Dec. 23, 1952 D. J. LESLIE 2,622,692

APPARATUS FOR IMPOSING VIBRATO ON SOUND

Original Filed July 9, 1945

Fig. 1.

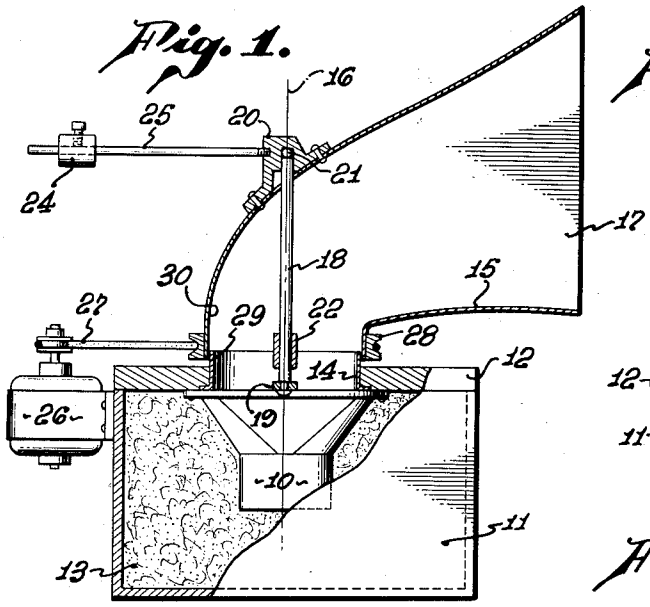



Fig. 3.

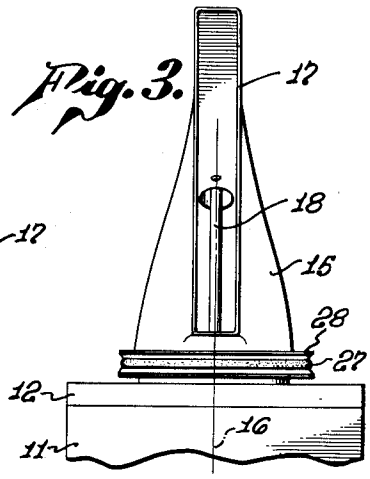



Fig. 2.

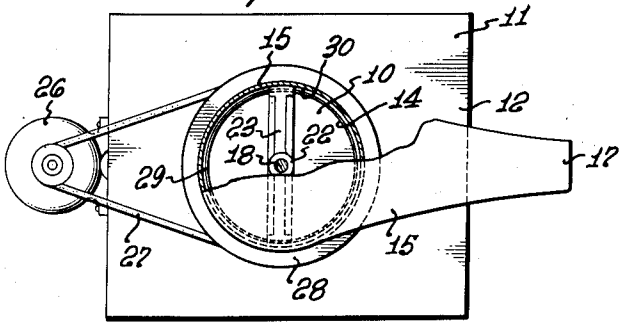



Fig. 4.

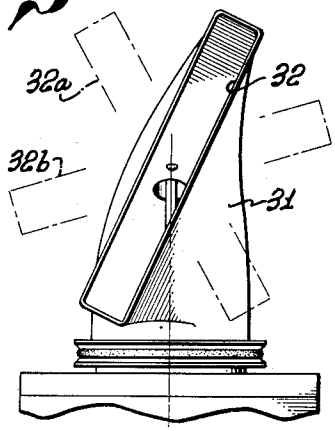



Fig. 5.

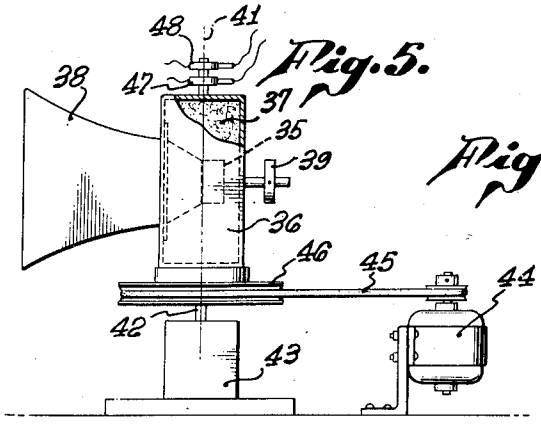
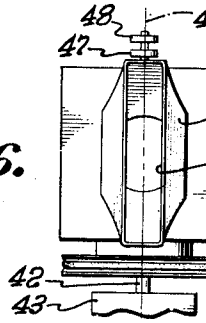



Fig. 6.

