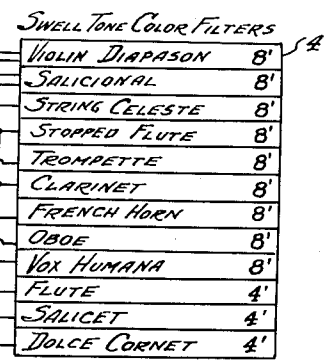


A. MEYER
OBTAINING ENSEMBLE AND CELESTE EFFECTS
IN ELECTRICAL MUSICAL INSTRUMENTS

5 Sheets-Sheet 1

Filed Nov. 22, 1957



GREAT TONE COLOR FILTERS 6

BOURDON	16'
OPEN DIAPASON	8'
MELODIA	8'
FLUTE CELESTE	8'
DULCIANA	8'
DULCIANA CELESTE	8'
TRUMPET	8'
OCTAVE	4'
VIOLINA	4'
CLARION	4'

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PEARL TONE COLOR FILTERS

OPEN DIAPASON	16'
DULCIANA	16'
BOURDON	16'
CELLO	8'
FLUTE	8'

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IN ELECTRICAL MUSICAL INSTRUMENTS

3,049,959

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5 Sheets-Sheet 2

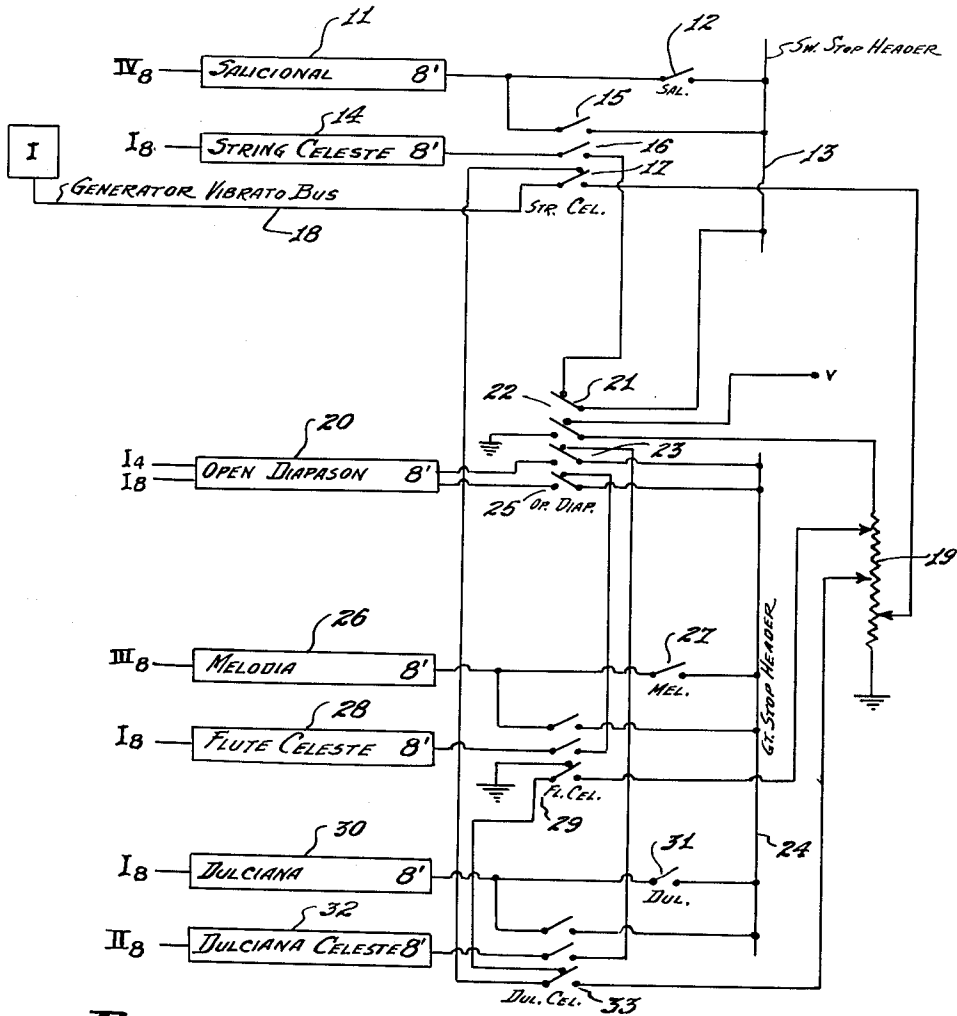


FIG. 2.

