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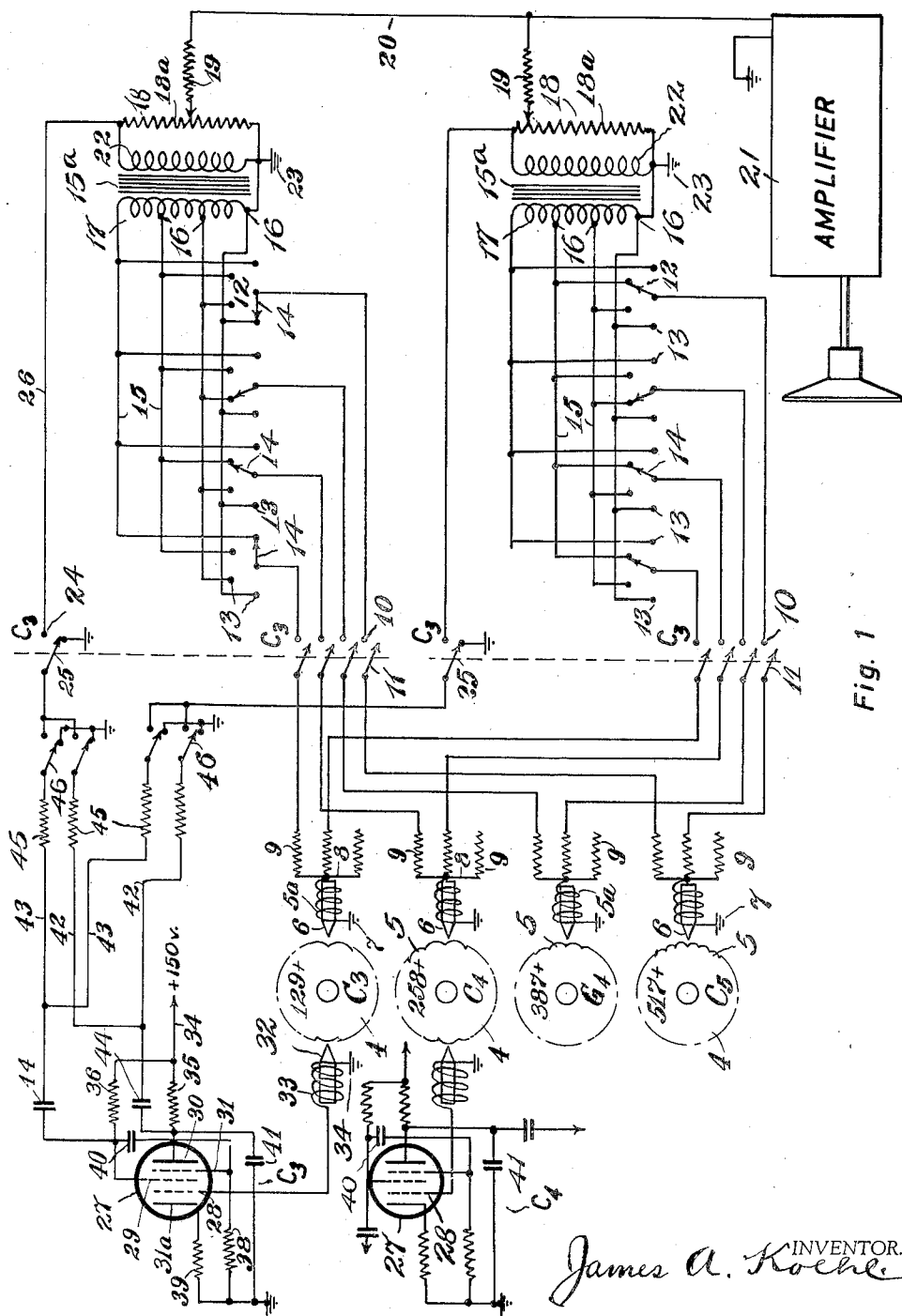
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2,305,574

