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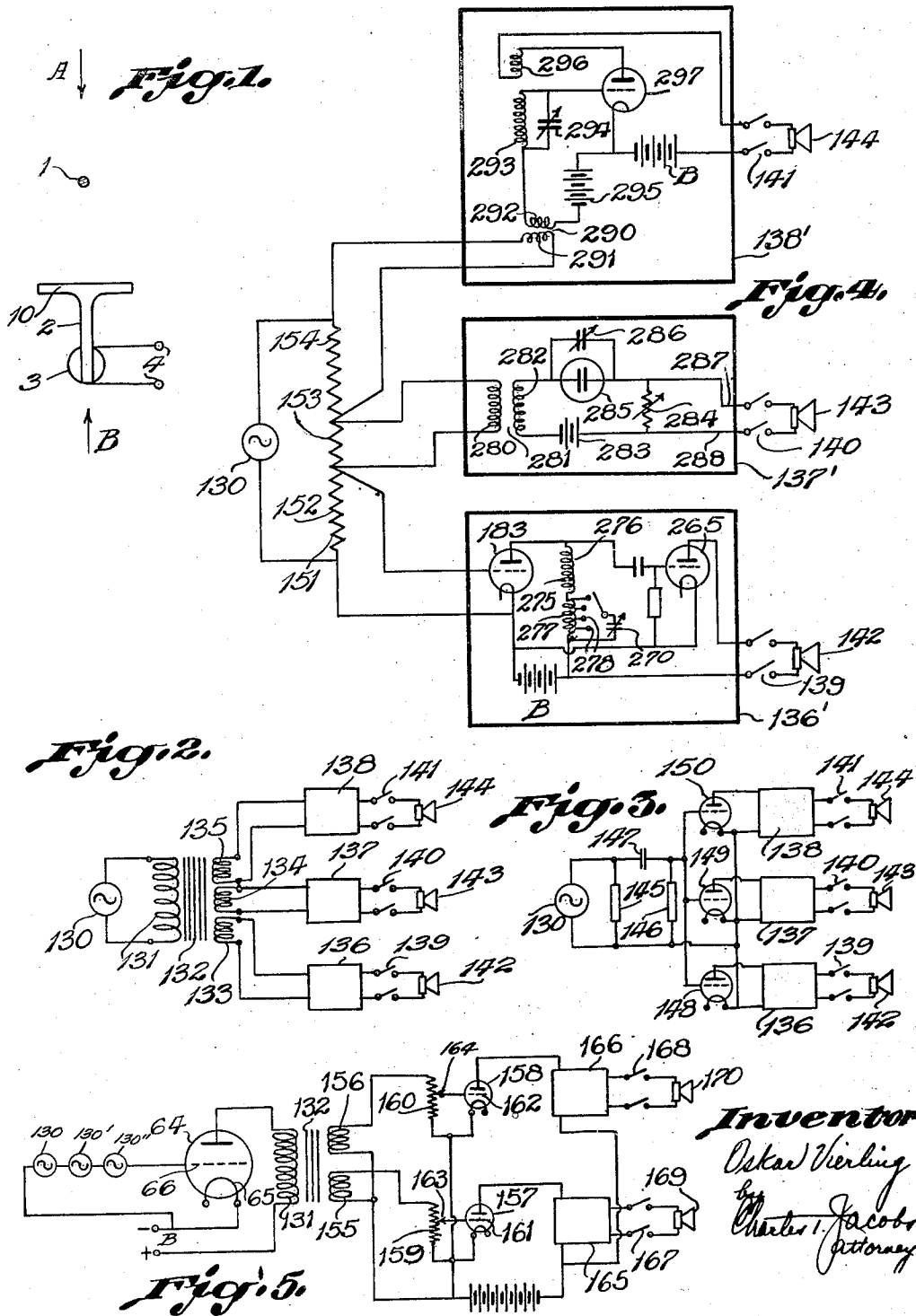
O. VIERLING

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ELECTRICITY CONTROLLED MUSICAL INSTRUMENT

Filed Oct. 29, 1931

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Fig. 6.

