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LOUDSPEAKER SYSTEM UTILIZING ROTATABLE SPEAKERS AND AN ACOUSTIC SHIELD FOR TREMOLO AND VIBRATO

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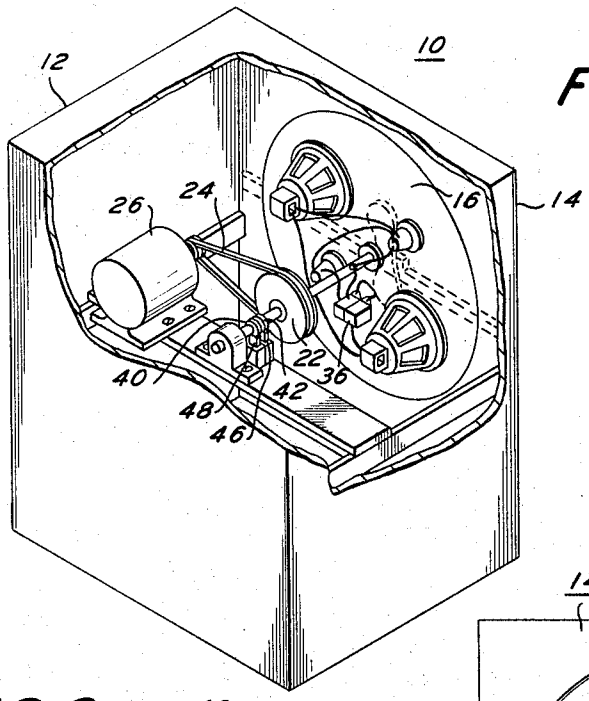


FIG. 1

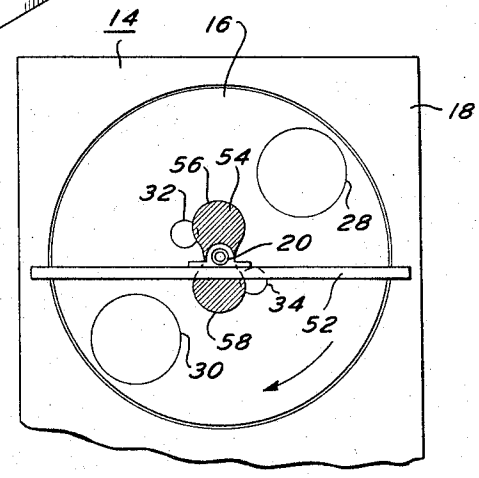


FIG. 2

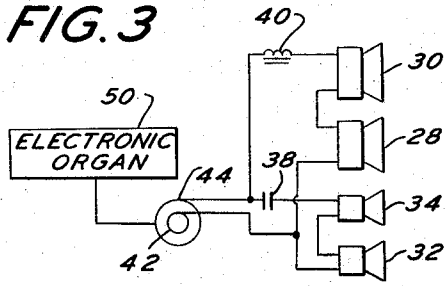


FIG. 3

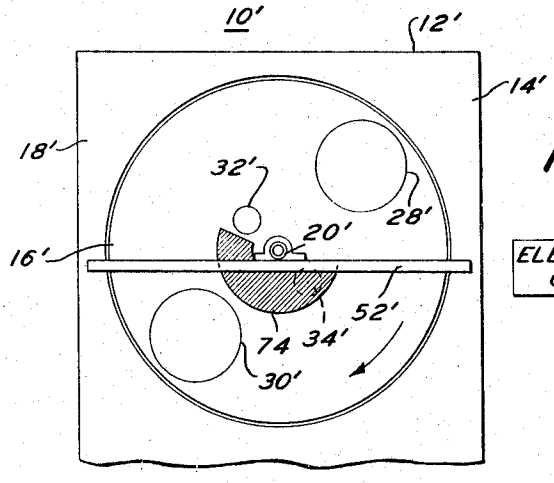


FIG. 4

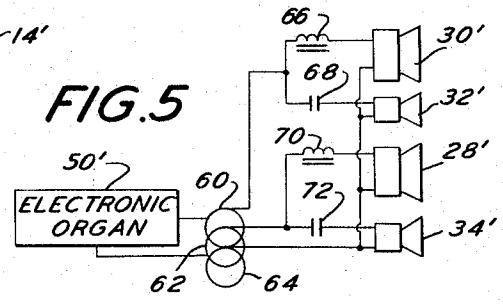


FIG. 5

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LOUDSPEAKER SYSTEM UTILIZING ROTATABLE SPEAKERS AND AN ACOUSTIC SHIELD FOR TREMOLO AND VIBRATO

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17 Claims. (Cl. 84—1.25)

In general, this invention relates to a new and improved loudspeaker system and more particularly to an electrical system which produces, or reproduces sounds, tones or music. The present invention concerns a loudspeaker arrangement for such system, capable of imparting to the normal sounds emanating therefrom a certain quality, or effect, similar to vibrato or tremolo which is produced when a multiplicity of musical tones are uniformly varied in both frequency and amplitude.