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5 Sheets-Sheet 3

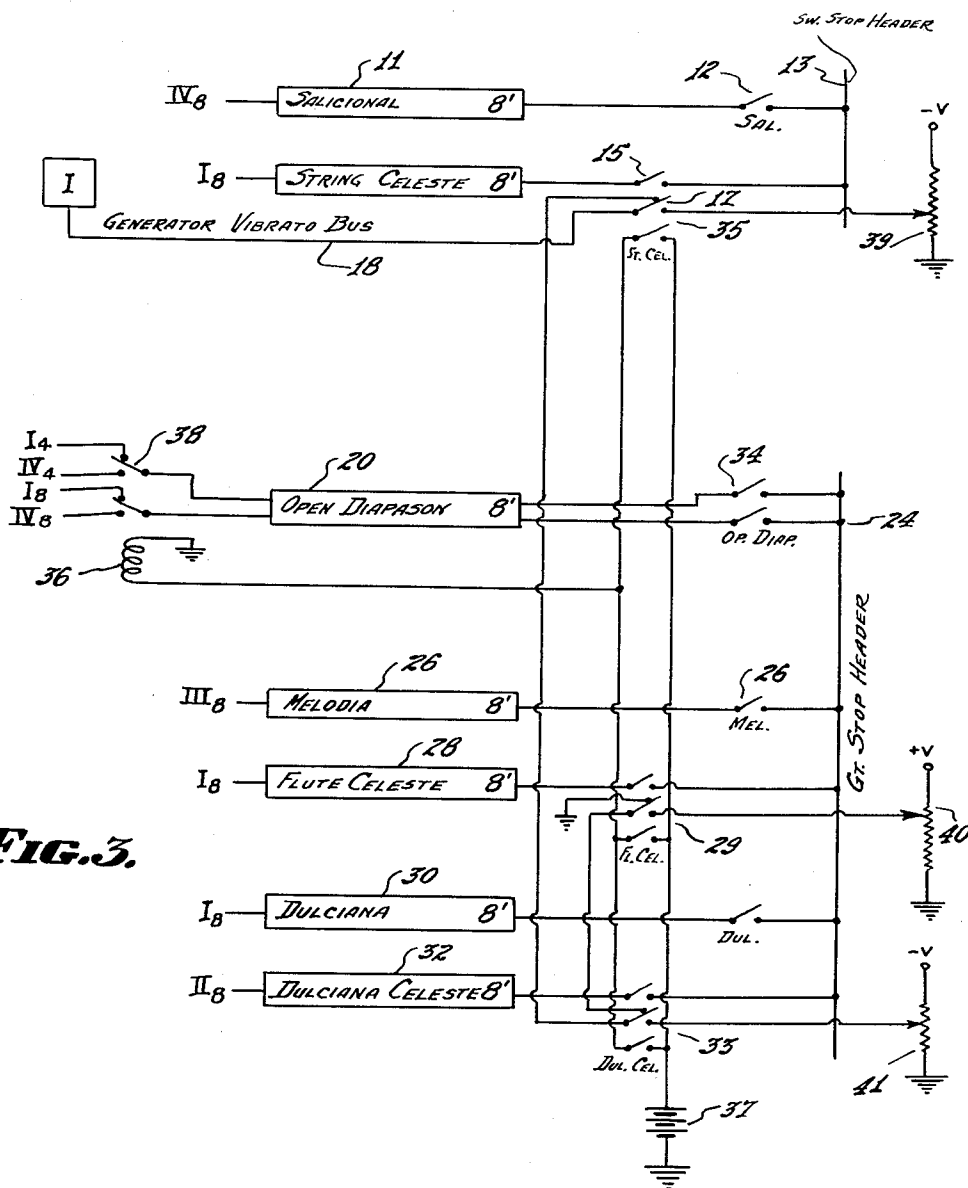


FIG. 3.

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FIG. 4.

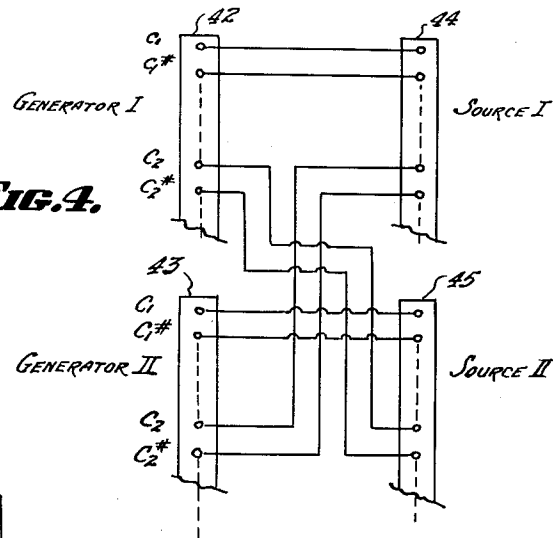
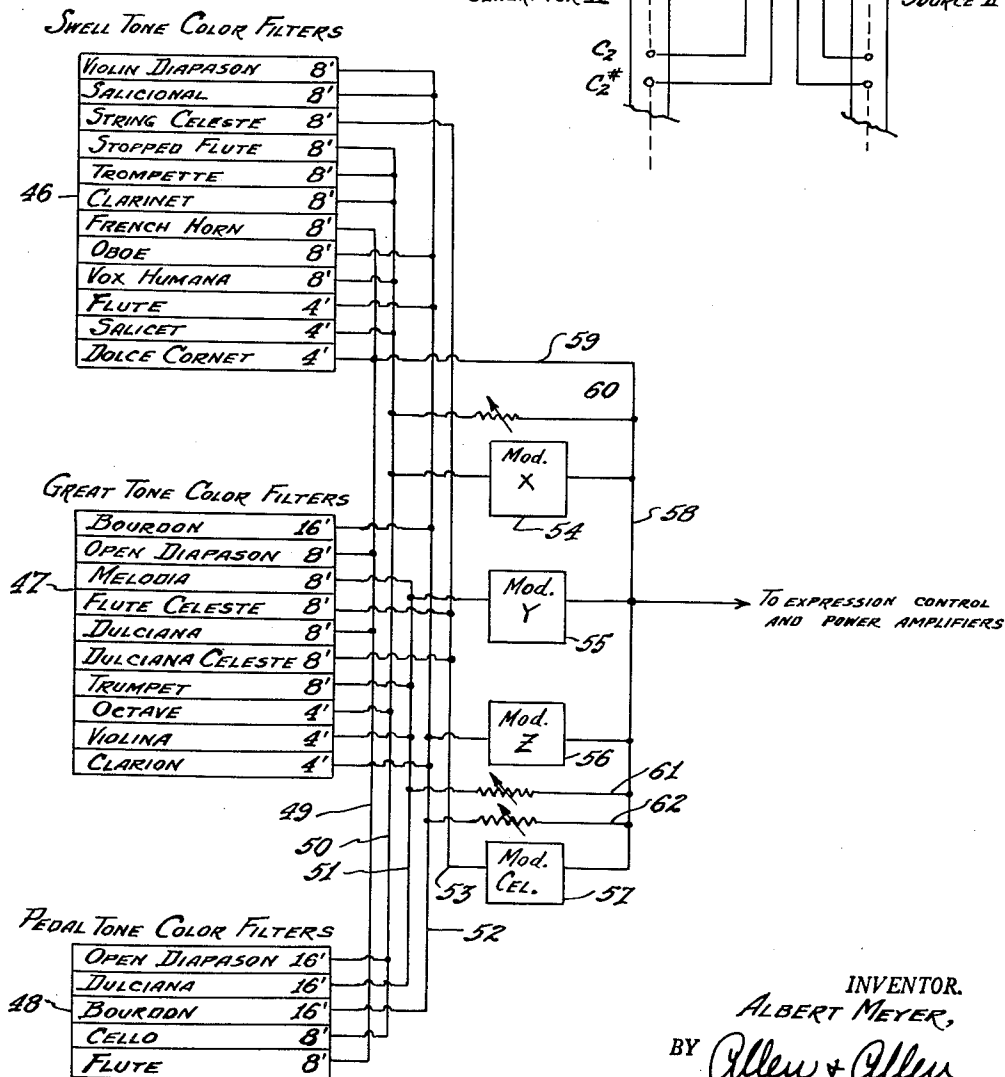


FIG. 5.