MUSICAL INSTRUMENT

Filed Oct. 24, 1940

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

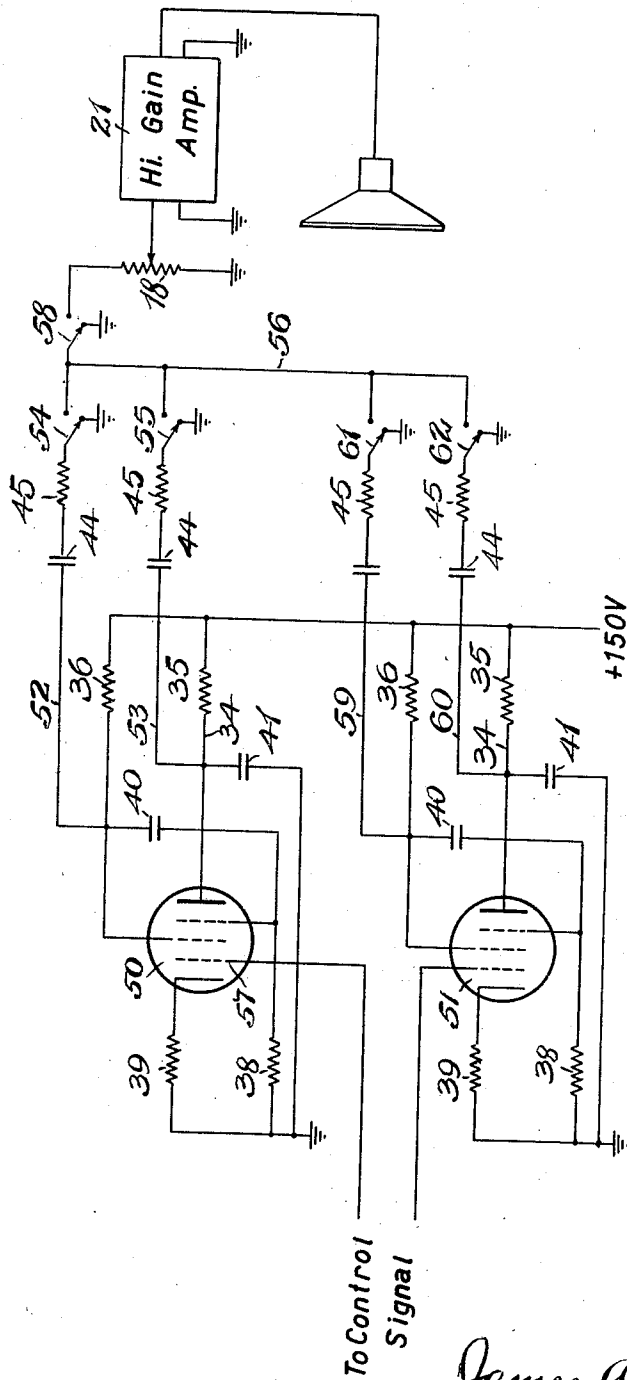


Fig. 2

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UNITED STATES PATENT OFFICE

2,305,574

MUSICAL INSTRUMENT

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This invention relates to electrical musical instruments of the class employing means for producing sets of electrical impulses of a plurality of different frequencies representing different note positions in a musical scale and adapted to be selectively combined to produce a tone of any desired timbre.

An object of my invention is to provide electrical sources in coaction with and controlled by continuous simple tone frequencies from well known pulsation alternators, whereby selected timbres obtained by the synthesis of said simple tone frequencies can, as desired, be combined with complex waveforms of continuous wave oscillations supplied by said electrical sources.

Another object is to provide sets of frequency sources in which frequencies developed by sources of one set are controlled by frequencies developed by sources of the other set and whereby frequencies from either set of sources can be used independently of and for musical results not possible of attainment with frequencies developed by sources of the other set.

Another object is to provide means enabling phase changes to be had between frequencies with resultant production of an effect like the voix celeste stop of an organ, i. e., a single, double or triple organ-stop tuned sharp or flat, or both, to produce an acoustical tremolo.

A further object is to simplify the construction of such instruments while contributing to the musical advantages thereof.

Another object is to provide means for supplying such instruments with a greater number of higher harmonics than has heretofore been possible with instruments employing rotary or vibratile pulsation, generators, whereby more complex colors are obtained.

