices with each section. This has been simply illustrated in the partial plan view 1a of a piano, wherefrom many of the components have been omitted in the interest of clarity; but there will clearly be seen the plurality of extensions 16 and of co-operating screw-heads or electrodes 17a held in the respective brackets 19, with the wire or lead 20a contacting all of those electrodes.

My invention contemplates the selective use of the first- and second-power oscillations, or their combination, in controllable mutual amplitude relationships, and still more particularly in controllable mutual amplitude and phase relationships. One advantageous manner of effecting such controllable combination is the passage of the two distinct series of oscillations through respective repeated tubes (such as 22 and 23), with respective grid leaks 24 and 25 coupled through respective condensers 26 and 27 across the respective resistors 14 and 20), and the use in the output circuits of those tubes of a mixing system of amplitude- and phase-control type, such as shown in the output circuits of tubes 50, 51, 52 of Figures 4 and 6 of U. S. Patent No. 1,906,607 to Jacobs, and therein described. For simplicity I have herein shown such a mixing system simply schematically as 28. From the mixing system the combined and controlled oscillations may pass for example through amplifiers 29 and 31 and through volume control 30, and may be translated into sound by the loudspeaker or other electro-acoustic translating device 32.

It is of course to be understood that while I have particularly described only a single first-power translating means in the form of the conductive strip or electrode 11, with its associated apparatus, my invention contemplates the use

of as many such means as may be desired—such as a plurality of such conductive strips at a plurality of different points along the string, each strip having for example its own additional grid-leak, condenser and tube and feeding, like tube 22, into the mixing system 28. This elaboration has been schematically indicated simply by the additional strips 11*a*, 12*a* in the figures.

The addition, so typically described, of the second- to the first-power oscillations is of material musical value—if for no other reason, in view of the additional harmonic development thereby made possible. But particularly in the case of any damped tone, and still more particularly in the case of an instrument wherein (as in the case of a piano) a tone may be selectively produced at a variety of amplitudes, it is of tremendous value, as the essential dependence of the additions on the square of vibration amplitude causes the additions to change automatically in their prominence, according to the instantaneous volume level of the tone.

In Figure 1 I have also shown translation, electrostatic by way of example, from the harmonic rear string section 1*b*. This is simply provided by a conductive strip 33 slightly spaced vertically from an intermediate point along this string section and secured to an insulating strip 34 which, while it may be rigidly mounted, is desirably secured to the rear of the bridge 2 as by spacers 35. The conductive strip 33 is electrically connected, as through lead 36*a*, to the top extremity of a resistor 36, of which the bottom extremity (like those of resistors 14 and 20) is connected to source 15. Accordingly first-power oscillations representing the vibration of the rear string section will appear across the resistor 36; and from this resistor they may be applied through condenser 37 to the grid leak 38 of a repeater tube 39. The output circuit of this tube may be connected to the mixing system 28 (similarly to the output circuits of tubes 22 and 23) for combination of these oscillations with the others in controllable amplitude and phase relationships.

It is to be appreciated that this addition, to oscillations from the main string sections, of controlled amounts of oscillations from the rear string sections, particularly when in controlled phase, is very useful in obtaining certain subtle but desirable tonal characteristics; that the controlled combination of these rear string-section oscillations with the second-power oscillations, both of them tending to have a higher-partial harmonic development, provides some very interesting tonal effects; and that the fully controlled use of the three or more oscillation series as I have disclosed provides an extremely flexible and highly useful musical output.

The cathodes of the repeater tubes 22, 23 and 39 may be connected together and through the by-passed bias resistor 40 to the common lower ends of the several grid leaks; plate current supply for the several tubes may be provided by a common battery or other high potential current source 41. It may be noted that if the source 15 is a direct current source, these tubes will be operated as simple amplifiers; but that if that source is one of high frequency current adapted for modulation as above explained, these tubes may be operated as demodulators (for example by an appropriate increase in the value of the biasing resistor 40).

