June 5, 1934. B. F. MIESSNER 1,961,159

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

Filed Dec. 6, 1932 2 Sheets-Sheet 1

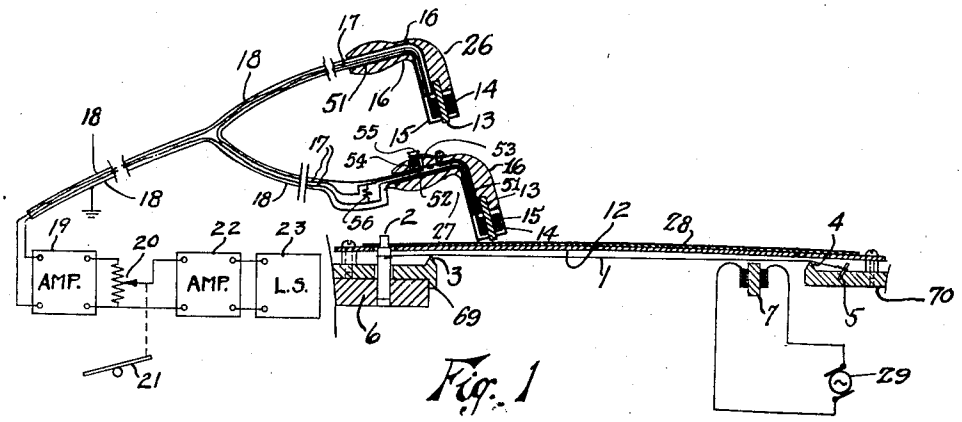

Fig. 1

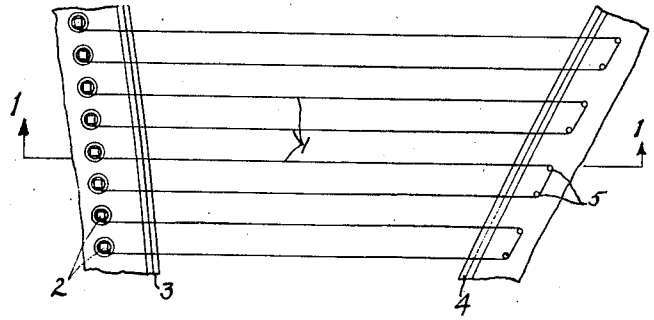

Fig. 2

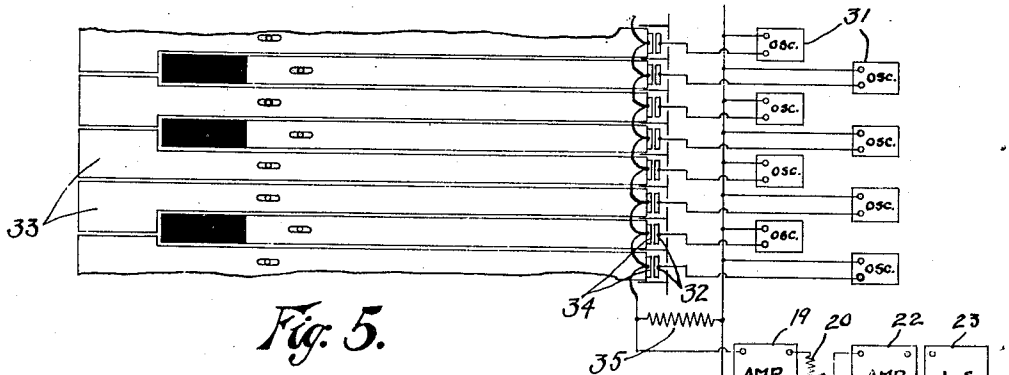

Fig. 5.

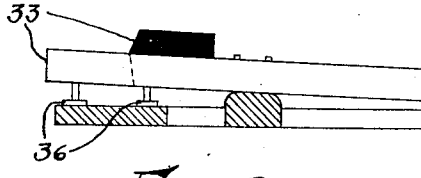

Fig. 6.

