

June 17, 1969

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3,450,825

CELESTE SYSTEM FOR A LOCKED-OCTAVE ELECTRONIC ORGAN

Filed Nov. 26, 1965

Sheet 1 of 3

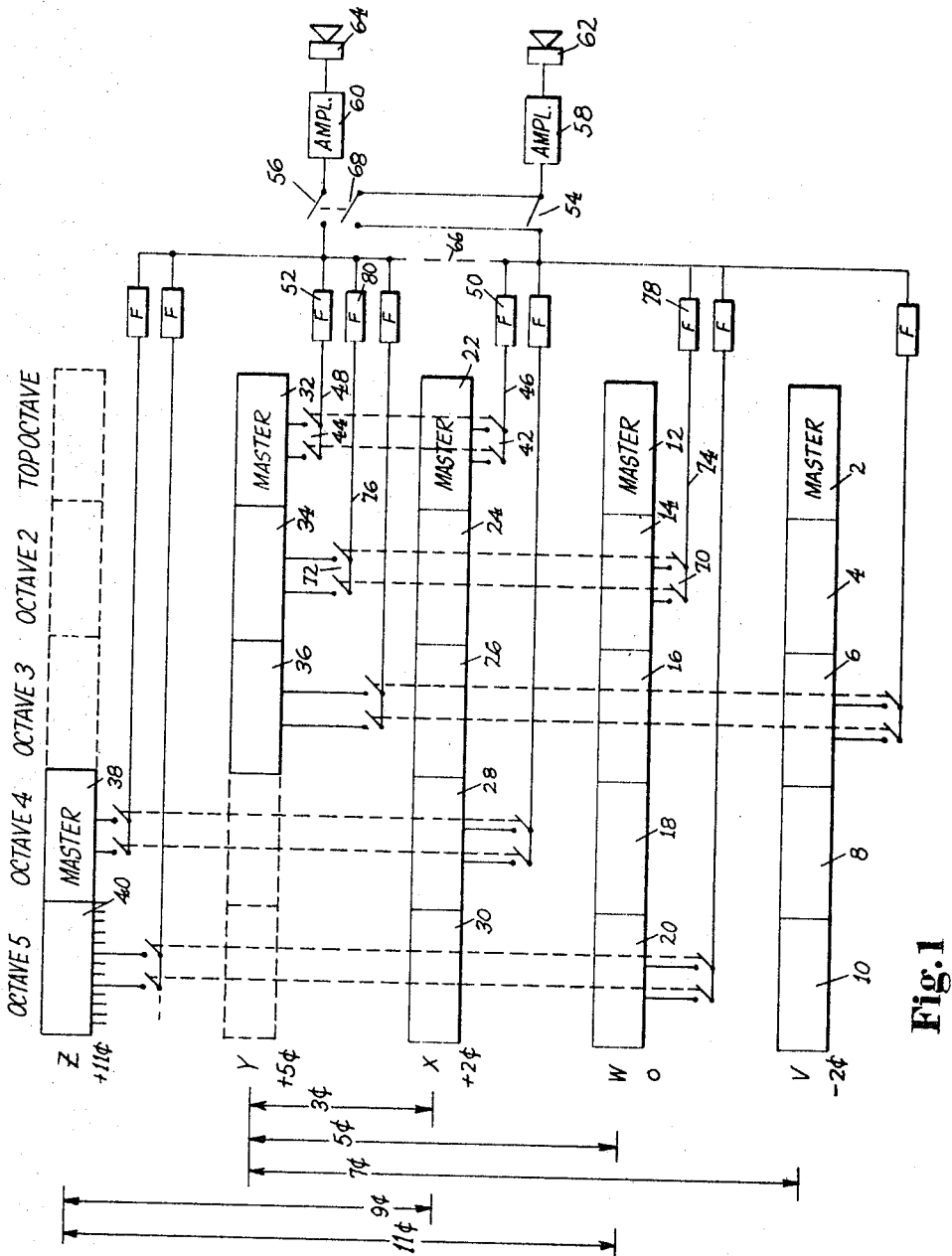


Fig. 1

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COMBINATION 1:

