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# (54) INTERFERENCE TUBE FOR A MICROPHONE

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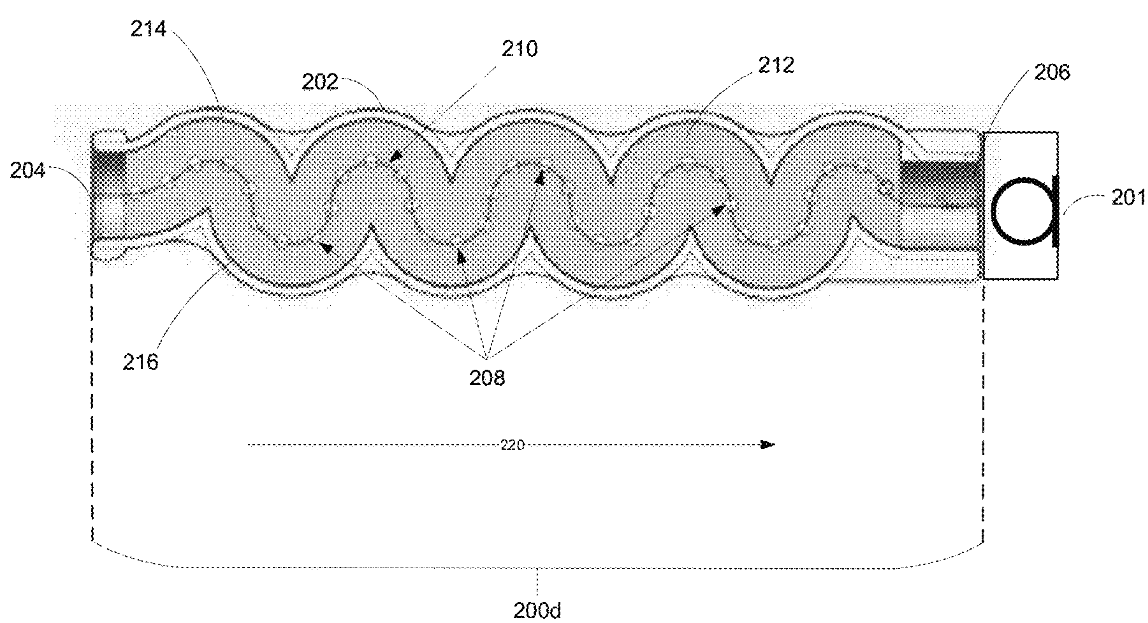
(57) **ABSTRACT**

Apparatuses and methods for a linearly compressed interference tube for use with microphones having an internal acoustic path with a geometry that approximates a longer interference tube within the same linear footprint in order to provide improved low-frequency attenuation and stable polar patterns in the microphones.

