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J. MANATT

2,229,755

ELECTRICAL MUSICAL INSTRUMENT

Filed Dec. 22, 1939

3 Sheets-Sheet 1

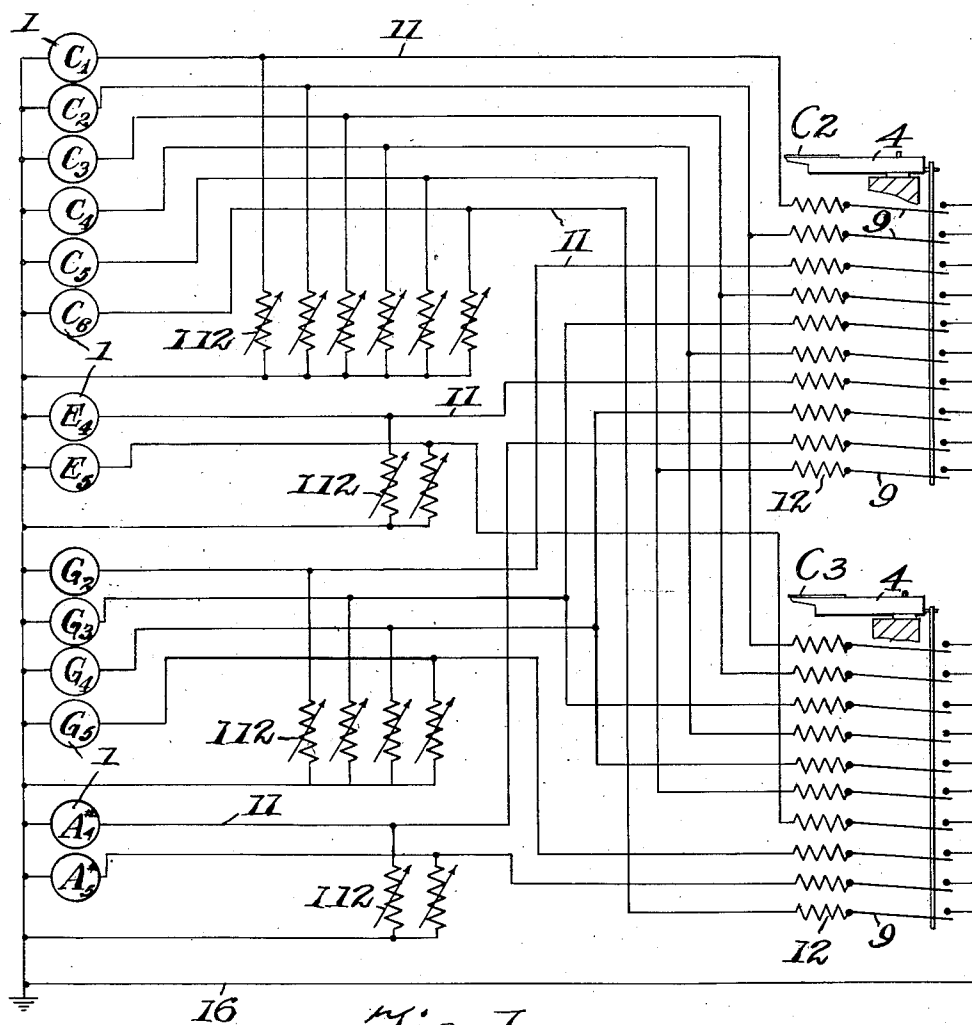


Fig. 1.

JAMES MANATT

INVENTOR.

BY James A. G. Koehl.

ATTORNEY.

Jan. 28, 1941.

