

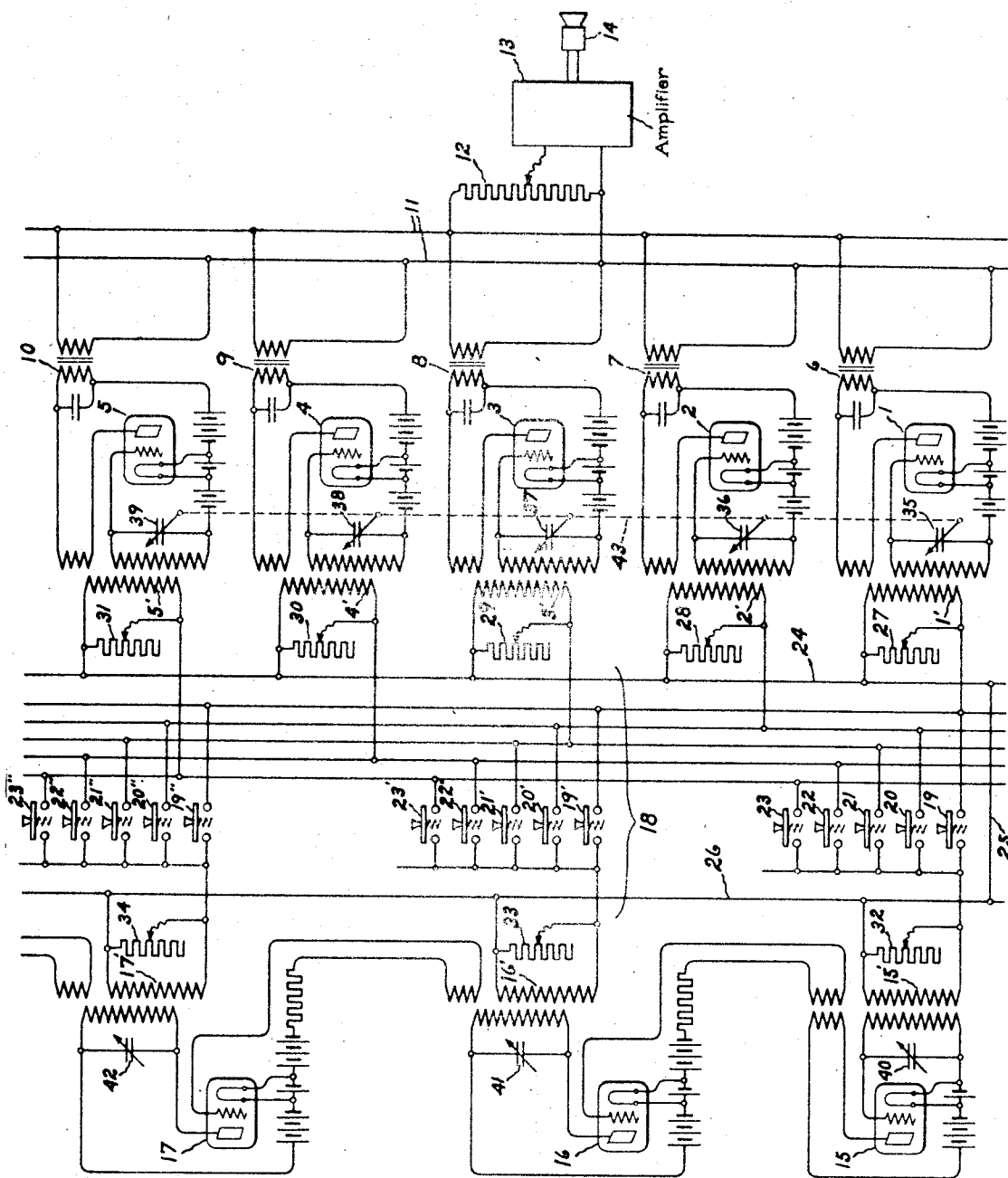
Sept. 15, 1931.