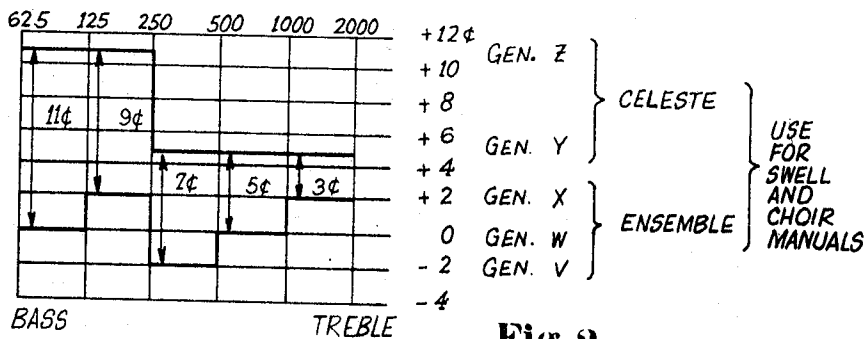


Fig. 2

COMBINATION 2:

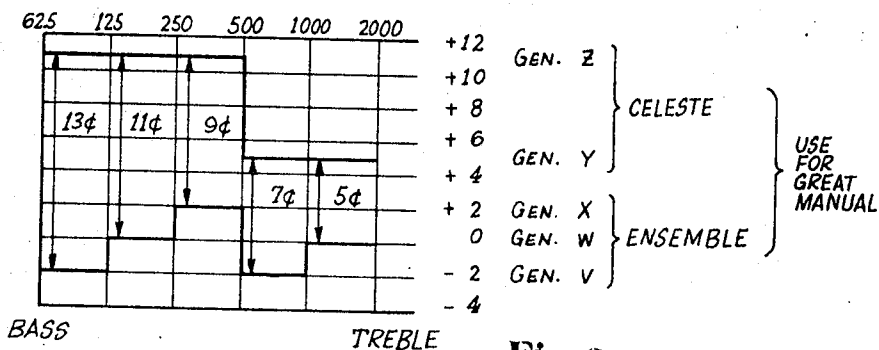


Fig. 3

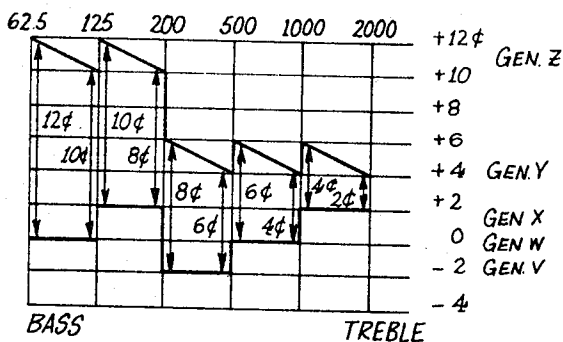


Fig. 4

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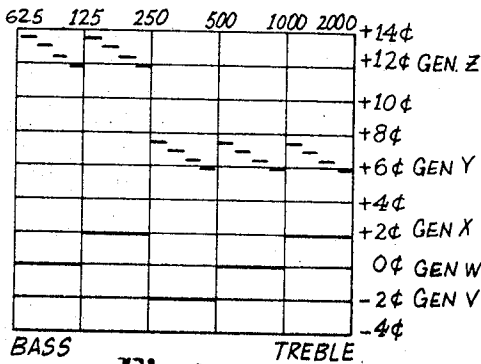


