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ELECTRICAL MUSICAL INSTRUMENT

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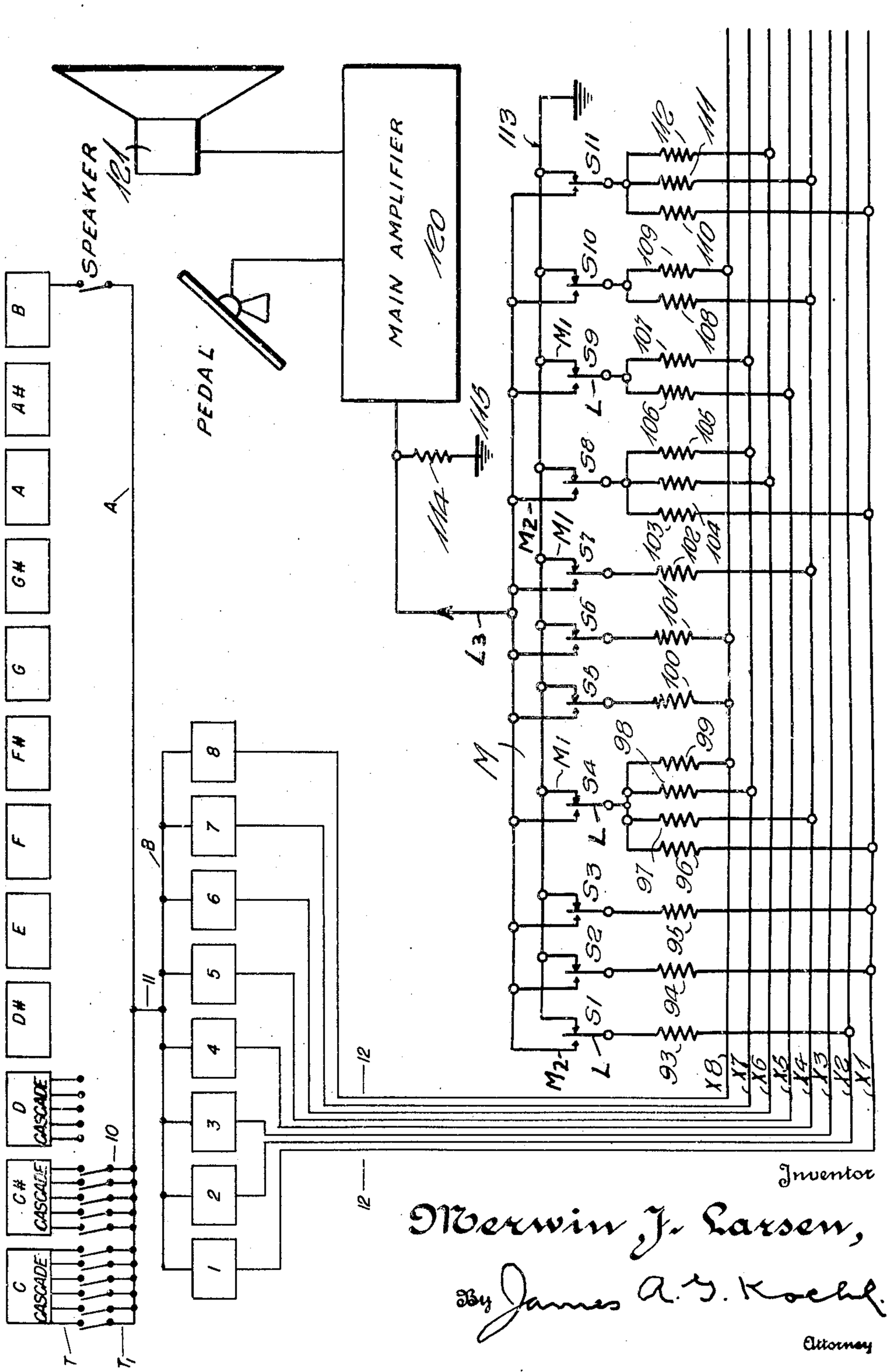

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ELECTRICAL MUSICAL INSTRUMENT

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This invention relates to electrical musical instruments of the class employing generators of stabilized audio signals having the tone frequencies of different notes of a musical scale and an electro-acoustical amplifying and translating system adapted to be selectively activated in response to actuation of keying switches. An instrument of this general class is disclosed and claimed in my Patent #2,403,090 of July 2, 1946, reference is made herein for an understanding of the invention when used in the environment evidenced by said disclosure.

In the aforementioned Patent #2,403,090, two separate filter systems are employed for repeating produced complex waves of audio tone signals as waves differing therefrom only in their harmonic composition above the fundamental frequencies thereof, certain of said repeated waves consisting substantially of only the fundamental frequency components of the produced waves. Others of said repeated waves follow the complex waveforms of tones of given timbre. There is also disclosed in said application means for selectively producing any desired admixture of said repeated waves or for using any repeated wave alone and effecting translation of any of said repeated waves into audible sound for musical expression.