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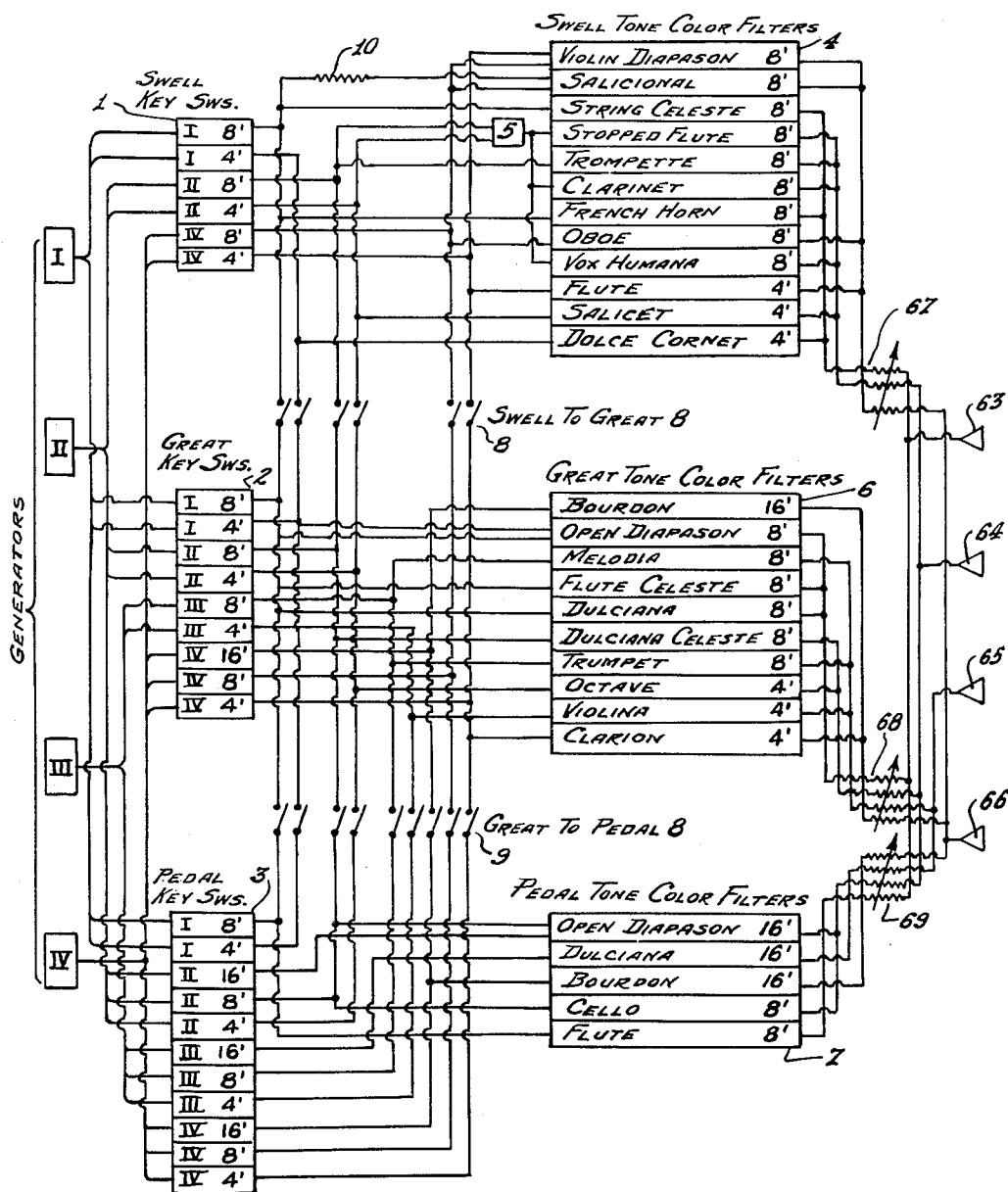


FIG. 6.

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3,049,959

OBTAINING ENSEMBLE AND CELESTE EFFECTS IN ELECTRICAL MUSICAL INSTRUMENTS

Albert Meyer, Deer Park, Ohio, assignor to The Baldwin Piano Company, Cincinnati, Ohio, a corporation of Ohio

Filed Nov. 22, 1957, Ser. No. 698,222
19 Claims. (Cl. 84—1.24)

The invention relates to electrical musical instruments, primarily but not exclusively those in which tones are continuously generated by electrical means in the nature of oscillators, the electrical oscillations being derived and combined by means of key switches, modified as to harmonic content by filter means, amplified, and converted into sound by one or more loud speaker channels.

The tones produced by such instruments may be given substantially any tone color desired, may be controlled as to onset and cessation by various means including resistive switches, and may have vibrato imparted thereto. Nevertheless, the tones do not fully simulate the tones of the pipe organ because the tones, being derived from a single rank of oscillators, are always precisely in tune. In even the smallest pipe organ, the various voices are produced from separate ranks of pipes which are slightly detuned with respect to each other, giving what is generally termed an "ensemble effect" which is pleasing to the ear. The difference is essentially that existing between the music of a single violin and that of a plurality of violins played together, the difference being readily detectable even if the amplitudes of the tones are the same. In addition, the pipe organ usually has the ranks of pipes for certain voices more sharply detuned from each other, giving an effect known generally as a "celeste effect."

It has hitherto been suggested that the tonality of a pipe organ could be more nearly reproduced in an electrical musical instrument if separate ranks of generators were set up for the various voices, these ranks of generators being slightly detuned from each other. However, the use of a number of ranks of generators equal to the number of voices in the instrument increases the cost tremendously, and is economically disadvantageous.

It is an object of the invention to provide for the obtaining of an ensemble effect in an electrical musical instrument without the use of large numbers of ranks of generators.

It is an object of the invention, also, to provide for the obtaining of celeste effects in an electrical musical instrument without the use of large numbers of ranks of generators.

It is a further object to obtain celeste effects without significant interference with the tonality of other stops which may be employed with the celeste stops.

These and other objects of the invention, which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, are accomplished by that construction and arrangement of parts of which exemplary embodiments will hereinafter be described. Reference is made to the accompanying drawings wherein:

FIGURE 1 is a diagrammatic representation of an electrical musical instrument arranged for ensemble effects.

FIGURE 2 is a diagrammatic representation of an arrangement including means for the production of celeste voices and including means for the elimination of the celeste effect when a main organ voice is used deriving oscillations from a generator rank which is detunable for celeste purposes.

