

March 12, 1963

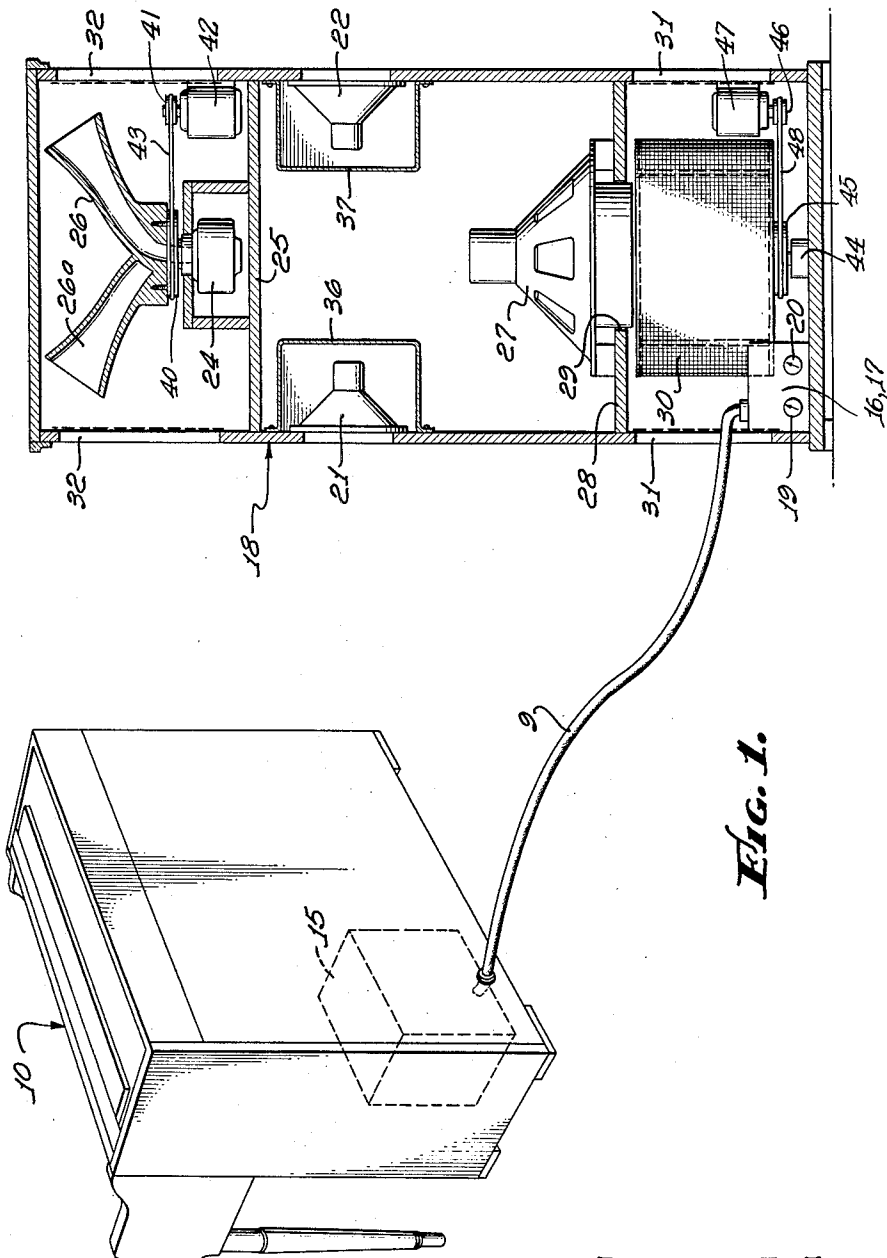
D. J. LESLIE

3,080,786

SPEAKER SYSTEM FOR ADDING TREMOLO

Filed July 17, 1959