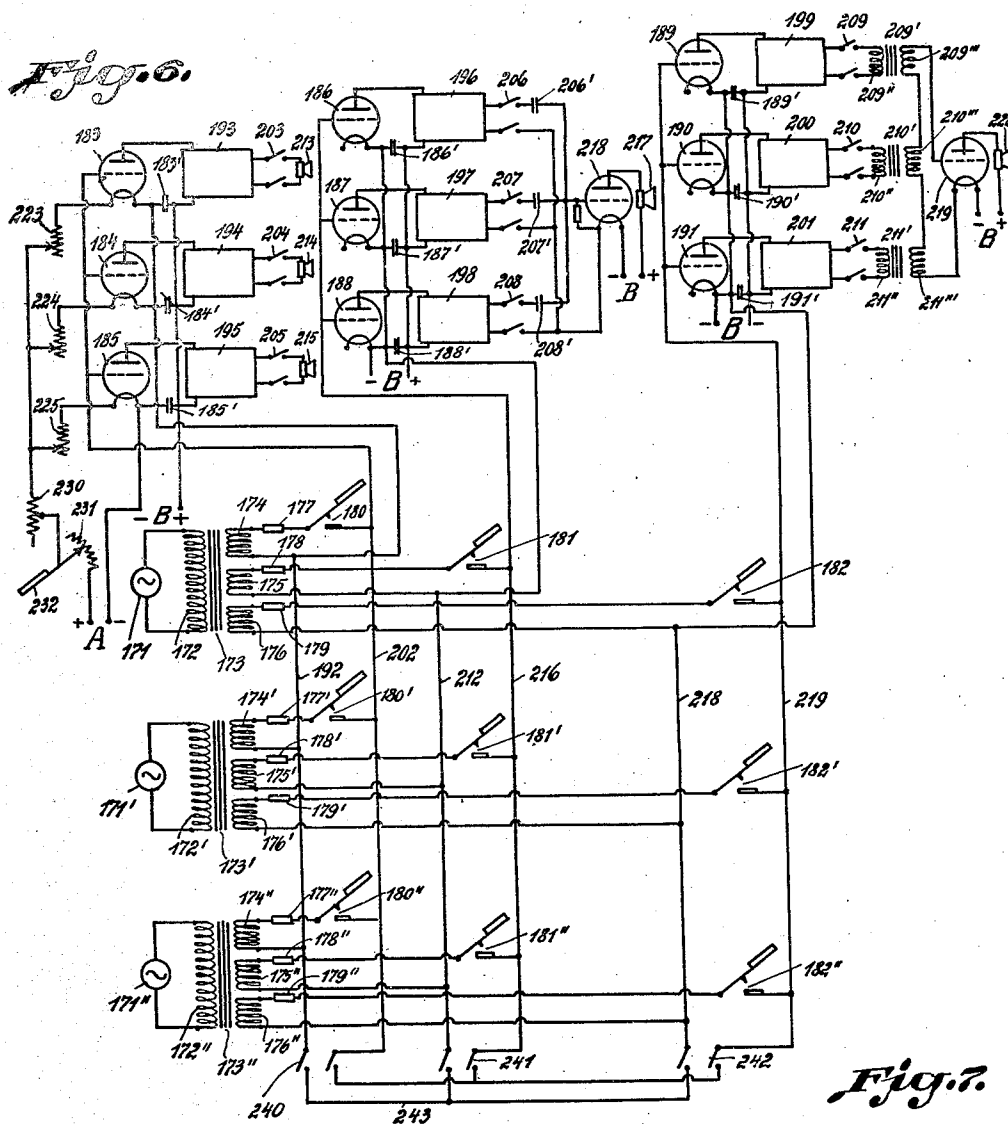


Fig. 7.

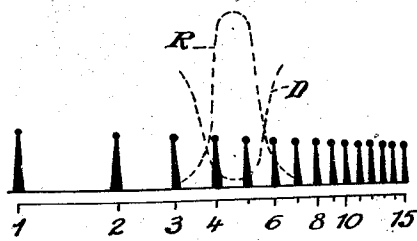
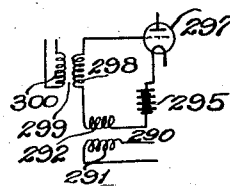


Fig. 8.



Fig. 9.



