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PITCH BROADENING APPARATUS FOR MUSICAL INSTRUMENTS HAVING ELECTRONIC TONE GENERATORS

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FIG. 1.

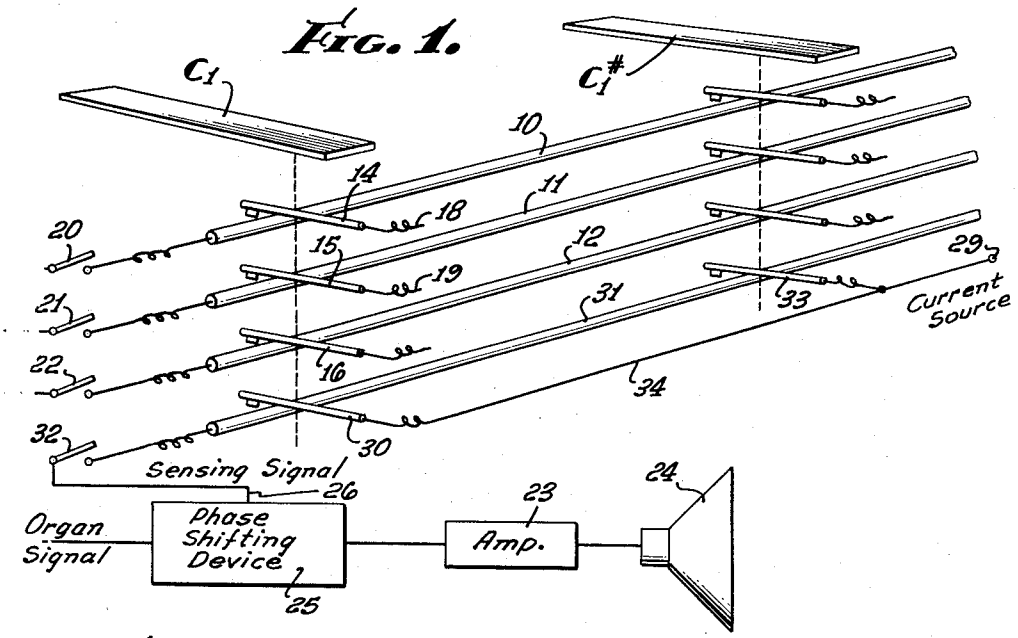
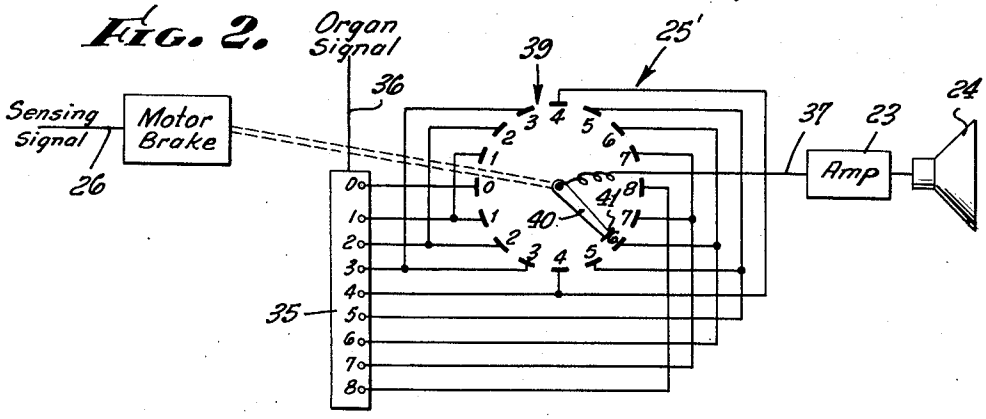


FIG. 2.



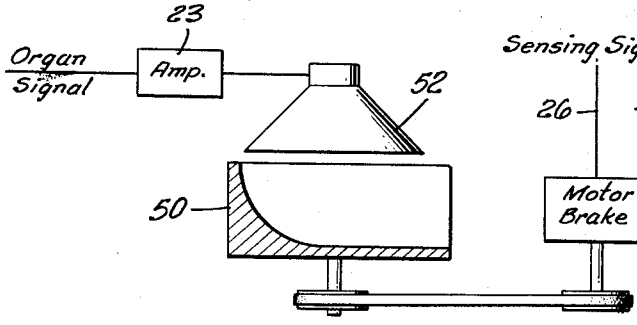


FIG. 3.

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PITCH BROADENING APPARATUS FOR MUSICAL INSTRUMENTS HAVING ELECTRONIC TONE GENERATORS

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This invention relates to music and particularly to electrical musical instruments, such as organs, utilizing electronic generation of impulses for the production of music.

Electronic generators are normally characterized by a fixed frequency, whereas acoustic generators, as a rule, are characterized by a lack of pitch certainty. The lack of pitch certainty, commonly termed a "broadening" of the sound, is desirable since the lack of broadening results in a shallow sound.

Broadening may be produced by changing the phase of the acoustic radiations, or changing the phase of electrical impulses corresponding to sound at a stage in advance of the speaker system.

