

Feb. 5, 1957

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2,780,302

ACOUSTIC VIBRATO DEVICE FOR ELECTRONIC ORGAN

Filed Aug. 8, 1955

2 Sheets-Sheet 1

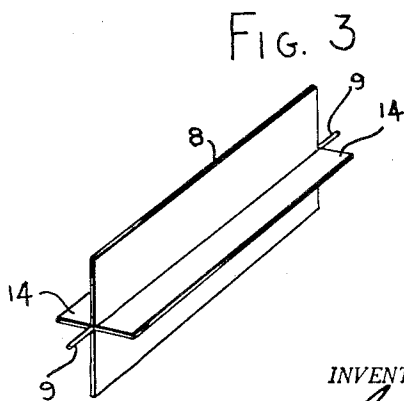
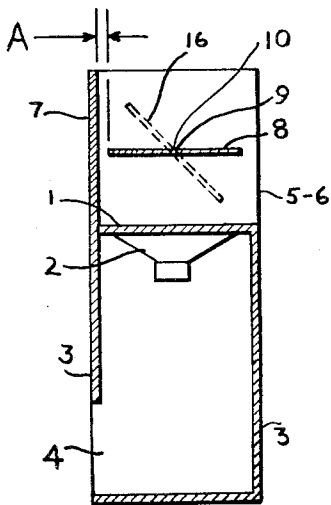
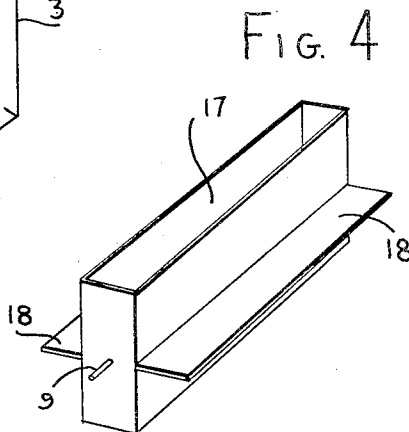
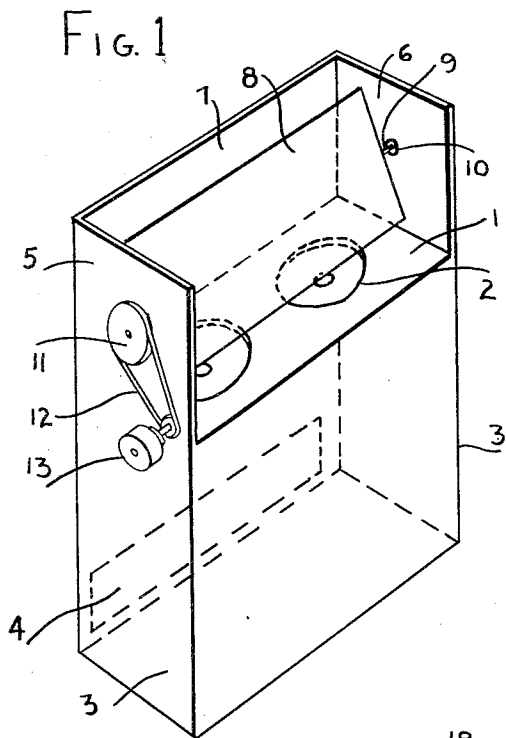