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UNITED STATES PATENT OFFICE

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ELECTRICITY-CONTROLLED MUSICAL INSTRUMENT

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Application October 29, 1931, Serial No. 571,824, and in Germany June 18, 1927

19 Claims. (Cl. 84-1)

My invention relates to electricity-controlled musical instruments and more particularly to instruments of the kind in which alternating currents of frequencies corresponding to those of the sounds to be created are produced in an electric circuit, the current being fed, directly or indirectly, to a loudspeaker or the like.

It is an object of my invention to provide means for imparting to the oscillations produced in the electric circuits a predetermined timbre in order to imitate various musical instruments, for instance a piano, an organ, other string or wind instruments, human voices or the like. In order to accomplish this I provide suitable timbre circuits in connection with the electric circuits referred to.

It is a further object of my invention to provide a polyphonic instrument having one or more keyboards or manuals in which the sound character of the single tones can be changed at will, or distinct keyboards can be connected with distinct timbre systems so that for instance one keyboard reproduces piano sounds and the other violin sounds or the like. Preferably means are provided for influencing the intensity of each single note and of the whole instrument at once.

My invention is not limited to the use in connection with key instruments, but can also be applied to string instruments, for instance in order to influence the timbre of a violin in such manner as to produce thereon at will either violin tones or flute-like tones.

Other objects and advantages of my invention will become apparent from the following description in connection with the accompanying drawings, in which some embodiments of my invention are illustrated diagrammatically by way of example.

In the drawings

Figure 1 is a schematic view of a form of oscillation generator which may be employed with my invention;

Figures 2 and 3 are simple diagrams schematically illustrating the combination with oscillation generating systems of various means for subdividing their outputs for tone control purposes;

Figure 4 is a diagram alternative to Figures 2 and 3 but including a detail showing of timbre systems of different species as embodied in my invention;

Figure 5 is a diagram developed from Figures 2 through 4 showing a plurality of oscillation generators and showing individual amplitude control of the subdivided oscillations;

Figure 6 is a diagram of a musical instrument

in which the subdivision contemplated by my invention is carried out;

Figures 7 and 8 are diagrams aiding in the description of operation of the timbre systems shown in Figure 4; and

Figure 9 is a diagram of a timbre system of the general species shown as 138' in Figure 4, but somewhat modified therefrom.

Referring now to the drawings and first to Fig. 1, I show a non-limitative example of a generator which might be employed in connection with my invention. 1 is string tuned to the frequency of a tone to be produced such as a piano or violin string, which is vibrated by a hammer, bow or the like (not shown). It may be assumed that the vibration takes place principally in the plane A—B. 2 is an electromagnet equipped with pole piece 10 and a winding 3 having output terminals 4. Obviously the vibrating string will induce in the winding 3 and alternating current of a frequency corresponding to the vibrational frequency of the string, which current is made available at the terminals 4.

In order best to explain the principles of operation of my invention, some illustrations are shown in Figs. 2-4 of the subdivision of oscillations from a single tone generator, while the arrangement for a polyphonic instrument will be described further below.

In Fig. 2, 130 indicates a generator, the output circuit of which is connected to the primary winding 131 of a transformer 132 having three secondary windings 133, 134, 135. Each secondary winding is connected to a load circuit comprising a timbre system 136, 137 or 138, a disconnecting switch 139, 140 or 141, and a loudspeaker 142, 143 or 144, respectively. The construction and design of the timbre systems will be described in detail hereinafter. The systems may influence the secondary currents of the transformer 132 in such manner that they amplify certain predetermined overtones in order to change the tone color of the note produced by the generator 130. For instance system 136 may be designed in such manner that it amplifies the overtones which are characteristic for string instruments, while systems 137 and 138 amplify the overtones characteristic for wooden wind instruments or brass wind instruments, respectively. It should however be understood that the systems can be designed in any desired manner and that the number of systems is not confined to the three.

The operation of the device is as follows: If the generator 130 is excited, for instance by a key

(not shown), an alternating current having a frequency equal to the oscillating frequency of the generator 130 is fed to the primary winding 131. If the switches 139, 140, 141 are in the open position shown in Fig. 2, no loudspeaker will be excited, but if for instance switch 139 is closed, loudspeaker 142 will produce a note having a fundamental frequency corresponding to the natural frequency of generator 130, but with a timbre which is determined by the system 136, for instance in such manner that a string instrument note is reproduced. In the same manner loudspeakers 143 and 144 will produce notes of wood wind instruments or brass wind instruments when switches 140 and 141 are closed. It should be noted that it is possible to produce either single timbres or combinations of timbres. Thus for instance all timbres are obtainable by the systems simultaneously.