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# UNITED STATES PATENT OFFICE

2,622,692

## APPARATUS FOR IMPOSING VIBRATO ON SOUND

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Original application July 9, 1945, Serial No. 603,850. Divided and this application April 30, 1949, Serial No. 90,649

9 Claims. (Cl. 181—27)

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The present invention relates to the production of musical tones, and more particularly to the production of tones possessing pitch tremolo or vibrato.

This application is a division of my application for "Acoustic Apparatus," filed July 9, 1945, Serial No. 603,850, now Patent No. 2,489,653, which is a continuation-in-part of my application for "Acoustic Apparatus," filed December 10, 1940, Serial No. 369,413, now abandoned.

In playing an ordinary musical instrument, as a stringed or wind instrument, or in singing, the pleasing quality of the music may be enhanced by producing a pitch tremolo or vibrato. This vibrato effect, in the case of an instrument, is produced by a slight, rapid motion of the finger on the appropriate key or string, causing cyclic and rapid minor variations of pitch.

As described in the above applications, a tremolo effect can be produced by moving a sound transmitting channel at a certain rate. The sound transmitting channel may be associated with a loud speaker, the rotation of the channel causing its mouth to move alternately toward and away from the listener at a frequency corresponding to the vibrato; or the channel may be associated with a microphone, in which rotation of the sound channel causes its mouth to move toward and away from the source of sound. In both cases, the pitch of the sound issuing from a speaker and heard by the listener is alternately increased and decreased.

It has been found that proper vibrato effects are obtainable by moving the sound channel cyclically between 5 and 8 cycles per second.

It is an object of the present invention to provide a sound horn capable of producing a broader distribution of the sound, in order that more of the sound from the horn will be heard when it is moved toward and away from the listener.

Another object of the invention is to provide a sound horn in which a smoother and fuller vibrato effect is obtained as a result of rotating the horn at the desired frequency for producing vibrato effects.

Yet another object of the invention is to provide a rotating sound horn, in which all of the sound moves as nearly as possible at the same speed with respect to the listener at any given moment.

Another object of the invention is to provide a horn or other sound channel forming means having special radiating properties for improving the character of the vibrato.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown 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 such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

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Referring to the drawings:

Figure 1 is a vertical section through one form of the invention;

Fig. 2 is a plan view of the apparatus shown in Fig. 1;

Fig. 3 is an elevation as seen from the right hand side of Fig. 1;

Fig. 4 is a view similar to Fig. 3, but showing a modified form of apparatus;

Fig. 5 is a side elevation, partly in section, of another form of apparatus embodying the invention;

Fig. 6 is an elevation of the apparatus disclosed in Fig. 5, as seen from the left hand side thereof.

As described in the above referred to applications, the vibrato is obtained by cyclically moving an opening, through which sounds are emitted, toward and away from the listener, as by rotating a directing sound horn providing such opening. The rate of movement of the mouth toward and away from the listener is a function of the angular position of the horn, as well as of the length of the horn, such rate of movement approaching zero as the horn approaches a position pointing directly at the listener. Thus, the frequency change and the vibrato also approach zero. The amplitude of the sound is at a maximum with respect to the listener with the horn pointing at him, which further reduces the vibrato effect.

By modifying the usual radiation pattern of a sound horn to obtain broader distribution of the sound, more of the sound from the horn will be heard when the horn is moving toward and away from the listener. Also, the amplitude of the sound will be decreased when the horn is pointed directly at the listener. In this way, a smoother and fuller vibrato effect is obtained. This is particularly important at the higher frequencies where the usual sound horn is highly directive. Furthermore, it may be desirable to provide that all of the sound moves, as nearly as possible, at the same speed with respect to

the listener at any given moment. For this purpose, the horn mouth, or other sound emitting opening, should be narrow, or of small angular extent, in the plane of its rotation.