Fig. 5

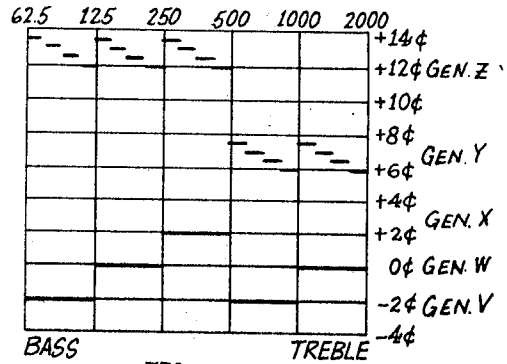


Fig. 6

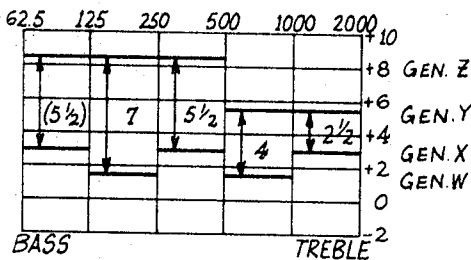


Fig. 7

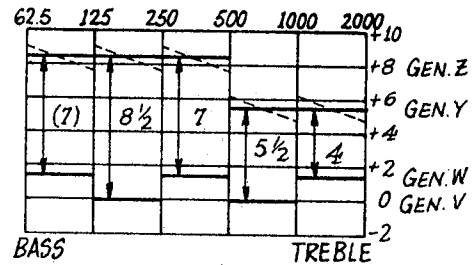


Fig. 8

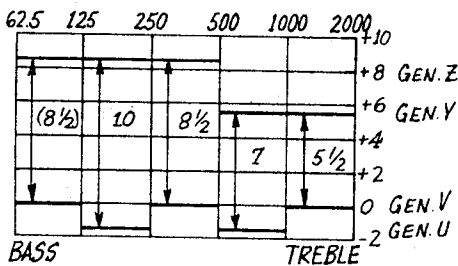
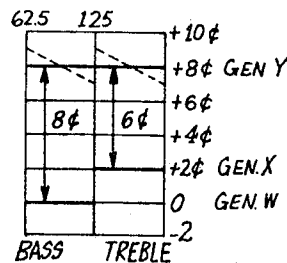


Fig. 9

Fig. 10



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**CELESTE SYSTEM FOR A LOCKED-OCTAVE
ELECTRONIC ORGAN**

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Int. Cl. G10h 1/02

U.S. Cl. 84-1.24

15 Claims

ABSTRACT OF THE DISCLOSURE

An electronic organ wherein two or more locked-octave tone generators are detuned one from another to an extent sufficient to produce an ensemble effect, while one or more additional locked-octave tone generators are detuned with respect to the first mentioned generators by an amount sufficient to produce a celeste effect, the celeste generators preferably being of lesser pitch range, so that two, for example, may cover the same range as the ensemble generators, the outputs of the generators being keyed and filtered prior to combination so that, if desired, the tone signals can be acoustically mixed.

This invention pertains to electronic organs and particularly to means for achieving excellent celeste effects in such instruments having locked-octave generating devices such as cascaded flip-flops.

In institutional electronic organs wherein the simulation of the characteristics of pipe organs is even more important than in organs for home or popular use, it is very desirable to provide for celeste effects. For example, the Voix Celeste (French for "a celestial voice") in a pipe organ is a string voice played along with the Salicional 8'. Also, the Unda Maris (Latin for "wave of the sea") is a soft and ordinary organ voice played with the Dulciana. Both of these combination voices use ranks of pipes which are purposely detuned from each other to give a pleasant undulation in the tones.

In electronic organs having ranks of individually tuned oscillators as sources of tone signals, celeste voices merely pose a problem of providing an additional rank or ranks of generators and effecting a relative detuning of the ranks (as in the case of pipes in a pipe organ) to achieve the desired effects, although this is a laborious process. The problem of providing celeste effects in organs having locked-octave generators is much more difficult. It is not considered satisfactory to detune the master oscillators by a desired amount, because this results in a percentage relationship in which the beat rate between tones is halved in adjacent octaves going down from the master oscillators.

In accordance with the teachings of this invention, a rather unobvious compromise is achieved. Usually, in an institutional instrument of the type in which celeste effects are desired, there are already two or three ranks of locked-octave generators for ensemble or chorus effects, the generators being respectively deliberately detuned by relatively small amounts—say, 1¢ to 3¢—that is, .01 or .03 semitones. For example, one rank of generators may be tuned right on standard pitch ($A=440$ c.p.s.). A second generator rank may be tuned to a relative value of +2¢, while a third rank may be tuned to a relative value of -2¢, both detuned ranks extending throughout the full pitch range of the instrument. Such slight detuning can be tolerated in generator ranks for ensemble effects, even though the beat rate doubles by octaves, because the beat rate is a full, 8-octave instrument would extend only from about .04 c.p.s. to about 9 c.p.s. On the contrary, if a desirable celeste of say +14¢ is provided in

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the lowest octave of a 5-octave generator rank, the achievement of about $\frac{1}{2}$ c.p.s. of detuning in the bottom octave would produce an intolerable discrepancy of 16 c.p.s. in the top octave of the instrument, if the same generator ranks were used throughout the range.