FIGURE 3 is a diagrammatic representation of an arrangement including celeste voices, together with a

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means for shifting a main organ voice from one generator rank to another when a celeste stop is drawn.

FIGURE 4 is a diagrammatic representation of means for utilizing oscillations from different ranks of generators to provide sources of oscillations in which the oscillations are not precisely in tune with oscillations octavely related thereto, these sources being used in the invention in the same way as ranks of generators in earlier figures.

FIGURE 5 is a diagrammatic representation of an arrangement using electronic means for modifying the frequency of oscillations after they have been produced.

FIG. 6 is a diagrammatic representation of an electrical musical instrument arranged for ensemble effects, similar to the arrangement shown in FIG. 1, but showing the use of separate loud speakers for the reproduction of tones generated by the several ranks of generators.

In making the exemplary disclosures herein, the invention will be described in connection with an electrical musical instrument of the type shown in patent No. 2,233,948 to Winston E. Kock, issued March 4, 1941, to which reference is hereby made for the details of such an instrument. The patent shows a rank of generators divided into twelve groups of octavely related oscillators, each group having a master oscillator in a high register and a plurality of other oscillators controlled directly or indirectly thereby. The application of a varying potential to the master oscillators of the several groups produces vibrato. By means of switches operated by playing keys, the oscillations from the various generators are transferred to headers. Each key operates several switches for the derivation of harmonically related oscillations; and the oscillations of different "footages," e.g. 4', 8', and 16', are collected in different headers.

From the headers, the oscillations are transferred to tone color filters, some of which derive their oscillations from one header, while others are fed by more than one header. To produce certain voices, usually of woodwind character, it is the practice, in this instrument, to combine, say, 8' oscillations with corresponding 4' oscillations 180° out of phase therewith, the result being suppression of the even order and accentuation of the odd order harmonics. The tone color filters are controlled by switches connected with stop tabs. The oscillations from the tone color filters pass to an amplifier with volume control, and thence to one or more loud speakers.

In the organization of this invention, a small number of ranks of generators is provided. While the number may vary, the invention will be described in connection with an instrument having four ranks of generators, designated generally in the drawings by the Roman numerals I, II, III and IV. The number of ranks of generators for optimum ensemble effect is determined, in accordance with this invention, by the number of most important manual stops in full organ condition, these stops being the loudest stops. Thus, where in a particular instrument, these stops are:

(Great) Open Diapason 8'
Octave 4'
Trumpet 8', and
(Swell) Violin Diapason 8'

four ranks of generators are used. The ensemble is, as it were, built out in each division, Great or Swell, of the organ, as will hereinafter be explained.

Referring now to FIGURE 1, four ranks of generators, I, II, III and IV, have been indicated by blocks at the left hand side. The drawing is not a circuit diagram, as will be understood, and does not show the various circuit elements. However, the paths of the oscillations are diagrammatically indicated by single lines. The index numeral 1 designates a series of switches operated by one

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of the keys of the Swell Manual of the organ. It will be understood that similar groups of switches are operated by the other keys of the manual. Generator ranks I, II and IV are shown connected variously to these key switches. It will be understood by the skilled worker that if the key switch group 1 is, say, the group for Middle C, then 4' and 8' C oscillators of ranks I, II and IV respectively will be connected through the switches of the group, as indicated by the footage notations on the drawing. The key switches themselves are connected through various headers to the tone color filters for the Swell Manual. These filters are diagrammed as a group at 4. Three of the voices of the group require the outphasing which has been mentioned above and outphasing means is indicated at 5.

Similarly, the index numeral 2 indicates a group of key switches operated by one of the keys of the Great Manual. These switches are connected variously to the several ranks of generators, and they feed, through suitable headers, a group of tone color filters 6 for the Great Manual. Again, index numeral 3 indicates a group of switches operated by a key of the pedal clavier, again connected to the ranks of generators, and feeding the oscillations to a group of pedal tone color filters 7.

The index numeral 8 appended to a series of aligned switches diagrams means for coupling the Swell to the Great Manual. Similarly, the numeral 9 indicates means for coupling the Great Manual to the pedal clavier. The circuit elements are not shown as such; the coupling is preferably accomplished by the means shown in Patent No. 2,557,133 issued June 19, 1951, in the name of Raymond P. Mork.

In the diagram, FIGURE 1, it will be easy to determine, however, from what generator rank each of the individual tone color filters derives its oscillations. This is summarized in the following table:

Stop	Generator			
Swell Manual:				
Violin Diapason 8'				IV
Salicional 8'				IV
String Celeste 8'	I			
Stopped Flute 8'		II		
Trompette 8'		II		
Clarinet 8'		II		
French Horn 8'	I			
Oboe 8'				IV
Vox Humana 8'		II		
Flute 4'				IV
Salicet 4'		II		
Dolce Cornet 4'	I			
Great Manual:				
Bourdon 16'				IV
Open Diapason 8'	I			
Melodia 8'			III	
Flute Celeste 8'	I			
Dulciana 8'	I			
Dulciana Celeste 8'		II		
Trumpet 8'			III	
Octave 4'		II		
Violina 4'			III	
Clarion 4'				IV
Pedal Clavier:				
Open Diapason 16'		II		
Dulciana 16'			III	
Bourdon 16'				IV
Cello 8'		II		
Flute 8'	I			

The Open Diapason (Great) is on generator rank I, while Octave (Great) is on generator rank II. Thus the ensemble effect will be attained if they are played together. Trumpet (Great) is on generator rank III, and Violin Diapason (Swell) is on IV. Thus, any two or more of these voices, played together, will produce the ensemble effect.

But the ensemble effect is also provided in connection with other voices, and in particular in connection with successively softer stops in each of the four basic tone color families (Diapason, Flute, String, and Reed), and

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in connection with the provision of ensemble accompaniment to solo voices. For example:

- Trompette (II) ensembles with Violin Diapason (IV)
- Dolce Cornet (I) ensembles with Trompette (II)
- Dulciana (I) ensembles with Melodia (III)
- Violina (III) ensembles with Dulciana (I)
- Salicional (IV) ensembles with Dulciana (I)
- Stopped Flute (II) ensembles with Melodia (III)
- Melodia (III) ensembles with Bourdon (IV)
- Salicet (II) ensembles with Salicional (IV)
- Flute (IV) ensembles with Stopped Flute (II)

and so on.

Further, solo voices such as Clarinet (II), Vox Humana (II), French Horn (I) and Oboe (IV) will ensemble with a wide variety of accompaniments.