A speaker adapted for operation in the lower frequencies requires a mouth opening of considerable area; the mouth shape is thus preferably such that its dimension parallel with the axis of rotation is substantially greater than its dimension in the plane of its rotation. A horn of this nature is illustrated in Figs. 1, 2 and 3.

It can be shown that such a horn, having an opening with a dimension in one direction equal to several wave lengths of the sound emitted, and with a dimension in the other direction of less than one-quarter of such a wave length, is highly directive in the plane of its length, or long dimension, but has a broad radiation pattern in the plane of its width, or short dimension. Thus, a horn with a mouth of this character has the double advantage of providing a broad radiation pattern, as well as causing all of the emitted sound to advance with respect to the listener at a more nearly constant instantaneous speed.

In Figs. 1, 2 and 3, a speaker **10** is shown which may be of the type employing a moving cone as the air actuator. The speaker is supported within a casing **11**, and with its axis vertically disposed, by being secured to the top wall **12** of the casing **11**. The casing or enclosure serves to prevent radiation from the back of the speaker cone, and may be filled with rock wool or other sound absorbent material **13**. An opening **14** in the top wall **12** serves to transmit sound waves from the speaker **10** to a horn **15** mounted on the casing **11** for rotation about the speaker axis **16**. As clearly shown in Figs. 1 and 2, the mouth **17** of the horn **15** is quite narrow in the plane of rotation of the horn, to insure that sound waves emitted by the mouth all move at substantially the same speed with respect to a listener, as well as produce a broad radiation pattern. At the same time, the mouth **17** is quite long in a direction parallel with the axis to provide the necessary area.

The horn **15** is supported and guided for rotary movement by means of a stationary vertical shaft **18** mounted in a bar **19** extending across the opening **14** and fixed to the top casing wall **12**. This shaft **18** extends through the upper wall of the horn **15** into a thrust bearing structure **20**, a hardened ball **21** therein supporting the weight of the horn by engagement with the end of the shaft **18**. A radial bearing **22**, supported in the throat of the horn by a bar **23** extending across the throat of the horn and engaging the rod **18**, serves to guide the horn for rotary movement about the rod **18**.

A counterweight **24** adjustably mounted in an arm **25**, extending radially from the thrust bearing **20** opposite the horn **15**, serves to balance the weight of the horn **15** about the supporting ball **21**, thus reducing the pressure on the radial bearing due to the weight of the horn, as well as maintaining the horn in rotating balance.

The horn **15** is arranged to be rotated at an appropriate speed (5 to 8 cycles or revolutions per second), as previously discussed, by a small electric motor **26** mounted on the casing **11**, and connected by a belt **27** to a pulley structure **28** secured about the throat of the horn. A ring **29** is provided about the opening **14** and telescopes into the throat **30** of the horn **15** for sealing against escape of sound passing from the speaker **10** to the horn.

The character of the vibrato may be varied by providing rotating horns, such as just described, with differently proportioned mouths; for example, with mouths variously inclined in the direction of rotation. Fig. **4** is a front view similar to Fig. **3**, and shows a horn **31** which has a mouth **32**, the long dimension of which is oblique with respect to a plane normal to the axis of rotation. This angle of obliquity may be chosen as desired, as indicated by the mouth outlines **32***a* and **32***b*.

In the arrangements so far discussed, a rotating horn has been provided in connection with a stationary speaker. It may be desirable to provide for rotating the speaker, as in this way a better connection to the horn or other means forming the rotating mouth is possible, and the necessity of employing a curved horn is obviated.

Figs. 5 and 6 show a rotating speaker. Therein, a speaker **35** of any suitable type is shown as enclosed in a casing **36**, which may be filled with sound absorbent material **37** to prevent sound radiation from the back of the speaker. A directional horn **38** is mounted on the front of the casing **36** for cooperation with the speaker **35**, a suitable counterbalance **39** being provided on the back of the casing. As shown in Fig. 6, the mouth **40** of the horn **38** is of small angular extent in the plane of rotation and of considerable length parallel with the axis of rotation, thus providing the advantages of a narrow source and a broad radiation pattern, as previously discussed.