It is a primary object of this invention to provide a comparatively simple and economical, yet highly desirable celeste system in an electronic organ having already therein ensemble generators.

It is a further important object of the invention to provide a celeste system for a locked-octave electronic organ in which the beat rate may be continuously variable throughout the entire pitch range of celeste voices.

These and other objects which will be set forth hereinafter, or will be apparent to one skilled in the art upon reading this specification, are accomplished by those systems and structures of which exemplary embodiments will now be described, reference being made to the accompanying drawings, wherein:

FIG. 1 is a partially block, partially schematic diagram of a preferred embodiment of the invention.

FIG. 2 is a chart representing in graphical form the tuning system of FIG. 1.

FIG. 3 is a chart showing an alternative arrangement for employing the generators of FIG. 1.

FIG. 4 is a chart showing how taper tuning may be applied to the system of FIG. 1.

FIG. 5 is a chart showing a compromise arrangement for taper tuning a celeste system in accordance with the invention.

FIG. 6 is a chart illustrating an arrangement which is alternative to that of FIG. 5, such as might be used on a different manual of the same instrument.

FIG. 7 is a chart illustrating a first arrangement for a celeste system incorporating two ensemble generator ranks.

FIG. 8 is a chart illustrating a second arrangement for a celeste system incorporating two ensemble generator ranks.

FIG. 9 is a chart illustrating a third arrangement for a celeste system incorporating two ensemble generator ranks.

FIG. 10 is a chart illustrating an arrangement of generator ranks according to the simplest embodiment of the invention.

According to the present invention, as applied to an the three highest octaves tuned +5¢ and the other being organ with assembly generators tuned +2¢, 0 and -2¢ from standard pitch, two abbreviated range celeste generator ranks are provided—one, for example, being for the three highest octaves tuned +5 and the other being for the two lowest octaves tuned +11¢. By pairing off signals for top octave notes from the +2¢ and +5¢ ranks, the difference is only 3¢—a desirable amount of detuning for this octave. The next lower octave may draw from the 0¢ rank and the +5¢ rank, providing a difference of 5¢. The next lower octave may employ the -2¢ and +5¢ generator, resulting in a 7¢ difference. The next to bottom octave could then draw from the +2¢ and +11¢ generators, providing a 9¢ difference, while the bottom octave could use the 0 and +11¢ ranks, resulting in an 11¢ difference. As will be explained hereinafter, other desirable combinations may be achieved with similar systems of separate shot range generators, which in toto, comprise the approximate equivalent of only one additional rank of generators. Also, as will be explained in detail hereinafter, the individual sources can be "taper tuned" within an octave so that a smooth transition from one octave to another may be achieved.

Referring to the embodiments of FIG. 1, there are five groups of blocks labeled V, W, X, Y and Z, repre-

senting five generator assemblies or ranks. V, W and X preferably, but not necessarily, represent five octave generator ranks whose individual oscillators are continuously running, transistorized flip-flops, such as are common in the art, each individual oscillator of a given nomenclature controlled by a top octave master oscillator of an appropriate, stable, transistorized type. Tuning a master oscillator of, say, C nomenclature tunes in turn the four octavely related C flip-flops. Rank V, for example, may have its signal sources tuned -2ϕ from standard pitch (A=440 c.p.s.)—rank W may have its sources tuned at 0ϕ from standard; while rank X may be tuned $+2\phi$, all as indicated in FIG. 1 by the numerals under the indicia V, W and X.