FIG. 2

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2 Sheets-Sheet 2

FIG. 5

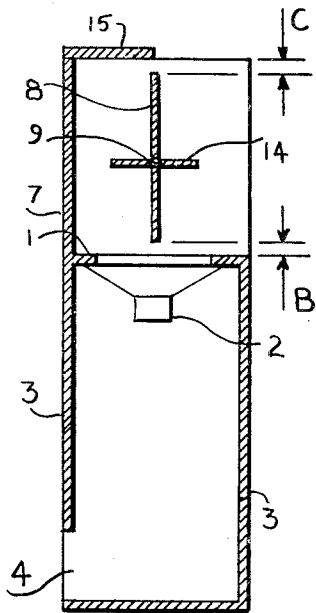


FIG. 6

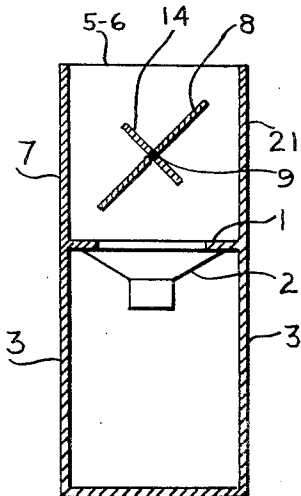
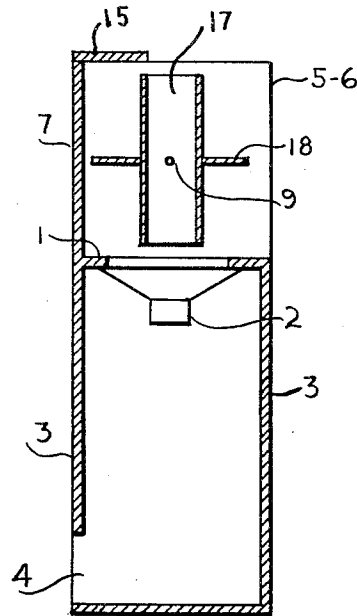


FIG. 7

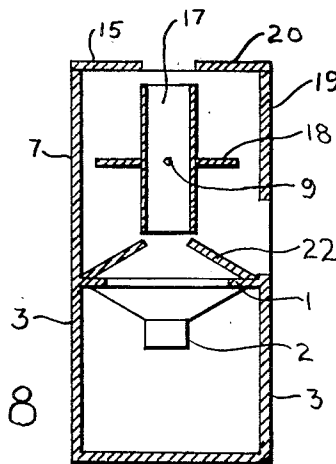


FIG. 8

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1

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ACOUSTIC VIBRATO DEVICE FOR ELECTRONIC ORGAN

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Application August 8, 1955, Serial No. 527,013

15 Claims. (Cl. 181—31)

The present invention relates in general to loud speaker enclosures and in particular to reproducers for electronic organs.

There are two general methods in common usage for imparting vibrato to the tones of the electronic organ. One involves periodically changing the pitch or amplitude of the tones by entirely electronic means. This is an electronic vibrato. The other operates to modify the organ tones issuing from the reproducing speaker by mechanical or acoustical means. This is an acoustic vibrato. The present disclosure relates to the second method.

It is well known that the use of vibrato in the playing of organ music adds richness and appeal to the music. This is especially true of ballads and so called "popular" music. This type of organ music achieved considerable popularity during the time when the theatre pipe organ, with its heavy vibrato, was common.

The vibrato is obtained in the pipe organ by a rising and falling pressure in the wind supply which is blowing the pipes. This causes both the amplitude and pitch of the pipe tones to rise and fall, thus producing the vibrato.

The electronic organ has now become more common, especially for entertainment purposes, and for music of this type a heavy theatrical vibrato is often desirable. According to tone quality classifications, there are two major classes of such organs. One includes those which produce tones which are essentially flute-like in character, which tones are added together in various ways to produce tones of more complex character. The other class includes those electronic organs in which the tones as produced, are complex, and have many "natural" harmonics. These latter tones include such voices as reed and string tones.

A successful means for obtaining a heavy acoustic vibrato with the flute-like tones is in common usage, and involves passing the tones from the organ speaker through a revolving horn (see Leslie 2,489,653). This arrangement, however is not very successful with the class of organs generating complex tones. Accordingly, it is a principal object of this invention to provide means for obtaining a heavy acoustic vibrato with organs generating complex tones, as well as with organs which produce the flute-like tones.

The normal vibrato rate is from approximately six to seven beats per second. It has been found in the structure of the present disclosure that in addition to the normal or primary vibrato beat, a secondary vibrato beat, spaced in time between the primary beats is very desirable. It is therefore a further object of this invention to provide means for obtaining a secondary beat in addition to the normal vibrato beat.

Another object of the invention is to employ a moving acoustic resonating chamber to further enhance the vibrato effect.

Another object is to employ a fixed acoustic resonating chamber to increase the vibrato effect.

Another object is to provide an organ tone cabinet

2

which, in conjunction with the vibrato which it produces, imparts a characteristic timbre to the tones.

Another object is to disclose how the invention can be used to advantage, in a tone cabinet for a church organ, and in a tone cabinet for an entertainment organ.

Another object is to provide means for producing the heaviest useful vibrato for the entertainment organ.

