United States Patent [19]

Leslie

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[54] **PLANETARY ACOUSTIC PHASE SHIFT MECHANISM**

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[52] **U.S. Cl.** **179/1.5**

[51] **Int. Cl.**[2] **H04R 1/28**

[58] **Field of Search** ..... 179/1 J; 181/143

[56] **References Cited**

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Primary Examiner—Kathleen H. Claffy
Assistant Examiner—E. S. Kemeny
Attorney, Agent, or Firm—Flam & Flam

[57] **ABSTRACT**

A speaker system for pulsato and chorus effects for an electronic musical instrument includes one or more rotating sound channels, which consist of a speaker in a rotating drum, all supported as an assembly which also rotates or reciprocates. All axes of rotation are parallel. Reciprocal assembly motion is perpendicular to the axes of channel rotation.

10 Claims, 7 Drawing Figures

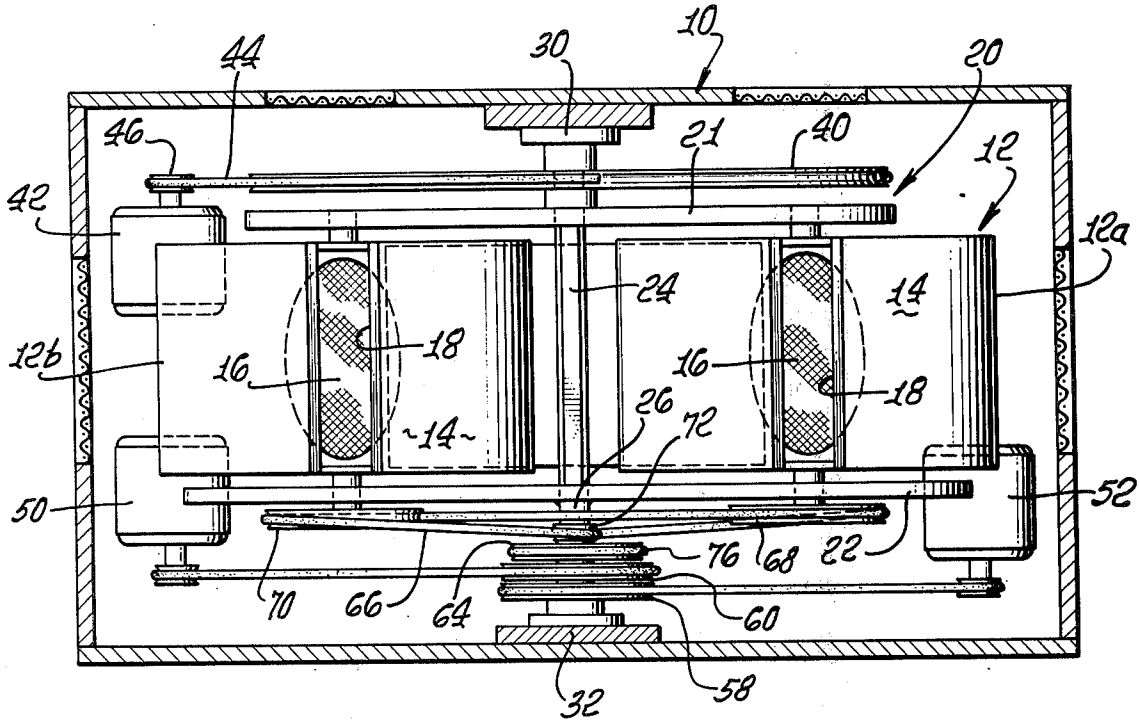


FIG. 1.