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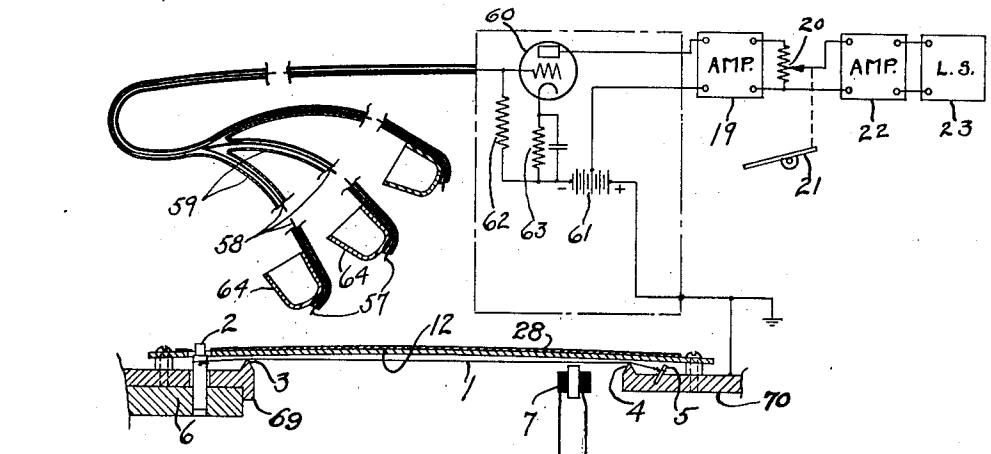


Fig. 4.

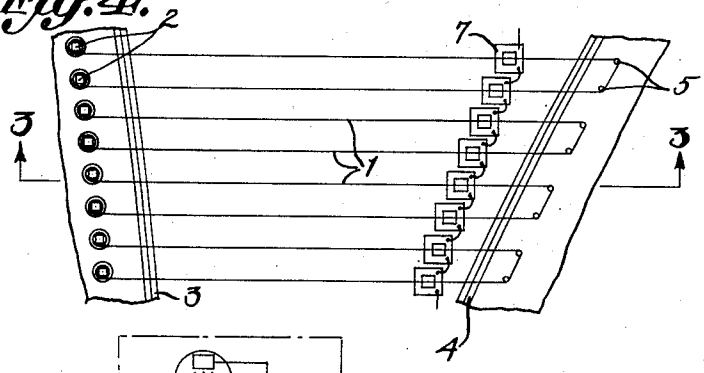
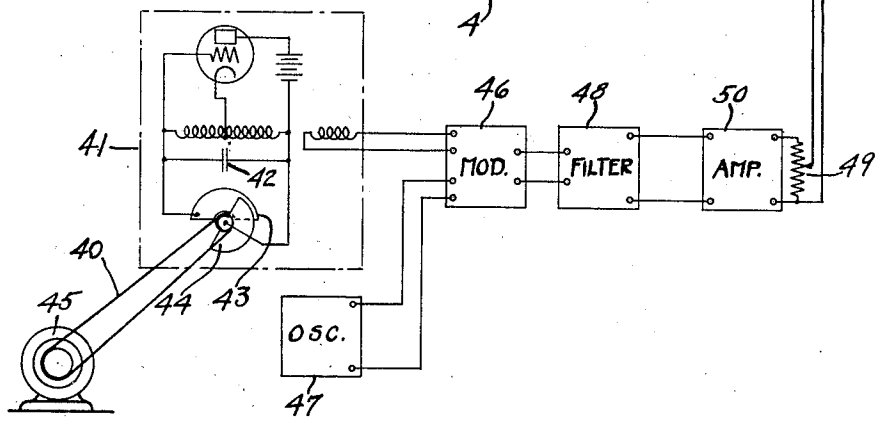


Fig. 3.



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Patented June 5, 1934 1,961,159

UNITED STATES PATENT OFFICE

1,961,159

METHOD AND APPARATUS FOR THE PRODUCTION OF MUSIC

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Application December 6, 1932, Serial No. 645,883

16 Claims. (Cl. 84—1)

This invention relates to musical instruments in which the output sound is translated from electric oscillations, and more particularly to such instruments wherein the oscillations are derived from a plurality of oscillators, either mechanical or electrical.

