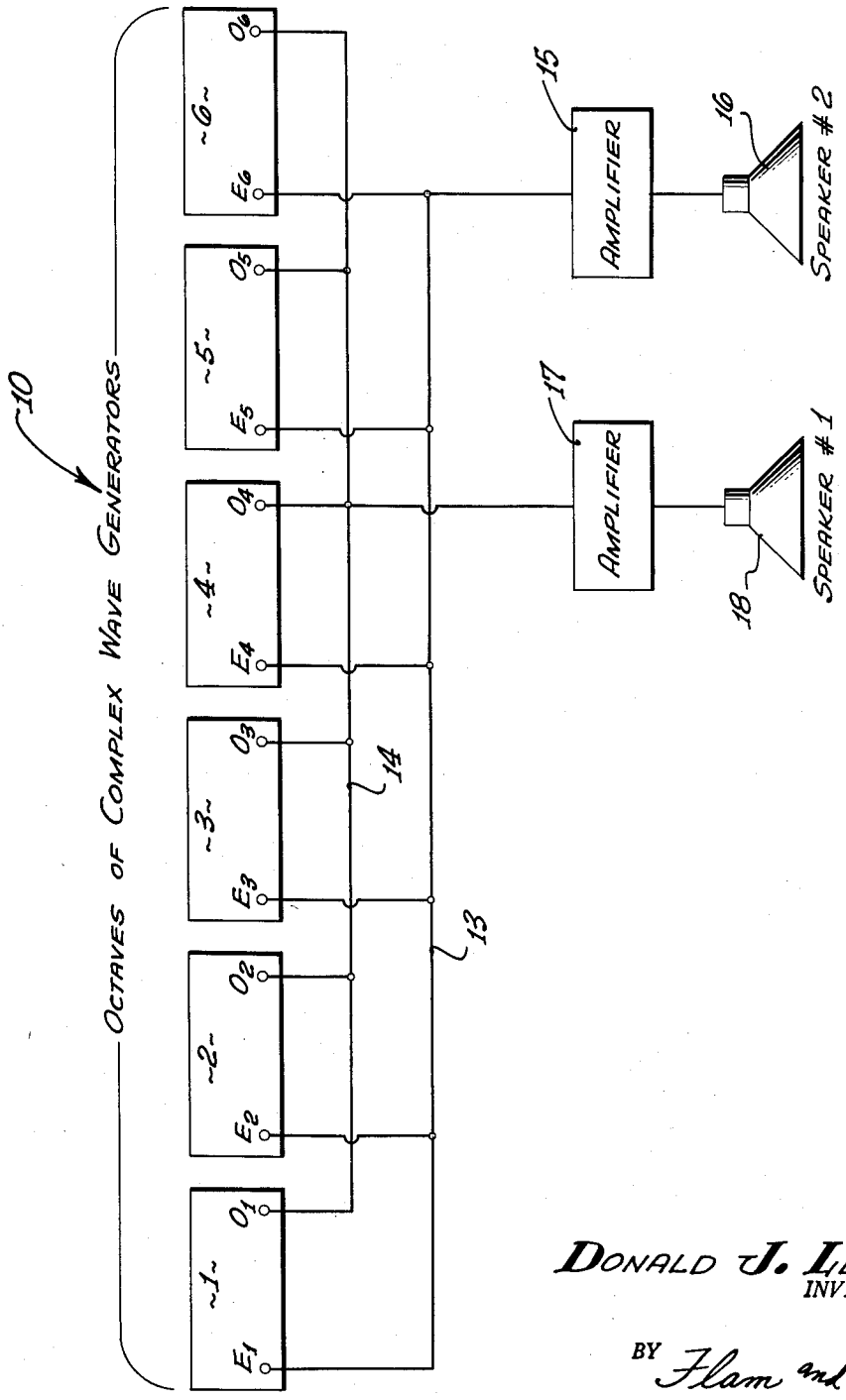
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ELECTRICAL CIRCUIT ARRANGEMENT FOR COMPLEX WAVE GENERATORS

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ELECTRICAL CIRCUIT ARRANGEMENT FOR COMPLEX WAVE GENERATORS

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This invention relates to musical instruments, particularly electronic instruments which generate impulses corresponding to musical tones.

The significant problem in connection with electronic instruments is that upon electrical mixture, certain "beat effects" are produced due either to mistuning of generators or the inherent characteristics of the tempered scale.

Thus, for example, if the impulse for A_4(440 cycles per second) contains a second harmonic at 880.00 c.p.s., this second harmonic may "beat" with the fundamental of the impulse for A_5. Thus, the generator for A_5 may be slightly mistuned so that the fundamental impulse is at a frequency of, say, 881.00 c.p.s. Periodically, the two components will, in the electrical circuit, reinforce and buck each other, and a "beat effect" will be perceived. Periodic reinforcement and bucking occurs at the rate corresponding to the mistuning of the respective components, in this instance at about one cycle per second.