Another object is to provide a system of complex waveform generators which are readily applicable to electrical musical instruments now in common use and which employ either rotary or vibratile alternators whose harmonically related output frequencies are of simple waveform and adapted to be synthesized into selected timbres.

A still further object is to provide one or more high impedance oscillating circuits in electrical coaction with a low impedance pulsation alternator of simple tone frequency whereby, in response to depression of an associated playing key, either a simple tone frequency produced by said alternator or one or more complex waveforms from the oscillating circuits, or both the complex waveforms and said simple tone fre-

quency can be translated into sound at the will of the player.

A still further object is to provide in association with high and low impedance load circuits, resistive output paths from high and low impedance generators respectively in which the impedances in said paths are proportioned relative to each other so that the amplitudes of voltages delivered to said high and low impedance load circuits from said paths are equal.

Another object is to provide in association with an output circuit having high and low impedance sides respectively connected with high and low impedance frequency sources so that the output voltage from said circuit is proportional to the combined voltages of any frequency delivered from said sources.

My invention will be more clearly understood from the specification hereinafter following and by reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a two manual instrument in which my invention is incorporated, and

Figure 2 is a schematic illustration of a slightly modified form thereof.

In carrying the invention into practice, I may employ any well known organization of constant speed generating devices for producing electrical vibrations corresponding to different notes of a musical scale through a range of more than one octave. A system well suited to my general purpose is disclosed and fully described in Letters Patent to Thaddeus Cahill, No. 1,107,261, Aug. 18, 1914, and can be used with the multiple key contactors disclosed in the Cahill Patent No. 1,295,691, Feb. 25, 1919.

In Figure 1 of the accompanying drawings, I show four constant speed low impedance generators respectively designated C3, C4, G4 and C5, each comprising a tone wheel rotor 4 of magnetic material provided with equi-distantly related peripheral high points 5 of precalculated shapes, and a pick-up magnet 6 associated therewith and provided with a coil 5a having a grounded terminal 7 and an output terminal 8, the latter having a plurality of high resistive, parallel output paths 9. As it is well known that such tone wheel rotors driven at assigned constant angular velocities and having predetermined numbers of peripheral high points, will induce periodic flux changes in the coils of their associated permanent magnets at rates corresponding to the tone frequencies of different notes of a musical scale, it will suffice merely to

say that the four low impedance generators herein shown are designed, shaped, constructed and adapted to be driven at respective constant angular velocities to produce 129., 258., 387., and 517., vibrations per second, respectively corresponding to the vibration frequencies of notes C3, C4, G4 and C5 of the even tempered musical scale.

Figure 1 schematically represents an instrument having two keyboards, for each of which is a set or system of conductors or bus-bars 10. I show but a single playing-key for each of said key-boards, namely, the key C3, and as illustrated, each key has a plurality of simultaneously actuatable circuit controlling contactors 11, such that there is one such contactor in circuit controlling relation to each individual bus-bar of a respective set of said bus-bars. As the two keys are associated with the same note of the scale, it need only be said that each generator supplies frequencies to corresponding contactors 11 of the respective keys.

For each keyboard of the instrument, I employ a harmonic control system comprising a plurality of multiple contact switches 12, each provided with similar contacts 13 and an adjustable bridging member 14 therefor. Contacts occupying the same numerical order in each of the switches connect by a conductor 15 to a pre-assigned tap 16 from a predetermined number of turns of the primary or low impedance winding 17 of a transformer 15a. One terminal of said primary winding connects with one terminal of a potentiometer 18 whose variable contact member 19 for the high resistance 18a is connected by a common conductor 20 to the input circuit of an amplifier 21. The other terminal of said potentiometer connects with one terminal of the secondary or high impedance winding 22 of said transformer, the opposite terminal of said secondary winding and one terminal of said primary winding being grounded at 23.