It will be understood that the various generator ranks will be detuned slightly with respect to each other, preferably in a random manner. Thus, for ensemble effects, one of the generator ranks may be tuned exactly on pitch, while the others are detuned within the range of substantially $\pm 3-4$ cents. Since in the particular embodiment, the application of a small voltage to the master oscillators will result in a change of frequency, it is possible to tune the entire organ including all of the generator ranks to standard pitch and then slightly detune three of the generator ranks by the application of small steady voltages. Further, provision may be made for the adjustment of the detuning.

The system, as outlined in the exemplary embodiment, requires a greater number of key switches than is standard in instruments not making provision for ensemble effects. Thus, the Swell Manual must provide for the keying of generator ranks I, II and IV at footages of both 8 and 4, thus requiring a total of six switches operated by each key. As to the Great Manual, and by reason of the coupling between the manuals, it is necessary to derive 8' and 4' tones from all of generators I, II and III, and 4', 8' and 16' tones from generator rank IV, making a total of nine switches to be operated by each Great Manual key. By reason of the coupling as shown in the diagram of FIGURE 1, the switches for each pedal should key the II, III and IV ranks of generators at 4', 8' and 16' tones each and the I rank of generators at 4' and 8' respectively, making a total of eleven switches for each key of the pedal clavier. If the manual to pedal coupling means were eliminated, five switches would serve for each pedal key.

In order to complete the exemplary showing, an amplifier diagrammed at A and a loud speaker L are indicated as connected to receive the output of the Great Tone Color Filters, it being understood that the same output system or separate ones are connected to receive the output of the Swell Tone Color Filters and the Pedal Tone Color Filters.

Thus far there has been described a mode of securing ensemble effects as between voices. Within the purview of this invention it is possible to enrich any single voice to impart ensemble characteristics to it, by adding some of the output from another rank or ranks of generators at a low level. For example, the Salicional voice of the Swell Manual is shown in FIGURE 1 as connected to a header which, in turn, is connected to the key switches so as to receive the 8' output of the IV generator rank. To enrich the Salicional voice, it would be possible to resistively add, say, signal from the 8' header of the I rank of generators, by means of an attenuating impedances indicated at 10. A similar connection could be made with the 8' header of the II rank of generators. In the Great Manual arrangement, as illustrated in FIGURE 1, any voice filter (except the Bourdon) could be similarly connected with as many as three other ranks of generators. By a "low level" is meant an amplitude of, say, 20 to 30 decibels less than the amplitude of the oscillations from the IV rank of generators.

The invention also makes provision for the obtaining of celeste tones which, as set forth above, are brilliant effects

produced by the simultaneous sounding of tones which are detuned as respects each other by a greater degree than is usual or proper in the obtaining of the ensemble effect. Thus, whereas the ensemble effect is best obtained by a detuning of, say, $\pm 3-4$ cents, celeste effects generally contemplate a detuning of the order of $\pm 12-13$ cents. Celeste effects are readily obtained in the practice of this invention by making one at least of the four ranks of generators selectively tunable electrically by means of a controllable D.C. voltage applied to the vibrato bus. For those voices in which a celeste effect is desired, the stop tabs can be made to operate switches which will detune this generator rank to the desired degree, and draw excitation from it as well as from one other generator rank in the group. Individually, the celestes may be either flat or sharp and may be so in different amounts; but if all are simultaneously played, they must of necessity be identical in the amount of detuning of the tunable generator rank, so that some switching precedence should be provided in this event. The detuning of the celeste generator rank may be fixed or provision may be made within the control of the musician for adjustment of the detuning.

Further, if one of the main stops of the organ, as set forth herein, should derive its principal excitation from the celeste generator rank, there would have to be provided a detuning cut-out switch in connection with such main voice since the celeste effect detuning would be inappropriate in connection with it.

FIGURE 2 illustrates an arrangement which makes provision for celeste effects. It is diagrammatic in nature and is based on the arrangement shown in FIGURE 1. Generator rank I is in this instance chosen as the generator rank which will be selectively detuned for celeste purposes. There is shown a Salicional voicing means 11 connected to the 8' header of the IV rank of Swell key switches and provided with a Salicional stop switch 12 by which its output is transferred to the header 13 leading to the amplifier. Next, there is shown a String Celeste voicing means 14. It is connected to the 8' header of Swell key switch rank I. The String Celeste stop tab operates three switches. The first is a normally open, single-pole, single-throw switch 15 operating to connect the Salicional voicing means to the header 13. The second is a normally open, single-pole, single-throw switch 16 operating to connect the String Celeste voicing means to the header 13. The third is a single-pole, double-throw switch 17 which operates upon the actuation of the stop tab to connect the vibrato bus 18 of generator rank I to a point on a potentiometer or resistive network 19 such that a steady potential above ground potential is applied to said vibrato bus, resulting in the detuning of generator rank I. A celeste effect will be obtained because of the combination of oscillations from the generator rank IV and the very substantially detuned oscillations from the generator rank I.

FIGURE 2 also shows an Open Diapason voicing filter 20 deriving oscillations at 4' and 8' from Great key switch rank I. If the Open Diapason stop is to be played, the tuning of generator rank I should be restored. Accordingly, the stop tab of the Open Diapason voice is arranged to operate four switches. The first of these is a single-pole, single-throw switch 21, normally closed, but in series with switch 16 and acting, when the Open Diapason stop tab is depressed, to break the circuit between the String Celeste voicing means and the header 13. The second is a single-pole, double-throw switch 22 acting when the stop tab is off, to connect the upper end of the resistive network 19 to a source of detuning voltage V. When the stop tab is depressed, the switch 22 connects the resistive network to ground as shown, thus eliminating any celeste bias on the generator rank I. The third is a single-pole, double-throw switch 23 acting, when the stop is depressed, to connect the Open Diapason voicing means with the Great Manual stop header 24. When the stop is on, this switching serves to cut out a celeste voice, as

hereinafter explained. A similar switch 25 acts when the stop tab is down to connect the Open Diapason to the header and to break the circuit of a Flute Celeste stop hereinafter described. In the Great Manual assembly there is shown a Melodia voicing means 26 having stop switch 27 and connected to the 8' header of Great key switch rang III. Flute Celeste voicing means is shown at 28 connected to the 8' header of generator rank I. This voicing means has a stop tab operating three switches and indicated generally at 29. The arrangement is similar to that described above in connection with the String Celeste. One of the switches connects the Melodia voicing means to the header 24; another connects the Flute Celeste voicing means through switch 25 of the Open Diapason stop switch arrangement to the header 24. The third switch normally connects the vibrato bus 18 of generator rank I to ground, but when the stop tab is actuated, it connects it with the resistive network 19. The position of this connection on the resistive network may be different so as to accomplish a different degree of detuning.