3 Sheets-Sheet 1



**FIG. 1.**

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3 Sheets-Sheet 2

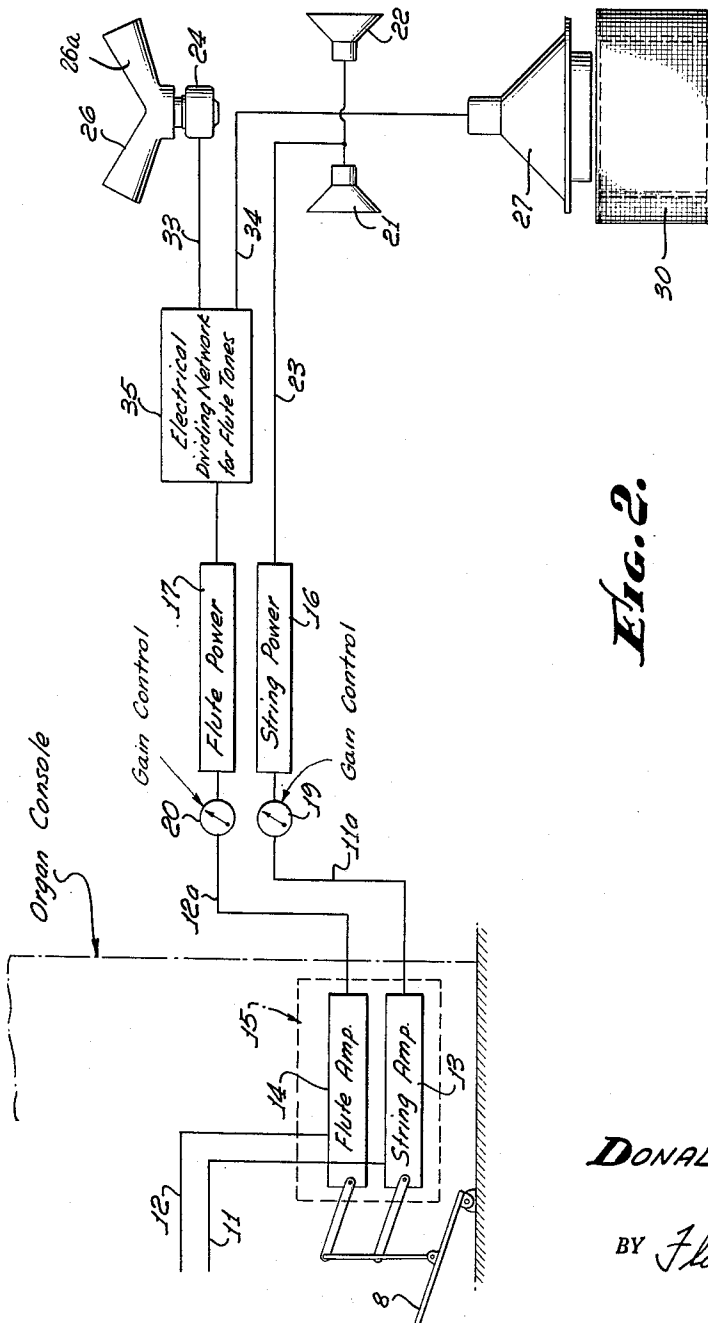


Fig. 2.