Instruments of this type are customarily operated with continuously acting pick-up from the several oscillators. They are played—i. e., their several output tones selectively produced at will—either by selective control of the operation of each oscillator, or by selective switching of the picked-up outputs of the several oscillators which are then continuously operated. The present invention contemplates selective pick-up from the several oscillators. The pick-ups employed in the invention may be termed "electrical" in that they are of a form yielding an electric output corresponding to the oscillations of oscillators employed, whether mechanical or electrical. By the use of suitable pick-up arrangements instruments may be constructed with which the player will have a high degree of artistic "contact"—i. e., with which intimate and delicate control over the output tones is readily available—and which are capable of creating various novel and interesting effects.

Accordingly it is an object of my invention to provide an instrument employing a plurality of oscillators whose oscillations are made selectively available by improved means and methods. It is a further object of my invention to provide such improved means and methods. A still further object of my invention is the provision of an instrument over which the artist or player will have intimate control.

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 cross-sectional view and Figure 2 a plan view of one form of my invention, wherein mechanical oscillators are employed;

Figure 3 is a cross-sectional view and Figure 4 a plan view of a further form of my invention, wherein mechanical oscillators are again employed, but with modified pick-ups and a specific vibrating means;

Figure 5 is a plan view and Figure 6 a side view of another embodiment of my invention, wherein electrical oscillators are employed.

Reference being had to Figures 1 and 2, there will be seen a plurality of strings 1, strung for example from tuning pins 2 over edges 3 and 4 to hitch pins 5. The edges 3 and 4 may be respectively formed on portions 69 and 70 of an integrally-cast frame or plate, such as a small piano plate; hitch pins 5 may be set in such plate; and tuning pins 2 may be set in pin-block 6 attached to such plate. A string 1 may be provided for each note in the desired pitch range of the instrument. All of the strings 1 are intended to be kept in a state of continuous vibration during the playing of the instrument; and since any well-known means for accomplishing this may be employed, I have schematically illustrated in this embodiment of my invention a polarized electromagnet 7 opposite each string, with a generator 29 supplying thereto electric oscillations comprising the fundamental vibrational frequency of the associated string.

The pick-up and associated system is shown only in Figure 1, being omitted from Figure 2 for the sake of clearer illustration of the portions above described. The instrument of these figures is adapted to be played by selectively positioning the pick-ups opposite the several strings, as hereinafter more fully described. Two pick-ups 26 and 27 are shown, one for use in each hand of the player; more may be employed, however, for the use of the especially dexterous player, or for duets, etc. To guard the pick-ups from contact with the vibrating strings there may be provided just above the latter a plate 12. This plate is of non-magnetic material and is preferably non-conductive; is as thin as consistent with rigidity; and is supported as near to the strings as conveniently practicable without risk of contact with the latter while vibrating—to this end it may advantageously be slightly curved, since the end portions of the strings do not vibrate at as high an amplitude as the center. The top of the plate is preferably coated thinly with rubber 28 or other soft material for the avoidance of noise upon occasional striking of the plate by the pick-ups. It will be understood that the plate should accord with these specifications, and that in Figure 1 the showing of the thickness of plate 12 and of rubber 28, and of the spacing of the plate from the string, is exaggerated in the interest of clear illustration.

Each of the pick-ups 26 and 27 may comprise a polarized electromagnet operating as a mechanico-electric translating device and consisting of a permanent magnet 13 surrounded by a coil 14. They may be encased, excepting for the extremity of the magnet 13, by a metal shield 15, and may be mounted to the end of a wooden or other insulating handle 16. This may convenient-

ly be of an approximate L-shaped cross-section, and may be provided with a longitudinal hole. This hole may be lined with metal shield 51 for the shielding of the pick-up leads 17 which may pass therethrough. The shielding is preferably continued along the leads 17 by a metallic braid 18 or the like, the entire shielding system being grounded by the grounding of such braid. The pick-ups may be connected in series by the leads 17, and the combination connected to the input of amplifier 19. This amplifier may be followed by volume control 20, operated as by foot-pedal 21, and by further amplifier 22 and loudspeaker or other electro-acoustic translating device 23.