When a playing-key is depressed four circuits are simultaneously completed, each of which includes a coil 5a of the pick-up magnet of an associated tone wheel rotor, and a resistance 9 which is sufficiently high relative to the internal impedance of the generator of which said wheel is a part and the remaining portion of the circuit so as substantially to determine the amount of current which will flow through said circuit. Such circuits provide a low impedance load and are fully disclosed and described in Letters Patent No. 1,956,350 of April 24, 1934, to Laurens Hammond, and are employed in association with an output circuit which includes a transformer designed so that only a small proportion of the electrical energy which might be generated is ever utilized by a single circuit, even tho all of the circuits of the low impedance load should be completed at the same instant. I therefore make no claim to this feature so far as it embodies use of such transformer, but point to it as an example of one well known means in which low impedance generators of simple tone frequencies may be satisfactorily used in a low impedance load including means such as a transformer having a secondary winding whose number of turns is so in excess of the number of turns of the primary windings as to form part of a high impedance load in which generators embodied in my invention can be connected and their output frequencies rendered effective in said high impedance load during transmission of

simple waveforms of potential through the low impedance load circuits.

It is not intended that my invention shall be confined to use in connection with low impedance generators of the electromagnetic type as satisfactory results can be had with circuits in which high impedance generators are employed as disclosed in Letters Patent to Floyd A. Firestone, No. 1,953,753 of April 3, 1934. Neither shall use be confined to any particular well known harmonic mixing system, nor to generators of simple partial frequencies.

The upper keyboard of the instrument herein diagrammatically illustrated has associated therewith a bus-bar 24 and as shown, the key C3 has in addition to its contactors 11, a contactor 25 adapted to be close circuited with said bus-bar when depressing the key to close circuit contactors 11 with their respective bus-bars 10. Said bus-bar 24 is connected by a conductor 26 to the high resistance 18a of said potentiometer 18 at its junction with the secondary winding 22 of the transformer 15.

For each note in the instrument's gamut, there is an oscillator 27, preferably of the pentode vacuum tube type, having a controlling electrode 28, screen grid 29, plate 30, suppressor grid 31 and filament 31a. The tone wheel C3 has associated therewith a permanent magnet 32, having a coil 33, one terminal of which is grounded at 34 and the other terminal connected to the control grid of said vacuum tube, whereby and simultaneously with the production of flux changes in the coil of the magnet 6 like flux changes are induced in the coil 33 and impressed upon the control grid of said tube so as to synchronize operation of said tube with the simple tone frequency in the output of said magnet 6.

Voltage from a pure source of direct current of 150 volts under the load imposed upon it, is supplied the plate 30 through a resistor 35 of approximately 200,000 ohms in path 34. Current is supplied the screen grid through a resistor 36 of approximately 50,000 ohms from path 34. The suppressor grid is grounded through a resistor 37 of approximately 500,000 ohms and the cathode 31a is grounded through a resistor 38. Due to the voltage drop across resistor 38, the control and suppressor grids receive a bias that is negative to the cathode. The resistor 38 thus equalizes differences in the tube characteristics by applying greater bias if the tube tends to draw greater anode current, thereby reducing the current to approximately normal and vice versa. The alternating current appearing across the resistor 39 degenerates the tube and reduces the harmonic content of the plate output. A capacitor 40 of approximately .1 mfd. couples the screen grid to the suppressor grid whereby alternating potential is the same at each of said grids. Since the control grid is supplied with a constant alternating current of the frequency determined by the tone wheel of generator C3, the tube is predisposed to oscillate at some multiple or sub-multiple of the controlling frequency supplied the control grid as aforementioned. When the tube is tuned by capacitor 41, connected as shown, it oscillates at the same fundamental frequency as that of alternating potential from said generator.

The tube has output paths 42 and 43 from the plate and screen grid respectively, each serving as a carrier of a waveform of alternating potential, the waveform from the plate having a smaller number of harmonics than the number of harmonics taken off of the screen grid. In each of

these output paths from the tube is a blocking condenser 44, a high resistor 45 and a stop 46. These stops may be selectively close circuited with the bus-bar 24, whereby either or both of said waveforms may be conducted to the high impedance side of the transformer 15 through said conductor 26. At this point, it should be noted that the resistances 45 and the resistances 9 are of such relative values that the amplitude levels of voltages delivered to the high impedance load are proportional to the amplitude levels of voltages delivered to the low impedance load.