C. J. YOUNG

1,823,716

SYSTEM FOR PRODUCING MUSIC

Filed May 22, 1930



Inventor:
Charles J. Young,
by *Charles V. Tulla*
His Attorney.

UNITED STATES PATENT OFFICE

CHARLES J. YOUNG, OF ARDMORE, PENNSYLVANIA, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

SYSTEM FOR PRODUCING MUSIC

Application filed May 22, 1930. Serial No. 454,810.

My invention relates to systems for electrically producing music, and it has for one of its objects to provide a system of the type indicated which is capable of producing
5 either pure musical tones, or complex tones, and tones having desired quality as determined by the presence of multiple tones and overtones, in proportions determined by the skill and manipulation of the operator.

10 A further object of the invention is to provide, in a system for producing music, means whereby a plurality of different tones may be simultaneously produced. In accordance with the invention the different tones simul-
15 taneously produced may be tones of the same octave, or of different octaves, as, for example, overtones, and may vary over a wide range both in pitch and intensity.

A further object of the invention is to provide a system which is economical in construction and in which the number of oscillation sources, which in the system to be described comprise electron discharge devices, is materially reduced over systems of the
25 prior art.

Still another object of the invention is to provide a system which may be readily adjusted, or tuned, to produce the desired tones. Thus in accordance with my invention means
30 are provided whereby corresponding notes of all of the different octaves may be simultaneously adjusted by a single operation; i. e. upon adjustment of the different notes of a single octave the notes of each of the
35 other octaves are automatically adjusted. In this way the tuning process is materially simplified and ease in adjustment of the system to produce the various musical scales demanded by the operator, is secured.

40 Another object of the invention is to provide a system in which the different tones are produced as a result of beating together a plurality of oscillations having different high frequencies whereby the system may be controlled with the facility and flexibility with
45 which the circuits of the high frequency sources may be controlled.

The novel features which I believe to be characteristic of my invention are set forth
50 with particularity in the appended claims.

My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing, in which the single figure represents an embodiment of my invention.

In accordance with my invention the various notes of a single octave of the musical scale are produced by selectively combining or beating together, oscillations produced by a fixed high frequency source, which I shall hereinafter term an octave source, and other oscillations having a plurality of
65 different frequencies in accordance with the different tones or notes which are to be produced. These other oscillations may be produced in any known way for producing oscillations having different frequencies. As
70 shown in the drawing these oscillations are produced by a plurality of fixed sources, which I shall hereinafter term the note source, circuit arrangements being provided whereby oscillations having the fundamental
75 frequency of the first-mentioned fixed high frequency source may be selectively combined with any of the latter. In this way all of the desired notes of a given octave may be produced.

In order to produce the various notes of higher octaves circuit arrangements are provided in accordance with my invention whereby desired harmonics of the first-mentioned octave source may be selectively combined
85 with the corresponding harmonic of a desired note source. Thus by combining the fundamentals, second harmonics, or corresponding higher harmonics of the first-mentioned octave source and any one of the note
90 sources the corresponding note of any of the different octaves may be produced.

Referring to the drawing I have shown at 1, 2, 3, 4, 5, a bank of oscillating detectors, each of which has an output transformer
6, 7, 8, 9, 10, the secondary windings of which are connected in multiple to a load circuit 11 across which is connected a volume control resistance 12. An amplifier 13 is connected across this resistance, and is arranged to sup-
95

ply amplified oscillations to a sound-producing device or loud speaker 14. The oscillating detectors 1—5 etc. are arranged to produce oscillations of high frequency, preferably, of frequencies in the radio or inaudible range, and the frequencies produced by the different oscillators differ in accordance with the difference in pitch of the various notes to be produced.

While I have shown in the drawing only five of these sources, it will of course be understood that the number of sources employed in this group will correspond with the number of notes which are to be produced in the various octaves as, for example, twelve.