The herein disclosed invention consists essentially of certain features of the invention disclosed but not claimed in my aforestated application except in the particular environment shown and described in said application. Particularly is this true of the mixing system shown and described in said application, which said mixing system provides the principal feature of the present invention and will be employed in combination with a wave filter system and a system of keying switches without regard to the specific grouping described and claimed in my aforementioned application.

My invention has for an object the prevention of interaction between and modulation of waveforms of tone signals being concurrently transmitted to a power amplifier.

A further object is the provision of means for insuring reasonably accurate mathematical proportionality between selected waveforms of tone signals employed as admixtures of tones of given timbre, whereby upon conversion of said signals into audible sounds close simulation of ensemble effects are assured.

In the accompanying drawing, forming a part of this specification, the figure is a diagram illustrative of the theory or method of my invention.

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In carrying my invention into practice, use is preferably, but not necessarily made of high vacuum tube generators as sources from which complex waveforms of alternating voltages at given tone frequencies are derived and adapted to be selectively converted into audible sounds for musical expression. Generators of this type are fully disclosed in the aforementioned Patent #2,410,883 of myself, James A. Oswald and Carl S. Schjonberg. In said patent, twelve similar cascades of multivibrator stages are employed, such that for a keyboard employing a scale tuned in equal temperament, there will be a cascade of multivibrator stages respectively generating sensibly identical complex waveforms of alternating voltages at the tone frequencies of all C notes at octave separation; a cascade of multivibrator stages generating sensibly identical complex waveforms of alternating voltages at the tone frequencies of all C# notes at octave separation; a cascade of multivibrator stages generating sensibly identical complex wavesforms of alternating voltages at the tone frequencies of all D notes at octave separation, and so on throughout the gamut of the instrument to and inclusive of a cascade of multivibrator stages generating sensibly identical complex waveforms of alternating voltages at the tone frequencies of all B notes at octave separation.

The instrument herein shown will embody a single keyboard of the conventional 8 foot range wherein C_2=65.4 cycles per second and C^3=2093 cycles per second. As many keyboards as desired may be provided and the instrument can of course be equipped with a pedal section.

In the accompanying drawings, twelve cascades of generators are illustrated in block diagram and designated C cascade, C# cascade, and so on, to and inclusive of the last of the series, the same being the B cascade.

A is a common conductor. Each individual generator of each separate cascade of generators is provided with an electric switch 10, one terminal T, of which leads from the output of said generator and the other terminal T1 of which is connected to said common conductor A.

Wave filters 1, 2—8, are herein shown and these may be of the type shown and described in my Patent #2,403,090. All of said filters are connected to a common input conductor B, the latter connected to common conductor A by a lead wire 11. Each individual wave filter is provided with an output path or channel 12.

At M is a mixer which comprises a plurality of conductors X1, X2—X8, each of which is con-

nected to the output path or channel 12 from one of the aforementioned wave filters 1, 2—8. The function of this mixer is to provide a means of selecting any number of outputs from the various filters at predetermined amplitudes. This is accomplished by decoupling resistances 93, 94—112 which connect either singly or in predetermined groups to a simple "stop" switch. Such switches are shown at S1, S2—S11. When the switches are "on" the main amplifier 120 herein shown as connected by a common lead wire L3 to contactors M2 of said switches amplifies signals that are intended to be effective at any instant on the input circuit of the loud speaker 121, the latter connected in the output circuit of said amplifier. When the switches are in their "off" positions the contact levers L connected to their respective resistances 93, 94—112 are grounded through a common lead wire 113 to which contactors M1 of said switches are connected. These switches are of the single pole, double throw type, the pole M2 of each of which connects with a respective one of said conductors X1, X2, etc. by the aforementioned resistances 93, 94, 95, etc. In this manner, the magnitude of signals from the various wave filters is predetermined, such, for example, that the waveform impressed on the input circuit of said amplifier when close circuiting selected stop switches is a mixture of waveforms from said filters. The output from any individual filter can by this method be mixed with the output from any other filter of the system of filters herein provided. Similarly, the amplitude of the output from any individual filter is controlled by the amount of resistance in its transmission path.

At this point it should be borne in mind that the filters 1, 2—8, which may be designed as set forth in my Patent #2,403,090, provide predetermined formant regions of a number and spacing along the frequency spectrum adequate to provide a wide range of tone qualities. It should also be observed that said filters are employed in combination with tone generators producing stabilized output wave forms which are rich in harmonics, said filters serving to suppress certain of the upper harmonics of said waveforms without resultant attentuation of the fundamental frequency components of said waveforms. In this matter various organ and orchestral tones are closely simulated.