This invention is an improvement over my apparatus shown in U.S. Patent 2,491,674 issued December 20, 1949 for Rotatable Loudspeaker Support With Associated Stationary Baffle. In this patent, there was described a loudspeaker arrangement in which two loudspeakers were mounted opposite each other on a disk which was rotated by means of a motor. The speakers were supplied with electrical signals coming from an amplifier, which signals corresponded to the musical tones to be produced and/or reproduced. By rotating the disk at a speed of about one revolution per second, a uniform non-directional variation in amplitude and Doppler effect variation in frequency is obtained from the speakers which is much more pleasant to listen to than when the speakers are fixed permanently. Faster rotation of the disk supporting the speakers produces a smoother vibrato or tremolo effect desirable on organs of the "romantic" type.

Thus, it is well known that acoustical transducing of the audio spectra utilizing a transducer or speaker pointing in a given direction at all times, but continually changing its position achieves an apparent movement of the sound source about a room and periodic frequency shifts due to the Doppler effect. Doppler effects can be defined as that shifted frequency which occurs when a sound source moves relative to a stationary observer, the direction of frequency shift being upward when the source approaches the observer and vice versa.

When utilizing loudspeakers mounted on a rotating support in the manner discussed above, it is customary to provide separate speakers for different frequency ranges by utilizing standard frequency crossover components. Thus, in order to avoid the necessity for additional slip rings, the crossover components are mounted on the rotating support.

However, when high frequency speakers were mounted on a rotating support, it was not possible to achieve a smooth tremolo. By high frequency speaker, it is intended to mean those speakers which would produce audio signals above 2000 cycles per second. The tremolo effect for the high frequency speaker is weaker than the same effect for the lower frequency speakers and is also not as smooth as the tremolo effect for the lower frequency speakers. Further, the tremolo effect for the high frequency speakers takes on unwanted random characteristics for reasons not readily explainable.

Therefore, in order to avoid the foregoing and other difficulties of prior art practices, it is the general object of this invention to provide a new and improved loudspeaker system with improved audio characteristics.

Another object of this invention is the provision of a new and better rotating loudspeaker support with associated stationary baffle which is simple and easy to manufacure and produces a better tremolo effect over a wider range of audio frequencies.

Still another object of this invention is the provision of a new and better rotatable loudspeaker sytem capable of being utilized with multiple channel audio outputs.

Still another object of this invention is the provision of a new and better loudspeaker system in which tremolo may be effected over the full range of audio frequencies.

Other objects will appear hereinafter.

For the purpose of illustrating the invention, there are shown in the drawings forms which are presently preferred, it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a partially broken away perspective view of the back of a loudspeaker enclosure incorporating the principles of the present invention.

FIGURE 2 is a front plan view of the loudspeaker enclosure of FIGURE 1.

FIGURE 3 is a schematic showing of the electrical circuitry for a loudspeaker system utilizing the enclosure shown in FIGURES 1 and 2.

FIGURE 4 is a front plan view of a loudspeaker enclosure built in accordance with the second embodiment of the present invention.

FIGURE 5 is a schematic showing of the electrical circuitry for the loudspeaker enclosure of FIGURE 4.

In FIGURES 1, 2 and 3, there is shown a single channel loudspeaker system built in accordance with the principles of the present invention and generally designated by the numeral **10**.

The single channel system **10** includes a loudspeaker enclosure **12** having a front wall **14**. The front wall **14** includes a rotating circular support **16** and a baffle section **18**. The support **16** rotates within a circular opening in the baffle section **18** with a small gap for clearance which gap is not large enough to allow the low frequency signals to be transmitted therethrough.