Referring now to Fig. 3 the arrangement is substantially the same as that shown in Fig. 2, except that connection between generator 130 and timbre systems 136—138 is not established by means of a transformer but by means of electron tubes. 145 and 146 are high ohmic resistances connected in parallel to the output circuit of the generator 130. 147 is a condenser connected between the upper terminals of the resistance 145 and 146. 148, 149 and 150 are electron tubes the input circuits of which are connected in parallel across the terminals of resistance 146. The timbre systems 136, 137, 138 are connected to the output circuits of the electron tubes 148, 149, 150. The operation of the device is substantially the same as of that shown in Fig. 2, but the use of electron tubes instead of a transformer has the advantage that by overmodulating the tubes electric oscillations having a great number of distinct overtones are obtained. The timbre systems 136, 137, 138 may depress in the currents fed by the tubes 148, 149, 150, respectively, the partial tones which are not characteristic of the timbre to be imitated and may amplify the partial tones characteristic of the desired timbre.

Referring now to Fig. 4, another subdividing means comprising a subdivided resistance 151 connected across the output of generator 130 is shown. The timbre systems, herein designated as 136', 137 and 138, are connected to the sections 152, 153, 154 of resistance 151, respectively. The operation of this device is substantially the same as that of the devices shown in Figs. 2 and 3. In Figure 4 the timbre systems, 136', 137' and 138', are each shown as of a particular form; these are hereinafter described in detail.

It should be noted that in all figures the output circuits of the timbre systems could be connected to a common loudspeaker instead of being connected to distinct loudspeakers. A connection arranged in this manner is shown in Fig. 6 described hereinafter.

In Figs. 2-4 the timbre systems are shown in connection with a single generator. It should however be noted that such systems could be connected to an instrument having a plurality of generators. With an instrument of this kind polyphonic music can be reproduced with distinct timbre but all tones reproduced together have the same timbre or a mixture of a plurality of timbres (e. g., if a plurality of switches 139, 140, 141 shown in Fig. 2 are in their closed position). It is possible to change the timbre from time to time by suitably opening and closing the switches 139, 140 and 141, but it is not possible to

simultaneously reproduce a plurality of voices with distinct timbres.

Such a connection is schematically shown in Fig. 5, wherein a plurality of generators 130, 130', 130'' are connected to the input circuit of tube 64. The primary 131 of the transformer 132 is connected to the output circuit of tube 64. Transformer 132 has two secondary windings 155, 156 connected to the input circuits of two electron tubes 157 and 158, respectively. The upper terminals of the secondaries 155, 156 are connected to the upper terminals of resistances 159 and 160, respectively, to which the grids 161, 162 of the tubes are connected by means of adjustable contacts 163 and 164, respectively. The plate circuits contain the timbre systems 165 and 166, respectively, which are connected through switches 167, 168 to loudspeakers 169 and 170, respectively. The operation of this device is as follows:

The combined oscillation amplified by tube 64 is fed to the primary 131 of transformer 132. Corresponding alternating currents are induced in the secondary windings 155, 156 and fed to the tubes 157, 158 where they are amplified again and then fed to the timbre systems 165, 166 and to the loudspeakers 169, 170. The relative intensity of the output currents of tubes 157, 158 can be adjusted by changing the position of contacts 163, 164. It is thus possible to reproduce sounds with mixed timbres by simultaneously closing switches 167 and 168, and to cause one timbre to predominate over the other.

As stated above, in all devices hitherto disclosed all sounds simultaneously reproduced have the same timbre or the same mixture of timbres.

Following these simple illustrations of timbre control by subdivision of oscillations from a single generator or plurality of generators, there is shown in Fig. 6 an instrument by which distinct voices can be produced simultaneously with distinct timbres. In order to simplify the figure, merely the generators and corresponding parts of three notes are shown. 171, 171' and 171'' are generators connected to primary windings 172, 172', 172'' of transformers 173, 173', 173'', respectively. Each transformer is provided with three secondary windings 174, 175, 176; 174', 175', 176'; 174'', 175'', 176'', respectively. The secondary windings are connected through resistances 177, 178, 179; 177', 178', 179'; 177'', 178'', 179'' and key-operated switches 180, 181, 182; 180', 181', 182'; 180'', 181'', 182'' to the input circuits of electron tubes 183, 184, 185; 186, 187, 188; 189, 190, 191, respectively in a manner to be described more in detail hereinafter. The output circuits of the electron tubes 183—191 are connected to timbre systems 193—201 respectively through condensers 183'—191' connected in parallel to the B-batteries (not shown) delivering the d. c. space current. The timbre systems are connected through switches 203—211 respectively, to loudspeakers.