The amplitudes of the outputs from selected filters 1, 2—8 are determined by the amount of resistance in the output conductor of a respective filter, such for example, resistance 93 which connects conductor X2 of filter 2 with mixer switch S2 will have a value which will be different from that of the resistance 95 which connects the same filter with switch S3, a feature which enables a tone of the same quality to be impressed on the input circuit of the amplifier at any desired amplitude. This also enables a tone of given quality to be added to one or more tones of selected quality at either a low or high amplitude as the circumstances demand for proper musical expression. By the sake token, the relative values of resistances 96, 97, 98 and 99 which connect conductors X1, X4, X7 and X8 and filters 1, 4, 7 and 8 with switch S4, will produce an admixture consisting of the outputs of said filters, said outputs being at relative amplitudes for a resultant tone which is the sum of the outputs of said filters 1, 4, 7 and 8. By determining the amount of resistance in any filter output and grouping the resistances as herein proposed, tones simulating given instruments as well as many pleasing tones can be obtained.

To prevent "robbing" amongst the various switches S1, S2—S11 and also to prevent modulation of waveforms and insure reasonably accurate mathematical proportionality between said waveforms, resistance 114 is connected across the input circuit of said amplifier 120 and is grounded at 115. This resistance should not be greater than one-tenth of that of the lowest decoupling resistance 93, 94—112. Resistances 93, 94—112 should each thereof be high relative to the highest internal impedance of any of said filters 1, 2—8. The exact values of these various resistances need not be stated for a full understanding of my invention as this will depend upon the magnitude of the output of a filter to meet desired musical requirements.

The number of wave filters may of course be added to or subtracted from without departing from the spirit and intention of my invention. It is not entirely necessary that they be of the band-pass or low-pass variety and I do not wish to be limited in this respect as certain well known reactances, resonant circuits and resistance-capacitance circuits can be used to good advantage.

The herein described organization of elements is such that with a very minimum number of filters a large number of "stops" can be readily incorporated in the instrument at slight expense. The arrangement also makes possible a quick change over from a "stop" indicative of a given timbre to one indicative of another timbre or pleasing tone.

What I claim as my invention is:

1. In an electrical musical instrument, the combination of generators producing complex electrical impulses at predetermined tone frequencies; a set of wave filters including an input conductor connected to said generators to receive impulses therefrom, each filter having an output path; an amplifier having a resistance connected in shunt across the input circuit thereof; a set of electric switches connected by a common output conductor to the input circuit of said amplifier; and a system of decoupling resistances, said decoupling resistances being of predetermined relative values and having connection with preassigned filter output paths and with preassigned switches of said set of switches so that one or more of said filter output paths connect to a given one of said switches, the resistance across the input circuit of said amplifier being less than that of the lowest decoupling resistance and said decoupling resistances each thereof being high relative to the highest internal impedance of any of the aforementioned filters.

2. In an electrical musical instrument, the combination of generators producing complex electrical impulses at predetermined tone frequencies; a set of wave filters including an input conductor common thereto and connected to said generators to receive output impulses from any thereof, each filter having an output path; an amplifier having a resistance connected in shunt across the input circuit thereof; a set of electric switches connected by a common output conductor to the input circuit of said amplifier; and decoupling resistances of predetermined values connecting preassigned ones of the aforementioned switches with the output paths of one or more of said filters, the resistance across the input circuit of said amplifier being less than that of the lowest decoupling resistance and said de-

coupling resistances each being high relative to the highest internal impedance of any filter in said set of filters.

3. A mixer for musical instruments employing a power amplifier having a loud speaker in its output circuit, generators of waveforms of complex audio signals having the tone frequencies for more than an octave of notes of the chromatic scale, and means for impressing the outputs of said generators on all filters of a set of wave filters; said mixer comprising a set of selectively actuable electric switches adapted to be connected to the input circuit of said power amplifier, a plurality of conductors such that there is a conductor for and connected in the output of each individual wave filter; and a system of impedances in which one or more thereof connect preassigned switches of said set of switches with one or more of said conductors, said switches each comprising a movable contactor, a contactor engageable with the movable contactor and connecting the switch to ground when the switch is "off," and a second contactor with which the movable contactor is adapted to be engaged when the switch is "on."

4. In an electronic organ, a set of wave filters; a conductor for and connected in the output side of each filter; a translating device including a power amplifier; and a system of stops for impressing the output of one or more filters on the input circuit of said power amplifier, at least one of said stops being connected to a conductor from only one of said filters by a resistance of given value, others of said stops being connected to conductors from preassigned ones of said filters by resistances of relatively different values, the values of all of the aforementioned resistances being high relative to the internal impedance of any of said filters.

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