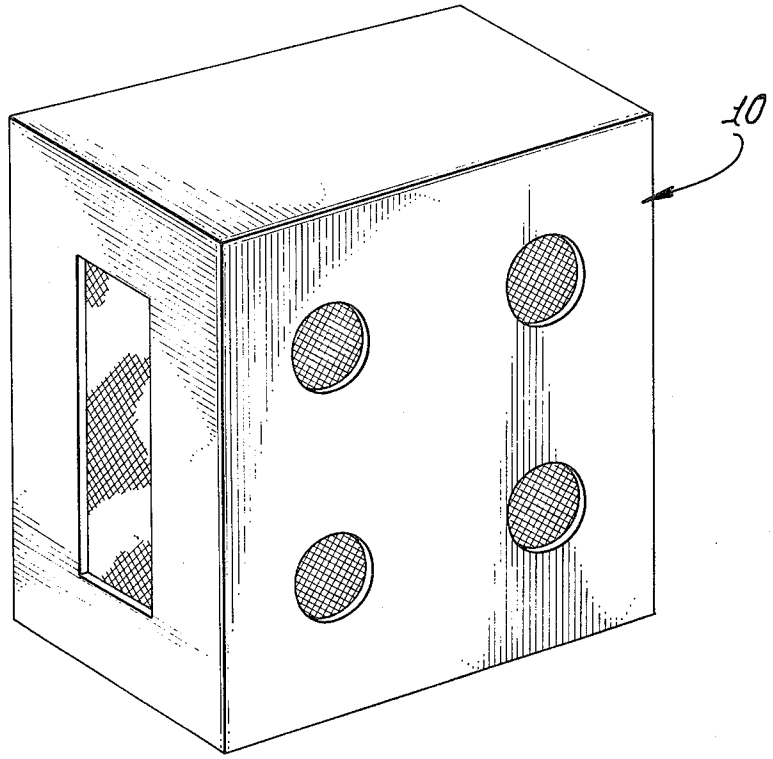


FIG. 2.