The support **16** is fixedly secured to a rotating shaft **20** having a pulley **22** thereon within the enclosure **12**. The pulley **22** is driven by a belt **24** from a motor **26**. In normal operation, the motor **26** drives the shaft **20** at a speed between one-half and three and one-half revolutions per second. For best tremolo results, it is desirable to rotate the shaft **20** between one and one-half and three and one-half revolutions per second. For each revolution per second of the support there then occurs a two cycle per second modulation of the audio output of the speaker.

The support **16** in one preferred embodiment of the present invention is approximately two feet in diameter. The support **16** has placed thereon at diametrically opposite points adjacent the periphery thereof two mid frequency speakers **28** and **30**. The mid frequency speakers **28** and **30** are intended to operate between 250 cycles per second and 2000 cycles per second. For low frequency audio signals below 250 cycles per second, a separate woofer can be provided in the enclosure fixedly supported on the baffle support **18**. However, in the interest of clarity, such woofer has not been shown nor described.

For high frequency audio signals, i.e. above 2000 cycles per second, two high frequency speakers or tweeters **32** and **34** are placed on diametrically opposite sides of the support **16**. The tweeters **32** and **34** are along a diameter perpendicular to the diameter on which mid frequency speakers **28** and **30** are located. Further, the outermost points of tweeters **32** and **34** from the shaft are spaced closer to the shaft **20** than the innermost portions of the mid frequency speakers **28** and **30**.

A suitable crossover network **36** is mounted on the support **16** for rotation therewith. The crossover network **36** includes a capacitor **38** in series with the tweeters **32** and **34** and an inductor **40** in series with the mid frequency speakers **28** and **30**. As can be seen in FIGURE 3, the mid frequency speakers **28** and **30** are in series with each other and the high frequency speakers **32** and **34** are in series with each other. Further, the mid frequency speakers **28** and **30** and inductor **40** are in parallel circuit relation with respect to the high frequency speakers **32** and **34** and capacitor **38**.

On the shaft **20** there are provided a pair of slip rings **42** and **44**. Slip ring **42** is connected to ground through a brush **46** while slip ring **44** is connected to the circuit of the electronic organ **50** by the brush **48**. Thus, the speakers **28**, **30**, **32** and **34** are intended to receive musical signals from the electronic organ **50** through the slip rings **42** and **44**. The portion of the electronic organ **50** which delivers its output to the loudspeaker system **10** in one embodiment of the present invention is in the flute circuit. The inductor **40** and capacitor **38** act as a frequency crossover network in that the frequencies below 2000 cycles per second will be delivered to the mid frequency speakers **28** and **30** while the frequency signals above 2000 cycles per second will be delivered to the tweeters **32** and **34**.

The crossover circuit **36** is mounted on the rotating support **16** so as to avoid the use of additional slip rings.

On the front wall **14** of the enclosure **12** there is provided a support **52** for receiving one end of the shaft **20**. Additionally, the support **52** has fixedly secured thereto an acoustic shield **54**. The shield **54** includes two diametrically opposite equally sized portions **56** and **58** which are slightly larger than the exposed area of the tweeters **32** and **34** respectively. The acoustic shield portions **56** and **58** will not cover the mid range speakers **28** and **30**. The acoustic shield **54** is arranged to provide an approximately fifty percent periodic cutoff or attentuation of tone only from the high frequency speakers **32** and **34**.

The result of this fifty percent periodic cutoff is a superior acoustic tremolo of a very desirable intensity and smoothness.

The acoustic shield **54** does not cover the medium frequency speakers **28** and **30**. If this were done, there would be a loss in audio power by absorption and reflection back into the medium frequency speaker by the acoustic shield. This undesirable effect is eliminated by merely masking the high frequency speakers.

The need for this masking arises because of the fact that in the loudspeaker system shown in Patent 2,491,674 the high notes, for reasons which are not fully understood, did not provide a smooth tremolo or vibrato effect. Not only was the tremolo effect weaker, but it also was not smooth and took on unwanted random characteristics.