A single loudspeaker can be provided for each timbre system, or a group of several systems or all systems can be connected to the same loudspeaker. For instance separate loudspeakers 213, 214, 215 are associated with timbre systems 193, 194, 195, respectively, while common loudspeakers 217 and 220 are provided for the two other groups of timbre systems, respectively. The output circuits of timbre systems 196—198 are connected in parallel to the input circuit of an electron tube 218. Between each timbre system and the input circuit of tube 218 a switch and a con-

denser are connected in series, as for instance switch 206 and condenser 206' between timbre system 196 and tube 218. Switch 207 and condenser 207' as well as switch 208 and condenser 208' are associated with timbre systems 197 and 198, respectively. The loudspeaker 217 is connected in the output circuit of electron tube 218. The third group of timbre systems 199—201 is connected to a common loudspeaker 220 by means of transformers 209', 210', 211' instead of condensers. The primaries 209'', 210'', 211'' of the transformers are connected to the output circuits of the timbre systems 199—201 by means of switches 209—211, respectively. The secondaries 209'''—211''' are connected in series to each other and to the input circuit of an electron tube 219 in the output of which the loudspeaker 220 is connected. The tubes 218 and 219 are heated in a manner well known in the art, the heating supply and the B-battery not being shown in the drawings.

192, 202, 212, 216, 218, 219 are connections connecting the lower and upper terminals of the secondary transformer windings 174, 174', 174'' and 175, 175', 175'' and 176, 176', 176'', respectively. The discharge tubes 183—191 are arranged in three groups comprising the tubes 183—185, 186—188, and 189—191, respectively. The input circuits of the tubes of each group are connected in parallel and to the conductors 192 and 202, 212 and 216, and 218 and 219, respectively. It should be noted that key-operated switches 180, 180', 180''; 181, 181', 181''; and 182, 182', 182'' are arranged between the corresponding secondary windings and the connections 202, 216 and 219, respectively, so that in the normal open position of the switches shown in the drawings the input circuits of the electron tubes are open.

For the sake of simplicity the heating circuits of the tubes 183—191 are merely shown for the tubes 183—185 of the first group. The heating currents are fed by a common direct current supply A which is connected to the heating filaments of the tubes by means of a system of adjustable resistances. 223, 224, 225 are resistances connected in series with the heating filaments of tubes 183, 184, 185, respectively. By adjusting the resistances the relative sound intensities produced by the timbre systems 193, 194, 195, respectively can be changed in a similar manner as shown in connection with Fig. 5, in which the corresponding resistances are 159 and 160. Similar resistances (not shown) are provided for the tubes 186—191, respectively. 230 and 231 are adjustable resistances connected in series with the heating circuits of the first group of tubes 183—185. Similar resistances (not shown) are provided in connection with the other groups of tubes. By adjusting these resistances the relative intensity of the single groups of timbre systems can be changed. The resistances 223—225 and 230 are preferably hand-operated resistances which can be adjusted by means of actuating devices (not shown) which are mounted on the instrument in such manner that the player can operate them during the playing. Resistance 231 is preferably actuated by means of a pedal 232. Preferably means (not shown) are provided for mechanically coupling the pedals associated with the single groups in order to change the sound intensity of all timbre systems simultaneously without changing the relative sound intensity of the single timbre systems or groups of systems.