Generator rank V comprises a master oscillator section 2 and four slave oscillator or divider sections 4, 6, 8 and 10, each section being composed of twelve sources tuned -2ϕ from equally tempered standard pitch (A=440 c.p.s.). Similarly, rank W comprises a master oscillator section 12 and four divider sections 14, 16, 18 and 20; while rank X is composed of a master section 22 and four divider sections 24, 26, 28 and 30. The rank W is tuned at 0 from standard pitch, while rank X is tuned at $+2\phi$ from standard pitch. Obviously, if another base pitch range is desired, rank W would be tuned to it, with ranks V and X being tuned respectively -2ϕ and $+2\phi$ in this embodiment. Ranks V, W and X are hereinafter called ensemble generators, and may be programmed in, say, a two manual organ for maximum ensemble in the regular organ voices in accordance with the teachings of a copending application of the same inventor, Ser. No. 291,662, filed July 1, 1963, now Patent No. 3,300,569 and assigned to the same assignee as the present application.

In accordance with the teachings of this invention, generator rank Y comprises a master oscillator section 32 having locked thereto only two divider sections 34 and 36, all tuned $+5\phi$ from standard pitch. On the other hand, generator rank Z comprises a master oscillator section 38, covering a pitch range equal to that of the fourth octave of the ensemble ranks V, W and X, and only one divider section 40, all tuned $+11\phi$.

Obviously, all generator sections, for the equally tempered scale, have twelve outputs each, as indicated by incomplete leads at the section 40 of rank Z. For simplicity throughout the diagram, only two outputs from each section are shown complete with switching and collecting circuitry.

Further in accordance with the present invention, concurrent keying via key switches 42 of octave section 22 of the X rank of generators and key switches 44 of octave section 32 of the Y rank of generators for the simultaneous playing of notes which differ in pitch by 3ϕ —that is $+5\phi - (+2\phi)$. The tone signals thus concurrently keyed are collected in buses 46 and 48 for filtering, as desired, by appropriate tone color filters 50 and 52. Although it is preferred to beat these outputs acoustically by way of stop switches 54 and 56, amplifiers 58 and 60 and loudspeakers 62 and 64, the output signals may be electrically combined as indicated by dashed line 66 and converted to sound via either of the output systems 54–58–62 and 56–60–64. Also, an additional stop switch 68 (in parallel with switch 54) may be ganged to switch 56 for actuation by a single stop tab (not shown), if desired.

Similarly for the next octave, key switches 70 and 72 may be ganged for the concurrent keying of tone signals from the sections 14 and 34, respectively in the W and Y ranks of generators, which will be 5ϕ apart—that is $+5\phi - 0$. These signals are collected as at 74 and 76 for filtering at 78 and 80 and conversion to sound via the same output systems as previously mentioned. Likewise, signals for the following octave are derived from generator sections 6 and 36 of the V and Y ranks respectively; signals for the next following or fourth octave are derived

from generator sections 28 and 38 of the X and Z ranks respectively; and signals for the next following or fifth octave are derived from generator sections 20 and 40 of the W and Z ranks respectively. Thus, the third octave signals will be 7ϕ apart—that is $+5\phi - (-2\phi)$; the fourth octave signals will be 9ϕ apart—that is, $+11\phi - (+2\phi)$; and the fifth octave signals will be 11ϕ apart—that is, $+11\phi - 0$. Typical connections are indicated in FIG. 1 but are not numbered.

One skilled in the art will readily observe that the present invention thus provides a novel, yet simple and economical way of achieving desirable celeste effects in organs of the locked octave type.

The chart of FIG. 2 illustrates in graphical form the first described tuning combination in FIG. 1, and simplifies analysis thereof. The vertical lines represent C notes at the end of each octave; approximate pitches are indicated at the top of each. Light horizontal lines indicate steps of 2ϕ each from standard (that is, 0), with generator rank designation showing how far off standard each is tuned. Thus, the heavy lines indicate the tuning by octaves of each generator used. Vertical arrows represent the difference in tuning with actual values indicated in cents.

FIG. 3 shows the second pitch combination and indicates that if rank Y is two octaves long and tuned $+5\phi$ and if rank Z is three octaves long and tuned $+11\phi$, a celeste range of 5ϕ difference in the top octave and 13ϕ difference in the bottom octave can be achieved. It will be noted that three ensemble generator ranks are still required, but that different octave sections are paired off with the celeste rank sections used.