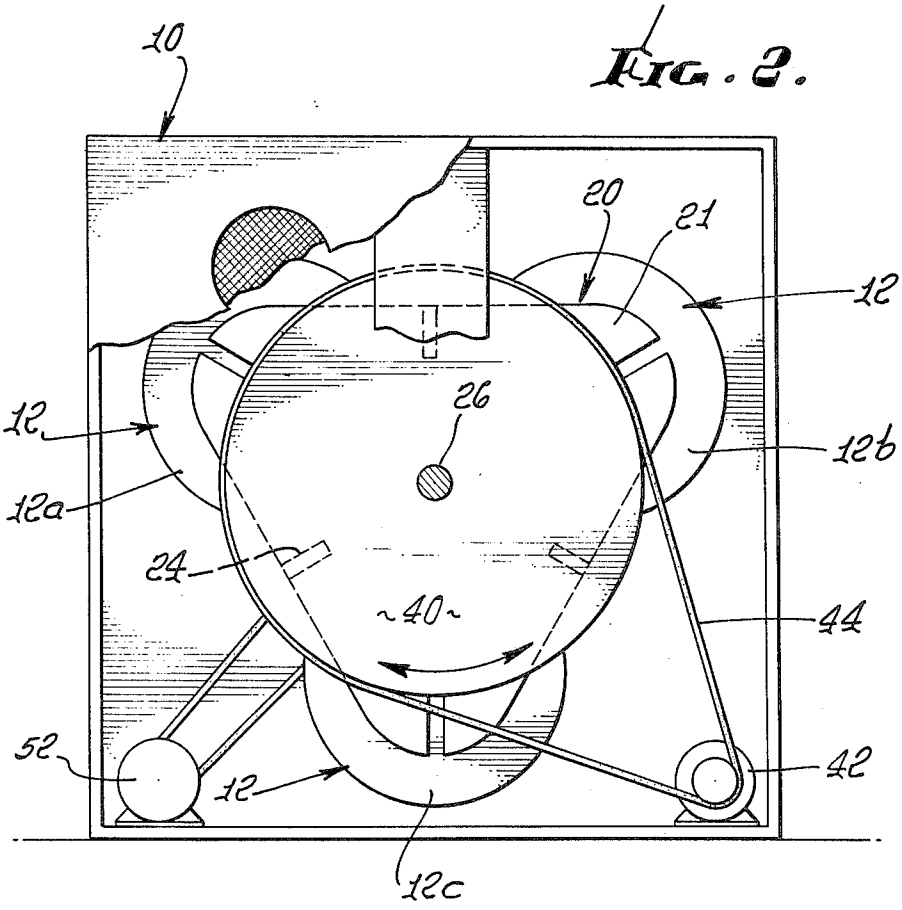
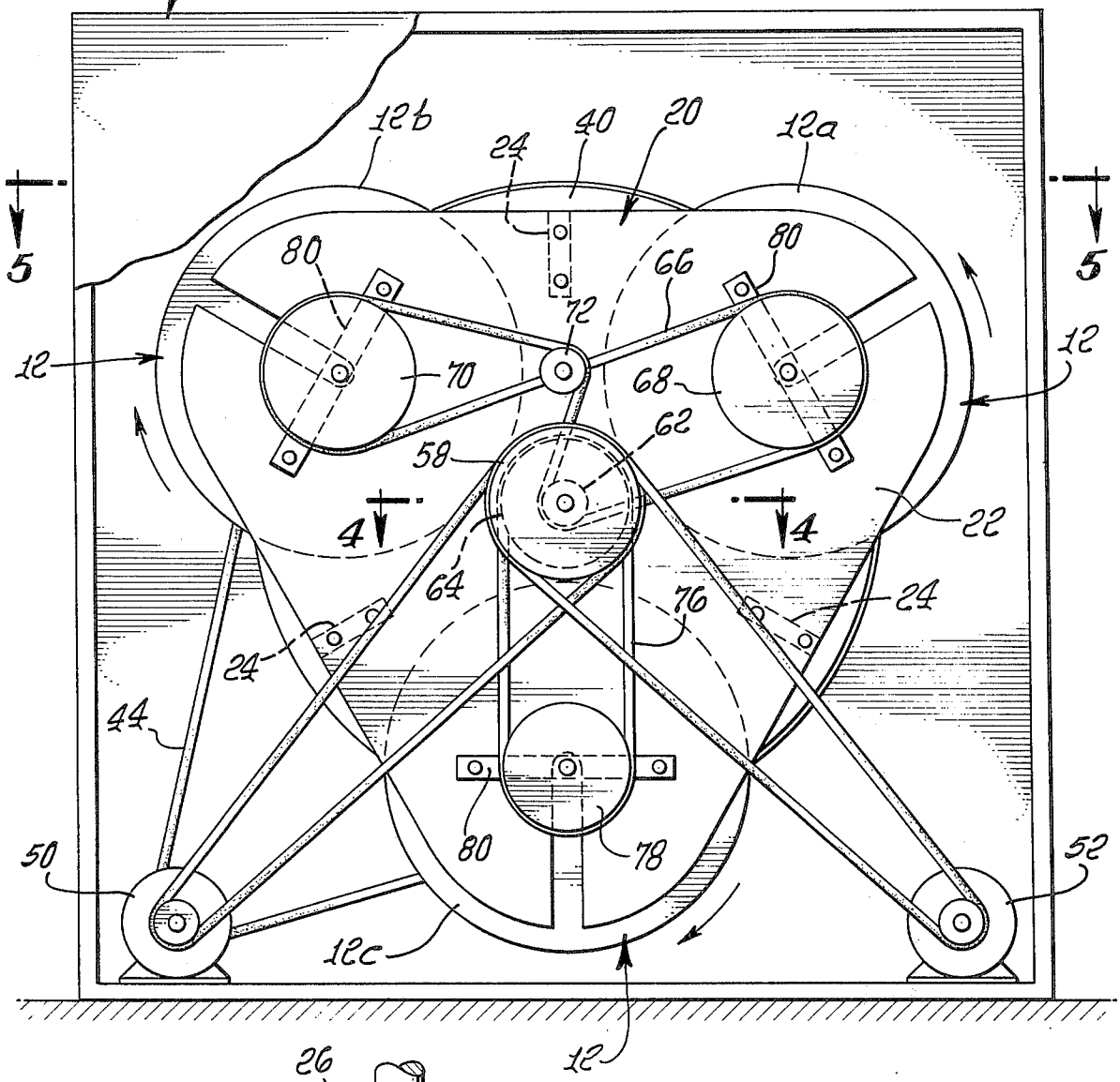


FIG. 3.