Other objects will appear from the following description, reference being had to the accompanying drawings, in which;

Figure 1 is a pictorial view of one form of the invention.

Figure 2 is a diagrammatic end view of the structure shown in Figure 1.

Figure 3 is an improved form of rotor for the invention.

Figure 4 is another improved form of rotor.

Figure 5 is a diagrammatic end view of one form of the invention.

Figure 6 is a diagrammatic end view of another form of the invention.

Figure 7 is a diagrammatic end view of another form of the invention.

Figure 8 is a diagrammatic end view of another form of the invention.

In Figure 1 is shown a pictorial view of a speaker enclosure or tone cabinet, embodying one form of the invention. A horizontal speaker board 1 supports loud speakers 2, and is mounted upon an enclosure hereinafter referred to as the rear baffle, and which in this case is a box 3, entirely enclosed, excepting for the open port 4, near the bottom and at the rear of the enclosure. Above the speaker board are two end walls 5 and 6, and rear wall 7. These three walls in conjunction with the speaker board 1, form four sides of a box which is hereinafter called the front baffle, and will appear in modified forms, as shown in the other figures. A flat wooden vane 8 called the rotor, and mounted upon shafts 9, is rotatably supported in bearings 10. By means of electric motor 13, pulley 11, and belt 12, the rotor is caused to rotate at a rate of approximately three revolutions per second. By means of a signal source, such as an electronic organ and an amplifier (not shown), signals are impressed upon the voice coils of the loud speakers. The tones issuing from the speakers are acoustically influenced by the rotating vane, and a very pleasing vibrato is imparted to the tones. Note that to produce a vibrato of six beats per second the shaft rotates three times per second. This occurs because any given angular position of the rotor occurs twice in one revolution of the shaft.

The requirements for successful design of a structure in accordance with the invention are as follows. The rear baffle enclosure 3 in Figures 1 and 2 should be at least partially open for best frequency response characteristics. A completely enclosed rear baffle produces the heaviest vibrato, but the frequency response is somewhat restricted for average requirements.

A second requirement is that the front baffle should be partially enclosed. In Figures 1 and 2 the front baffle is comprised of the speaker board 1, the two end walls 5 and 6, and the rear wall 7, thus forming a box-like structure in which the front and top are open. Other figures will show how the front and top may be partially enclosed to provide different vibrato effects.

A third requirement is that the rotor vane 8 of Figures 1 and 2 should be nearly as large as the speaker board 1. Thus as shown in Figure 2 when the bearings are centrally located in the end walls 5 and 6, the clearance A between the rear wall 7 and the edge of the rotor vane 8 when in the horizontal position, should be as small as is practically possible. Approximately one quarter inch will meet this requirement. Similarly, the clearance B in Fig-

ure 5 between the edge of the rotor in the vertical position, and the speaker board should be not more than approximately one quarter inch. These three requirements cooperate in this structure to produce a vibrato (or tremulant) which includes three acoustic effects. The first is a periodic change in pitch of the tones; the second is a periodic change in intensity of the tones; and the third is a periodic change in the timbre of the tones. These are the same three effects which are produced in the tones from organ pipes, when the wind pressure is raised and lowered to produce vibrato.

Another effect which has been found to enhance the vibrato is the introduction of a secondary vibrato beat in addition to the normal or primary vibrato beat. These secondary beats are of somewhat lesser amplitude, and are spaced alternately in time between the primary beats. Figure 3 illustrates a modified form of rotor designed to produce a secondary beat in addition to the normal vibrato beat, and which may be substituted for the single rotor vane 8. In addition to the large vane 8 as shown in Figures 1 and 2, two smaller vanes 14 are mounted at right angles to, and along the center line of the main vane. These vanes should be slightly wider (measured at right angles to the shafts) than half the width of the large vane 8. Thus if vane 8 measures 12 inches tip to tip, then the two smaller vanes (measured from tip to tip), should measure approximately seven and one half inches. With this arrangement the secondary beat is less prominent than the primary vibrato beat. The smaller rotor vanes should not be made too large, for then the secondary beat becomes too prominent. This is very undesirable. The secondary beat should never be more than just barely audible as a secondary beat for greatest effectiveness. The secondary beat has the effect of "filling out" the vibrator cycle; making it heavier and smoother. It has an equally important effect in the treble range of the organ as follows: other widely used acoustic type vibrato systems have a decided tendency to introduce in the treble range extraneous sounds and beats, which are not pleasant. Since this is the range where most of the harmonics lie in organs generating complex tones, these systems have not proven successful when used with organs of this class. An outstanding feature of the present invention is that it imparts a very pleasing and heavy vibrato to the tones in the treble range without introducing undesirable extraneous sounds.