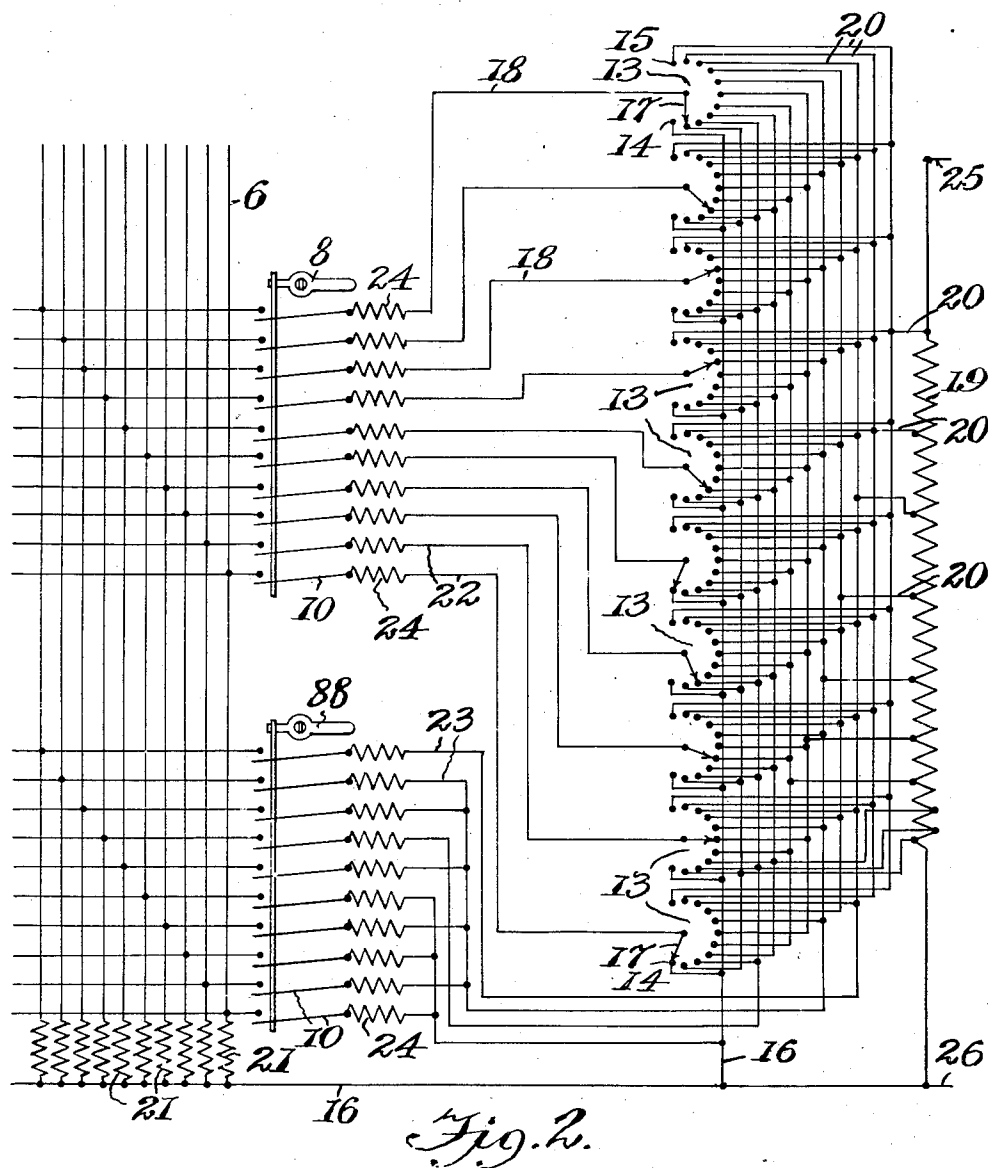
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JAMES MANATT

INVENTOR.

BY *James A. G. Koche*

ATTORNEY.

Jan. 28, 1941.