No limitation is intended as to the manner of the controllable combination of the several series of oscillations; for example, instead of being accomplished in the output circuits of individual tubes such as 22, 23, 39, the controllable combination may be effected in the input circuit of a single tube functioning in common (but otherwise like tubes 22, 23, 39) for all the oscillation series. Further, the amplitude and phase control need not be exerted on each oscillation series following an always-similar generation of that series, as in Figure 1, but may be exerted in the initial generation. As an illustration of both these alternative possibilities, I have shown in Figure 2 a modified circuit intended for substitution for the portion of Figure 1 lying above the line A—A. In Figure 2 the source 15' (analogous to the source 15 of Figure 1) is provided with a center-tap 15*b*', connected as through the lead 15*a*' to the plate portion 1*b*; further, the source 15' is shunted by a potentiometer 42 having the independently fully movable contacts 14*b*, 20*b* and 36*b*, to which the lower extremities of the three resistors 14, 20 and 36 are respectively connected. The coupling condensers 26, 27 and 37 are again employed for these respective resistors, but in this instance to apply the oscillations from there across to a common repeater tube 43, which has grid leak 44, bias resistor 45, and plate current supply 46, and in whose output circuit the cascade 29—30—31—32 may be connected. This circuit arrangement is analogous to that shown in Figure 2 of U. S. Patent No. 2,027,075 to Jacobs; and its operation, if not entirely evident, will be understood from that patent. As in the case of the tubes of Figure 1, tube 43 will be operated as an amplifier or as a demodulator according to whether source 15' is a direct current or high frequency alternating current source.

Still further, the combination of oscillations according to my invention need not take place while these oscillations are in electric form; instead there may be combined the acoustic oscillations separately translated from the several series of electric oscillations. This I have illustrated in Figure 2*a*, which is generally similar to Figure 2 excepting that (*a*) the condensers 26, 27, 37 feed into separate tubes 22, 23, 39, as in Figure 1; (*b*) separate amplifier-loudspeaker systems 31*a*—32*a*, 31*b*—32*b*, 31*c*—32*c* are provided in the output circuits of the respective tubes; and (*c*) volume control is conveniently effected by a variable resistor 42*v* in series with potentiometer 42, the tap 15*b*' on source 15' being conveniently replaced by a center-tap 42*c* on potentiometer 42. The several loudspeakers 32*a*, 32*b*, 32*c* will of course be disposed sufficiently near each other for their acoustic outputs to combine, and are preferably in very close spacing to each other to create the impression of unity of tone source.

In both Figures 1 and 2 it will of course be understood that the leads 14*a*, 20*a*, 36*a*, and the repeater tubes with their grid leaks and condensers, etc., should be provided with reasonable electrostatic shielding, to prevent the susceptibility thereof to stray electrostatic fields; and such shielding I have indicated schematically as 1*c*, at the potential for example of the plate portion 1*b*.

In Figure 3, which may be taken as an enlargement of the showing of conductive strip 11 and insulating strip 12 of Figure 1 (or correspondingly of conductive and insulating strips 33 and 34 respectively), I have shown a desirable detail of construction which cannot satis-

factorily be shown on the scale of Figure 1. This consists in the covering of the top of the conductive member, or strip 11, with a thin coating 11c of hard insulating material such as enamel or lacquer; this coating may if desired spread down over the sides of the strip 11 and slightly overlap the insulating strip 12, serving to improve the bond between the two strips. The prime function of the coating 11c, however, is the prevention of electrical short-circuiting of the vibrator or string 7 against the electrode or conductive strip 11, under any abortive condition such as vibrator vibration at an unusually high amplitude or the like. It is of course to be understood that normally the electrode will be adjusted far enough away from the vibrator to obviate possible contact therewith under any normal conditions; and that even though the insulating coating 11c be provided, a mildly objectionable tonal effect will be produced should the vibrator nevertheless strike the coating, by virtue of the mechanical interference with vibration. But the provision of the coating does obviate the highly objectionable electrical effect produced in the rare case of vibrator contacting with translating device, and for that reason is extremely valuable. Desirably, of course, a sufficient thickness of coating is employed to insure against potential breakdown through the coating.