As hereinabove stated, the instrument is designed to be played by selectively positioning the pick-ups opposite the several strings. It is obvious that when the pick-up is at an appreciable distance from the strings, and is therefore substantially equidistant from several, no appreciable selecting effect can exist. Under these same conditions, however, no appreciable picking up of string vibration takes place. As the pick-up is brought close to the plate 12 above one of the strings, however, the selecting effect increases rapidly by virtue of increasing contrast between the distances of the pick-up from that string and from others. At the same time the volume of the picked-up oscillations is being increased from a negligible to a substantial value. It is obvious that by reasonable apportioning the distance between adjacent strings good selectivity may be obtained under conditions of sufficient proximity between pick-up and string to produce an appreciable oscillation amplitude.

It will be appreciated that many factors are under the control of the player. First among these is the obvious one of note selection—i. e., the note or notes at any time produced by the instrument are a function of the string or strings opposite which the pick-ups or pick-up are placed. Secondly there is the factor of volume of individual notes, which may be varied by varying the proximity of the pick-up to the strings. Thirdly there is the factor of harmonic structure of the output tone. This may be varied within certain limits by positioning the pick-up opposite various points longitudinally along the string, and may be varied within even more wide limits by positioning two pick-ups each at various such points. These variations result from the well-known differences of vibrational waveform between different points along a tuned string. It is important to note that such variations may not only be effected from time to time or from note to note, but may also be effected during the playing of the single note, as by sliding the pick-up along or slightly above the plate 12 in the longitudinal direction of the string.

Fourthly there is the factor of individual tone "dynamics", by which is meant the shape of the envelope of the train of sound waves constituting a tone. This factor includes not only the rapidity or slowness of the attack, which may be variously established by rapid or slow motion of the pick-up toward the string, but also the nature of the tone continuation. Thus a fully sustained tone may be obtained by maintaining unvaried the position of the pick-up adjacent the string; a tremolo may be introduced by rapid slight variations of the distance of pick-up from string; an effectively slow damping of the tone may be obtained by gradual withdrawal of the pick-up, or an effective rapid damping by quick withdrawal; etc. Fifthly there is the factor of the manner of playing a series of notes. Thus the pick-up may be withdrawn to an appreciable distance from the strings in passing it from a position adjacent one to a position adjacent another, providing clear separation of consecutive tones; on the other hand, the pick-up may be slid along the surface of plate 12, or in a horizontal plane somewhat above it, in a direction transverse to the strings; this provides a "slurred" or glissando-like chromatic run.

In addition to these and other factors over which excellent control is had by manipulation of the pick-ups, there is the factor of general output volume, over which control may of course be had by variation of the total amplifier gain, as by pedal-operated volume control 20. This also, in combination with pick-up manipulation, may serve to modify at will many of the individual note effects obtainable with the instrument.

Additional control, facilitating the production of still further effects, may be provided by including in the handle 16 for each pick-up means whereby the output of that pick-up may be controlled. Thus in Figure 1 I show a variable resistance connected in series with one of the leads 17 from the pick-up 27. This variable resistance may comprise a metal disc 52, a spring 53, a pile of carbon discs 54 between disc and spring, and a button 55 by which the pile 54 may be placed in compression to reduce its electrical resistance. Across the leads 17 from the pick-up 27 may be connected a fixed resistance 56. According to the pressure exerted on the button 55, as by the thumb of the player, the series variable resistance will be reduced, and the volume of output of the pick-up 27 increased. Obviously each pick-up may be provided with a similar system, and thus volume control individual to the several pick-ups is obtained.

In Figures 3 and 4 a further form of instrument is shown wherein the pick-ups are of modified form, operating upon an electrostatic instead of an electromagnetic principle, and wherein a particular novel vibrating means is employed. Herein the strings are again provided and supported for example as in Figures 1 and 2. The curved shield 12 of Figure 1 may again be provided, this time necessarily of electrically insulating material, such as thin bakelite or the like, and again preferably coated on the top with a thin, soft layer 28 of rubber or the like. For continuously vibrating the strings there may again be provided a polarized electromagnet 7 opposite each string. To all of these electromagnets simultaneously there are supplied alternating currents periodically varying in frequency over the pitch range of the instrument. The source of these currents is described imemdiately below. Figure 3 schematically shows the source connected to the single electromagnet 7; but it will be understood that the several electromagnets respectively employed with a plurality of strings 1 are connected together and supplied from a common source. Thus Figure 4, a partial plan view, shows the electromagnets connected in series with each other.