10
12b
24
40
20
12a
5
5
80
80
66
72
12
12
70
68
62
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4
4
22
64
76
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24
44
80
78
50
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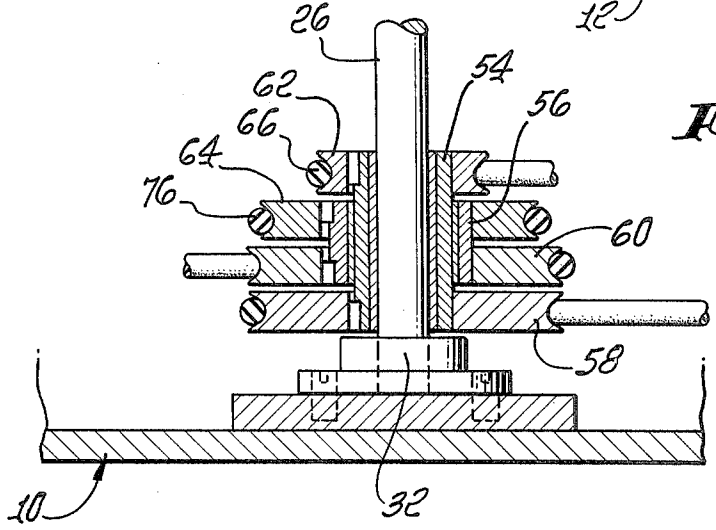
12c
12

FIG. 4.


26
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62
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66
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10
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FIG. 5.

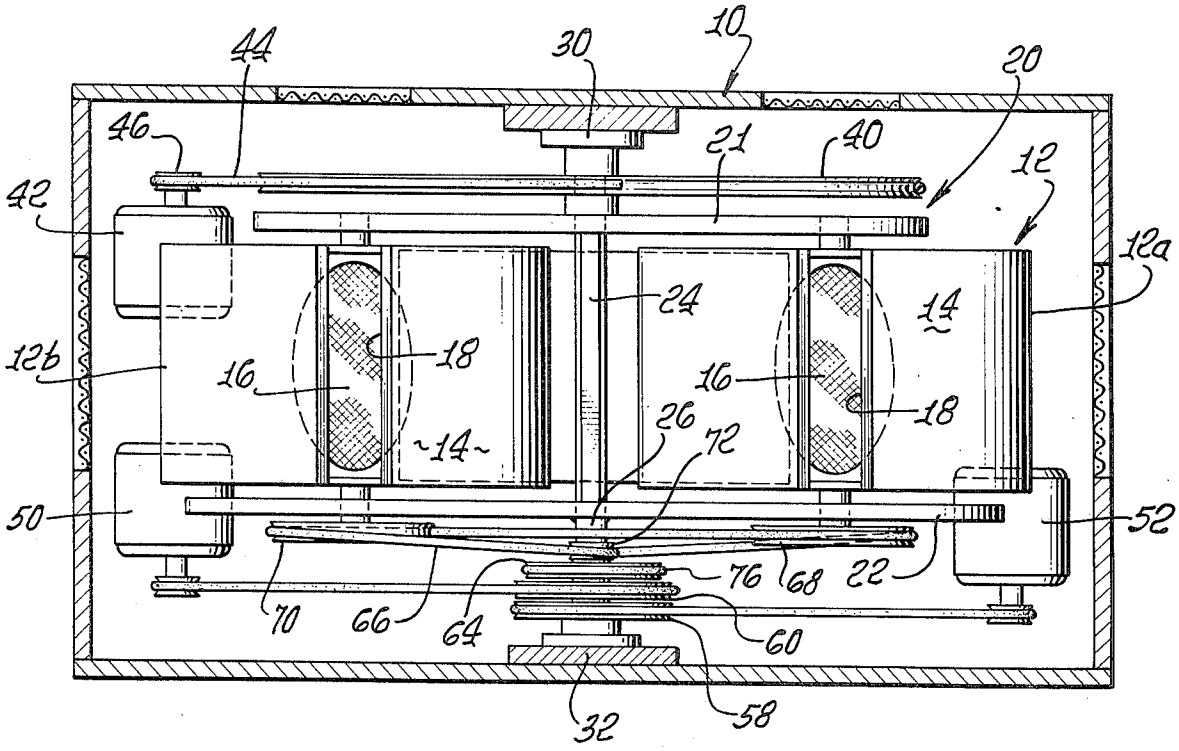


FIG. 6.