There is also shown a Dulciana voicing means 30 connected to the 8' header of Great key switch rank I and having a stop switch 31. A Dulciana Celeste voicing means 32 may be connected to Great key switch rank II. It is provided with a stop tab operating three switches and indicated generally at 33. The first of these switches connects the Dulciana voicing means with the header 24; the second connects the Dulciana Celeste voicing means with the header 24 through switch 23 of the Open Diapason stop tab. The third switch, when the stop tab is actuated, connects the vibrato bus of generator rank I with yet another position on the resistive network 19 through switch 17 of the String Celeste stop tab. Otherwise, it grounds the vibrato bus through the same switch and through the last mentioned switch of combination 29.

There is included in the vibrato bus switching circuit a precedence such that when several celeste stop switches are actuated, the celeste having the least amount of detuning takes precedence. For pleasing celeste effects, bright tone colors (such as string stops) require less tuning separation (i.e. detuning) between the two components, whereas purer tone colors (such as flutes) allow considerably more tuning separation. Since generator detuning increases (though not linearly) with increasing control voltage, the connection for the String Celeste is shown at the lowest point on the resistive network 19 since this is the brightest tone color. The connection for the Flute Celeste is shown highest because this is a relatively pure tone color. The Dulciana Celeste, being an intermediate tone color, allows an intermediate amount of detuning, and is shown as having its connection in an intermediate position.

Of course, other arrangements are possible. For example, the Oboe stop of the Swell Manual could be connected to generator rank II instead of IV, and in this event the IV generator rank may be made the Celeste generator rank. A Salicional Celeste stop could derive its oscillations from II and a detuned IV; a Melodia Celeste could derive its oscillations from III and a detuned IV; and a Dulciana Celeste could derive its oscillations from I and a detuned IV. All of these combinations are different. Since, however, the Violin Diapason is connected with generator rank IV, this stop will require a detuning cut-out.

FIGURE 3 illustrates another arrangement which somewhat simplifies the stop tab switching. In it the detuning cut-out switches are obviated; but each celeste stop is provided with an additional contact, and these contacts are wired in parallel to operate a relay. This relay acts, when a celeste stop is being used and generator rank I (for example) is, therefore, substantially detuned, to transfer any main organ stop normally connected with the highly detuned generator rank to some other generator rank. There may in this system be a

slight sacrifice in the over-all ensemble effect, but its advantage is that it does not preclude the playing of a celeste voice with one of the main voices of the full organ such as the Open Diapason.

In FIGURE 3 like parts have been given like index numerals and do not require re-description. The Open Diapason voicing means 20 has a stop switch assembly 34 which simply acts to connect it with the bus 24. The String Celeste stop tab operates a switch 35, and similar switches are arranged in parallel with it and operated by the stop tabs of the Flute Celeste and the Dulciana Celeste to connect the operating coil 36 of a relay with a source of power 37. The relay has a double-pole, double-throw switch 38. When the relay is unactuated, the Open Diapason voicing means 20 is connected respectively to the 4' and 8' headers of Great key switch rank I. Actuation of any of the celeste stops shown will result in switching the connections of the Open Diapason voicing means to the 4' and 8' headers respectively of Great key switch rank IV. Instead of a single resistive network 19, there is shown in FIGURE 3 separate resistors 39, 40 and 41 to which the generator I rank vibrato bus 18 may be selectively connected by switches operated from the several celeste stop tabs. In this way different celeste effects may be attained by connecting the resistors to sources of positive and negative voltage. Again, it will be evident to the skilled worker in the art various other arrangements may be made, which it is not necessary to outline here.

The effects contemplated herein are enhanced by the use of several loud speaker channels, preferably as many channels as there are ranks of generators. Thus the signals of all of the stops supplied by generator rank I can be radiated by one speaker, the signals of all stops supplied by generator rank II can be radiated by another speaker, and so on. Besides resulting in a desirable acoustic mixing of the several signals (such as is obtained in pipe organs) rather than an electrical mixing, this also yields a desirable spatial effect. In following this system, it will be within the skill of the worker in the art to provide several stop headers with associated preamplifiers and amplifiers and with volume controls for each division of the organ.

This is illustrated in FIG. 6, which is comparable to FIG. 1, and in which like parts have been given like index numerals and legends. In this figure, it will be seen that there are four elements indicated at 63, 64, 65 and 66 which may be considered as combinations of power amplifiers and loud speakers constituting output systems for the instrument. In the figure it will be seen that these output systems are respectively connected to the voicing circuits of the swell manual, great manual and pedal clavier of the instrument in such a way that each output system receives oscillations from one only of the illustrated ranks of generators, I, II, III and IV. There have further been shown in connection with this system separate volume controls 67, 68 and 69 which serve as volume controls respectively for the swell, great, and pedal keyboards. These volume controls may be in the form of multiple potentiometers, since, although the output systems 63, 64, 65 and 66 are connected respectively with the ranks of generators aforesaid, more than one rank of generators is used with respect to the various series of swell, great and pedal voices. Consequently, actuation of the swell volume control will simultaneously affect the inputs to any of the output systems which are connected to voices in the swell organ grouping. The same thing is true of the great organ voice grouping, and the grouping of voices derived from the operation of the pedal clavier.

Although it has been implied in the disclosures above that a given stop is supplied throughout its entire compass by oscillations from a unitary generator rank having locked octaves, this is not a limitation on the invention,

and generator ranks may be used in which all generators are separately tunable. With locked generator ranks, it is frequently an advantage that different octavely related oscillations from the same rank are not integrally related in frequency. However, there are many advantages in unitary generator structures which have locked octaves; and the present invention includes means whereby effects similar to the effect produced by a single rank of organ pipes slightly detuned with respect to each other or comparable effects from a rank of individually tunable generators may be obtained.