J. MANATT

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3 Sheets-Sheet 3

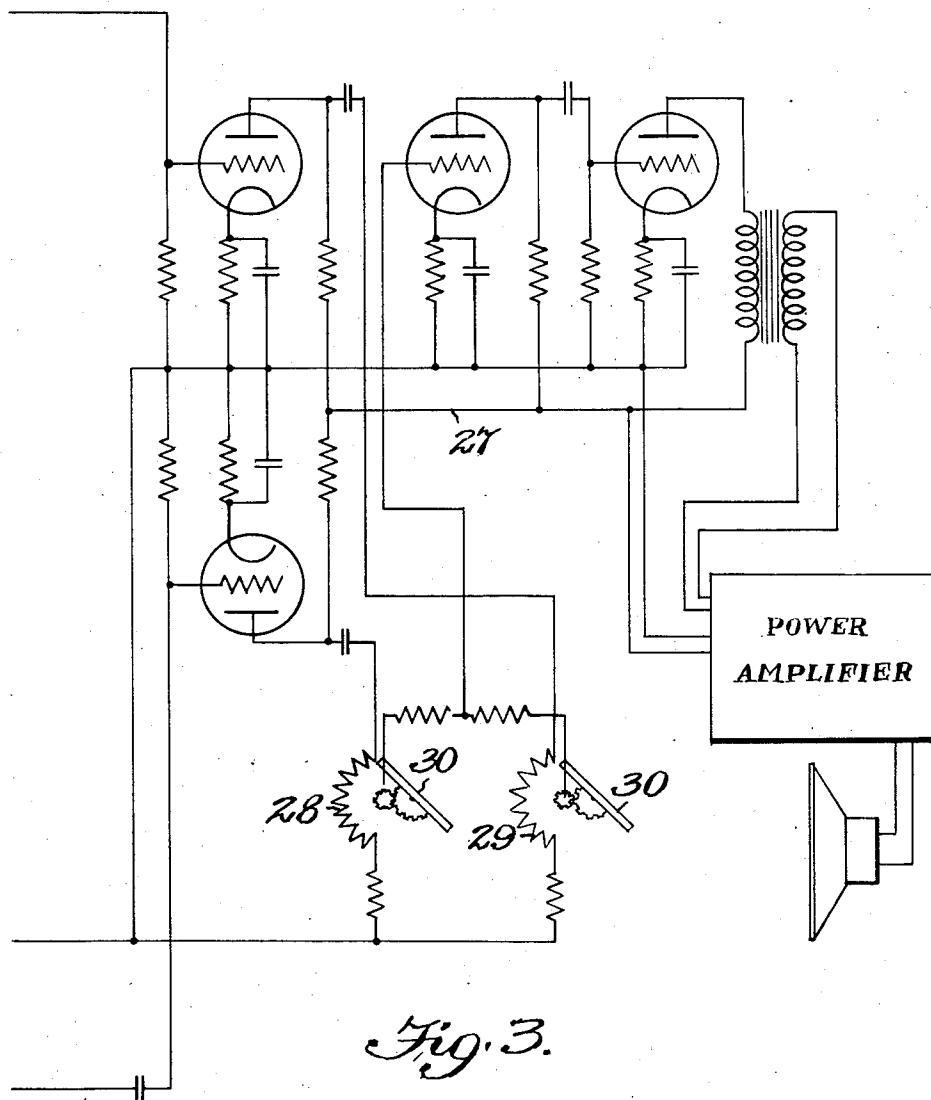


Fig. 3.

JAMES MANATT

INVENTOR.

BY

James A. G. Koehle.

ATTORNEY.

UNITED STATES PATENT OFFICE

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ELECTRICAL MUSICAL INSTRUMENT

James Manatt, Chicago, Ill., assignor to Central Commercial Company, Chicago, Ill., a corporation of Illinois

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7 Claims. (Cl. 84-1.17)

This invention relates to electrical musical instruments of the class employing sources of electrical energy respectively furnishing harmonically related tone frequencies and means by which said frequencies can be selectively synthesized into qualities simulating organ tones and tones of the various orchestral instruments.

An object is to provide means by which tones will be accurately integrated according to the number sounded at any instant.