As can be guessed from the drawings, each note

generator, for instance 171, is associated with three secondary windings, for instance 174, 175, 176, and three key-operated switches (in the examples 180, 181, 182), so that each note can be reproduced with any of the timbres producible by means of the timbre systems 193—201. The secondary windings 174, 174' and 174'' with the corresponding key-operated switches 180, 180', 180'' are associated with the first group of tubes 183—185 and timbre systems 193—195, so that if for instance key switch 180 is closed, the note corresponding to generator 171 will be reproduced with the timbre corresponding to timbre system 193, provided that switch 203 is closed. The note can be reproduced with a mixture of timbres when a plurality of switches 203—205 are closed. If it is desired to produce a tone with a timbre produced by the systems of the other groups, the corresponding key switches, for instance 181 or 182, should be closed. It is seen from the foregoing that by operating key switches 180, 180', 180'' similar timbres are produced. I therefore arrange the keys associated with the distinct notes in distinct keyboards or manuals so that the player can play distinct voices with distinct timbres by playing them on distinct keyboards. By actuating switches 203—211 the player can couple distinct timbres with each keyboard in a similar manner as in organs. In order to couple a plurality of timbre groups or all timbre systems with a single manual, switches 240, 241, 242 are provided connecting the connections 192, 202, 212, 216, 218, 219 with auxiliary connections 243. For instance, if switches 203—208, 240 and 241 are closed, together with any of the key switches 180—181'', the corresponding note will be reproduced simultaneously by means of the timbre systems 193—198.

The switches 203—211 and 240—242 preferably are of the rotary type and are arranged near the corresponding keyboards in a similar manner as the stop knobs of an organ in order that the player be enabled to change the registers during playing.

In Figs. 2, 3, 5 and 6 the timbre devices were diagrammatically indicated by rectangles. Particular constructions of these systems will now be described more in detail. In order to explain the requirements to be fulfilled by the timbre systems, in Figs. 7 and 8 some tone diagrams are illustrated. Fig. 7 is the tone diagram of an oboe. The tone of an oboe is characterized in that the fourth, fifth and sixth overtone have a relatively large amplitude. In the diagram the horizontal line indicates the frequencies of the overtones and the scale below the abscissa axis indicates the order of the overtones. Each overtone is indicated by a cone, the height of which corresponds to the relative amplitude. Fig. 7 shows that the fundamental tone has a relatively small amplitude, while the fifth overtone has a large amplitude. The fourth overtone has an amplitude slightly below the amplitude of the fifth overtone, while the amplitude of the sixth overtone is smaller than the amplitude of the fourth and fifth overtones, but still considerably larger than the amplitude of the fundamental tone or the other overtones. Fig. 8 shows diagrammatically the composition of oscillations which might be produced by typical generators or by the tubes 183—191 in Fig. 6. As stated above, the tubes are provided in order to enrich the sounds produced by the generators with overtones. Therefore the oscillations produced in the output circuits of these tubes have a composition as shown in Fig. 8.

8, in which all overtones have nearly equal amplitudes, the latter merely slightly decreasing for overtones of increasing order. It is the task of the timbre systems to set forth in sounds, the overtones characteristic of the instrument to be imitated. For instance a timbre system corresponding to an oboe should change the composition shown in Fig. 8 to a composition as shown in Fig. 7. In other words, the timbre systems are required to accentuate a certain range of overtones characteristic of the instrument to be imitated. Such an overtone range is called a formant.

It should be understood that all timbre systems indicated in the preceding figures may be designed according to one or more of the three forms shown as 136', 137' and 138' in Fig. 4.

One form of timbre control comprises a filter or resonant circuit inserted for example between the electron tube 183 and the output loudspeaker. The elements of the filter are preferably variable in order to afford the player the possibility of changing the formant range brought out by the filter so that the timbre produced by the system can be changed at will. The values of the capacities the inductance and the resistance are chosen in such manner, that frequencies without the formant range are attenuated, while frequencies within the formant range are not considerably influenced. If for instance the system is designed to imitate the timbre of an oboe, it should have a damping characteristic as shown by curve D in Fig. 8. If the system has this damping curve, the fourth and fifth overtones will be left substantially unaltered. The sixth overtone will be attenuated to about half its normal value, while the other overtones will be considerably attenuated so that the system produces an overtone composition corresponding to that shown in Fig. 7. The ratio of amplitudes of overtones within and without the formant range can be changed by adjusting the variable resistance 264 so as to more or less bring out the formant overtones.