Impulses for notes in fourth or fifth musical interval relationship with respect to each other also create the possibility of "beat effects" even though the impulses are perfectly tuned. Thus, for example, the impulse for A_4 may contain a substantial third harmonic at 1320.00 c.p.s. If an impulse rich in second harmonic for the note E_5 (five musical intervals above A_4) is simultaneously sounded, a component of twice 659.26 c.p.s. or 1318.52 c.p.s. will be created. Thus, the third harmonic of A_4 creates the possibility of a "beat effect" with the second harmonic of E_5 and even though these notes are precisely tuned in accordance with the tempered scale.

Similarly, if an impulse rich in fourth harmonic exists simultaneously with an impulse for a note in fourth interval relationship therewith, a possibility of "beating" is also created. For example, the fourth harmonic of A_4, 1760.00 c.p.s., may "beat" with the third harmonic of B_5, 1761.99 c.p.s.

While there are other conditions of harmonics or fundamentals creating the possibility of "beat effects," I have noted that the most objectionable "beats" result from the simultaneous existence of odd harmonics with even harmonics, the fundamental being considered the first harmonic for purposes of this discussion. An object of this invention is to provide a novel system whereby "beat effects" due both to mistuning as well as to inherent characteristics of the tempered scale are at the same time minimized, and by providing only two channels.

To implement the invention, electrical isolation of incompatible frequencies is achieved by grouping generator output into two sections. One section contains the fundamental and all odd harmonics; the second section contains only the even harmonics. Both sections have their separate amplifiers and speakers, and electrical intermixture is avoided. When the sounds emanate from the respective speakers of the sections that are necessarily spaced from each other, the "beat effect" is minimized, the acoustic mixing being random rather than regular, Hence, the regular periodic reinforcement and bucking does not occur to the extent that it would if the impulses were mixed electrically.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the

invention. For this purpose, there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

The single figure diagrammatically illustrates the system incorporating the present invention.

In FIG. 1, a set of generators **10** is illustrated which, for purposes of discussion only, is made up of a plurality of octave sets **1**, **2**, **3**, **4**, **5** and **6** designated by corresponding blocks.

Available in association with the the generators are two types of outputs, one, as at E_1, for the octave group **1** at which only even harmonics are present. Another terminal O_1 provides only the fundamental in odd harmonics. These different outputs may be made available in a number of various ways, for example, by transformer arrangements, non-linear circuit elements, bucking circuits, and the like; or they may be made available by different pickups from tone wheels or the like. Terminals E_2, E_3, E_4, E_5 and E_6 for even harmonics and O_2, O_3, O_4, O_5 and O_6 for the fundamental and odd harmonics are provided for the octave generator groups **1**, **2**, **3**, **4**, **5** and **6**. Corresponding outputs are connected together; for example, a lead **13** connects with like E terminals, and a lead **14** connects with corresponding O terminals.

An amplifier **15** and a transducer or speaker **16** cooperate with the bus connection or output lead **13**, and a separate amplifier **17** and speaker **18** cooperate with the other outputs via the lead **14**. Suitable key switches (not shown) may be interposed either in the excitation or input circuit to the various generators or in the output circuit, and as diagrammatically indicated for example in FIGS. 1 and 2 respectively of my prior Patent No. 2,596,-258, issued May 13, 1952. Since this invention requires the use of two output connections **13** and **14**, key switches are most advantageously placed in the input circuits.

Electrical intermixture of even and odd harmonics (considering the fundamental as the first harmonic) is thus precluded by the present segregation system, and "beating" accordingly is substantially minimized. For example, the second harmonic of A_4 will exist at the tap E_4 by virtue of the fact that it is an even harmonic. This will be translated into sound by virtue of the channel including the amplifier **15** and speaker **16**. There will be no possibility of "beating" occurring with respect to the fundamental of A_5 for the reason that the fundamental of A_5 exists at the tap O_5 and is translated by the other channel including the amplifier **17** and the speaker **18**. Similarly, odd and even harmonics in notes of fourth or fifth musical interval relationship exist in the respective channels and "beating" due to this cause is likewise minimized.

The inventor claims:

1. In an electronic organ system or the like: a set of generators for producing impulses corresponding to musical notes in a range of several octaves; means providing a pair of separate electrical channels in one of which substantially only fundamental impulses and all odd harmonics from all of the generators exist, and in the other of which substantially only even harmonics from all of the generators exits; and separate transducers for the respective channels.

2. In an electronic organ system or the like: a set of generators for producing impulses corresponding to musical notes in a range of several octaves; each generator having a first output at which only the fundamental and odd harmonics exist and a second output at which only the even harmonics exist; a pair of separate electrical chan-

nels each including transducer means; first coupling means between corresponding first outputs of the generators and one of said channels; and second coupling means between corresponding second outputs of the generators and the other of said channels.

3. In an electronic organ system or the like: a pair of transducers; a pair of bus connections substantially exclusively connected to the respective transducers; a set of generators for producing impulses corresponding to musical notes in a range of several octaves; each generator having a first output at which only the fundamental and odd harmonics exist and a second output at which only the even harmonics exist; means connecting the said first outputs substantially exclusively to one of said bus connections; and means connecting the said second outputs substantially exclusively to the other bus connection.

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