I have shown in Figure 3 a source of alternating current with a smooth pitch variation, which occurs from minimum to maximum and back to minimum frequency. This source may comprise a beat frequency oscillator system including a varying frequency oscillator 41, a fixed frequency oscillator 47, a modulator 46 wherein the outputs of 41 and 47 are beat together, optionally a filter 48 for removing all except the "difference" frequencies produced by the modulator, an amplifier

50, and a potentiometer 49. The varying frequency oscillator 41 is shown schematically as including fixed tuning condenser 42, whereby its frequency may be adjusted for example to approximate that of the fixed oscillator 47. In parallel with the condenser 42 may be provided a small capacity comprising stationary plate 43 and movable plate 44. When the variable capacity is at its minimum value the frequency of the oscillator 41 may coincide with that of the oscillator 47. The maximum value of the variable capacity is chosen so that it will reduce the frequency of the oscillator 41 to a value less than that of oscillator 47 by an amount equal to or slightly greater than the top fundamental frequency in the pitch range of the strings 1. Therefore if the variable capacity be continuously varied from minimum to maximum to minimum to maximum, etc., as by rotation of plate 44 by motor 45 and belt 40, the frequency of the oscillator 41 will recurrently vary back and forth over the range between the frequency of the oscillator 47 and the mentioned lower frequency. Upon the beating together of fixed and varying frequency oscillator outputs by modulator 46 there will then be produced currents continuously varying from zero or a low frequency upward to the top fundamental frequency in the pitch range and back to a low or zero frequency. These may be amplified by amplifier 50 and applied to all the electromagnets 7 in series. The system just described operates in the following manner to vibrate the strings:—

Because of the range of frequencies through which the oscillation output of the amplifier has been shown to pass, oscillations of the frequency of any string 1 will be present at recurring instants in the electromagnets 7. Considering now any particular string 1, it will be readily understood that during a period comprising an instant when the frequency of oscillations in the electromagnets coincides with the fundamental frequency or one of the harmonic frequencies of the string and also comprising brief intervals immediately preceding and immediately following such instant (during which intervals the frequency of the oscillations approximately so coincides), the string will be strongly influenced to vibrate at such fundamental or harmonic frequency. Except at these periods, which obviously are recurring ones, the influence of the electromagnets on the string is negligible in comparison. Unless the frequency variation of the oscillations, effected in the apparatus shown by rotation of the plate 44, be made very rapid, the string will have time during the mentioned period to go into vibration in response to the influence of the associated electromagnet. As the loss of vibration amplitude of a vibrating string whose extremities are rigidly supported is very gradual, the once-initiated vibration will continue at an amplitude diminishing only slowly. The speed of rotation of the plate 44 need therefore be made only fast enough so that like periods of influence on the string recur sufficiently often to avoid a serious loss of string vibration amplitudes between the periods. The potentiometer 49 may serve to adjust the amplitude of the oscillations, and hence of the string vibration, to a desired value.

The pick-ups illustrated in Figures 3 and 4 each comprise small electrodes 57, which may most simply comprise a short, unshielded extremity of an insulated wire 58 elsewhere shielded by shielding 59. All the electrodes 57 which are employed may be connected in parallel by connection of wires 58 inside shielding 59, and may be connected to the grid of a thermionic vacuum tube 60. The cathode of this tube may be energized in any suitable manner; its anode current may be supplied as from a tap on high voltage battery or other source 61; and its grid may be biased through high resistance 62 to a point maintained slightly more negative than its cathode by virtue of anode current flow through condensively by-passed resistor 63. In the anode circuit of tube 60 may be connected the amplifying, controlling and electro-acoustic translating system 19—20—21—22—23 similar to that of Figure 1. The strings 1 may be rendered at the potential of the positive terminal of battery or source 61 by connection to the latter of the plate portion 70, with which the strings all make contact.