A preferred embodiment of this filter or resonant circuit above mentioned is shown as system 136' in Fig. 4. In order to diminish the damping of the circuit within the formant range, the inductance of the circuit should have a small ohmic resistance. Now oscillating circuits with little damping can be obtained by using inductances of relatively few turns and large wire cross section together with large capacities. But such oscillating circuits would have a small apparent resistance while, in order to avoid power losses for the distinct frequencies, a large apparent resistance is desirable. I overcome this difficulty by providing a large inductivity 275 having two portions 276 and 277. Portion 276 has a relatively great number of turns of thin wire, while portion 277 has relatively few turns of large wire cross section. Condenser 270 is connected in shunt to portion 277, the latter being provided with a plurality of taps 278 in order to vary the inductance included in the resonant circuit if desired. This arrangement has the further advantage that the formant voltages produced in the oscillating circuit are stepped up by the combined inductance 275 acting as auto-transformer. The formant frequencies are thus amplified to a very high degree.

Such a filter or resonant circuit is adapted to particularly bring out a single formant range. If the timbre to be imitated comprises a plurality of distinct formant ranges, a plurality of filters or resonant circuits connected in series or in parallel

are provided, each filter or circuit being tuned to one of the distinct formant ranges.

In Fig. 4 another embodiment of a timbre system is shown as 137'. In this device a relaxation circuit tuned to formant frequency is provided. The primary 280 of a transformer 281 may form the input circuit of the timbre system. The secondary 282 of transformer 281 is connected in series with a battery 283, a resistance 284 and a glow lamp 285 shunted by a condenser 286. Resistance 284 and condenser 286 are adjustable in order to tune the circuit to the mid frequency of the formant range.

The operation of this device is as follows: A sound oscillation having an overtone composition as shown in Fig. 8 is fed to the primary 280 and transferred to the oscillating circuit by the transformer 281. Condenser 286 has been loaded by battery 283, the battery voltage being chosen in such manner that it does not reach the ignition voltage of glow lamp 285. When the sound oscillation is fed to the oscillating circuit, the condenser voltage will exceed the ignition voltage of the glow lamp, and oscillations will be initiated in the oscillating circuit, the frequencies of which correspond to the frequency of the formant range so that these frequencies will be amplified in the oscillation appearing at terminals 287, 288. It should be noted that if the oscillating circuit is tuned to a frequency below the fundamental frequency of the sound oscillation fed to the circuit, this lower frequency is delivered to the oscillation. Preferably in this case the circuit should be tuned in such manner that its natural frequency is one half, a third, or a quarter of the fundamental frequency of the sound oscillation fed to the circuit. In this case in the resultant sound oscillation arising between terminals 287, 288, the natural frequency of the oscillating circuit will be the lowest frequency, i. e. the fundamental tone, while the sound oscillation exciting the oscillating circuit constitutes the overtones or the formant of the resultant sound oscillation.

Still a third species of timbre system according to my invention is illustrated by timbre system 138' of Fig. 4 and by Fig. 9. In the first of these an oscillating tube 297 is provided to produce the timbre. The sound oscillation having an overtone as shown in Fig. 8 is fed to the primary 291 of transformer 290, the secondary 292 of which is connected in the input circuit of tube 297 in series with a grid biasing battery 295 and an oscillating circuit comprising an adjustable inductance 293 and an adjustable capacity 294 connected in parallel. This oscillating circuit is tuned to the mid frequency of the formant range. The output circuit of tube 297 contains in series the tickler coil 296 and the loudspeaker or the like.

The operation of this device is as follows: battery 295 imparts to the grid of tube 297 a negative bias of such height that tube 297 operates as a generator of formant frequency oscillations when its grid is periodically rendered more positive by alternate half waves of the fundamental frequency oscillations from secondary 292 of transformer 290. The tube 297 then produces the formant frequencies since its grid is controlled by the oscillating circuit 293, 294, tuned to formant frequency and coupled with the tickler coil 296.

In Fig. 9 instead of the oscillating circuit 293, 294 the secondary 298 of a transformer 299 is inserted in the input circuit of tube 297. The primary 300 of transformer 299 is connected to

an alternating current supply (not shown) feeding current of formant frequency. To the fundamental frequency fed by transformer 290 into the input circuit of tube 297 formant frequencies are now superimposed by means of transformer 299 so that in the output circuit of tube 297 a resulting oscillation having the proper overtone composition is produced.