At 15, 16, 17, I have shown a second group of high frequency oscillation generators which I choose to term the octave sources of the system. The oscillations produced by the source 15 is of inaudible frequency and differs from the frequency produced by the source 1 by an amount corresponding to the lowest tone which is to be produced. The sources 16, 17 etc. are harmonic amplifiers, or frequency doublers, the source 16 being supplied with oscillations from source 15, and source 17 being supplied with oscillations from source 16, and so on, in succession, through the octave groups. That is, as shown in the drawing, oscillations from the source 15 are supplied to the grid circuit of the source 16 and the anode circuit of this source is tuned to double the frequency of the source 15. Thus in the anode circuit of the source 16 will appear the second harmonic of the source 15. Similarly in the output circuit of the source 17 will appear oscillations which are double the frequency of the source 16. Thus, in the output circuit of the source 17 will appear oscillations corresponding to the second harmonic of the source 16, or the fourth harmonic of the source 15.

By means of the bracket 18 I have designated in the drawing a system of cross-connections employing keys 19—23, etc.; 19'—23', etc.; 19''—23'' etc. whereby the output circuit from any of the octave sources 15, 16, 17, may be selectively connected to the input circuit of any of the note sources 1 to 5. In this way it is possible to produce each of the different notes of the various octaves.

It will be seen from an inspection of the system of cross-connections that one side of all of the input circuits of the note sources are connected together and to one side of the output circuits of all of the octave sources through conductors 24, 25, 26. One group of keys 19 to 23 etc. is associated with the output circuit of each of the octave sources and the number of keys in each of these groups corresponds to the number of note sources or to the number of notes to be produced in the various octaves. These keys may accordingly, if desired, be arranged in the manner of the notes of a piano.

These keys are so connected that upon operation of any key in any group the note source to which the operated key is connected, is connected to the octave source with which the group of keys is associated. That is, upon operation of any key the side of the output circuit opposite to the conductor 26 of the octave source with which the group containing the operated key is associated may be selectively connected to the side opposite to conductor 24 of the input circuit of the note source corresponding to the operated key.

Thus, for example, to produce the lowest note of the first octave, key 19 will be operated. The output 15' of the source 15 will then be connected directly to the input 1' of the source 1 through key 19 and conductors 24, 25 and 26. As was previously stated these two sources differ in frequencies by an amount corresponding to the lowest note which is to be produced. The grid of the discharge device 1 is biased negatively sufficiently to cause this device to operate also as a detector, as is already understood, and, accordingly, in the output circuit of the source 1 will appear oscillations having the beat frequency between the oscillations produced by the source 15 and those produced by the source 1. These oscillations of beat frequency will be supplied to the circuit 11, amplified by the amplifier 13 and thence supplied to the loud speaker 14. To produce the next higher tone, key 20 will be operated, thereby connecting the output circuit 15' in circuit with the input circuit 2'. Since the fundamental frequency of the note source 2 differs from that of the octave source 15 by an amount corresponding to that of the next higher note, this note will be produced by the loud speaker 14. Similarly by operating each of the various keys 19—23 etc. of the group associated with octave source 15, each of the various notes of the first octave will be produced.

In order that each of the notes of the first and succeeding octaves shall have the same, or desired, intensity, adjustment means comprising resistances 27—31, etc. are provided, each of these resistances being connected in shunt with the input to one of the note sources. In a corresponding manner, means comprising resistances 32, 33, 34, etc., one for each octave, are provided whereby the overall intensity of the different octaves may be properly adjusted, with relation to each other. Thus by means of these resistances the intensity of the individual components of a multiple note may be independently controlled whether these components comprise different tones of the same octave or tones of different octaves as, for example, over-tones.

It will be apparent from the drawing that if desired two or more of the keys 19 to 23, 19' to 23', 19'' to 23'', etc. may be simultaneously pressed, thereby producing a combi-

nation of notes, or a multiple or complex note, that is, a musical chord from the loud speaker 14.