The practise of my invention is of course not limited to instruments of the piano type; accordingly by way of alternative illustration I have shown it in Figure 4 applied to a violin or like instrument. Herein the wooden sound board or belly of the instrument appears fractionally as 4', and the wooden bridge as 2'. The bridge, over which the strings 7' pass as usual, may be provided with a conductive coating by painting it with a colloidal graphite solution (such as is sold under the trade name of "Aquadag"), and may be electrically connected, as by lead 2a', to the shielding 47 of a low-capacity shielded conductor 48 hereinafter referred to. The first-power translating means may be provided (analagously to Figure 1) by a conductive strip 11' mounted on an insulating strip 12', which latter is fixed by space means 13' a little forward of the bridge. The second-power translating means may be provided by securing to the belly 4' a bracket 19', through an insulating bushing 18' in which there passes the screw 17'; an enlarged flat head 17a' of this screw may be in close spaced relationship to the rear surface (rendered conductive as above explained) of the bridge.

While full electrical control over the respective outputs of the first- and second-power translating means may be employed in this case as well as in Figure 1, I have here preferred in the interest of simplicity to dispense with phase control, and for amplitude control to rely on the mechanical adjustment of screw 17' which, by varying the spacing from 17a' to 2' varies the amplitude of the second-power oscillations, and hence the relative oscillation amplitudes, within useful limits. So electrically the screw 17' has been shown simply paralleled with the strip 11' in a connection to the conductor 48 proper. At its far extremity the conductor 48 may be connected to the top extremity of a resistor 14, like that of Figure 1, the lower extremity of which connects with a terminal of the again-corresponding source 15; and the shielding 47 of the conductor (to which the bridge was connected) may be connected to the other terminal of this source. The oscillations from across the resistor 14, which are of course the combined first- and second-power oscillations, may be applied through condenser 26 to the repeater tube 22, which has the grid leak 24, bias resistor 40, and plate current supply 41; and in the output circuit of the tube may be connected the cascade 29—30—31—32.

For simply providing reasonable electrostatic shielding in the instrument of Figure 4 above its belly 4' (below which the shielding 47 is effective) I may, as to the region behind the bridge, connect the lead 2a' to the bracket 19', thereby rendering the latter at the potential of the bridge. As to the region forward of the bridge, I may provide, slightly in front of the strips 11'—12', a strip 49 of metal (or of wood coated with colloidal graphite solution), preferably extending from near the belly 4' to near the strings 7'; this may be held spaced from the strips 11'—12' by a suitable spacing means 13'', and conductive screw means 50 may pass through the strip 49, spacing means 13'', insulating strip 11', and spacing means 13' to secure the whole assembly to the bridge—as well as to make the desired electrical contact of strip 49 to the bridge 2'. It will be seen that bracket 19' and strip 49, both extending desirably for the full width of the bridge, create with the bridge narrow wells 49a and 19a', within which the sensitive translating device portions above the belly are almost wholly confined. Shielding 47c has schematically been indicated about the tube 22 and immediately associated apparatus.

A string 7' of metal is of course electrically contacted with by the bridge 2', and no special remarks need be made regarding the translation of its vibrations. A string 7' may be employed, however, of gut or other electrically non-conductive material; and of course such a string may be coated in its section near the bridge with such colloidal graphite solution as abovementioned, to render its conductive. It is to be observed, however, that though this coating be not provided, or wear off with string vibration and use, the strip 11' in the structure of Figure 3 will still well translate the string vibration. This is because the effective value of capacity between strip 11' and the bridge (particularly the upper portion of the bridge) is modified by the presence of the string (typically increased, in view of the usual string dielectric constant of several times unity), and as the string vibrates the degree of this modification, and hence the effective capacity itself, is oscillatorily varied. And this action is effectively added to by a similar one taking place in respect of the capacity between strip 11' and the shielding member or strip 49—to a maximum extent if the top of 49 be brought as close to the string as safely may be done. So the member or strip 49 has at least a two-fold utility.