It is understood that each playing-key of the instrument has a contactor 25 adapted to be close circuited with the bus bar 24 of the keyboard with which it is associated when depressing said key and that for each low impedance generator of simple tone frequency there is an oscillator 27 whose fundamental frequency is the same as said simple tone frequency. In this manner, each key has at its command a simple waveform of undulating potential and one or more complex waveforms of undulating potential. By connecting the simple waveform generators and their interconnected oscillators in an electrical network as shown and described herein, any simple tone frequency can be translated into sound singly or it may be combined with any selected number of other simple tone frequencies which are harmonically related thereto. In like manner, any combination of simple tone frequencies can readily be combined with one or more complex waveforms delivered by said oscillators.

While I show but two output paths from each oscillator for each manual, additional paths can readily be provided by use of capacitor systems well known in the art, whereby many different waveforms can be produced.

The lower keyboard is of course connected in the system in the same manner as the upper keyboard and it is thought that a description of one will fully suffice for both. It accordingly follows that any quality can be set up upon either or both keyboards by combining selected portions of simple tone frequencies. It is further noted that one keyboard may render effective upon the sound translating system selected complex waveforms from the oscillators, whereas the other keyboard may render effective upon said system any desired number of simple tone frequencies according to the quality of tone desired to be produced when playing said keyboard. I have not disclosed a pedal section as it is obvious that same can be incorporated and its keys electrically connected with the respective frequency sources in the same manner as already described when referring to said upper and lower keyboards.

In Figure 2 two oscillation generators 50 and 51 are shown, such that the output leads 52 and 53 from the plate and screen grid respectively of generator 50 connect with stop switches 54 and 55, said switches being normally open circuited relative to a common conductor 56. The control grid 57 of said generator may receive a controlling signal from the coil 33 of any magnet 32 shown in Figure 1. Assuming that the signal is received from coil 33 of magnet 32 associated with tone wheel rotor C3, the signal will have a frequency of 129.4 cycles per second, corresponding to the vibration frequency of note C3. If stop 54 is close circuited with said conductor 56, a waveform of voltage will be delivered to the input circuit of the amplifier 21 from the screen

grid of said oscillation generator 50 upon close circuiting the key switch 58. When similarly close circuiting stop 55 a waveform of voltage is delivered to said conductor 56 from the plate of said oscillation generator 50 and impressed upon the input circuit of said amplifier upon close circuiting said key switch. When both stops are close circuited, a waveform of voltage which is the sum of the individual waveforms from said plate and screen grid is impressed upon said input circuit of said amplifier upon close circuiting said key switch.

It is understood that for each generator 50 employed in the instrument there will be one generator 51. This may be the same as generator 50 or it may be of any other well known type adapted to deliver a waveform of output voltage, the frequency of which is either sharp or flat relative to the frequency of output voltage from generator 50. In the instant embodiment of my invention, the generator 51 has its output paths 59 and 60 from the screen grid and the plate of the generator connected to respective switches 61 and 62 which are each thereof connected with the aforementioned conductor 56. In practice, upon close circuiting either or both stop switches 54 and 55, either or both celeste switches 61 and 62 may be selectively close circuited with said conductor 56 so that voltage from generator 51 whose frequency is either slightly sharp or slightly flat relative to that of the output voltage from generator 50 will be combined therewith for the production of celeste effects. The control signal for said generator 51 may be supplied from the coil of a tone wheel rotor of the instrument the output frequency of which is sharp or flat relative to the frequency of output voltage from said generator 50, or said signal may be supplied from any other well known source of controlling voltage.

I may use two oscillation beat note generators in association with a generator of simple tone frequency instead of one as above described, one of which produces a frequency which is flat and the other a frequency which is sharp relative to said simple tone frequency.

Depending upon the number of harmonies desired to be produced by simple tone generators, I may use in the low impedance load any desired number of generators, some furnishing higher or upper partial frequencies and others sub-fundamental frequencies. In practice, good results are had with the system of generators disclosed in Letters Patent No. 2,187,910, to Valentine Mohler, dated Jan. 23, 1940, wherein twelve assemblies of similar generators are employed, each driven at its own speed and provided with tone wheel rotors, the number of high points on which are accurately determined and shaped so that all the semi-tone frequencies for a scale in even temperament are produced. In this system, C3 note is produced by a tone wheel rotor driven at an angular velocity of 981 R. P. M. and having sixteen peripheral high points. Note C4 is produced by a tone wheel rotor driven at the speed above stated, said rotor having thirty-two peripheral high points. Note C5 is produced by a tone wheel rotor also driven at the speed above stated and provided with sixty-four peripheral high points. The note C4 will be produced by a tone wheel rotor driven at 1470 R. P. M. and provided with thirty-two peripheral high points.