The note sources 1 to 5 etc. are each designed, as by construction of the windings and proper adjustment of the voltages, to produce oscillations which are rich in harmonics. These harmonics are utilized in accordance with the invention to produce the corresponding notes of the higher octaves. Thus, for example, if it is desired to produce the note of a next higher octave corresponding to the note produced by operation of the key 19, key 19' will be operated. This key connects the output circuit 16' of the source 16 directly in circuit with the input circuit 1' of the note source 1. Thus the frequency of oscillations produced by the source 16 will beat with the second harmonic of the oscillations produced by the note source 1 and, accordingly the lowest note of the second octave will be produced by the loud speaker 14. Similarly the lowest note of the third octave may be produced by operation of key 19'' thereby causing the oscillations produced by source 17 to beat with the fourth harmonic of the oscillations produced by source 1. Of course any other note of each of the different octaves may be produced by operating the proper key of the corresponding octave group.

To produce a desired tone plus desired harmonics, or overtones thereof, corresponding keys of a plurality of octave groups may be operated. Thus, for example, if keys 19 and 19' are simultaneously operated the lowest note of the first octave and its first overtone will be produced from the loud speaker.

The tuning condensers 35—39, etc. of the individual note sources, and tuning condenser 40—42 etc. of the octave sources are shown as variable. The individual condensers of the note sources may be adjusted or, if desired, by means of a suitable vernier, to tune the instrument to produce the desired notes, each of these condensers of course simultaneously adjusting a corresponding note in each octave. The overall pitch of the system may be adjusted within certain limits by condenser 40 of the source 15. Preferably, however, this adjustment may be effected by means of a suitable unicontrol upon condensers 35—39 etc. and a construction of these condensers such that the frequencies of each of these sources are effected in proportional amounts. Such a unicontrol is indicated in the drawing by dotted line 43.

While, for the purpose of simplicity of the drawing the various oscillation sources have been shown as of a simple conventional design, it will of course be understood that these sources may be of any suitable construction for the purposes contemplated. Similarly low-pass filters in the output circuits of the various sources, particularly, of the octave sources for suppressing frequencies

which are higher than those desired, and amplifiers in the circuit where desired may be employed. Such amplifiers and filters are not shown in the drawing since their use in the circuit if found necessary in any equipment will be well understood by persons skilled in the art.

Further, while I have suggested an arrangement of the keys, 19—23; 19'—23'; 19''—23'', etc. in the nature of the keys of a piano, it will be understood that I do not wish to be limited thereto since many different arrangements of these keys and also of the controls for resistances 27—31, etc. and 32—34, etc. will suggest themselves in accordance with the particular requirements of different systems. Thus a system, in accordance with my invention, for producing a large number of notes of relatively pure composition will, desirably, employ a different arrangement of controls from one adapted to produce a fewer number of notes but in which each note is relatively rich in controllable harmonics. The overall volume of sound produced by the system may, of course, be controlled by potentiometer 12.

While in the drawing I have shown a particular embodiment of the invention, it will of course be understood that I do not wish to be limited thereto, since many modifications may be made, both in the circuit arrangement and in the instrumentalities employed. I contemplate, therefore, by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of United States, is:

1. In combination, means for producing oscillations of high fundamental frequency and oscillations having frequencies corresponding to certain of the harmonics thereof, means for producing oscillations of a frequency differing from said fundamental by an amount corresponding to a musical tone and for producing oscillations having frequency corresponding to certain of the harmonics thereof, and means for selectively producing a beat frequency between the oscillations of said fundamental frequencies and between corresponding harmonics thereof.

2. In combination, means for producing oscillations of high fundamental frequency and oscillations having frequencies corresponding to certain of the harmonics thereof, means for producing oscillations of frequency differing from said fundamental by an amount corresponding to a musical tone and producing oscillations having frequency corresponding to certain of the harmonics thereof, and means for selectively producing a beat frequency between the oscillations of said fundamental frequencies and between corresponding harmonics thereof, and means

for independently controlling the intensity of each of said beat frequencies.