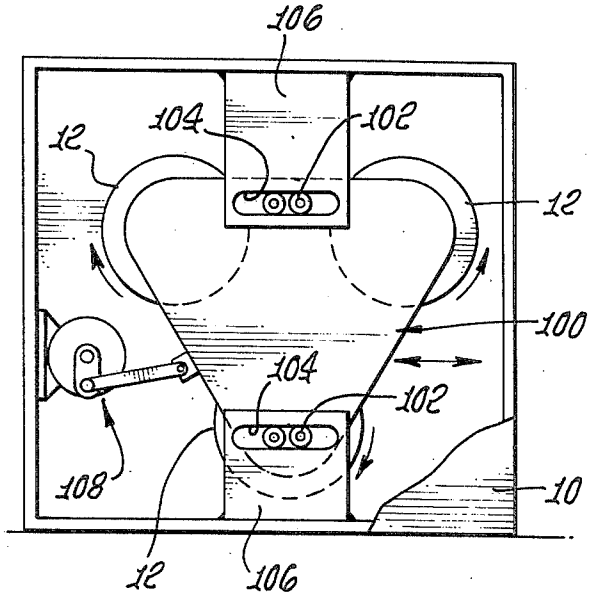
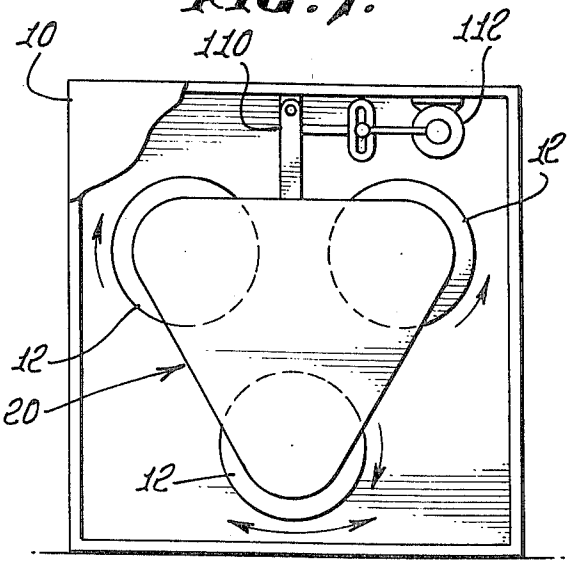


FIG. 7.



PLANETARY ACOUSTIC PHASE SHIFT MECHANISM

FIELD OF INVENTION

This invention relates to speaker systems for translating electrical impulses into sound, and more particularly to chorus, ensemble or spatial effects.

BACKGROUND OF THE INVENTION

In the early days of the electronic organ, wondrous tones were created by simple electronic tone generators and by mechanical-electrical transducers operating in conjunction with mechanical tone generators. The sounds produced by the early instruments were figuratively flat and both literally and figuratively monotonous. Performance of such electronic organs was substantially improved with the advent of LESLIE (trademark of CBS INC.) speaker systems which utilize rotating sound channels. The previously monotonous sounds became lively and bright by superimposing vibrato and tremolo upon the electrical impulses.

Various improvements and refinements have been made in connection with such acoustic pulsato systems. Some improvements involve chorus and ensemble effects to enhance the depth and breadth of the sound source to an extent such that the listener perceives spatial and reverberation effects characteristic of a large concert hall. In general, it has been necessary to utilize a plurality of spaced speaker systems in order to obtain good concert hall effects.

A system described in USA Pat. No. 3,083,606 to Don L. Bonham issued Apr. 2, 1963 and entitled ELECTRICAL MUSIC SYSTEM achieves the illusion of space by dividing an electrical signal into a plurality of channels and superimposing different electrical phase-shift or vibrato in each of the channels. Such or similar effects have heretofore been unobtainable by mechanical means alone.

An object of the present invention is to provide chorus and ensemble effects upon musical signals by a simple mechanical structure capable of compact accommodation in a single small cabinet.