This improvement is due in part to the secondary beat feature, and in part to the use of acoustic resonators. In one form, the resonator is in fixed position, and in the other form the resonator is in motion, and is a component part of the rotor.

Referring to Figure 2, the rotor vane is shown in dashed lines 16 in an intermediate angular position of rotation of approximately 45 degrees from vertical. Figure 1 shows the rotor in approximately the same position. In this position a partially enclosed resonator is formed by the three plane surfaces comprising speaker board 1, back wall 7, and the rotor vane. The end walls 5 and 6 complete this enclosure. The speaker is coupled to this resonator, and for a brief interval, as the rotor passes through this position, the frequency response of the system is altered somewhat. A change of timbre thus becomes a component of the vibrato cycle. In this position also, there is a reduction in audio output level, thus introducing some degree of tremulant into the vibrato cycle. A rise and fall in pitch is simultaneously taking place, due to the Doppler effect, as the vanes rotate toward and away from the speakers. The three effects therefore combine to produce a satisfying and organ-like vibrato.

Acoustic resonators have been widely used in speaker enclosures for bass frequency reinforcement, and even for high frequency reinforcement, but I am not aware of the use of acoustic resonators for intentionally and periodically altering the character of tones produced.

These effects may be modified in various ways, as

shown in the other figures, to produce other and useful effects in vibrato and tone color variations.

The effectiveness of the fixed resonator just described, may be increased by the addition of a partial top 15 to the front baffle. This is shown in Figure 5. The resonator thus formed when the rotor is in the vertical position as shown, is more enclosed due to the smaller clearances at B and C. It is therefore a more effective resonator. Also the speakers are more closely coupled to the resonator. The result of this change is to produce a heavier vibrato by increasing the amount of change of timbre.

Figure 4 illustrates another form of rotor which is even more effective than that shown in Figure 3. This rotor may be used in place of either rotor previously described. The requirement for minimum clearances with the front baffle walls still applies. In this rotor the large flat vane 8 has been replaced by a resonator box 17 which is open at both top and bottom. The shorter vanes 14 have been replaced by longer vanes 18 to provide a heavier secondary beat. Figure 6 is a diagrammatic end view of the tone cabinet, showing the rotor of Figure 4 in position. The partial top 15 should extend approximately to the near edge of the resonator 17 when the resonator is in its vertical position. In this rotor the tip to tip dimension of the vanes 18 should be the same as the tip to tip dimension of the resonator 17, measured at right angles to the shafts 9.

Figure 8 illustrates a diagrammatic view of one form of the invention which provides the maximum usable vibrato. In this case the rear baffle 3 is a box, entirely enclosed. Mounted above the speaker 2 and resting upon the speaker board 1, is a resonator box 22. This resonator has sloping sides and is shaped like a hollow wedge, with the top open to provide egress for the tones from the speaker. The rotor of Figure 4 having the resonator 17 is used, and when the resonator is in the vertical position as shown in the figure, the action of the two resonators is similar to that of a funnel, so that nearly all the sound from the speaker is carried upward and out of the top opening of resonator 17. To further increase this effect the top of the baffle is covered excepting for an opening immediately above the opening in the resonator 17. This is accomplished by means of the partial top members 15 and 20. Also a partial front 19 has been installed to cover the upper portion of the front baffle.

During the interval when the rotor 17 is approaching and leaving the vertical position, there is a very marked change in the amplitude and timbre, as well as the pitch of the tones issuing from the speaker, with the result that the structure provides a very heavy vibrato. Also it has several peaks in its frequency response characteristic, which may be used to advantage.