In the combinations of FIGS. 2 and 3, celeste ranks Y and Z are tuned so that all notes in each octave are tuned respectively by 5ϕ and 11ϕ from standard pitch. If, on the other hand the individual groups of tone generators of the same nomenclature in rank Y of FIG. 1 are "taper-tuned," say from $+4$ to $+6$ in each of its three octaves and from $+10\phi$ to $+12\phi$ (from upper end to lower end in each octave), a smooth transition from one celeste pitch difference (in cents) to another will be achieved. Note that the difference arrows in FIG. 4 show a range of 2ϕ to 4ϕ in the top octave, 4ϕ to 6ϕ in the second, 6ϕ to 8ϕ in the third, 8ϕ to 10ϕ in the fourth and 10ϕ to 12ϕ in the fifth octaves.

Obviously, the arrangement of FIG. 4 requires more specific attention to tuning than does that of FIGS. 2 and 3. A compromise, the effect of which is hardly detectable from the arrangement of FIG. 4, is illustrated in FIG. 5, wherein the notes of each octave are tuned off by equal cents in four groups of three notes each. Thus the notes are tapered in steps and there are no abrupt changes from one octave section to the next.

Although the embodiments thus far described have been based on systems having three ensemble generator ranks, the utility of this invention extends to organs having two or four and even more such generator ranks, if so desired. FIGS. 7 to 9 illustrate graphically three additional arrangements of tuning based individually on two ensemble generator ranks each. When taken all together, they provide the basis for a four-ensemble generator system. Referring first to FIG. 8, there are two ensemble generator ranks V and W, tuned respectively at 0 and $+1\frac{1}{2}\phi$ from standard pitch. Ranks Y and Z at the same time are respectively $+5\frac{1}{2}\phi$ and $+8\frac{1}{2}\phi$ from standard. This provides (for four octaves) a celeste range of 4ϕ difference at the treble end to $8\frac{1}{2}\phi$ for the fourth octave. If a fifth octave were desired for a two-ensemble generator instrument, it could be a compromise at a difference of 7ϕ , as shown in FIG. 7, because the lesser difference would probably be preferably to sacrificing ensemble, for example, between notes concurrently played from the fourth and fifth octaves (for the normal voice without celeste). However, if the fifth octave were desired to be 10ϕ , the normal amount in a progression such as that of FIG. 8, the rank Z could be beat with a

rank U at $-1\frac{1}{2}\phi$ from standard. The octave sections of generators Y and Z may be taper-tuned, if so desired, in any suitable manner, as indicated, for example, by the dashed lines in FIG. 8.

FIG. 7 illustrates a chart for a celeste using two ensemble ranks, in a manner somewhat similar to FIG. 8, for a celeste range of from $2\frac{1}{2}\phi$ difference to 7ϕ in four octaves. A compromise celeste for the fifth octave in a two manual instrument would be a $5\frac{1}{2}\phi$ difference as shown. Similarly, FIG. 9 illustrates a combination for another two-ensemble rank celeste for a range of from a $5\frac{1}{2}\phi$ difference to an $8\frac{1}{2}\phi$ difference in four octaves. The compromise for a fifth octave would be at $8\frac{1}{2}\phi$ difference.

From FIGS. 7 to 9, it can be realized that in a more elaborate organ, having four ranks of ensemble generators, three different celeste combinations are available for at least four octaves.

In FIG. 10 is illustrated a tuning chart indicating a minimum structure necessary for an embodiment incorporating the present invention. The ensemble generator ranks W and X are each one octave in compass and need not be locked-octave type. The celeste generator rank Y is of two-octave compass and it, too, need not be of a locked-octave type. The essential teachings here are that (1) the two ensemble ranks W and X be respectively tuned apart an amount suitable for ensemble (as between like nomenclature notes in the respective octaves) and (2) the celeste rank Y be tuned farther away from the ensemble rank X, so that the tuning difference (in cents) between the ranks W and Y is greater than the tuning difference between the ranks X and Y. Obviously, the celeste rank Y may be taper-tuned, if so desired.

In accordance with a principal teaching of the invention, the ensemble and celeste generator ranks need not be of locked-octave type. However, if a given celeste rank covers more than one octave, it is obvious that the taper-tuning of a celeste rank will be greatly simplified if the rank is of a locked-octave type.