SUMMARY OF INVENTION

The foregoing objects are made possible by utilizing one or more rotary sound channels mounted upon a movable support that either rotates or oscillates in order periodically to add to and subtract from the velocity of sound issuing from the rotating sound channel. Different effects can be obtained by changing both the rate of rotation of the sound channel and the rate of rotation or oscillation of its support through wide ranges. Valuable effects are also obtained by separate speed control of a number of rotary sound channels all mounted on the common support.

DESCRIPTION OF THE DRAWINGS

A detailed description of the invention will be made with reference to the accompanying drawings wherein like numerals designate corresponding parts in the several figures. These drawings, unless described as diagrammatic, or unless otherwise indicated, are to scale.

FIG. 1 is a front pictorial view of the speaker cabinet incorporating the present invention.

FIG. 2 is a front elevational view of the speaker cabinet with the front panel being broken away.

FIG. 3 is an enlarged rear elevational view of the speaker showing the back panel being broken away.

FIG. 4 is an enlarged fragmentary sectional view taken along a plane corresponding to line 4—4 of FIG. 3.

FIG. 5 is a horizontal sectional view taken along the plane corresponding to line 5—5 of FIG. 3.

FIGS. 6 and FIG. 7 are front elevational views similar to FIG. 2 but illustrating modified forms of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following detailed description is of the best presently contemplated modes of carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention since the scope of the invention is best defined by the appended claims.

Structural and operational characteristics attributed to forms of the invention first described shall also be attributed to forms later described, unless such characteristics are obviously inapplicable or unless specific exception is made.

Located inside the speaker cabinet **10** are a plurality of acoustic phase shift or pulsato devices **12.** These devices each have one or more rotating sound channels to produce a vibrato and tremolo. The rotating sound channels are formed in this instance by cones of speakers which are mounted within the pulsato drum or rotor. A device of this general character is shown, for example, in my USA Pat. No. 3,014,192 issued Dec. 19, 1961.

Each of the devices **12,** as shown in FIG. **5,** includes a generally cylindrical enclosure **14** having flat top and bottom walls. Each of the devices **12** includes at least one oval speaker **16** mounted on the inside with the speaker mouth registering with a slot or opening **18** in the peripheral wall of the drum oriented to extend generally parallel to the drum axis.

The pulsato devices **12** are clustered together and supported in triangular array for rotation with their axes parallel. For this purpose, a cage **20** is provided. The cage includes two mounting plates **21** and **22** connected together by three struts **24.** The drums fit into the cage **20.**

Each pulsato drum has a shaft supported by suitable bearing structures attached to the mounting plates **21** and **22.** In order to impart rotation to the drums, their shafts are accessible beyond the cage. Thus their shafts correspondingly project beyond the mounting plate **22.** However the cage itself is mounted for rotation in the cabinet **10** (FIG. **5**). For this purpose, the cage **20** has a main shaft **26** supported in bearings **30** and **32** attached to the inside of the cabinet. By rotating the cage **20,** planetary motion is imparted to the pulsato devices.

On one side of the cage the main shaft **26** carries a large diameter pulley **40** and is rotated by a drive motor **42.** The motor is located at one corner of the cabinet **10.** A belt **44** connects a small pulley **46** of the drive motor to the large diameter pulley **40.** Mechanism for imparting orbital motion to the pulsato drum is located on the opposite side of the cage **20.**

Two motors **50** and **52** (FIGS. **2** and **3**) are provided for driving the three pulsato drums for purposes of economy. These motors are mounted on the cabinet and do not rotate with the cage. In order to provide a drive mechanism notwithstanding the planetary motion

of the drums and the fixed location of the motors **50** and **52**, a transfer pulley mechanism (FIG. 4) is provided on the main shaft **26.**

The pulley mechanism includes a pair of hollow shafts **54** and **56.** The longer inside hollow shaft **54** is journalled upon the main shaft **26.** The outer shorter hollow shaft **56** is, in turn, journalled and centered upon the inner hollow shaft **54** in order to expose the ends of the inside hollow shaft.

Corresponding outer ends of the shafts carry pulleys that are driven by the motors **50** and **52** respectively. Thus the inner longer hollow shaft **54** carries a pulley **58** and the outer shorter shaft **56** carries a pulley **60.** (See also FIG. **5**). The inner ends of the hollow shaft provide power takeoff operative notwithstanding planetary motion of the pulsato drums since the power takeoff is at the axis of planetary motion. The inner ends of the hollow shafts **54** and **56** carries drive pulleys **62** and **64** for this purpose.