Preferably the actuating means for changing the resistance, inductances and capacities constituting the oscillating circuits of the timbre systems are arranged in the proximity of the keyboards, so that the player can change the values of these elements while playing. The adjusting means can be designed in a manner well known in the art, for instance as rotary knobs, rotary switches or the like.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

In the claims affixed to this specification no selection of any particular modification of the invention is intended to the exclusion of other modifications thereof and the right to subsequently make claim to any modification not covered by these claims is expressly reserved.

I claim:—

1. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; and separate timbre systems respectively connected in said several output circuits.

2. In a musical instrument, the combination of a source of electric oscillations of a plurality of fundamental frequencies respectively corresponding to those of sounds to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; and separate timbre systems respectively connected in said several output circuits.

3. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; separate timbre systems respectively connected in said several output circuits; a switch connected in each said output circuit; and a separate playing key for closing each said switch.

4. In a musical instrument, the combination of a plurality of source of electric oscillations, respectively of fundamental frequencies corresponding to those of different notes to be produced; a plurality of subdividing means respectively associated with said sources, each said means having an input circuit energized by the associated said source and a plurality of output circuits; a switch connected in each said output circuit; a separate playing key for closing each said switch; and manuals of keys, each manual comprising the keys associated with a corresponding output circuit in each of said subdividing means.

5. In a musical instrument, the combination of a plurality of sources of electric oscillations, respectively of fundamental frequencies corresponding to those of different notes to be produced; a plurality of subdividing means respectively associated with said sources, each said

means having an input circuit energized by the associated said source and a plurality of output circuits; a switch connected in each said output circuit; a separate playing key for closing each said switch; manuals of keys, each manual comprising the keys associated with a corresponding output circuit in each of said subdividing means; and switches for coupling together said first mentioned switches associated with different manuals.

6. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; separate timbre systems respectively connected in said several output circuits; and means for controlling the outputs of said timbre systems.

7. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; separate timbre systems respectively connected in said several output circuits; and means individual to a plurality of said timbre systems for independently controlling their several outputs.

8. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; separate timbre systems respectively connected in said several output circuits; and means common to a plurality of said timbre systems for similarly controlling their several outputs.

9. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; separate timbre systems respectively connected in said several output circuits; means common to a plurality of said timbre systems for similarly controlling their several outputs; and means individual to a plurality of said timbre systems for independently controlling their several outputs.

10. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; separate timbre systems respectively connected in said several output circuits, each said system including a resonant circuit comprising a high inductance element having a portion of small ohmic resistance and a condenser connected in shunt to said portion.

11. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such oscillations including a circuit resonant to formant frequency, said circuit comprising a high inductance element having a portion of small ohmic resistance and a condenser connected in shunt to said portion.

12. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such

oscillations including a circuit resonant to formant frequency, said circuit comprising a high inductance coil having a portion wound with wire of large cross section and a condenser in shunt to said portion.

13. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such oscillations including a resonant circuit comprising a high inductance element having a portion of low ohmic resistance, a plurality of taps in said portion, and a tuning condenser adapted to be connected in shunt to said portion by means of said taps.

14. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; and separate timbre systems respectively connected in said several output circuits, each said system containing a relaxation circuit tuned to formant frequency.

15. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such oscillations including a relaxation circuit tuned to formant frequency.

16. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such oscillations comprising a circuit formed by a direct current supply, a resistance, a glow lamp, and a condenser connected in parallel to said lamp; and means for introducing said oscillations into said circuit.

17. In a musical instrument, the combination of a source of electric oscillations of fundamental frequency corresponding to that of a sound to be produced; means for subdividing said oscillations, comprising an input circuit thereby energized and a plurality of output circuits; and separate timbre systems respectively connected in said several output circuits, each said system including a source of oscillations of formant frequency and means connected with the associated said output circuit and controlled by the instantaneous amplitudes of sound frequency oscillations therein for combining with said last mentioned oscillations said oscillations of formant frequency.

18. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such oscillations, comprising a source of oscillations of formant frequency and means connected with said first mentioned source and controlled by the instantaneous amplitudes of said first mentioned oscillations for combining therewith said oscillations of formant frequency.

19. In a musical instrument including a source of electric oscillations of sound frequency, a timbre system for altering the waveform of such oscillations comprising an electron discharge tube, a grid in said tube, means for imparting to said grid a high negative bias, means for impressing on said grid said oscillations of sound frequency, and means for impressing on said grid oscillations having formant frequency.

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