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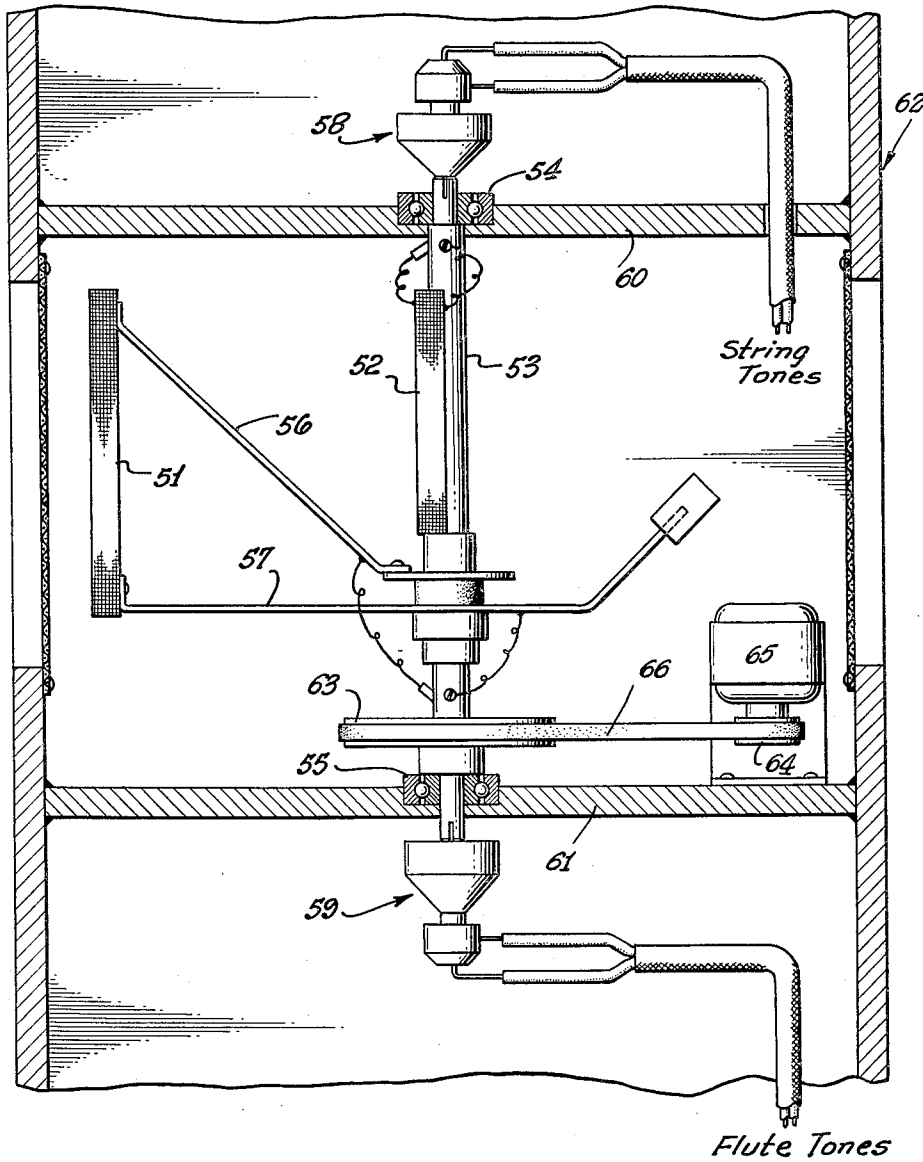
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SPEAKER SYSTEM FOR ADDING TREMOLO

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3 Sheets-Sheet 3

*FIG. 3.*



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1

3,080,786

**SPEAKER SYSTEM FOR ADDING TREMOLO**

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3 Claims. (Cl. 84-1.25)

This invention relates to pulsato apparatus for electrical musical instruments, and particularly for electrical organs.

In some organ systems, the tone generators for octaves are not electrically interlocked for perfect relative tuning. Commonly the impulses produced by the generators exist in the same electrical channel, and if a slight relative mistuning of generators in octave relationship exists, simultaneously operating such generators causes certain annoying "beat effects." This is caused by the impulses produced by the generators passing into and out of phase relationship with each other, which corresponds to reinforcement and cancellation of the impulses at a rate dependent upon the extent of mistuning.

These "beat effects" are also produced as a result of the tempered scale between perfectly tuned generators separated either by four or five musical intervals. Thus, the third harmonic of  $A_{440}$  (1320 c.p.s.) may produce this "beat effect" with the second harmonic of  $E_{659.26}$  (1318.52 c.p.s.).