As the gist of my invention is in providing different pluralities of generators of the same

semi-tone frequencies, which generators are in electrical coaction with each other so that the frequency generated by a generator of one of said pluralities of generators is used both to provide a fundamental tone and to control the fundamental frequency of a complex waveform produced by a generator of the other plurality of generators, I am not to be limited to the forms of generators constituting either of said pluralities. Any well known generator providing space current of complex waveform and capable of being controlled and used as herein taught, may readily be substituted for the oscillators first above referred to.

I prefer to connect the keyboards to a single amplifying and sound translating system through the respective high resistances 18a. However, if desired, each of these resistances can be connected to its own amplifying and translating system.

While I show separate pick-up magnets for the controlling electrodes of the aforementioned oscillators, controlling currents from the output paths of magnets 6 of said oscillators can be impressed upon said controlling electrodes.

It also will be appreciated that while I show an oscillator for each semi-tone frequency throughout the instrument's gamut, tubes employing multiple controlling electrodes and emitting space currents of different semi-tone frequencies can be employed, thus materially reducing the total number of tubes necessary to be used. For example, an instrument employing ninety-six generators of simple tone frequencies will require but forty-eight tubes each having two controlling electrodes.

While I prefer to employ an oscillator, from separate electrodes of which different waveforms may be separately or simultaneously transmitted to an electro-acoustic sound translating device, a space discharge device emitting but a single waveform but containing a large number of harmonic components can be substituted therefor without departing from the spirit and intention of my invention and same can be connected in any well known system having filtering means for modifying said waveform and producing different timbres.

What I claim as my invention is:

1. In an electrical musical instrument, sources of relatively different impedance respectively producing simple and complex waveforms of alternating potentials, means controlling the frequency of one of said potentials and including a constant speed alternator, means for utilizing the controlled potential to synchronize the frequency of the other potential therewith and including a transmitting path for said controlling potential electrically interrelating said sources, and means for translating either of said potentials into sound.

2. In an electrical musical instrument employing rotary alternating current sources, separate sets of switches and connections between said sources and said switches connecting switches of different sets to a single one of said sources; a thermionic discharge tube for each of said sources and including a controlling electrode connected therewith to receive a controlling signal therefrom, and a system in coaction with said tubes, said switches and said sources for selective translation of current from the tubes and said sources into sound.

3. In an electrical musical instrument, a plurality of low impedance generators respectively

generating variable currents at the tone frequencies of different notes of a musical scale, an electrical network having an output circuit provided with a transformer embodying a stepped low impedance primary coil and a high impedance secondary coil, means for selectively conducting variable current from any generator to a selected number of turns of said primary coil, a variable current generator of high impedance for generating a complex waveform of space current, said high impedance generator connected with a low impedance generator to receive a controlling signal therefrom to thereby synchronize the fundamental frequency of said space current with the frequency of current from the low impedance generator, said high impedance generator connected in the output circuit at the side of said secondary coil, and means for selectively conducting said space current to said output circuit.

4. In an electrical musical instrument in which an alternator embodying relatively movable elements are formed and related to each other to produce when in constant relative motion a sinusoidal waveform of undulating potential of predetermined tone frequency; an electrical network having a playing-key actuable therein to close circuit said alternator with the input circuit of a vacuum tube amplifier and means interposed between said alternator and said input circuit for generating a complex waveform of potential and impressing same upon said input circuit, and means electrically interconnecting said alternator and said complex waveform generator for utilizing undulating potential produced by said alternator to control the frequency of the complex waveform of potential.