A further object is to provide means by which a tone of any quality can be selectively sounded as desired and tones of different qualities correctly added to each other.

A still further object is to provide means enabling a player to compound any selected number of harmonically related simple partials into a tone of any desired quality.

A still further object is to provide means enabling a player to add to one or more "fixed" qualities of tone, one or more simple partials at any desired amplitude, whereby the tone color can be changed to suit the individual taste of the player.

The invention will be more fully understood by reference to the following description when read in connection with the accompanying drawings, in which:

Figures 1, 2 and 3, taken together illustrate an electrical network embodying the various features of my invention.

While I disclose but a single manual, a single "fixed quality" stop and a single harmonic control system, it shall be clearly understood that for each manual, there will be employed in practice, any desired number of stops and that for each of said manuals, there will be a separate harmonic control system. The term "fixed quality" employed herein to designate certain stops shall be construed to mean stops connected in the system so that any desired waveform of voltage can be selectively produced in the output circuit of an amplifier.

In Figure 1 is illustrated a plurality of alternators 1, respectively furnishing electrical pulsations at the tone frequencies of notes C1, C2, C3, C4, C5, C6, E4, E5, G2, G3, G4, G5, A#4 and A#5. In practice, any well known type of alternator can be employed. Desired results have been had with alternators of the kind disclosed in the application of Valentine J. Mohler, Serial No. 203,891, filed April 23, 1938, wherein twelve identical alternator assemblies are provided, each furnishing signals or electrical pulsations at the tone frequencies of notes in octave relation. As

each assembly operates at its own speed which is different from that of the assembly next above it by the twelfth root of two, signals are furnished for all prime tones of the equally-tempered musical scale.

In Figure 1, two playing-keys 4 are illustrated and in Figure 2 I disclose a harmonic control stop 8, a fixed timbre stop 88 and a system of conductors or bus-bars 6, the latter common to all of said stops and comprising a total number of individual conductors corresponding to the total number of contact devices 10 for each of said stops. Said playing keys are each thereof provided with a similar arrangement of contact devices 9, and as shown, each said device is connected by a circuit lead 11 to the output side of a respective alternator 1. The key at the top of Figure 1 corresponds to the note C2 and the circuit lead 11 for the uppermost contact device 9 for said key connects to the output side of an alternator furnishing a signal having the tone frequency of note C1 which is the sub-partial of said note C2. The remaining contact devices for said key have their circuit leads 11 respectively connected to alternators furnishing signals at the tone frequencies of notes C2, G2, C3, G3, C4, E4, G4, A#4 and C5 reading successively downward in the series of said contact devices. In this manner, when close circuiting the different contact devices with respective bus-bars 6, signals at harmonically related tone frequencies are impressed upon said bus-bars.

The lowermost playing-key 4 which is assigned to note C3, has the circuit leads of its respective contact devices 9 connected to alternators 1 respectively furnishing signals at the tone frequencies of notes C2, C3, G3, C4, C5, E5, G5, A#5 and C6, the note C2 being the sub-partial of said note C3.

Connected in series in each circuit lead 11 of the contact devices 9 for each playing-key is a high resistance 12. Connected across each lead 11 at the output side of a respective alternator is a grounded variable, impedance element 112, whereby any desired amount of voltage developed by said alternator can be effectively impressed upon an associated bus-bar 6. In this manner, the relative amplitudes of said voltages can be readily and accurately controlled and the instrument correctly voiced.

In order that a player may compound from different signals any desired tone quality or, add as he wishes, one or more signals to one or more fixed tone qualities, I provide in electrical coaction with the aforementioned stops 8 and 88, an

electrical network having a set of multiple switches 13. For each keyboard of the instrument there will be one set of said switches, one stop 8 and any desired number of stops 88. While I show ten such switches, the total number obviously will depend upon the number of partials desired to be made electrically effective at any instant upon depressing the playing keys.