Referring to FIGURE 4, the numeral 42 indicates diagrammatically the points of output (represented as though it were a connector board) of generator rank I. Similarly, 43 represents the points of output of generator rank II. These generator ranks and others which may be included in the system are of the type having locked octaves. A connector board is shown at 44; and it will be seen from the diagram that for the first octave the points on the connector board 44 are connected directly to corresponding points at 42. For the second octave on the connector board 44, however, the points are connected to the second octave on 43. For the third octave on connector board 44, there may be connections to the third octave on 42, or to the third octave in a generator rank III or a generator rank IV (not shown) in the drawings. Similarly, a connector board 45 is indicated in the drawing as having its first octave points connected with the first octave output points of 43. Its second octave is shown connected to the output points of the second octave of 42, and so on, as described above.

In an organ structure having four ranks of generators, there may be four connector boards. By reason of the detuning of respective generator ranks I, II, III, and IV, it will be observed that the octavely related oscillations available on the connector boards 44, 45, etc. will be slightly detuned with respect to each other. It will further be observed that each connector board presents for use an organization of oscillations which is specifically different from that presented by any other connector board in the group, so that oscillations derived from different connector boards will ensemble with each other. The connector boards, therefore, may be treated as sources of oscillations; and by making appropriate connections to the connector boards, the invention hereinabove described in connection with FIGURE 1 may be practiced, as will now be clear to the skilled worker in the art. In any given instrument some of the switches under any given key may be connected to the connector boards or "sources I, II, III and IV," while others may be connected directly to the generator ranks I, II, III and IV heretofore described. In the claims which follow, the terms "generators" and "ranks of generators" are intended to be construed broadly enough to include the "sources" described in connection with FIGURE 4.

Where celeste effects are desired in an instrument making use of the "sources," it is possible to provide a celeste generator rank which is not connected to any of the connector boards forming the so-called sources.

While the invention has been described herein in connection with ranks of generators or "sources" which are slightly detuned as respects each other, the art has produced electronic devices which are capable of modifying the frequency of oscillations after they have been produced. Reference is made to the copending application of William C. Wayne Jr., Serial No. 631,650, filed December 31, 1956, and entitled Audio Modulation System, now patent 3,004,460 issued October 17, 1961, and to the copending application of Ernest J. Timperman, Serial No. 631,883, filed December 31, 1956, and entitled Audio Modulator, now Patent 2,916,706 issued December 8, 1959, in which exemplary devices of this character are disclosed involving phase shift means. The principles of this invention may be applied to the use of such devices for creating ensemble and celeste effects, the phase

shift devices being located between the tone color circuits and the output system. An arrangement of this character is illustrated in FIGURE 5 hereof. The numerals 46, 47 and 48 indicate assemblies of tone color filter means respectively for the Swell and Great Manuals and for the Pedal Clavier. These tone color filter assemblies can be considered as connected in the manner taught in the Kock Patent 2,233,948, referred to hereinabove to a single rank of generators. But the outputs of the tone color filters in the several assemblies are organized in the way taught hereinabove by selectively connecting them to different headers such as the headers 49, 50, 51 and 52. Where celeste voices are desired, there will be in addition a celeste header 53.

A series of phase shift frequency modulating devices is shown at 54, 55, 56 and 57. In the particular embodiment the header 49, which receives the outputs of the Pedal Flute 8', the Great Dulciana 8', the Great Open Diapason 8', the Swell French Horn 8', and the Swell Dolce Cornet 4', is shown as connected directly to an output header 58 by a lead 59. The output header will, of course, be connected through expression control means to a power amplifier and loud speaker system, which may comprise several loud speaker channels as described above. Header 50, which receives the output of the Pedal Cello 8' and Open Diapason 16', the Great Octave 4', and the Swell Salicet 4', Vox Humana 8', Clarinet 8', Trompette 8', and Stopped Flute 8', is connected through the phase shift modulating device 54 to the output header 59. Similarly, header 51, receiving the output of the Pedal Dulciana 16' and Great Violina 4', Trumpet 8', and Melodia 8', is connected to the output header 58, through a phase shift modulator 55. The header 52, receiving the output of the Pedal Bourdon 16', Great Clarion 4', and Bourdon 16', and Swell Flute 4', Oboe 8', Salicional 8', and Violin Diapason 8', is connected to the output header 58 through the phase shift modulator 56. The header 53, which receives the output of two Great Celeste stops and one Swell Celeste stop, is connected to the output header 58 through the phase shift modulator 57.

The phase shift modulators 54, 55 and 56 are adjusted to produce change in frequency which are slightly different, so that they will ensemble with each other and with the output of header 49. The phase shift modulator 57, being a celeste modulator is, of course, adjusted to produce a greater change in frequency productive of a celeste effect.

Inasmuch as phase shift devices of this type produce very pleasing effects when their outputs are combined with unmodulated outputs from the same headers, it is within the scope of the invention to provide direct connections between headers 50, 51 and 52 and the output header 58. These direct connections are diagrammatically illustrated at 60, 61 and 62; and they may be provided with adjustable attenuating means in the nature of variable resistances as shown.

Modifications may be made in the invention without departing from the spirit of it. The invention having been described in certain exemplary embodiments, what is claimed as new and desired to be secured by Letters Patent is:

1. In an electrical musical instrument, a plurality of ranks of generators slightly detuned as respects each other, a plurality of playing key operated switches, a plurality of tone color circuits, connections through said playing key operated switches between said ranks of generators and various ones of said tone color circuits, whereby ensemble effects are produced when oscillations derived from different ranks of generators are simultaneously transmitted to an output system, and means operatively associated with one of said ranks for selectively further detuning said one rank by an amount sufficient to produce a celeste effect when its oscillations are simultaneously sent to said output system with the oscillations of another of said ranks of generators.

2. The structure claimed in claim 1 in which said tone color circuits include means operatively associated therewith for producing a plurality of main full-organ voices of relatively greater amplitude and a plurality of solo and supplementary voices of relatively lesser amplitude and in which the number of said ranks of generators is equal to the number of said main full-organ voices.

3. The structure claimed in claim 2 wherein the tone color circuits producing said main full-organ voices are provided with stop tabs having switching means, and wherein the stop tab for a main full-organ voice, the tone color circuit of which is connected with said detunable rank of generators, is provided with means for rendering the said additional detuning inoperative.

4. The structure claimed in claim 2 wherein the said tone color circuits are provided with stop tabs having switches, wherein one at least of the said supplementary voices is a celeste voice having means in connection with its stop tab switches to further detune said detunable rank of generators, there being a main full-organ voice also connected with said detunable rank of generators, and means in connection with the stop tab of said full-organ voice to render said further detuning ineffective.