5. In a musical instrument employing an alternator for producing alternating potential at the tone frequency of a note of a musical scale and a playing-key for controlling conduction of the produced potential to the input circuit of a vacuum tube amplifier; a thermionic discharge device having a controlling electrode, means including a circuit path between said alternator and said controlling electrode for impressing controlling potential upon said electrode from said alternator, and selectively actuable means connected for coaction with said key and said thermionic discharge device to render space current developed by said tube effective upon said amplifier.

6. In a musical instrument, a translating device, a transmitting network having separate paths over which alternating current potentials are transmitted to said translating device, a key having contacts controlled thereby, a plurality of rotary pulsation generators having output terminals respectively connected to said separate paths and to said contacts and with each other by a path over which frequency controlling alternating current potential from one generator is conducted to the other generator and means for selectively controlling delivery of alternating current potentials from said generators to said separate paths.

7. In a celeste mechanism for electrical musical instruments, comprising an alternator producing output oscillations at a predetermined tone frequency, a vacuum tube generating output oscillations at a beat frequency relative to the frequency of the output oscillations from said alternator, and an electrical network in which said alternator and said vacuum tube are connected so as selectively to render their output oscillations effective upon an electroacoustic translating device.

8. In a musical instrument, high and low impedance loads respectively, generators of different simple tone frequencies including means for selectively close circuiting same with the low impedance load and controlling the relative amplitudes of said frequencies, oscillation generators, and means for selectively close circuiting said oscillation generators with said high impedance load.

9. In a musical instrument, high and low impedance loads respectively, low impedance generators of different fundamental frequencies, means for close circuiting selected generators with said low impedance load, high impedance generators of complex waveforms and means for close circuiting selected high impedance generators with said high impedance load.

10. In an electrical musical instrument, a rotary generator continuously generating a frequency corresponding to a tone of predetermined pitch, a generator continuously generating a waveform of frequencies having a tonal component corresponding to said predetermined pitch, an output circuit, and a system in which said generators are connected to enable their output frequencies to be selectively impressed upon said output circuit either conjointly or independently of each other.

11. In an electrical musical instrument, the combination of an output circuit, a set of rotary generators of simple tone frequencies corresponding to the vibration frequencies of the notes of the tempered musical scale, a set of generators of complex waveforms of tone frequencies, the first and second named generators electrically coupled together to control the operating frequencies of the generators of one set of generators by the output frequencies of assigned generators of the other set of generators, and means including a keying mechanism and a system of stops in electrical coaction with the generators of both said sets of generators and with the output circuit for selectively rendering said generators effective to produce in said output a waveform which is the sum of the output frequencies from any selected ones of said generators.

12. In an electrical musical instrument, rotary generators continuously generating predetermined tone frequencies; other generators continuously generating tone frequencies, the waveforms of which are characteristic of tones of a higher harmonic content than those represented by the frequencies produced by the first mentioned generators, said other generators coupled to the first mentioned generators to provide pairs of generators in which the operating frequency of one generator of the pair is controlled by the operating frequency of the other generator of said pair, an output circuit, and mechanism in electrical coaction with the first and second mentioned generators for selectively rendering effective in said output circuit a waveform which is the synthesis of tone frequencies from any selected generators.

13. In an electrical musical instrument, the combination of an output circuit, a set of rotary generators of simple tone frequencies corresponding to the vibration frequencies of the notes of the tempered musical scale, a set of generators of complex waveforms of tone frequencies, the first and second named generators electrically coupled together to control the operating frequencies of the generators of one set of generators by the output frequencies of assigned generators of the other set of generators, and means

including a keying mechanism in electrical coaction with generators of the respective sets of generators and with said output circuit for producing in said output circuit a waveform which is the sum of the simple output tone frequency of a generator of one of said sets of generators and the complex waveform of output frequencies of a generator of the other set of generators which is electrically coupled thereto.

14. In an electrical musical instrument employing tone wheel generators of simple tone frequencies, an electro acoustic translating device, and keying means for controlling conduction of frequencies to said electro-acoustic translating device from selected tone wheel generators; a thermionic discharge tube for each individual tone wheel generator and having a plurality of output electrodes and a controlling electrode, a condenser-resistive circuit in which each individual thermionic discharge tube is connected so that the waveform of output frequency from one output electrode of the tube is different from the waveform of output frequency from the other output electrode of the same tube; and mechanism embodying a system of stops electrically connected with said tone wheel generators and said thermionic discharge tubes for rendering the output frequencies from said tubes selectively effective upon said translating device in response to actuation of the aforementioned keying means.