For the most part, these "beat effects" are tolerated as mere unmusical sounds. If mild pulsato such as of the vibrato type is added electrically, for example, the unmusical sounds become slightly annoying, especially to the musically trained ear. If, however, full rich pulsato is added acoustically, as for example by rotary sound channels, the slightly annoying sounds become clearly annoying, and even to the untrained ear. The result simply meant that, in the past, full rich pulsato acoustic means has not been provided. Yet the demand for such pulsato means has not lessened.

As a solution to the "beat effect" problem, I previously proposed a system wherein electrical mixture of impulses was made impossible by grouping the generators for various notes into separate electrical-acoustic channels. Such a system is disclosed in my United States Letters Patent No. 2,596,258. In carrying out that invention, separate filters and ganged organ stop switches are required, and busses from the various generators must be provided within the organ proper.

Accordingly, an important object of this invention is to provide an improved system for minimizing "beat effects" that requires only a slight change in the construction of the organ. No changes in the construction of the organ stops, or multiplications in the numbers of filters are required. By following the present invention, full, rich acoustic pulsato can be provided without producing any significant emphasis of the "beat effects."

In carrying out my invention, separate electrical-acoustic channels are provided, not for generators for different notes, but for the flute and string type stops of the electronic organ. Separation is provided at the normal electrical juncture of flute and string type outputs. Such juncture is usually quite accessible and electrically adjacent the speaker system. Full, rich acoustic pulsato is then added only to the tones relatively free in harmonics. For other impulses, only slight pulsato is added, for example electrically in the organ, or acoustically by a rotor having a very small orbital movement. Surprisingly, the overall pulsato effect quite nearly approached what might be expected by adding full, rich acoustic pulsato to all tones. Accordingly, an effective system is provided in which pulsato does not emphasize the "beat effects" because no "beat effects" are in fact present where the tones are relatively free of harmonics.

This application is a continuation-in-part of my prior

2

application, Serial No. 590,629, filed June 11, 1956, entitled "Speaker System for Adding Tremolo," now abandoned.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several embodiments of the invention. For this purpose, these are shown a few forms in the drawings accompanying and forming part of the present specification. These forms 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 the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a view showing an electric organ system incorporating one embodiment of the invention, the speaker cabinet structure and the high frequency horn being shown in a sectional vertical median plane;

FIG. 2 is a diagrammatic view of the apparatus shown in FIG. 1; and

FIG. 3 is a fragmentary sectional view which illustrates rotary apparatus illustrating a second embodiment of the invention, the plane of the section being vertical and median.

The electric organ console 10 (FIG. 1) includes oscillating tubes, reeds or other means for the purpose of generating electrical impulses corresponding to musical tones throughout the musical range of the instrument. Various controls, such as the usual stops of an electric organ, select the type of impulses produced by operation of keys of the instrument. The tone generators in the organ console are capable of producing electrical impulses having a substantial harmonic content as well as other impulses relatively free of harmonics. Either by virtue of the characteristics of the generators or by special provisions, electrical impulses free of harmonics and impulses rich in harmonics are grouped in two separate electrical channels.

A line 11 (FIG. 2) indicates the electrical channel or bus connection for impulses rich in harmonics; a line 12 indicates the other electrical channel or bus connection for impulses relatively free of harmonics. The lines 11 and 12 respectively lead to separate preamplifiers 13 and 14 which may conveniently be mounted on the organ console. The preamplifiers 13 and 14 utilize a common chassis 15. A common swell pedal 8 cooperating with the preamplifiers simultaneously and correspondingly controls the amplitude of the impulses in both channels.

Further amplification for the respective electrical channels is provided by separate power amplifiers 16 and 17 mounted upon a common chassis located within a speaker cabinet 18 (FIG. 1). Connections 11a and 12a (FIG. 2), contained in a common cable 9 (FIG. 1), indicate connections from the preamplifier outputs to the power amplifiers.