One of the drive pulleys **62** serves to rotate two of the pulsato drums **12***a* and **12***b*. In order that the drums **12***a* and **12***b* produce different acoustic effects notwithstanding the use of a common belt **66,** the driven pulley of one of the drums might be slightly larger than the other. However, in the present instance, the pulleys **68** and **70** for the drums **12***a* and **12***b* are the same size. Instead, the direction of rotation of the drums is opposite. For this purpose, the lower run of the pulley belt **66** from the drive pulley **62** runs counterclockwise about pulley **12***a* and then clockwise about pulley **12***b*. An idler pulley **72** carried by the mounting plate is provided for the belt **66** in order to ensure sufficient driving contact between the belt **66** and the drive pulley **62.**

The third pulsato drum **12***c* has a pulley **89** (FIG. **3**) connected to drive pulley **64** by an endless belt **76.** The drive pulley **64** is significantly larger than pulley **62.** Thus the drum **12***c* rotates at a reduced rate. The drum **12***c* may have two speakers on opposite sides so that the characteristic pulsato rate is about the same as that produced by the drums **12***a* and **12***b* but with a smaller percent frequency deviation. In practice, string or complex signals can be translated by unit **12***c* while flute or simpler signals can be translated by units **11***a* and **11***b*.

Tension of the belts **66** and **76** may be controlled by adjustment of the bearing brackets **80** in a conventional manner.

If desired, a common electrical signal can drive all of the speakers. In order to make connections suitable slip ring structures (not shown) may be provided such as shown in my patent above identified.

MUSICAL EFFECTS

Each of the motors **42, 50** and **52** preferably has speed control so that various modes of operation can be achieved. Different modes are achieved by ensemble use of the pulsato units or individual use for different tones or voices. The following are examples:

1. Cage stationary, pulsato drums rotating slowly. This produces excellent phase shift for ensemble or separate voice use. Phase shift may also be produced by slow rotation only of the cage.

2. Cage and units both rotating slowly. Highly complex and desirable chorus effects are achieved.

3. Cage rotated slowly as compared to that of drums, say one or two cycles per second, and pulsato drums operated at orbital speeds of 5 to 8 cycles per second, either ensemble or individual voice use. This produces an exceptionally broad ensemble effect in pulsato mode that simulates a concert hall having widely spaced sound sources. Since the cage rotates at a fraction of the rotary speed of the drums and since the axes of rotation are parallel, the velocity of the cage produces a modulation which is far less than 100%. Modulation of about 20% – 25% produces very good results.

4. Cage rotated fast, say 2 or 3 cycles per second, and fast orbital speed of pulsato devices. This produces a warbling effect for special purposes. The percent modulation is high.

DESCRIPTION OF ALTERNATE EMBODIMENTS

In the form illustrated in FIG. **6,** the cage **100** for the several pulsato drums is itself mounted for horizontal reciprocation by the aid of a pair of roller assemblies **102.** These roller assemblies track in grooves **104** formed in brackets **106** attached to the cabinet.

The cage is reciprocated by a crank mechanism **108.** Results similar to those achieved in the previous form are obtained. The motion of the cage is transverse to the axes of the rotors. Hence a velocity is superimposed upon the orbital motion of the pulsato rotors.

In the form illustrated in FIG. **7,** the motor cage is pivotally suspended by bracket **110** that is reciprocated by a drive motor **112.** A pendulum type motion is imparted to the cage which is superimposed upon that of the pulsato motors. Similar effects are likewise obtained.

Intending to claim all noval, useful and unobvious features shown or described, I make the following claims:

1. In apparatus for superimposing a frequency or phase modulation upon an acoustic phase shift device:
- a. a speaker having a cone;
- b. a rotor for the speaker and forming with the speaker cone, a sound channel having a sound emitting opening;
- c. a support for the speaker rotor;
- d. means mounting the speaker rotor on the support for rotation about an axis spaced from said sound emitting opening to impart orbital movement to the sound emitting opening and rotation to the sound radiation pattern produced thereby;
- e. means mounting the support for rotation about an axis substantially parallel to, but spaced from, the axis of movement of said rotor axis so that a substantially epicycloidal movement is imparted to said sound emitting opening upon rotation of said support and said rotor; and
- f. means rotating both said support and said rotor.