In FIGURE 4, there is shown a second embodiment of the present invention utilized with a two channel loudspeaker system **10'**. The loudspeaker system **10'** includes an enclosure **12'** having a front wall **14'** with a rotating support **16'** therein. The remainder of the front wall **14'** is formed by a sectional baffle **18'**. A support **16'** is rotated in the manner shown for the loudspeaker system **10** of FIGURE 1. The support **16'** has secured thereto two diametrically oppositely spaced mid range speakers **28'** and **30'**. Further, a pair of diametrically oppositely spaced tweeters **32'** and **34'** are secured to the support **16'** along an axis perpendicular to the axis on which the mid range speakers **28'** and **30'** lie. The speakers **28'** and **30'**, **32'** and **34'** are connected in the manner shown in FIGURE 5. That is, three slip rings **60**, **62** and **64** are provided with the slip ring **64** acting as a ground terminal associated with a grounding brush. Slip ring **60** is connected to a parallel circuit in one branch of which is an inductor **66** in series with mid frequency

speaker **30'** and in the other branch of which is a capacitor **68** in series with high frequency speaker **32'**. Inductor **66** and capacitor **68** act as a crossover network for the mid frequency speaker **30'** and the tweeter **32'** so that frequency signals below 2000 cycles per second will be supplied to the frequency speaker **30'** while those signals above 2000 cycles per second will be supplied to the tweeters **32'**.

Slip ring **62** is connected to a parallel circuit including mid frequency speaker **28'** and tweeter **34'**. One branch of this last-mentioned parallel circuit includes inductor **70** in series with mid frequency speaker **28'** and the other branch of the parallel circuit includes capacitor **72'** in series with tweeter **34'**. Inductor **70** and capacitor **72** are a crossover network in the same manner as was discussed with respect to inductor **66** and capacitor **68**.

Thus, electronic organ **50'** supplies the two channels represented by slip rings **60** and **62** with audio signals which are broken down in accordance with their frequency by the crossover networks **66**, **68** and **70**, **72**.

The front wall **14'** of the enclosure **12'** is also provided with a suitable support **52'** in the same manner as was discussed with respect to the enclosure **12**. However, the support **52'** has mounted thereon a stationary acoustic shield **74** which is semicircular in shape having a radius slightly greater than the outermost distance from the shaft **20'** of the tweeters **32'** and **34'**. In this way, the acoustic shield **74'** provides approximately fifty percent periodic cutoff or attenuation of tone from the high frequency speakers **32'** and **34'** and does not effect mid frequency speakers **28'** and **30'**. Further, this cutoff is achieved alternately for each channel associated with high frequency speakers **32'** and **34'** giving a smoother audio output.

The support **52'** is rotated one to seven revolutions per second to modulate each speaker channel at one to seven cycles per second. For best tremolo results, it is preferred that the speakers be modulated at four to seven cycles per second as noted previously.

Thus, it has been shown that the objects of the present invention have been achieved by the utilization of acoustic shields which provide periodic cutoff or attenuation of the tone from only the high-frequency speakers so that a smooth acoustic tremolo effect is achieved over the full range of audio frequencies. That is, a baffle will reinforce the low frequency output of the mid range speakers which, by rotating, will uniformly vary in frequency and amplitude while the high frequency signals from the tweeters will also vary by reason of their rotation as well as by reason of the placement of the acoustic shield.

It is within the scope of this invention to utilize any acoustic shield for a tweeter where the tweeter moves relative to the acoustic shield to achieve periodic cutoff or attenuation of the tweeter by the acoustic shield.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

I claim:

1. Apparatus comprising a source of electrical frequency signals within the audio range, an acoustic transducer for transducing electrical signals into audio signals, connecting means connecting said source to said transducer to transmit high frequency electrical signals within the audio range to said transducer, an acoustic shield spaced adjacent said transducer, motive power means for moving said transducer with respect to said acoustic shield to periodically pass said transducer by said shield, said acoustic shield periodically attenuating the audio output signals of said transducer.

2. The apparatus of claim **1** wherein said acoustic shield provides approximately fifty percent periodic cutoff of the audio output signal of said transducer.

3. Apparatus in accordance with claim 1 wherein said acoustic transducer is mounted on a support, said motive power means rotating said support about at least approximately a horizontal axis, said acoustic shield being mounted stationary with respect to said rotating support.

4. The apparatus of claim 3 wherein said shield covers at least a portion of said acoustic transducer over approximately fifty percent of the cycle of rotation of said support.

5. The apparatus of claim 3 including a second acoustic transducer, said connecting means connecting said source to said second transducer in a manner providing frequency signals to said second transducer lower than those applied to said first mentioned acoustic transducer, said acoustic shield periodically cutting off only said first acoustic transducer.

6. The apparatus of claim 5 including a third and fourth transducer, said third and fourth transducers being respectively similar to said first and second transducers, said connecting means connecting said source to said third and fourth acoustic transducers to supply high frequency and lower frequency signals respectively thereto, said acoustic shield periodically cutting off said third acoustic transducer in the same manner as said first acoustic transducer.