15. In an electrical musical instrument, the combination with an oscillatory circuit having means for continuously operating same to produce therein a complex waveform of output potential; a continuously operating pulsation generator connected by a circuit path with said oscillatory circuit for delivery to said circuit of a signal which controls the frequency of operation of said circuit, a resistive output path coupled to said oscillatory circuit, and a resistive output path coupled to said pulsation generator.

16. In an electrical musical instrument employing a keyboard and an electrical sound producer; oscillation generators of frequencies of complex waveform, pulsation generators of waveforms corresponding to notes associated with different playing keys of said keyboard, a path connecting each individual pulsation generator with one of said oscillation generators for transmission to the latter from the former of a signal which controls the frequency of operation of said oscillation generator, an electrical network in which all of the aforementioned generators are electrically connected, means in said network for producing beat frequencies; and means in said network responsive to depression of any selected playing key of said keyboard for simultaneously rendering effective upon said sound producer a complex waveform of frequency from an oscillation generator, a simple waveform of frequency from an associated pulsation generator and a beat note frequency from said beat note frequency producing means.

17. In an electrical musical instrument employing an electrical sound producer; oscillation generators of frequencies of complex waveform, pulsation generators of waveforms corresponding to predetermined simple tone frequencies, a path connecting each individual pulsation generator with one of said oscillation generators for transmission to the latter from the former of a signal which controls the frequency of operation of said oscillation generator, an electrical network in which all of the aforementioned generators are electrically connected,

and means in said network for rendering effective upon said sound producer waveforms of frequencies from selected ones of any of said generators.

18. In an electrical musical instrument employing a keyboard and an electrical sound producer; oscillation generators of frequencies of complex waveform, pulsation generators of waveforms corresponding to notes associated with different playing keys of said keyboard, a path connecting each individual pulsation generator with one of said oscillation generators for transmission to the latter from the former of a signal which controls the frequency of operation of said oscillation generator, an electrical network in which all of the aforementioned generators are electrically connected; and means in said network responsive to depression of any selected playing key of said keyboard for simultaneously rendering effective upon said sound producer a complex waveform of frequencies from an oscillation generator and a simple waveform of frequency from an associated pulsation generator.

19. In an electrical musical instrument, an output circuit, a low impedance load coupled to said output circuit, a high impedance load coupled to said output circuit, a set of low impedance pulsation generators continuously producing frequencies corresponding to the vibration rates of predetermined musical tones and provided with high resistive output paths, a set of high impedance generators of complex waveforms and provided with high resistive output paths, and respective mechanisms for selectively impressing the outputs of the first and second mentioned generators upon said output circuit through the aforementioned high and low impedance loads respectively.

20. In an electrical musical instrument, the combination with an output circuit; a set of low impedance alternating current generators, each generator provided with a low impedance

load; means for selectively coupling the low impedance loads with said output circuit and for predetermining the amplitude of alternating current delivered to said output circuit from said low impedance generators; high impedance generators of alternating current, each high impedance generator provided with a high impedance load, and means for selectively coupling the high impedance loads to said output circuit.

21. In a musical instrument, a thermionic discharge tube having a controlling electrode and a path for the discharge of space current; an alternator comprising a constantly driven element and a coacting pick-up element, said alternator providing a source of variable current of controlled frequency; a circuit path interconnecting said source of variable current with the controlling electrode of the aforementioned thermionic discharge tube for impressing said variable current upon said electrode so that space current generated by said tube has the same fundamental frequency as said variable current; and means by which either the controlled variable current or said space current or both said variable current and the space current can be translated into sound.

22. In a musical instrument, a playing key; a source of variable current of controlled frequency and comprising a generator embodying relative movable coacting elements; a thermionic discharge tube having a controlling electrode and a path for the discharge of space current, said path interconnecting said generator with said controlling electrode for impressing said controlled variable current upon said controlling electrode; and selectively actuable means responsive to depression of said key for translating either the space current or the controlled variable current or both thereof into sound.

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