While the figures so far described have illustrated particularly translation of the electrostatic type, it is obvious that my invention may be carried out with other types of translation. For example electromagnetic translation may be employed in translating both the first- and second-power oscillations or either; or piezo-electric translation may be employed—particularly effectively in the second-power translation, the first-power oscillations being meanwhile translated for example by electrostatic, electromagnetic or other translating means in spaced relationship to the strings. So in Figure 5 I have illustrated the

particularly simple and favorable arrangement—especially for a violin, or a guitar or other fretted instrument—of electromagnetic first-power, and piezo-electric second-power, translation.

In this figure the belly or frame of the instrument appears as 4'', the bridge as 2'', and the strings—for example of magnetic material—as 1''. Spaced underneath the strings somewhat forward of the bridge is seen the electro-magnetic pick-up 51, held for example in the clamp 52 secured to the belly 4''. Mounted vertically, in a suitable clamp 53 secured to the belly 4'' behind the bridge, is a piezo-electric bending unit 54 of the bi-morph type—e. g., two thin crystals cemented together and arranged so that one contracts vertically as the other expands, and vice versa. The top of the bending unit 54 is linked to an upper portion of the bridge 2'' as by the light but stiff rod 55. One terminal of the unit 54 may be electrically connected to the shielding 47' of a shielded multi-conductor 48' (comprising the three individual conductors 48*a*, 48*b*, 48*c*), and the other terminal of the unit 54 may be connected to the conductor 48*a*. At the far extremity of the multi-conductor 48', the conductor 48*a* may be connected to the top and the shielding 47' to the bottom of the grid leak 24 of the repeater tube 22; in the output circuit of this tube may be connected the potentiometer 56, provided for example with center-tap 56*c* and the fully adjustable contact 56*a*.

To the terminals of the electromagnetic pick-up 51 may be connected the conductors 48*b* and 48*c*; and at the far conductor extremity these conductors may be connected across a potentiometer 57, provided with the adjustable contact 57*a*. A series circuit may be made of the variable portion of potentiometer 57 which may lie between one of its terminals and the contact 57*a*; of the variable portion of potentiometer 56 which may lie between its center-tap 56*c* and the contact 56*a*; and of the input of the amplifier, volume control and loudspeaker cascade 29—30—31—32 of earlier figures. Accordingly the second-power oscillations from the bending unit 54, amplified by the tube 22 and controlled by potentiometer 56 in respect of amplitude and of phase (the latter by virtue of the center-tapping), may be mixed with first-power oscillations from the pick-up 51, themselves regulated in amplitude by potentiometer 57, and the mixture amplified and translated into sound.

Shielding 47*a*' and shielding 47*b*' have been shown schematically, disposed about the pick-up 51 and the bending unit 54 respectively, and electrically connected with the conductor shielding 47. Also shielding 47*c*' has been shown, similarly connected, disposed about the tube 22 and its immediately associated apparatus, including if desired the potentiometers 56 and 57.

The use of additional amplification for one only of the two series of oscillations is illustrative only, having been shown simply to indicate a compensation for either a possible lower efficiency of the piezo-electric than of the electromagnetic translation, or an otherwise-existing lack of sufficient prominence of the second-power oscillations, or both. A similar practise may of course be followed with the structure of earlier figures when desired.

Because the second-power translation according to my invention may in cases actually produce some appreciable percentages of oscillations of still greater order than second, I have in the claims utilized the term "higher-power" translation or oscillations to refer broadly not only to second-power, but also a second- and yet higher-power, translation or oscillations. Also in the claims I have used the phrase "variously combine" and its derivatives to refer broadly to the combining of oscillations in a variety of amplitude, or of phase, or of amplitude and phase, relationships.

Finally it will be understood that while I have disclosed my invention in terms of specific embodiments thereof, I do not intend any unnecessary limitations of its scope by virtue of the details of those embodiments; rather in the appended claims I undertake to express that scope as broadly as the state of the art will permit.

I claim:

1. In the production of a musical tone from the vibration of a tuned vibrator, the method of controlling the quality of said tone which comprises separately translating from said vibration electric oscillations representing respectively the first power and at least one higher power thereof, controlling said oscillations in respect of their relative amplitudes, and combining said controlled oscillations.