Separate gain controls, diagrammatically illustrated at 19 and 20 in FIG. 2, determine the normal gain of the power amplifiers 16 and 17 such as may be desirable for a given installation. The gain controls 19 and 20 furthermore are adjusted, as by knobs 19a and 20a (FIG. 1), to ensure appropriate relative intensities for the electrical impulses in the respective channels.

Separate speaker systems are provided for the respective electrical channels. Two speakers 21 and 22 are in this embodiment immovably mounted in the cabinet 18 at opposite sides thereof. A line 23 indicates a common connection for both speakers 21 and 22 from the output of the power amplifier 16. The impulses rich in harmonics are translated into sound by these fixed speakers 21 and 22.

The electrical impulses relatively free of harmonics cooperate with a speaker system provided with rotary ap-

paratus mechanically adding rich, full pulsato to the sound produced. In the present example, the pulsato has both vibrato and tremolo components. The rotary apparatus comprises two sections, both housed in the cabinet 18.

A high frequency speaker 24 is mounted upon a central partition 25 above the speakers 21 and 22 and near the top of the cabinet. A rotary horn 26 registers with the speaker 24 and is supported for rotation about the vertical axis of the driver or speaker 24. To maintain the horn 26 dynamically balanced, a horn 26a is formed diametrically opposite the horn 26. The sound waves enter only the horn 26. The horns 26 and 26a are formed as parts of a unitary casting. The mechanism for rotating the horn 26 is identical to that shown and described in detail in my Reissue Patent No. 23,323, dated January 9, 1951. Attached to the lower portion of the horn 26 is a pulley 40. A companion pulley 41 is attached to the shaft of a motor 42 mounted upon a side wall of the speaker cabinet 18. A belt 43, cooperable with both pulleys 40 and 41, serves as a means for imparting rotation to the horn 26 upon operation of the motor 42. Pulsato is accordingly added to the sound issuing from the horn 26.

A low frequency speaker 27 is supported above a lower partition 28, with the cone thereof registering with the port 29 in the partition. Beneath the partition 28 is a drum 30 that is supported for rotation about the vertical axis of the speaker 27 by the aid of a bearing 44 mounted on the lower wall of the cabinet 18 and a bearing (not shown) located at the partition wall 28. Attached to the lower portion of the drum 30 is a pulley 45. A companion pulley 46 is mounted upon the shaft of a motor 47 attached to a side wall of the speaker cabinet 18. A belt 48, cooperable with the pulleys 45 and 46, serves as a means for imparting rotation to the drum 30 upon operation of the motor 47. Accordingly, suitable pulsato is added to the sound issuing from the drum 30. The pulley arrangement is identical to that shown and described in my above-identified reissue patent.

The cabinet 18 has lateral ports 31 to which the sound from the rotary drum 30 may be directed. Lateral ports 32 permit outward passage of sound from the space in which the high frequency horn 26 is accommodated.

An electrical dividing network 35 cooperating with power amplifier 17 segregates high and low frequency impulses. Connections 33 and 34 appropriately direct the segregated impulses to the respective high and low frequency speakers 24 and 27.

In order to prevent the sound waves generated by the reverse side of the cone of the low frequency speaker 27 from influencing the operation of the speakers 21 and 22, isolation boxes 36 and 37 are provided that surround the speakers 21 and 22.

The impulses relatively free of harmonics have full, rich pulsato imparted thereto by the rotary apparatus 26, 30. The rotary pulsato apparatus does not unduly emphasize the "beat effects" since no "beat effect" is noticeably present in impulses relatively free of harmonics.

The speakers 21 and 22 cooperate with the electrical channel for impulses rich in harmonics have no pulsato mechanically added to the sound produced thereby. No undue emphasis is added to whatever "beat effects" may already exist.

FIG. 3 illustrates a fragmentary part of a speaker cabinet. In this form, two electrostatic speakers 51 and 52 are shown and as substantially disclosed in my copending application Serial No. 596,510, filed July 9, 1956, and entitled "Rotary Electrostatic Speaker."