200



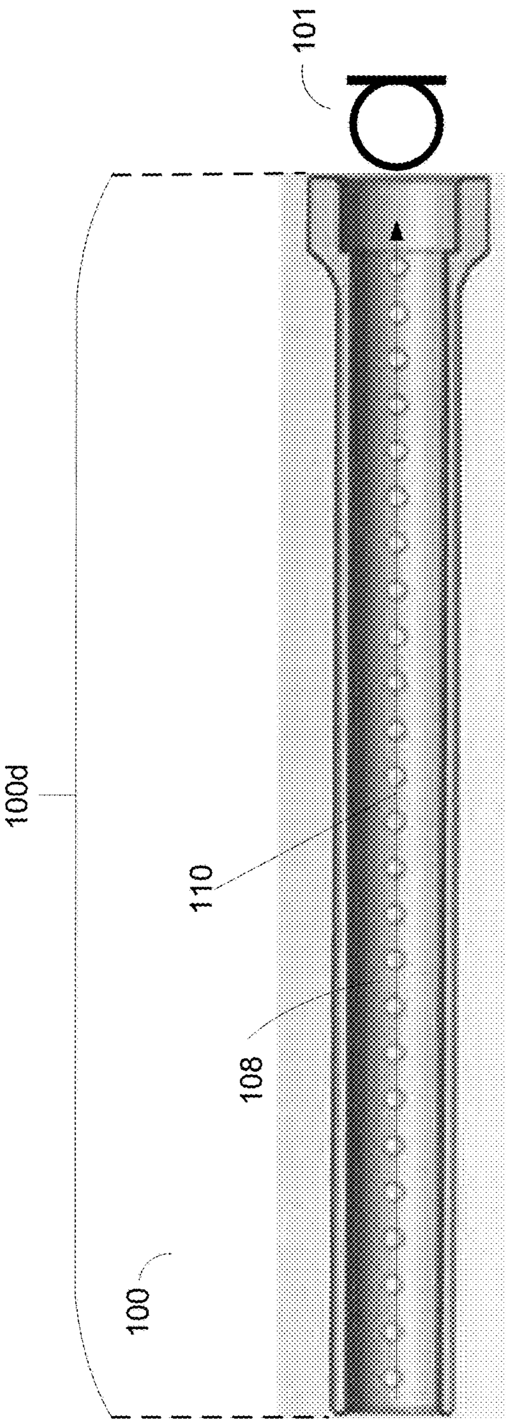



FIG. 1a

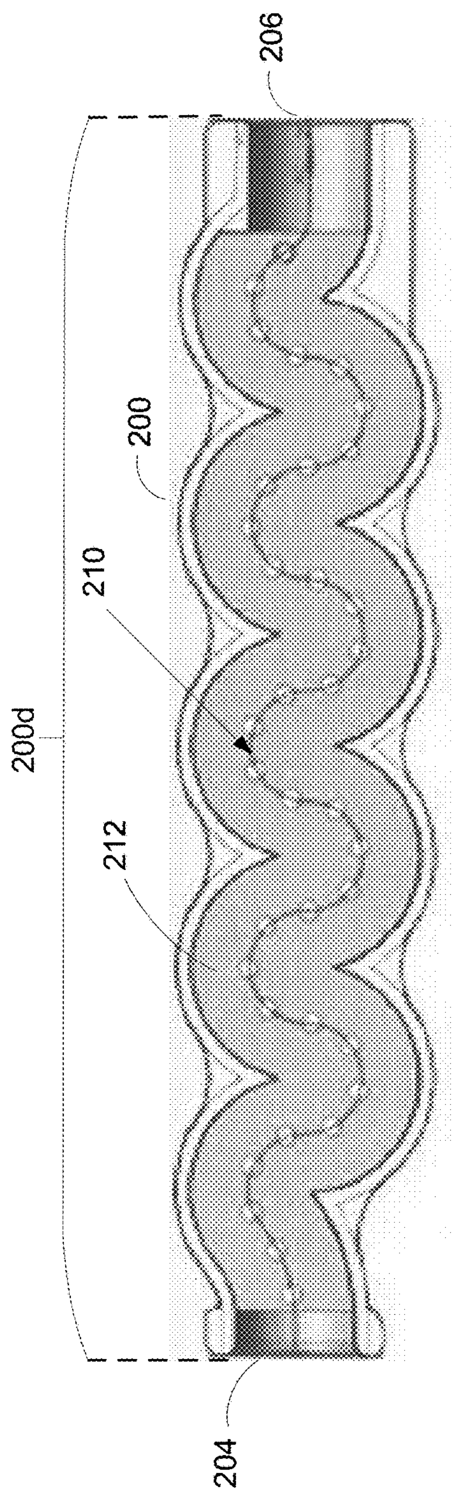



FIG. 1b

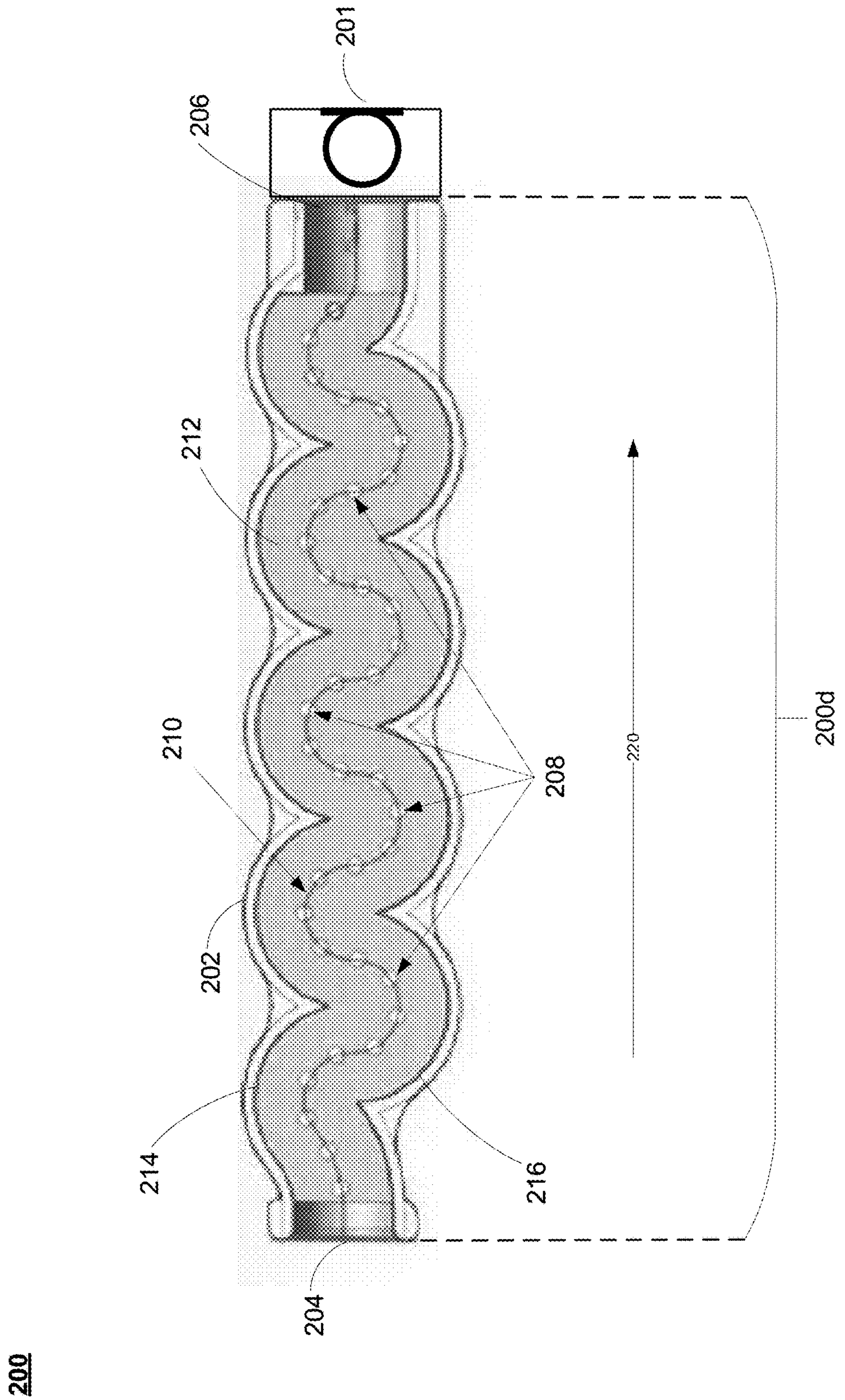



FIG. 2

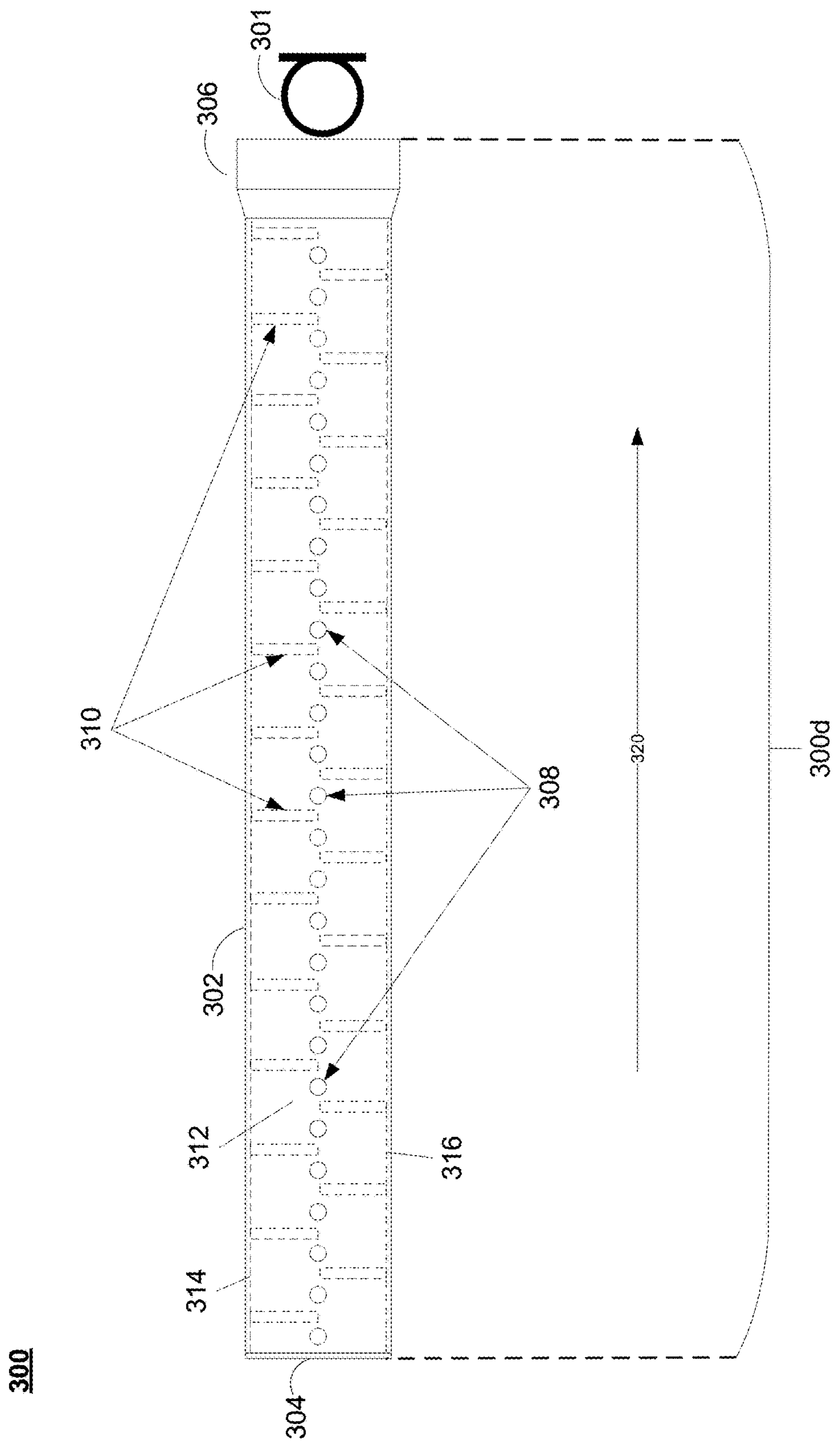



FIG. 3

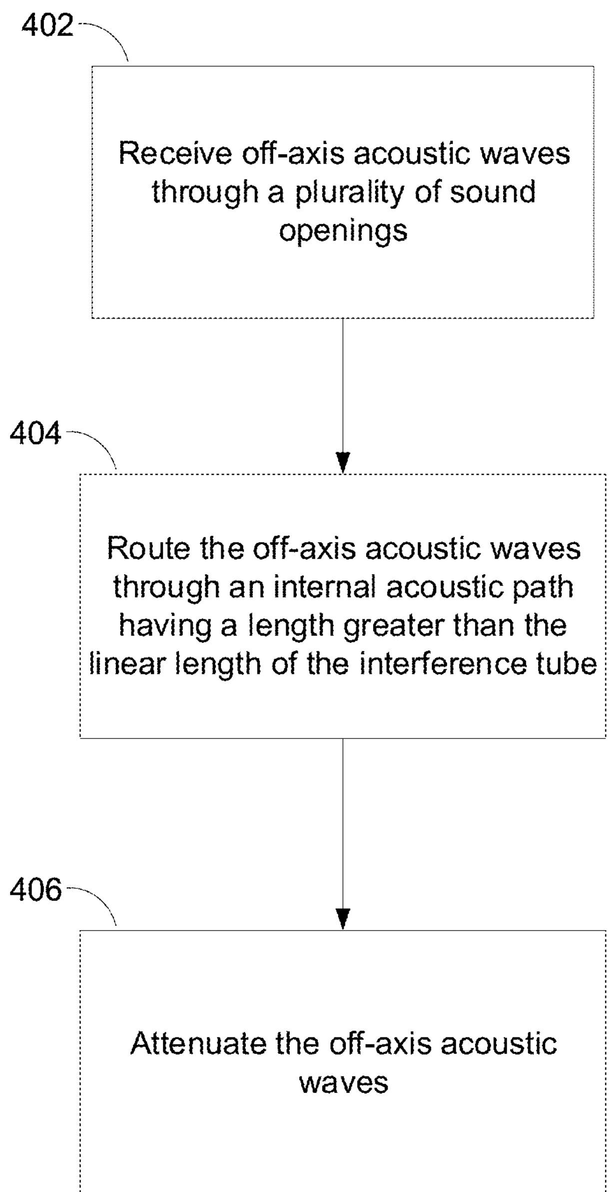

402
Receive off-axis acoustic waves through a plurality of sound openings
404
Route the off-axis acoustic waves through an internal acoustic path having a length greater than the linear length of the interference tube
406
Attenuate the off-axis acoustic waves

FIG. 4

# INTERFERENCE TUBE FOR A MICROPHONE

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims the benefit of U.S. Provisional Patent Application No. 63/554,029, filed on Feb. 15, 2024, which is fully incorporated by reference herein.