7. The apparatus of claim 6 wherein said source includes two channels of electrical frequency signals within the audio range, said connecting means connecting one of said channels to said first and second acoustic transducers, said connecting means connecting the other of said channels to said third and fourth acoustic transducers.

8. The apparatus of claim 7 wherein said first and third acoustic transducers are mounted diametrically opposite adjacent the axis of rotation of said support, said second and fourth transducers being spaced radially outwardly from the axis of said support a distance greater than the outer periphery of said first and third acoustic transducers, said acoustic shield being semi-circular, said acoustic shield being mounted adjacent the center of said support, said acoustic shield having a radius less than the radial distance from the axis of said support to any portion of said second and fourth transducers.

9. The apparatus of claim 6 wherein said first and third transducers are mounted diametrically opposite the axis of rotation of said support, said first and third transducers being mounted radially inwardly toward the axis of rotation of said support from said second and fourth transducers, said acoustic shield comprising diametrically opposite spaced portions adjacent the axis of rotation of said support, said portions being each capable of covering a portion of one of said first and third acoustic transducers for approximately 25% of the cycle of rotation of said support, whereby said acoustic shield achieves approximately 50% periodic cutoff of said first and third acoustic transducers.

10. The apparatus of claim 1 wherein said source of electrical frequency signals within the audio range is an electronic organ.

11. A system comprising an electronic organ providing electrical frequency signals within the audio range, acoustic transducer means coupled to said organ, means moving said acoustic transducer means about at least one axis to produce a Doppler effect, said acoustic transducer means including a high frequency electrical signal responsive means and a low frequency electric signal responsive means, frequency cross over means supplying the high frequency electrical signals from said organ to said high frequency electrical responsive means and additionally supplying the low frequency electrical signals from said electric organ to said low frequency signal responsive means, said acoustic transducer transducing said electrical frequency signals into audio output signals, and shielding means periodically shielding the audio output signal of said high frequency electric signal responsive means.

12. A loudspeaker unit comprising a housing, said housing having one wall shaped to form a baffle board provided with a circular aperture, a high frequency electric signal acoustic transducer, a disk-like support arranged in said wall and mounted for rotation within said circular aperture, means mounting said high frequency electrical signal transducer on said support in such manner that the longitudinal axis of sound propagation of said high frequency electric signal transducer is spaced from and substantially parallel with the axis of rotation of said support, means within said housing arranged to effect rotation of said support, and an acoustic shield fixedly supported outside of said housing one wall adjacent said support, said acoustic shield covering a portion of the path of said transducer about said axis of rotation of said support.

13. The loudspeaker unit of claim 12 including a second high frequency electrical signal transducer diametrically oppositely mounted on said support from said first mentioned high frequency electrical acoustic transducer, said second high frequency electrical signal transducer having its longitudinal axis of sound propagation spaced from and substantially parallel with the axis of rotation of said support, said second high frequency electrical signal transducer axis of sound propatation being spaced from said axis of rotation of said support an amount equal to the spacing of said first mentioned high frequency electrical signal transducer longitudinal axis from said axis of rotation of said support.

14. The loudspeaker unit of claim 13 wherein said acoustic shield includes two equal diametrically oppositely formed shielding portions, said acoustic shield portions periodically cutting off each of said high frequency electrical signal transducers approximately 50% of each cycle of rotation of said support.

15. The loudspeaker unit of claim 13 wherein said acoustic shield is semi-circular in shape, said acoustic shield having a radius at least equal to the radius of the outermost portion of said high frequency electrical signal transducers from said axis of rotation of said support, said acoustic shield being mounted adjacent the axis of rotation of said support.

16. The loudspeaker unit of claim 12 wherein said means within said housing arranged to effect rotation of said support is operative to rotate said support between one to seven cycles per second.

17. The loudspeaker unit comprising a rotatable support, loudspeaker means mounted on said support in such manner that the longitudinal axis of sound propagation of the loudspeaker means is spaced from and substantially parallel with the axis of rotation of said support, rotative power means arranged to effect rotation of said support, stationary baffle means arranged in adjacent surrounding relation to the loudspeaker means so as to maintain the intensity of the tonal energy produced, an acoustic shield means mounted adjacent said support to periodically attenuate the tonal energy produced by said loudspeaker means.

No references cited.

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