Phase shift is produced in pipe organs in several ways. For example, phase shift is produced by movement of the swell shutters, which the organist controls in relation to the progress of the music. Also, pitch change or phase shift is produced in pipes by virtue of small changes in wind pressure. Reed pipes also inherently produce minor pitch changes. Various phase shifting devices, acoustic and electronic, have been proposed for producing a broadening effect in electronic tone generation systems. Known devices are generally of two classes. In devices of one class, the broadening continues uninterruptedly, as by operation of an oscillator or a rotary sound channel. This droning operation results in an unnatural musical character that sooner or later becomes objectionable. In devices of another class, broadening is produced at random. While the droning is overcome, the untimely starting and stopping of the broadening apparatus is in the last analysis equally objectionable.

Accordingly, the primary object of this invention is to provide a broadening device that operates discontinuously, but compatibly with the progress of the music.

A companion object of this invention is to provide a device of this character that in a discontinuous fashion produces broadening, but yet does not detract from the musical effect of the instrument itself. For this purpose the discontinuities in the broadening functions are made to be coincident with the rhythm or progress of the music itself. In an electronic organ, a convenient means for achieving this result is to operate the broadening device only coincidentally with any one of the organ pedals. Accordingly, the discontinuities are completey masked by the music itself. Furthermore, the phase shift has no regular pattern inasmuch as it is controlled by the operation of the pedal notes. The broadening operation might be initiated in other manners in response to other characteristic transient operation of certain lower register notes.

Another object of this invention is to provide a device of this character that may be selectively operated by a conventional organ stop.

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, there 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 diagrammatic view illustrating the present invention as it is appplied to the pedals of an electronic organ;

FIG. 2 illustrates, by way of example, a phase shifting device for use in the present invention;

FIG. 3 illustrates, by way of example, a different phase shifting device for use with the present invention.

In FIG. 1 there are illustrated two pedals labeled C_1 and $C_1\#$ which are suitably oriented in a customary fashion at the organ console. The two pedals C_1 and $C_1\#$ illustrated are, of course, representative of a larger number.

Associated with the pedals C_1 and $C_1\#$, etc., are a series of bus bars **10**, **11** and **12**. Associated with each pedal C_1, for example, is a set of switch arms **14**, **15** and **16** respectively engageable with the bus bars **10**, **11** and **12** upon depression of the corresponding pedal C_1.

These switches **14**, **15** and **16** operating with the corresponding pedals serve as a means whereby generators for pedal notes are keyed. Thus, a lead **18**, connected to the switch arm **14** may connect, for example, to a generator or associated circuit that produces impulses corresponding to C_1 with various characteristic harmonics or overtones. For example, such impulses may correspond to a string tone. The switch arm **15** by the aid of a lead **19** may connect to the same or different generator and providing yet another characteristic tone upon depression of the pedal C_1. The impulses for various notes but of like tonal content or characteristic are cooperable with the same bus bar. Thus all switches **14** for the several pedal switch sets that cooperate with circuits for producing string tones connect to the bus bar **10**.

The bus bars **10**, **11** and **12** connect with the output of the organ system via switches **20**, **21** and **22** controlled by conventional organ stops. Thus, the stop operating the switches **20**, **21** and **22** may be variously and in an appropriate manner labelled such as "bourdon," "diapason," etc.

However produced, the signals are applied to a power amplifier **23** and a speaker system characterized diagrammatically by the speaker structure **24** via a phase shifting device **25**.

The phase shifting device **25** when operable, regularly or periodically shifts the phase of the impulses applied to it, resulting in a periodic crowding and separation of the waves forming the impulses. The pitch of the impulses is thus made indeterminate within a narrow band corresponding to the amplitude of phase shift. Accordingly, a broadening effect is produced in connection with the sound emitted from the speaker system **24**.

The device **25** if continuously operable, ultimately becomes annoying by its droning effect. Yet random operation is equally annoying.

Operation of the device **25** is accordingly made discontinuous, but with the discontinuities being related to the progress of the music.

Operation of the device is controlled by a lead **26**. When the lead **26** is energized, the phase shifting device **25** is in operation, but when the lead **26** is not energized, the phase shifting device **25** ceases operation. This or the equivalent result may be accomplished in various ways to be explained hereinafter.

Energization of the phase shift device **25** by lead **26** is accomplished by a current source indicated by the terminal **29**. The terminal **29** connects with the lead **26** whenever a pedal note is sounded. Thus a switch arm **30**, generally similar to the switch arms **14**, **15** and **16**, is also operated by depression of the corresponding pedal C_1. Upon such depression, the arm **30** engages a bus bar **31**. The bus bar **31** is common to the connection **26**

via a switch **32** which may also be controlled by a tab or stop.

Associated with the pedal $C_1\sharp$ is a switch **33** also engageable with the bus bar **31**. All of the switches so engageable with the bus bar **31** are connected to the source terminal **29** by the aid of a lead **34**.