2. In apparatus for superimposing a frequency or phase modulation upon an acoustic phase shift device:
- a. a plurality of speakers each having a speaker cone;
- b. a corresponding plurality of separate rotors for the speakers respectively, and each forming with the corresponding speaker cone, a sound channel having a sound emitting opening;
- c. a common support for the speaker rotors;
- d. means mounting the speaker rotors on the support for rotation about spaced but substantially parallel axes, each axis being spaced from the corresponding sound emitting opening to impart orbital movement to the sound emitting opening and rotation to the sound radiation pattern produced thereby;
- e. means mounting the support for rotation about an axis substantially parallel to, but spaced from, the axes of movement of said rotor axes so that a sub-

stantially epicycloidal movement is imparted to the sound emitting openings upon rotation of said support and said rotors; and

f. means for rotating both said support and said rotors.

3. The combination as set forth in claim **2** in which the speed of said rotating means is adjustable to determine both orbital speed itself and percent modulation.

4. The combination as set forth in claim **2** in which the number of speakers is at least three, one group of speaker rotors being mechanically interconnected orbitally to rotate in opposite directions at the same rate while the others rotate orbitally at a different rate.

5. The combination as set forth in claim **2** together with means grouping said speakers into two electrical channels for application of separate voices thereto.

6. The combination as set forth in claim **5** in which the number of speakers is at least three, one of the groups of speakers being mechanically interconnected orbitally to rotate in opposite directions at the same rate while the others orbitally rotate at a different rate.

7. The combination as set forth in claim **2** in which said speakers and rotors are three in number, said rotors being substantially equiangularly oriented about the axis of said support; a plurality of independently rotatable pulleys mounted coaxially of said support axis, one of said pulleys being directly connected to said support and other of the pulleys being connected respectively to groups of rotors; said rotating means being coupled to said pulleys.

8. In apparatus for superimposing a frequency or phase modulation upon an acoustic phase shift device:

a. a speaker having a cone;

b. a rotor for the speaker and forming with the speaker cone, a sound channel having a sound emitting opening;

c. a support for the speaker rotor;

d. means mounting the speaker rotor on the support for rotation about an axis spaced from said sound emitting opening to impart orbital movement to the sound emitting opening and rotation to the sound radiation pattern produced thereby;

e. means mounting the support for reciprocating movement in a path substantially perpendicular to said rotor axis; and

f. means for imparting reciprocating motion to said support.

9. In apparatus for superimposing a frequency or phase modulation upon an acoustic phase shift device:

a. a plurality of speakers each having a speaker cone;

b. a corresponding plurality of separate rotors for the speakers respectively, and each forming with the corresponding speaker cone, a sound channel having a sound emitting opening;

c. a cage for the speaker rotors;

d. means mounting the speaker rotors in the cage for rotation about spaced but substantially parallel axes, each axis being spaced from the corresponding sound emitting opening to impart orbital movement to the sound emitting opening and rotation to the sound radiation pattern produced thereby;

e. means mounting said cage for rotation about an axis substantially parallel to, but spaced from, the axes of movement of said rotor axes so that a substantially epicycloidal movement is imparted to the sound emitting openings upon rotation of said cage;

f. a first pulley mechanism at one end of the cage for rotating the cage;

g. a second pulley mechanism for imparting rotary motion to said rotors including pulleys mounted coaxially of said cage axis at the other end of said cage, said second pulley mechanism including a pair of hollow shafts rotationally free of each other and free of said cage rotation, the outer hollow shaft being shorter than and centered on the inner hollow shaft; each hollow shaft carrying, at its outer end, a pulley for rotating the corresponding shaft, and at its inner end, a pulley for power takeoff.

10. The apparatus as set forth in claim **9** in which said rotors are at least three in number, some of which are driven in opposite directions by said power takeoff pulleys.

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