The speaker **35** and the horn **38** are supported for rotation about a vertical axis **41**, as by the casing **36** being secured to a vertical shaft **42** rotatably supported by a suitable bearing structure **43**. The casing **36** is shown as arranged to be driven by a small electric motor **44** connected by means of a belt **45** with a pulley **46** secured to the casing. Modulated current is fed to the speaker **35** by means of slip rings **47** and **48**. The horn **38**, being without bends, does not materially attenuate the higher frequencies.

The inventor claims:

1. In apparatus for imposing vibrato on sound, a source of said sound, means forming a sound channel having an opening for directing sound from said source, means mounting said channel forming means for angular movement about an axis spaced from the opening, means for continuously moving said channel forming means about said axis, said opening having a width in the direction of rotation that is less than the length of the opening in a direction transverse to a plane normal to said axis, the ratio of the length to the width being at least three to two, the length of said opening being inclined to any plane including said axis that passes through said opening.

2. In apparatus for imposing vibrato on sound, a source of said sound, and means forming a sound channel having an opening for directing sound from said source, means mounting said channel forming means for angular movement about an axis spaced from the opening, means for continuously moving said channel forming means about said axis, said opening being elongated in a direction transverse to a plane normal to said axis and of small angular extent in the direction of rotation, the length of said opening being inclined to any plane including said axis that passes through said opening.

3. In apparatus of the character described: means for translating electrical impulses into

sound waves; means forming a sound channel for transmitting said waves; said sound channel having edges forming an opening; means for continuously rotating said sound channel forming means about an axis substantially equidistant from said edges to impart orbital motion to said opening; said opening subtending a small angle with respect to said axis in the direction of movement and elongated in a direction transverse to the movement.

4. In apparatus for imposing vibrato on sound, a source of said sound, a stationary speaker for transmitting sound from said source, a horn communicating with said speaker and having an opening for directing sound from said speaker, means for continuously rotating said horn with respect to said speaker about an axis spaced from its opening, said opening being elongated in a direction parallel with said axis and of small angular extent with respect to said axis in the direction of rotation.

5. In apparatus for imposing vibrato on sound, a source of said sound, a speaker for transmitting sound from said source, a horn communicating with said speaker and having an opening for directing sound from said speaker, means for rotating said horn about an axis spaced from its opening, said opening being elongated in a direction parallel with said axis and of small angular extent in the direction of rotation, the length of said opening being inclined to any plane including said axis that passes through said opening.

6. In apparatus for imposing vibrato on sound, a source of said sound, a speaker for transmitting sound from said source, a horn fixed with respect to said speaker and having an opening for directing sound from said speaker, means for rotating said speaker and horn about an axis spaced from the opening, said opening being elongated in a direction parallel with said axis and of small angular extent in the direction of rotation.

7. In an apparatus for imposing vibrato on sound: a source of mechanical sound vibrations; means forming a sound channel having a throat continuously cooperating with said source; means mounting said sound channel for angular movement about an axis; said channel having edges forming an elongated opening for directing sound from said source, said opening being spaced from said axis, and directed radially outwardly thereof, said edges forming said opening lying in a plane



substantially parallel to said axis, said elongated opening being narrow in the direction of angular rotation of said channel whereby for any plane perpendicular to said axis, said opening subtends a narrow angle with respect to said axis; and means for continuously rotating said channel about said axis.

8. In an apparatus for imposing vibrato on sound: a source of mechanical sound vibrations; means forming a sound channel having a throat continuously cooperating with said source; means mounting said channel for angular rotation about an axis; said channel having an elongated opening for directing sound from said source, said opening being spaced from said axis, the length of said opening being inclined to any plane including said axis that passes through said opening, said elongated opening subtending a small angle with respect to said axis in the direction of angular rotation of said channel; and means for continuously rotating said channel about said axis.

9. In an apparatus for imposing vibrato on sound: a source of mechanical sound vibrations; means forming a sound channel having a throat continuously cooperating with said source; means mounting said sound channel for angular movement about an axis; said channel having an edge forming an elongated opening for directing sound from said source; said opening being spaced from said axis, said edges forming said opening being at substantially the same radial distance from said axis, said opening subtending a small angle with respect to said axis in a direction of angular rotation of said channel; and means for continuously rotating said channel about said axis.

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