The operation of the phase shifting device may now be understood. As long as any pedal is depressed, the phase shifting device **25** operates. However, the continuous operation of the phase shifting device **25** is interrupted as the player engages different pedals in the course of play. Normally, there are periods when no pedal is operative, and usually whenever the player's foot is shifted. Thus discontinuous operation of the device **25** is ensured. Yet the discontinuities do not occur at random, but instead in harmony with the music. Initiation and cessation of operation of the device **25** is masked in the starting and stopping of the music itself.

In FIG. 2 there is illustrated a phase shifting device **25'** that may be used in the system of FIG. 1. The device includes a phase shift network **35** that has various taps numbered 0, 1, 2, 3, 4, 5, 6, 7 and 8 representing successively increasing amounts of phase shift with respect to the impulses at the input lead **36**. A connection **37** which drives the amplifier **23** and the speaker system **24** is cyclically associated with the taps 0 through 8 in continuous sequence by the aid of a rotary scanner **39**.

The taps of the network **35** connect with condenser plates located circularly about the scanner **39**. A rotatable arm **40** connected as by a brush to the connection **37** carries a condenser plate **41** that is moved successively into coupling relationship with the circularly arranged condenser plates. When the arm **40** is rotated the phase shifts periodically, and when it is not rotated the phase shift if any, is constant. Thus, when the arm **40** is operated, broadening is achieved.

The combination motor-brake structure controlled by the connection **26** is operated simultaneously with the pedals, and the operation as described in FIG. 1 results.

The phase shift device acts to impose oscillations on the impulses, and the motor-brake serves as a means for switching the oscillator on and off. Thus the brake part of the motor-brake quickly stops the motor when the connection **26** is deenergized. This may be accomplished by suitable relays of conventional form (not shown).

In the form illustrated in FIG. 3, an acoustic phase shifting device is provided in the form of a rotary sound channel **50**. The sound channel **50** is adapted to be rotated by a motor-brake structure **51** controlled by connection **26**. When the motor-brake structure is operative to rotate the channel **50**, the sound radiation pattern rotates, and the broadening effect is achieved by the Doppler effect. When the motor-brake structure is denergized the sound radiation is non-rotary, and the Doppler effect ceases. The sound channel **50** superimposes oscillations on the organ output at the acoustic rather than at the electronic stage.

In the present instance the organ output is applied directly to the speaker system **52** without the interposition of any other electronic phase shift network.

Various other means could be provided operatively associated with the pedal C_1, $C_1\sharp$, etc. for controlling the phase shift device. However, the use of a bus bar or switch structure indicated in FIG. 1 is convenient.

The inventor claims:

1. In a musical instrument having electrically operated means for producing impulses corresponding to sound and cooperable with a speaker system: means for imparting phase deviations to the instrument output to achieve a broadening effect; and means operatively associated with some of said electrically operable means for causing initiation and cessation of the operation of said phase deviation producing means in synchronism with said electrically operable means.

2. The combination as set forth in claim 1 in which said phase deviation producing means includes a phase shift network operable on impulses corresponding to sound at a stage in advance of the speaker system.

3. The combination as set forth in claim 1 in which said phase deviation producing means includes a rotatable sound channel operatively associated with said speaker system.

4. In an electronic organ having electrically operated generators for producing impulses corresponding to sound and cooperable with a speaker system, said organ including a set of pedals: means for imparting phase deviations to the organ output; and means operatively associated with the pedals for causing initiation and cessation of the operation of the phase deviation producing means upon depression and release of any of the pedals.

5. In an electronic organ having electrically operated generators for producing impulses corresponding to sound and cooperable with a speaker system, said organ including a set of pedals: means for imparting phase deviations to the organ output; and means operatively associated with the pedals for causing initiation and cessation of the operation of the phase deviation producing means upon depression and release of any of the pedals, comprising phase shift means having a control lead, and switch means operatively associated with the pedals, said switch means applying a signal to said control lead upon operation thereof.

6. The combination as set forth in claim 5 in which said phase deviation producing means also includes a motor-brake for operation of said phase shift means, and in which switches operatively associated with said pedals each control said motor-brake.

7. In an electronic organ having electrically operated generators for producing impulses corresponding to sound and cooperable wtih a speaker system, said organ including a set of pedals: means for imparting phase deviations to the organ output; and means operatively associated with the pedals for causing initiation and cessation of the operation of the phase deviation producing means upon depression and release of any of the pedals, comprising phase shift means having a control lead and operable upon application of a signal to its control lead, switches operatively associated with the pedals, and a bus bar connected to said control lead, said switches having corresponding terminals parallel connected for cooperation with a signal source, and having other corresponding terminals engageable with said bus bar.

8. In a musical instrument having electrically operated means for producing impulses corresponding to sound and cooperable with a speaker system: controllable means designed to impart phase deviations to the instrument output; and means producing a signal designed to operate said controllable means in synchronism with the operation of some of said electrically operated means.

9. The combination as set forth in claim 8 in which said controllable means includes a phase shift network designed to operate upon the instrument output prior to the conversion of the instrument output into acoustic form.

10. The combination as set forth in claim 8 in which said controllable means is designed to operate upon the instrument output after its conversion into acoustic form and including means for rotating the sound radiation path produced by at least a portion of said speaker system.

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