On the other hand, if all the generator ranks are of a locked-octave type, the teachings of the invention become necessary, if a good celeste arrangement is desired.

Although the embodiments shown herein indicate celeste ranks tuned sharp, it is within the scope of this invention to employ flat-tuned celeste ranks, in which case the charts required would be mirror images of FIGS. 2 to 10 inclusive.

Further modifications may be made in the invention without departing from the spirit of it.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an electronic organ the combination comprising:
 - (a) at least two multi-octave tone signal generator ranks detuned as respects each other to an extent which provides an ensemble effect when tones of the same nominal pitch frequencies are simultaneously derived from more than one such generator rank,
 - (b) an additional multi-octave tone signal generator rank detuned with respect to each of the first mentioned generator ranks by an amount sufficient to produce a celeste effect when tones of the same nominal pitch frequencies are simultaneously derived from said additional generator rank and any of said first mentioned generator ranks,
 - (c) circuit means for selecting tone signals from said first mentioned generator ranks individually for tone coloration and for conversion to sound,
 - (d) circuit means for concurrently selecting tone signals of the same nominal frequency from more than one of said first mentioned generator ranks for tone coloration and for conversion to sound, and
 - (e) additional circuit means for concurrently selecting tone signals of the same nominal frequency from said additional generator rank and said first men-

tioned generator ranks for tone coloration and for conversion to sound,

- (f) said additional circuit means being connected for the concurrent derivation of a tone signal from said additional generator rank and a tone signal of the same nominal frequency from one of the first mentioned generator ranks the two tone signals so derived being closest in actual pitch to each other, for tone coloration and conversion to sound.

2. The structure claimed in claim 1 wherein:

- (g) said additional multi-octave signal generator rank has groups of generators of adjacent nominal pitch frequencies, each group being characterized by taper tuning.

3. The structure claimed in claim 1 including:

- (h) a second additional multi-octave tone signal generator rank detuned with respect to each of the first mentioned generator ranks by an amount sufficient to produce a celeste effect when tones of the same nominal pitch frequencies are simultaneously derived from said second additional generator rank and any of said first mentioned generator ranks,

- (i) said addition circuit means being connected for the concurrent derivation of a tone signal from one of said additional generator ranks and a tone signal of the same nominal frequency from one of the first mentioned generator ranks which tone signals are closest in actual pitch.

4. The structure claimed in claim 3 wherein said first mentioned generator ranks cover substantially the range of the organ and wherein said additional generator ranks are of lesser extent but non-coterminous, said additional generator ranks, taken together, covering the range of the organ.

5. The structure claimed in claim 4 including three of said first mentioned generator ranks detuned from each other sufficiently to provide ensemble effects.

6. The structure claimed in claim 4 including three of said first mentioned generator ranks detuned from each other sufficiently to provide ensemble effects, said first mentioned generator ranks being locked octave generator ranks, one of said generator ranks being tuned to standard pitch, and the other two of said generators ranks being tuned respectively substantially $+2\phi$ and substantially -2ϕ from standard pitch.

7. In an electronic organ, the combination comprising:

- (a) a first locked-octave, tone-signal generator rank having master oscillators tuned to standard pitch frequencies of a musical scale,
- (b) a second, locked-octave, tone-signal generator rank having master oscillators tuned slightly off said nominal pitch frequencies, by an amount capable of producing an ensemble effect when tones of the same nominal frequency are simultaneously derived in an output system from both of said generator ranks,
- (c) a third locked-octave, tone-signal generator rank having master oscillators tuned on the average farther off said standard pitch frequencies, by an amount capable of producing a celeste effect when tones of the same nominal frequency are simultaneously derived in an output system from said third generator rank and either of said first and second generator ranks,

- (d) circuit means for concurrently selecting tone signals from said first and third ranks for tone coloration and for conversion to sound in a first frequency range, and

- (e) additional circuit means for concurrently selecting tone signals from said second and third ranks for tone coloration and for conversion to sound in a second frequency range adjacent to said first frequency range.