It will be seen that between each electrode 57 and any string 1 to which it may be placed adjacent a small electrostatic capacity will exist. This capacity, in parallel with other like capacities, is charged to the potential of battery 61 through resistance 62, but because of the high value of the latter the charge cannot change rapidly. Therefore oscillatory variations in the value of the capacity, produced by vibration of the strings 1, will produce a corresponding oscillatory variation in the voltage across the capacity, which appears as an alternating voltage across high resistance 62. Thence it is applied to the grid of tube 60 and, amplified by that tube, is further amplified, controlled in respect of amplitude and translated into sound by the system 19—20—21—22—23.

Each electrode 57 may conveniently be carried by a thimble 64, its shielding 59 being secured to the thimble. As many as ten electrodes may be employed, the thimbles therefor being worn on the several fingers of the player. The principles of playing of this instrument are entirely similar to those of the instrument of Figures 1 and 2, subject to the elaboration that a greater number of notes may be simultaneously sounded and to the obvious substitution of the player's finger-tips for the extremities of the translating device of the prior figures.

On the top of the shield 12 of Figure 1 or of Figure 3 may be printed or otherwise indicated the position of the various strings 1 lying therebelow; alternatively a keyboard design may be indicated thereon; or any other convenient means may be provided for designating the positions of the respective strings.

It will be understood that while I have illustrated the electromagnetic and the electrostatic forms of pick-up each with a particular string vibrating means, these and other forms of pick-up and vibrating means may be respectively interchanged.

Many of the advantages of the instruments above described may be retained, and others introduced, in a modified form of instrument wherein the pick-ups are key-controlled instead of hand-manipulated. Thus I show in Figures 5 and 6 an instrument wherein a separate pick-up is used for each tone and is movable by an associated key from an inoperative to an operative position. I have schematically shown electrical oscillators in this embodiment of my invention; but it will be appreciated that key-controlled pick-ups may be employed with mechanical oscillators, and hand-manipulated pick-ups with

electrical oscillators, the combinations herein specifically shown being by way of example.

Thus in Figure 5 there will be seen a plurality of oscillators 31, each having a different frequency output and having two terminals across which it develops its output voltage. One terminal of each oscillator may be connected to ground. Attached to the other terminal of each may be provided an electrode 32, which may be considered as a portion of the oscillator itself. This electrode is hereinafter termed the "output electrode", it being understood that the oscillator maintains an alternating voltage between it and ground. Attached to key 33 and movable by depression of the front end thereof into juxtaposition with each output electrode 32, may be a "pick-up" electrode 34, all the pick-up electrodes 34 being connected together and to one terminal of high resistance 35, the other terminal of which may be grounded. When the front end of a key 33 is raised, as normally, its pick-up electrode 34 is preferably in juxtaposition to a stationary grounded electrode 37, whereby the effective capacity of the pick-up electrode 34 to the output electrode 32 is rendered negligible.

As a pick-up electrode 34 is raised into juxtaposition with the associated output electrode 32 by depression of its key 33, the effective capacity between pick-up and output electrodes is steadily increased until the key 33 bottoms on its down-stop 36; the capacity is then at a maximum, the two electrodes being then preferably exactly opposite each other. As the pick-up electrode 34 is raised a steadily increasing voltage from the associated oscillator appears across resistance 35 by virtue of the decreasing value of reactance separating its ungrounded end from the oscillator output electrode 32. The outputs of the several oscillators are thus made to appear across resistance 35 in accordance with the manipulations of keys 33; and they may be translated into sound by an amplifier-potentiometer-loudspeaker system 19—20—21—22—23 similar to that of Figure 1.

The note selection in the instrument of Figures 5 and 6 is of course effected by the keys, which provide a more conventional type of control and facilitate the playing of full chords. While the harmonic structure control and the ability to produce slurred chromatic runs are sacrificed in this instrument, the volume of individual notes and the individual tone dynamics are as fully under control as in the first described instrument, the player in the present instance manipulating the key as he would the pick-up itself in the instruments first described.

It will be understood that the electrical oscillators 31 shown in Figures 5 and 6 may be of any form whatsoever yielding an electric output of audible frequency. Thus for example they may be conventional audio oscillators employing thermionic tubes, beat frequency oscillators, magneto-striction oscillators, alternators, etc.; or again they may comprise continuously operated mechanical oscillators, each continuously energizing an associated mechanico-electric translating device.