Both speakers 51 and 52 are mounted upon a shaft 53 which in turn is supported on walls 60 and 61 of a speaker cabinet 62 by the aid of bearing structures 54 and 55. The electrostatic speaker 51 is mounted at a substantial distance from the axis of the shaft 53 by the aid of bracket

arms 56 and 57 attached to the shaft 53 in an appropriate manner. The electrostatic speaker 52 is mounted substantially close to the axis of the shaft 53. The shaft 53 carries a pulley 63. A companion pulley 64 is carried by a shaft of a motor 65 which is mounted upon the partition wall 61. A belt 66, cooperable with the pulleys 63 and 64, imparts rotation to the shaft 53 and the speakers 51 and 52 carried thereby. The speakers 51 and 52 accordingly describe quite different orbits, the orbit of the electrostatic speaker 51 being relatively large whereby full, rich pulsato may be added to the sounds. The electrostatic speaker 52, however, describes a relatively small orbit, and a slight pulsato is added to the sounds.

Accordingly, the speakers 51 and 52 are respectively used for translating the flute and string type impulses into sound, and a system substantially equivalent to that shown in the previous form is provided. In the present instance, the pulsato added to string tones at the speaker 52 may be used in substitution for the electronic vibrato that might otherwise be provided in the organ itself or, if desired, it may be used in conjunction therewith.

For establishing connections to the speakers 51 and 52, slip ring units 58 and 59 are provided at the ends of the shaft 53, which respectively project beyond bearings 54 and 55. These slip ring units 58 and 59 are of a type disclosed in my copending application Serial No. 783,012, filed December 26, 1958, and entitled "Mercury Slip Ring Assembly," now Patent No. 3,014,192, issued December 19, 1961.

Should there be a mixture of string and flute tones, as is quite common in actual use of the organ, both forms of the invention will provide the sensation of rich and full pulsato. The fact that the string tones have no appreciable pulsato added is relatively undetectable.

A simple system, therefore, makes possible utilization of pulsato to a substantial extent and increases the capabilities of an otherwise limited and unsatisfactory instrument.

Pulsato is a term meaning cyclic variation of an otherwise relatively constant component or components of music or musical tones at the rate of from five to eight cycles per second. If the only varied component is frequency characteristic of the tone, then the pulsato is vibrato. If the only varied component is amplitude, then the pulsato is tremolo. Other musical components may be varied to produce pulsato.

The inventor claims:

1. In a musical instrument: a set of generators for providing electrical impulses corresponding to notes in a common musical range extending throughout several octaves; each of the generators having a characteristic fundamental frequency corresponding to a note; first electrical output connection means; second electrical output connection means; first circuit means operated by at least some of the generators and providing at said first electrical output means, impulses corresponding to the respective fundamental frequencies of the generators relatively free of their corresponding harmonics; second circuit means operated by at least some of the generators and providing at said second electrical output means, impulses corresponding to tones relatively rich in harmonics; a first speaker system connected to said first electrical output connection means; a second speaker system connected to the second electrical output connection means; and rotary apparatus operatively associated with said first speaker system for adding pulsato acoustically to the sound issuing from the first speaker system in an amount markedly greater than the amount of pulsato added acoustically, if any, to the sound issuing from said second speaker system.

2. The combination as set forth in claim 1, in which the rotary apparatus is operatively associated exclusively with said first speaker system.

3. The combination as set forth in claim 1, in which

5

said rotary apparatus includes a pair of means describing relatively large and small orbits at which the sound from the respective speaker systems issues.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,080,786

March 12, 1963

Donald J. Leslie

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 58, for "harmonies" read -- harmonics --.

Signed and sealed this 3rd day of December 1963.

(SEAL)

Attest:

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Attesting Officer

EDWIN L. REYNOLDS

Acting Commissioner of Patents