Each switch 13 comprises a tap 14 connected to a common ground 16, ten taps 15 and a circuit controlling member 17, the latter being manually adjustable from an open circuit position at the grounded tap 14 to a closed circuit position at any one of the taps 15. Each circuit controlling member has a resistive circuit lead 18 connected to a respective contact member 10 of the harmonic control stop 8. When said stop is drawn, its contact members 10 are simultaneously close circuited with the respective bus-bars 6, i. e. the uppermost contact member 10 engages the first bus-bar 6 at the extreme left hand side of the set shown in Figure 2, the next contact member engaging the next adjacent bus-bar of said set and so on, to and inclusive of the extreme lowermost contact member which engages the bus-bar at the extreme right of the set. Each bus-bar functions as a conductor for a particular harmonic order of tone signals and by reason of the disclosed arrangement of switches 13, each said bus-bar is adapted to coact with a particular switch and with an intensity grading resistor, 19 whereby upon moving the contact member 17 off of the grounded tap 14 and onto any desired one of the taps 15, a signal will be conducted to a particular tapped portion of said resistor through a circuit connection 20.

The circuit leads 20 from the taps 15 are preferably tapped in logarithmic steps corresponding to 3 decibels each to said grading resistor 19, the total value of said resistor being close to or the same as that of resistors 21 which connect the individual bus-bars 6 to the aforementioned common ground 16. Each switch is capable of giving to the signal conducted from a respective bus-bar any one of ten different intensity gradations as the taps 15 of said switch are each connected to a different tapped portion of said resistor. As regards the "fixed quality" stop 88, the circuit leads 23 from the contact members 10 thereof electrically connect to such of the leads 20 from taps 15 of respective switches 13 as is necessary to conduct harmonically related signals from different bus-bars 6 to predetermined taps of said resistor 19, whereby the relative intensities of the different signals and the number of said signals will determine the quality of a particular musical tone.

Connected in series in each of the circuit leads 22 and 23 from the contact devices 10 of the respective stops 8 and 88 is a high resistance 24.

The grading resistor 19 has terminals 25 and 26 connected to the input circuit of a conventional preamplifier, power amplifier and sound producing system 27 as shown in Figure 3. As said system is common to two manuals of the instrument, same embodies potentiometers 28 and 29, each of which is controlled by an individual expression pedal 30. In this manner, the volume of sound elicited when playing the keys of one manual can be controlled as desired relative to the volume of sound elicited when playing the keys of the other manual.

In order to satisfactorily add one quality to another or to add one or more partials at any strength to one or more "fixed" qualities, or to

compound selected partials for a waveform of voltage corresponding to any quality the player desires, intended results are had with impedances 112, variable approximately from 0 to 2,000,000 ohms; current limiting resistors 12 of approximately 2,000,000 ohms; grounded resistors 21 of approximately 100,000 ohms, resistors 24 of approximately 500,000 ohms and a resistor 19 of approximately 100,000 ohms.

From the foregoing description, it is appreciated that upon drawing any stop 88 to thereby close circuit the contact devices 10 thereof with respective bus-bars 6 harmonically related tone signals are impressed upon the aforementioned resistor 19 so that when the signals are received in the input circuit of said system 27 they will be at relative intensities for the production of a tone of the quality denoted by said stop.

Upon drawing a plurality of said stops 88, tones are accurately integrated in proper proportion to the total number of stops which are electrically active in the system at any instant.

Should the player desire to compound a quality satisfactory to his individual taste, this is accomplished by first retiring the stops 88 and close circuiting the contact devices 10 of stop 8 with respective bus-bars 6. Any fundamental tone at any desired intensity can now be sounded and combined with such harmonics of said fundamental and the intensities of the harmonics regulated to produce any desired timbre.

It frequently happens that "fixed" qualities incorporated in the instrument by the manufacturer are not always exactly acceptable to particular players, i. e. certain simple partials should, in the opinion of the player, be of different intensities than those chosen by the manufacturer. This condition can be readily corrected by the selective adjustment of switches 13 associated with partials, the intensities of which the player desires to change.