It will finally be understood that while I have disclosed my invention in terms of specific embodiments thereof, no limitation to these embodiments is intended, and that the scope of my invention is expressed in the following claims.

I claim:—

1. The method of operating a musical instrument of the type including a plurality of oscillators, which consists in maintaining continuous operation of each said oscillator and in electrically picking up their oscillations, said picking up being effected selectively with respect to the several said oscillators in accordance with the music to be played.

2. The method of controlling the production of musical tones by an electrical pick-up from the oscillations of an oscillator, which comprises moving said pick-up into and out of operative relationship to said oscillator to effect tone initiation and termination, respectively.

3. The method of controlling the production of musical tones by an electrical pick-up system from the oscillation of a plurality of variously tuned oscillators, which comprises moving at least portions of said system selectively into and out of operative relationship to the several said oscillators.

4. In the production of a single musical tone by an electrical pick-up from the oscillations of an oscillator, the method of control of tone dynamics which comprises selectively controlling the successive instantaneous positions of said pick-up with respect to said oscillator.

5. In a musical instrument, the combination of a plurality of oscillators, means for continuously operating said oscillators, and means for selectively transmitting their oscillations in accordance with music to be played, said last mentioned means including at least one electric pick-up adapted to be selectively positioned in operation relationship to any of said oscillators at will.

6. In a musical instrument, the combination of a plurality of tuned strings, means for continuously vibrating each of the same, and means selective with respect thereto for translating electric oscillations therefrom, said last mentioned means including an electric pick-up adapted to be selectively positioned in operative relationship to any of said strings at will.

7. In a musical instrument, the combination of a plurality of oscillators, an electric pick-up, a handle for said pick-up, and means carried by said handle for varying the amplitude of the electric output of said pick-up.

8. In a musical instrument, the combination of a plurality of tuned vibrators of magnetic material; means for continuously vibrating said vibrators; a shield of non-magnetic material in close proximity to said vibrators; and at least one electromagnetic pick-up sensitive to the vibrations of said vibrators and movable along said shield on the opposite side thereof from said vibrators.

9. In a musical instrument, the combination of a plurality of oscillators; a plurality of electric pick-ups; and separate thimbles carrying said pick-ups, said thimbles being adapted to be worn on the fingers of the player.

10. In a musical instrument, the combination of a plurality of tuned vibrators of conductive material; means for continuously vibrating said vibrators; a shield of non-conductive material in close proximity to said vibrators; and at least one electrostatic pick-up sensitive to the vibrations of said vibrators and movable along said shield on the opposite side thereof from said vibrators.

11. In a musical instrument, the combination of a plurality of continuously operating oscillators; electric pick-ups individually associated therewith; and means respectively associated with and influencing said pick-ups for moving

said pick-ups from an inoperative to operative positions with respect to their associated oscillators.

12. In a musical instrument, the combination of a plurality of oscillators; output electrodes on which said oscillators develop electric potentials; pick-up electrodes; and means respectively associated with and influencing said pick-up electrodes for bringing said pick-up electrodes into juxtaposition with said output electrodes to form electrical capacities therewith.

13. In a musical instrument, the combination of a plurality of oscillators; output electrodes on which said oscillators develop electric potentials; shielding electrodes; pick-up electrodes; and means respectively associated with and influencing said pick-up electrodes for moving said pick-up electrodes from positions adjacent said shielding electrodes to positions opposite said output electrodes.

14. In a musical instrument, the combination of a plurality of tuned vibrators and means for vibrating the same, said means comprising a source of electric oscillations of constantly varying frequency and electro-mechanical translating means associated with and influencing said vibrators and energized by said source.

15. In a musical instrument, the combination of a plurality of tuned vibrators and means for vibrating the same, said means comprising a source of electric oscillations, electro-mechanical translating means associated with and influencing said vibrators and energized by said source, and means for recurrently varying the fundamental frequency of said oscillations over at least the fundamental frequency range of said vibrators.

16. In a musical instrument, the combination of a plurality of tuned vibrators and means for vibrating the same, said means comprising two oscillators, means for continuously varying the fundamental frequency of one of said oscillators, means for beating together the outputs of said oscillators, and electro-mechanical translating apparatus associated with and influencing said vibrators and energized by the output of said beating means.

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