3. The combination, in a system for producing music, of means for producing oscillations having a plurality of different fundamental frequencies, said frequencies differing in accordance with the tones to be produced and for producing harmonics of each of said fundamental frequencies, means for producing oscillations having a different fundamental frequency, said frequency differing from the lowest frequency produced by said first means by an amount corresponding to the lowest tone to be produced and for producing harmonics of oscillations of said different fundamental frequency, and means whereby oscillations of said different fundamental frequency may be caused to beat with oscillations of any of said first-mentioned fundamental frequencies and whereby certain of the harmonics of said different fundamental frequency may be caused to beat with a corresponding harmonic of any of said first-mentioned fundamental frequencies.

4. The combination, in a system for producing music, of means for producing oscillations having a plurality of different fundamental frequencies, said frequencies differing in accordance with the tones to be produced and for producing harmonics of each of said fundamental frequencies, means for producing oscillations having a different fundamental frequency, said frequency differing from the lowest frequency produced by said first means by an amount corresponding to the lowest tone to be produced and for producing harmonics of oscillations of said different fundamental frequency, and means whereby oscillations of said different fundamental frequency may be caused to beat with oscillations of any of said first-mentioned fundamental frequencies and whereby certain of the harmonics of said different fundamental frequency may be caused to beat with a corresponding harmonic of any of said first-mentioned fundamental frequencies, and means for independently controlling the intensity of each of the beat frequencies produced.

5. The combination, in a system for producing music, of a plurality of note sources of oscillations, a plurality of octave sources of oscillations, said note sources being adapted to produce oscillations having fundamental frequencies differing in accordance with the notes of an octave, and to produce harmonics thereof, and said octave sources being adapted to produce oscillations differing by amounts in accordance with the different octaves to be produced, and means for producing beat frequencies between each of said octave sources and any of said note sources whereby any note of a desired octave may be produced.

6. The combination, in a system for producing music, of a plurality of note sources of oscillations, a plurality of octave sources of oscillations, said note sources being adapted to produce oscillations having fundamental frequencies differing in accordance with the notes of an octave and harmonics of said frequencies, and said octave sources being adapted to produce oscillations differing by amounts in accordance with the different octaves to be produced, and the lowest frequency produced by said octave sources differing from the lowest frequency produced by said note sources by an amount corresponding to the lowest note to be produced and cross-connections whereby any octave source may be associated with any note source to produce a beat frequency corresponding to any note of each of the octaves.

7. In combination, a plurality of detectors, each of said detectors having an input circuit, means for producing oscillations having a fixed high fundamental frequency and certain of the harmonics thereof in each of said detectors, the fundamental frequency of the oscillations produced in the different detectors differing in accordance with the notes to be produced, means for applying to the input of each detector oscillations differing in frequency from the first-mentioned oscillations of fundamental frequency produced in the respective detector by an amount corresponding to a tone to be produced and also certain harmonics thereof, means for selectively controlling said last means separately to supply the fundamental and any harmonic thereof to each detector, an output circuit for each detector and sound producing means associated with said output circuits.

8. The combination, in a system for producing music, of a plurality of note sources of oscillations, a plurality of octave sources of oscillations, said note sources being adapted to produce oscillations having fundamental frequencies differing in accordance with the notes of an octave and to produce harmonics thereof, and said octave sources being adapted to produce oscillations differing by amounts in accordance with the different octaves to be produced, each of said octave sources having an output circuit and each of said note sources having an input circuit, means whereby each input circuit may be selectively connected to any of said output circuits whereby oscillations from any octave source may be supplied to any note source, and a volume control device associated with each of said output circuits.

In witness whereof, I have hereunto set my hand this fourteenth day of May, 1930.

CHARLES J. YOUNG.