5. The structure claimed in claim 2 wherein said tone color circuits are provided with stop tabs having switches, one at least of said supplementary voices being a celeste voice and having means in connection with its stop tab switches to further detune said detunable rank of generators and to shift to another rank of generators a full-organ voice normally employing said detunable rank of generators.

6. In an electrical musical instrument of the organ type having a plurality of voices, in which an ensemble effect may be secured in the sounding of the usual combinations of voices of said instrument with a minimum number of means for causing oscillations of the same nominal frequency to bear a detuned relationship to each other:

- (a) at least one rank of generators producing electrical oscillations,
- (b) at least one keyboard having means operatively associated with said generators for deriving said oscillations in accordance with the requirements of a musical composition,
- (c) distributing means operatively associated with said deriving means for transferring the oscillations so derived to tone color circuits,
- (d) selectively operable tone color circuits for modifying the harmonic content of oscillations passing through them, said tone color circuits respectively producing timbres of
 - (1) a relatively smaller plurality of main, full-organ voices classifiable as diapason and chorus reed voices, and
 - (2) a relatively larger plurality of supplementary voices, classifiable as solo reed, string and flute voices,
- (e) collecting means for the modified oscillations connected to said tone color circuits,
- (f) an output system connected to said collecting means,
- (g) said electrical musical instrument having means associated with said tone color circuits for rendering oscillations of the same nominal frequency slightly detuned as respects each other,
 - (1) the oscillations so related being respectively associated with tone color circuits for a diapason voice and a chorus reed voice, whereby these voices will ensemble with each other, and
 - (2) the oscillations so related being respectively associated with tone color circuits for a string voice and a flute voice, whereby said last mentioned voices will ensemble with each other, and whereby at least one of said last mentioned voices will ensemble with a solo reed voice.

7. The structure claimed in claim 6 in which the means

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associated with said tone color circuits for rendering oscillations of the same nominal frequency slightly detuned as respects each other comprises at least a second rank of generators slightly detuned with respect to another rank of generators in the instrument, and in which the said distributing means selectively distributes the oscillations from said generator ranks to different ones of said tone color circuits.

8. The structure claimed in claim 6 wherein the means associated with said tone color circuits for rendering oscillations of the same nominal frequency slightly detuned as respects each other, comprises electrical frequency modifying means having connection with the collecting means which in turn are connected to said tone color circuits.

9. The structure claimed in claim 8 wherein the number of ranks of generators is the same as the number of main full-organ voices whereby all of said main full-organ voices are capable of ensembling with each other.

10. The structure claimed in claim 7 including oscillation correlating means to which generators from at least two separate ranks of generators are connected in a cyclicly permuted fashion, such that oscillations derived from said oscillation correlating means will ensemble with each other at least in octavely related relationship, said oscillation correlating means having connection with said oscillation deriving means.

11. The structure claimed in claim 7 wherein one of said ranks of generators is sufficiently detuned with respect to another of said ranks of generators to provide a celeste effect.

12. The structure claimed in claim 7 wherein said tone color circuits have stop switches, wherein one at least of said tone color circuits is in connection with two of said ranks of generators, wherein electrical means is provided for further detuning one of said ranks of generators to provide a celeste effect and wherein said means for further detuning one of said ranks of generators is operated by a stop switch for said last mentioned tone color circuit.

13. The structure claimed in claim 8 wherein the number of said electrical frequency modifying means is the same (less one) as the number of main full-organ voices in the instrument.

14. In an electrical musical instrument of the organ type having a plurality of voices, in which an ensemble effect may be secured in the sounding of the usual combinations of voices of said instrument with a minimum number of ranks of generators of electrical oscillations;

- (a) a plurality of ranks of generators producing electrical oscillations,
- (b) at least one keyboard having means operatively associated with said generators for deriving said oscillations in accordance with the requirements of a musical composition,
- (c) distributing means operatively associated with said deriving means for transferring the oscillations so derived to tone color circuits selectively,
- (d) selectively operable tone color circuits for modifying the harmonic content of oscillations passing through them, said tone color circuits respectively producing timbres of

- (1) a relatively small plurality of main, full-organ voices classifiable as diapason and chorus reed voices, and

- (2) a relatively larger plurality of supplementary voices, classifiable as solo reed, string and flute voices,

- (e) collecting means for the modified oscillations connected to said tone color circuits, and
- (f) an output system connected to said collecting means,
- (g) said ranks of generators being connectible to said tone color circuits for said main full-organ

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voices so that a plurality thereof (including at least one diapason voice and at least one chorus reed voice) will ensemble with each other, and being connected also with said tone color circuits for said supplementary voices selectively so that a plurality of said last mentioned voices (including at least two string voices of different footage, and at least two flute voices of different footage) will ensemble with each other, and so that certain at least of said last mentioned voices will ensemble with a solo reed voice.

15. In an electrical musical instrument in which ensemble effects may be secured:

- (a) at least two ranks of generators producing electrical oscillations, said ranks being slightly detuned as respects each other,
- (b) at least two oscillation correlating means, each such means having connection with generators of a plurality of ranks, said connections being cyclicly permuted so that at least octavely related oscillations will ensemble with each other in each oscillation correlating means;
- (c) the connections between said generators and said oscillation correlating means being of opposite order so that oscillations of the same nominal frequency in each oscillation correlating means will ensemble with each other,
- (d) a plurality of keyboards having means operatively associated with said oscillation correlating means for deriving said oscillations in accordance with the requirements of a musical composition,
- (e) distributing means operatively associated with said deriving means for transferring the oscillations so derived to tone color circuits,
- (f) selectively operable tone color circuits for modifying the harmonic content of oscillations passing through them,
- (g) collecting means for the modified oscillations connected to said tone color circuits, and
- (h) an output system connected to said collecting means.

16. The structure claimed in claim 12 wherein a main organ voice tone color circuit is connected to said detunable rank of generators and has a stop tab with switch means, one of said last mentioned switch means acting to inactivate the further detuning of said detunable rank of generators.

17. The structure claimed in claim 12 wherein one of said full-organ voices is normally connected to said detunable generator, and wherein the said celeste stop acts to shift said main organ voice to another rank of generators.

18. The structure claimed in claim 12 wherein one of said full-organ voices is normally connected to said detunable generator, and wherein the said celeste stop acts to shift said main organ voice to another rank of generators, by energizing a relay having contacts for effecting said switching.

19. The structure claimed in claim 18 wherein a plurality of said celeste tone color circuits is provided having stop tabs with switches and wherein a switch of each such stop tab is connected to operate said relay.

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