8. In an electronic organ, the combination comprising:

- (a) three locked-octave, tone-signal ensemble generators A, B and C respectively tuned about -2ϕ , about

0 and about +2¢ from standard pitch, and each covering a five-octave range from about 65.5 c.p.s. to about 1976 c.p.s.,

- (b) two locked-octave, tone-signal celeste generators D and E respectively tuned on the average about +5¢ and about -11¢, covering adjacent ranges of three and two octaves respectively within the said five-octave range, the said three octaves being the the upper three of five-octave range,

(c) an output system, and

- (d) circuit means for selecting signals in the top octave from generators C and D, in the second octave from generators B and D, in the third octave from generators A and D, in the fourth octave from generators C and E and in the fifth octave from generators B and E, all for tone coloration and translation to sound in said output system.

9. The combination according to claim 8, wherein said celeste generator D is taper tuned from about 4¢ to about 6¢ sharp from the highest to lowest note, and celeste generator E is taper tuned from about 10¢ to about 12¢ sharp.

10. In an electronic organ, the combination comprising:

- (a) three locked-octave, tone-signal ensemble generators A, B and C respectively tuned about -2¢, about 0 and about +2¢, each covering a five-octave range from about 65.5 c.p.s. to about 1976 c.p.s.,

- (b) two locked-octave, tone-signal celeste generators D and E respectively tuned on the average about +5¢ and about 11¢, covering adjacent ranges of two and three octaves respectively within said five-octave range, the said two octaves being the upper two of the five octaves of the range of said ensemble generators,

(c) an output system, and

- (d) circuit means for selecting signals in the top octave from generators B and D, in the second octave from generators A and D, in the third octave from generators C and E, in the fourth octave from generators B and E and in the fifth octave from generators A and E, all for tone coloration and translation to sound in said output system.

11. The combination according to claim 10, wherein said celeste generator D is taper tuned from about 4¢ to about 6¢ sharp and celeste generator E is taper tuned from about 10¢ to about 12¢ sharp.

12. In an electronic organ, the combination comprising:

- (a) two locked-octave, tone-signal ensemble generators A and B respectively tuned about 0 and about +3, each covering a four-octave range,

- (b) two locked-octave, tone-signal celeste generators C and D respectively tuned about +6 and about +12 on the average, covering adjacent ranges of two octaves each within said four-octave range, the generator C being at the upper two octaves,

(c) an output system, and

- (d) circuit means for selecting signals in the top octave from generators B and C, in the second octave from generators A and C, in the third octave from genera-

tors B and D and in the fourth octave from generators A and D, all for tone coloration and translation to sound in said output system.

13. The combination according to claim 12 wherein said celeste generators C and D are taper tuned.

14. In an electronic organ, the combination comprising:

- (a) at least two locked-octave ensemble generator ranks respectively tuned to a pitch difference of the order of 2¢,

- (b) a first locked-octave celeste generator rank tuned on the average farther from one of said at least two ensemble generator ranks than said at least two ensemble generator ranks are tuned from each other,

- (c) a second locked-octave celeste generator rank tuned still farther on the average from said one of said at least two ensemble generator ranks, said first and second celeste generator ranks being of shorter pitch range than said ensemble generator ranks, but together covering substantially the same pitch range as said ensemble generator ranks, and

- (d) circuit means coupled to said ensemble generator ranks and to said celeste generator ranks for deriving simultaneously therefrom tone signals of progressively greater pitch different in cents from the higher-pitched ends of said generator ranks to the lower-pitched ends of said generator ranks.

15. In an electronic organ, the combination comprising:

- (a) a first tone-signal generator rank having oscillators tuned to nominal pitch frequencies of a musical scale,

- (b) a second tone-signal generator rank having oscillators tuned slightly off said nominal pitch frequencies in the same direction,

- (c) a third tone-signal generator rank having oscillators tuned on the average farther off said nominal pitch frequencies than said second tone-signal generator,

- (d) circuit means for concurrently selecting tone signals from said first and third ranks for tone coloration and for conversion to sound in a first frequency range, and

- (e) additional circuit means for concurrently selecting tone signals from said second and third ranks for tone coloration and for conversion to sound in a second frequency range.

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DONALD D. FORRER, *Primary Examiner.*

U.S. Cl. X.R.

84—1.01, 1.04