I stress particularly the fact that all stops throughout my system are employed in electrical coaction with a common set of sources 1. As each playing-key is connected in the electrical network and with ten different sources of said common set of sources, it follows that a corresponding number of potentials will always be impressed upon respective bus-bars 6 of the system upon depressing any playing-key. In view thereof, it follows that there must necessarily be as many switches 13 per manual of the instrument as there are partials for each individual note. While I suggest the use of twelve assemblies of sources 1 operating as described herein, any well known means can be substituted therefor without departing from the spirit and intention of my invention and as many simple partials per playing-key may be provided as desired.

What I claim as my invention is:

1. In an electrical musical instrument, an amplifier having an input circuit, sources of electrical energy respectively and continuously furnishing undulating signals at different tone frequencies, an electrical network including a set of switches and a plurality of signal conducting paths from each switch, said switches each being manually actuable to control conduction of a signal along a selected one of said paths and cause same to be impressed upon said input circuit, and means common to all of said paths for electrically determining the intensity of any signal impressed upon said input circuit.

2. In a musical instrument employing an electrical transmitting network having means for

integrating the amplitude of electrical energy in accordance with the number of individual potentials simultaneously transmitted, generators producing and delivering said potentials to said network, and means for translating said potentials into sounds, the combination of means in said network for combining and rendering selected potentials at predetermined relative amplitudes simultaneously effective upon said translating means, and means in said network for selectively changing the amplitude of any of said potentials during translation thereof into sound.

3. In a musical instrument employing an electrical transmitting network having means for integrating the amplitude of electrical energy in accordance with the number of individual potentials simultaneously transmitted, generators producing said potentials and adapted to deliver same to said network, and means for translating said potentials into sounds, the combination of means in said network for rendering a predetermined waveform of selected potentials at precalculated relative amplitudes effective upon said translating means, and means for combining potentials from any selected generators into any desired waveform and for selectively controlling the amplitudes thereof and rendering same effective upon said translating means during translation of said first mentioned waveform.

4. In a musical instrument employing an electro-acoustic translating device provided with an input circuit, an electrical harmonic and amplitude controlling system having an output circuit connected with the input circuit of said translating device, a set of switches selectively actuable to cause simultaneous transmission to said harmonic and amplitude controlling system of alternating voltages at predetermined tone frequencies for production in said input circuit of a waveform having the characteristics of a tone of predetermined timbre, and means in said

harmonic and amplitude controlling system by which the amplitude of any individual one of said voltages can be selectively altered as desired during translation of said waveform into sound.

5. An electrical musical instrument comprising bus-bars, each of which is a carrier of alternating voltage of predetermined tone frequency, a harmonic control system having means for fixing the relative amplitudes of voltages conducted from said bus-bars, a selectively actuable stop for simultaneously effecting conduction of voltages to said amplitude fixing means from different ones of said bus-bars and for rendering said means effective to fix the relative amplitudes of said voltages, and selectively actuable means connecting said bus-bars with said amplitude fixing means for changing the amplitude of any individual one of said voltages as desired.

6. In an electrical musical instrument, a harmonic control system having an output circuit providing with an amplitude controlling resistance, means for simultaneously conducting a predetermined number of tone frequencies to said system and for fixing the amplitude of each of said frequencies at said resistance, and means in electrical coaction with said system and with said resistance for changing the aforementioned fixed amplitude of any of said frequencies.

7. In an electrical musical instrument, a set of multiple contact electric switches, an output circuit provided with a resistance, each individual contact of each of said multiple contact switches connected to said resistance by a frequency conducting path for transmission of a tone frequency to said resistance and control of the amplitude of said frequency when conducted from said output circuit, and a multiple contact switch in which each individual contact thereof is connected by a frequency transmitting path with an assigned switch of said set switches.

JAMES MANATT.