The vox humana organ voice is very beautiful and is widely used. Even for church organ use, heavy vibrato is always employed with the vox humana. Normally the vox humana harmonic distribution is approximately as follows: weak in the fundamental harmonic and any frequencies below a few hundred cycles; moderately strong in the higher frequency harmonics between two to four thousand cycles; and with a pronounced peak in the region between thirteen hundred to fifteen hundred cycles. This is quite similar to the frequency response characteristic of the structure illustrated in Figure 8. When the vox humana voice of an electronic organ is played through a tone cabinet of this construction, the effect is exceedingly realistic, and closely resembles the vox humana voice of the pipe organ. Other reed voices such as oboe and English horn, as well as the string voices, are also enhanced when played through this type tone cabinet.

In Figure 7 is illustrated another modified form of the invention. The rear baffle 3 may be completely or partially enclosed. Any of the three rotors disclosed may be used, and the one of Figure 3, having the large vane 8 and the short vanes 14 is shown. The front baffle is

shown entirely enclosed excepting for the open top, a front wall 21 having been added to the structure shown in Figure 1. In this arrangement the change in intensity or tremulant, during the vibrato cycle is more pronounced than in any of the other structures shown.

Although in this description the secondary vibrato beat has been considered only as a secondary beat of the same periodicity as the primary vibrato beat, it might also be thought of as introducing a double vibrato rate component into the overall vibrato cycle; and in fact the maximum effectiveness is obtained when the double beat is just barely apparent as such.

It will be seen from the foregoing that there are numerous combinations of the six basic features disclosed, which may be utilized to provide a plurality of interesting and useful effects in electronic organ tone cabinets, for both church use and entertainment use.

The number of loud speakers actually used in the tone cabinet is not important so long as the other requirements laid down are met.

In summary, the six basic features disclosed are:

- (1) A partially enclosed front baffle.
- (2) Enclosed and partially enclosed rear baffle.
- (3) Fixed resonator chamber coupled to the speaker.
- (4) Resonator chamber in rotor.
- (5) Minimum clearance between the rotor and the walls of the front baffle.
- (6) The secondary vibrato beat added to the normal vibrato beat.

I am aware that in the prior art, moving horns, vanes, speakers, drums, and deflectors, have been used to produce acoustic vibrato, but I am not aware that any of them have been used in structures similar to those disclosed herein, or that any of them have been as effective with organ tones of complex character as the present disclosure. And in fact, almost any of the prior art structures would be improved by the addition of the secondary vibrato beat feature.

Although for the purpose of illustrating and describing the invention certain preferred embodiments have been shown, it will be apparent to those skilled in the art that various modifications can be made, such as the use of different rotor shapes, or different baffle configurations, without departing from the basic principles of the invention. I therefore do not wish to be limited to the precise details set forth herein, but desire to include within the scope of the invention those modified forms by means of which similar results may be obtained in substantially the same way.

Having thus described my invention, I claim as follows:

1. In a tone cabinet for an electronic organ, a baffle enclosure, a speaker, a rotor for influencing sound from said speaker, means for rotating said rotor, said rotor comprising a main deflecting means, and a secondary deflecting means, said main deflecting means operating to produce a vibrato beat of one intensity, said secondary deflecting means operating to produce a secondary vibrato beat of lesser intensity.

2. In a sound radiating device of the class described, acoustic radiating means, means for restricting the radiation of sound in one direction, means for periodically altering the sound radiated in another direction, said latter means comprising means for imparting a first acoustic beat of normal vibrato rate, and a secondary acoustic beat, to the radiated sound.

3. In a device of the class described, a baffle enclosure, a loud speaker, means for imparting acoustic vibrato to the tones issuing from said loud speaker, means for causing said acoustic vibrato to have primary beats of one intensity and secondary beats of lesser intensity, said primary beats and said secondary beats being alternately spaced in time.

4. In a tone cabinet for an electronic organ, a horizontal speaker support, a partially enclosed rear baffle, a speaker, a front baffle, a rotor, said speaker mounted

upon said speaker support, with the body of said speaker within said rear baffle, said front baffle comprising two end walls and a rear wall vertically mounted upon said speaker support and a horizontal top member partially covering the top opening of said baffle, said horizontal top disposed rearward and adjacent said rear vertical wall, bearing means centrally located in said end walls, said rotor rotatably mounted in said bearings, mechanical means for rotating said rotor, the outermost edges of said rotor while in rotation, passing within approximately one quarter inch in each case, the surfaces of said speaker support, said vertical rear wall, and said horizontal top member, said rotor comprising means for causing a primary vibrato beat of one intensity and a secondary vibrato beat of a lesser intensity.