2. In the production of a musical tone from the vibration of a tuned vibrator, the method of controlling the quality of said tone which comprises separately translating from said vibration electric oscillations representing respectively the first power and at least one higher power thereof, controlling said oscillations in respect of their relative amplitudes and phases, and combining said controlled oscillations.

3. In the production of a musical tone from the vibration of a tuned vibrator, the method of controlling the quality of said tone which comprises translating from said vibration a series of electric oscillations representing the first power and a series of electric oscillations representing at least one higher power of said vibration, differentially controlling said two series of oscillations, and combining said two series of oscillations.

4. In a musical instrument, a vibratile bridge, tuned strings passing over said bridge and having sections in harmonic relation to each other on each side of said bridge, means operative on said strings in a first of said sections for vibrating said strings, and means associated with the other of said sections for translating vibrations thereof into electric oscillations.

5. In a musical instrument, a vibratile bridge, tuned strings passing over said bridge and having sections in harmonic relation to each other on each side of said bridge, means operative on said strings in a first of said sections for vibrating said strings, and means associated with both of said sections for translating vibrations thereof into electric oscillations.

6. In a musical instrument, a vibratile bridge, tuned strings passing over said bridge and having sections in harmonic relation to each other on each side of said bridge, means operative on said strings in a first of said sections for vibrating said strings, two means respectively associated with said two sections for electrically translating the vibrations thereof into two respective series of oscillations, and means for variously combining said two series of oscillations.

7. In a musical insrument, a tuned vibrator, means in spaced relation to said vibrator for translating electric oscillations from its vibration, and piezo-electric means coupled to said vibrator for translating electric oscillations at

least preponderantly representing a higher-than-first power of said vibration.

8. In a musical instrument, a tuned string arranged for vibration, a vibratile bridge engaged by said string and vibrated thereby in accordance with both first and higher powers of the string vibration, means in spaced relation to said string for translating electric oscillations from the string vibration, and means associated with said bridge for translating electric oscillations at least preponderantly from the higher-power bridge vibration.

9. In a musical instrument, a tuned string arranged for vibration, a vibratile system including a bridge engaged by said string, said system being vibrated by said string in accordance with both first and higher powers of the string vibration; means, secured to said vibratile system but having a sensitive portion in spaced relation to said string, for translating electric oscillations from the string vibration; and means associated with said system for translating electric oscillations at least preponderantly from the higher-power vibration of the system.

10. In a musical instrument, a tuned string arranged for vibration, a vibratile bridge engaged by said string and vibrated thereby in accordance with both first and higher powers of the string vibration, means for translating a series of electric oscillations from the string vibration, means associated with said bridge for translating a series of electric oscillations at least preponderantly from the higher-power bridge vibration, and means for variously combining the respective series of oscillations.

11. In a musical instrument, a tuned string arranged for vibration, a vibratile bridge engaged by said string and vibrated thereby in accordance with both first and higher powers of the string vibration, means for translating a series of electric oscillations from the string vibration, means associated with said bridge for translating a series of electric oscillations at least preponderantly from the higher-power bridge vibration, and means for combining the respective series of oscillations in a variety of phase and amplitude relationships.

12. In a musical instrument, a tuned string arranged for vibration; a vibratile support; a bridge passed over and engaged by said string and supported by said support, to be subjected with said support to vibration in a first direction in accordance with the first power of string vibration and to be subjected in another direction to vibration representing at least one higher power of the string vibration; and mechanico-electric translating means, operatively associated with said bridge, characterized by a direction as to vibration in which it is relatively sensitive and by another direction as to vibration in which it is relatively insensitive, and having the first-mentioned of its two said directions substantially coinciding with the direction of said higher-power-representing bridge vibrations.

13. The combination according to claim 12, wherein the second-mentioned of the two directions characterizing said translating means substantially coincides with said first direction of bridge vibration.

14. In a musical instrument, a plurality of tuned vibrators arranged for selective vibration; stationary electrode means having portions respectively adjacent to but out of contact with said vibrators, each said portion being periodically approached by the respective vibrator in its vibration and being polarized relative to that respective vibrator; and coatings of insulating material over at least the surfaces of said stationary electrode means portions most closely approached by the respective vibrators in their vibrations.

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