5. The combination set forth in claim 4 in which said rotor incorporates an acoustic resonator.

6. In a tone cabinet for an electronic organ, a partially enclosed rear baffle, a horizontal speaker mounting board, a speaker mounted thereon, a partially enclosed front baffle having four sides mounted vertically upon said speaker mounting board and forming a five sided box the top of which is open, bearing means centrally mounted in opposite ends of said box, a rotor comprising an acoustic resonating chamber, said rotor rotatably mounted in said bearings, the dimensions of said rotor being such that while it is in rotation the minimum practical clearance exists between the edges of the rotor and the walls of said box, means for mechanically rotating said rotor.

7. In a tone cabinet for an electronic organ, a partially enclosed rear baffle, a partially enclosed front baffle, a speaker mounting support, a speaker mounted thereon, a rotor, bearing mounting means for said rotor, means for rotating said rotor, said rotor comprising two flat vanes set at right angles to each other, one of said vanes being larger than the other.

8. In a tone cabinet for an electronic organ, a partially enclosed rear baffle, a partially enclosed front baffle, a speaker mounting support, a speaker mounted thereon, a rotor, bearing mounting means for said rotor, means for rotating said rotor, said rotor comprising an acoustic resonating chamber having at least three plane surfaces.

9. In a tone cabinet for an electronic organ, a horizontal speaker mounting board, an enclosed rear baffle, a speaker, a rotor, a partially enclosed front baffle, said speaker mounted upon said speaker board with the body of said speaker within said enclosed rear baffle, said front baffle comprising a six sided box, said speaker board forming the bottom of said box, bearing means centrally located in the opposite end walls of said box, said rotor rotatably mounted in said bearings, an opening in the top of said box opposite to said speaker, an opening in one of the sides of said box adjacent said speaker board, a fixed acoustic resonator located within said box and closely coupled to said speaker, said rotor incorporating a channel means of such configuration that when said rotor is in its vertical position sound is conducted from said speaker via the channel to the opening in said top, and mechanical means for rotating said rotor.

10. The combination set forth in claim 9 in which said fixed resonator is shaped like a hollow wedge having the top open to provide egress for the tones from said speaker.

11. In a device of the class described, at least one loud speaker, enclosure means serving both as an acoustic baffle and as means for restricting radiation of sound from one side of said speaker, means including fixed baffle walls and a rotatable member for modifying sound radiated from the opposite side of said speaker, said rotatable member comprising means for imparting a primary vibrato beat of one intensity and a secondary vibrato beat of lesser intensity, to the sound radiated from said speaker.

12. In a tone cabinet for an electronic organ, a loud speaker and a supporting means therefor, said supporting means serving also to restrict sound flowing from the

7

rear surface of said speaker, cooperative means for influencing sound flowing from the front surface of said speaker, said cooperative means comprising both fixed and movable members, said fixed members mounted upon said supporting means in a plane normal with the axis of said speaker, said movable member rotatably mounted in a plane at right angles to the axis of said speaker and closely adjacent said supporting means and said fixed members, said fixed members and said movable member cooperating to form a partially enclosed acoustic resonator during at least part of a revolution of said movable member.

13. The combination set forth in claim 12 in which said movable member comprises means for producing a primary influence and a secondary influence upon the sound flowing from the speaker.

14. The combination set forth in claim 12 in which said movable member comprises an acoustic resonator chamber having at least three plane surfaces.

15. In a tone cabinet for an electronic organ, speaker supporting means forming the upper surface of a box-like baffle enclosure, said enclosure having an opening along

8

the lower edge of one wall, speakers mounted upon the underside of said support means and directed upward, means for introducing an acoustic vibrato into the tones issuing from said speakers, said means comprising fixed members and a movable member, said fixed members comprising three walls mounted vertically upon said support means, and forming therewith four sides of a partial enclosure, the two opposite of said three walls having bearings means centrally mounted therein, said movable member comprising a narrow box shaped acoustic resonator open at top and bottom, and having a flat vane mounted longitudinally upon, and at right angles to, each of its long sides, said movable member being rotatably supported in said bearing means, mechanical means to cause said movable member to rotate.

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