## FIELD

**[0002]** The present disclosure relates generally to an interference tube for use with shotgun-style microphones.

## BACKGROUND

**[0003]** Interference-type line microphones, otherwise known as "shotgun" microphones, are a highly directional type of microphone that can "reject" or dampen sounds coming from directions other than directly in front of the microphone capsule (i.e., sounds that are "off-axis"). Shotgun microphones sometimes include a straight, open-ended interference tube appended to the front of the microphone capsule. Off-axis sounds may enter the tube at various lengths from the capsule and may consequently arrive at the capsule out of phase with one another and experience phase interference or phase cancellation (also known as deconstructive interference). The lowest frequency that an interference tube can effectively cancel is a function of the length of the interference tube. Additionally, certain applications often dictate the permissible linear footprint, or length, of an interference tube.

## SUMMARY

**[0004]** The following presents a simplified summary of the disclosure in order to provide a basic understanding of some aspects of the disclosure. This summary is not an extensive overview of the disclosure. It is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. The following summary merely presents some concepts of the disclosure in a simplified form as a prelude to the more detailed description provided below.

**[0005]** Aspects of the disclosure pertain to an interference tube comprising an internal acoustic path having a greater length than an external dimension of the interference tube, and a plurality of sound entrance holes. The internal acoustic path may be configured to attenuate at least a first acoustic wave and a second acoustic wave that enter the internal acoustic path through one or more of the plurality of sound entrance holes. Based on the non-linear geometry of the internal acoustic path, the interference tube may attenuate acoustic waves having a lower frequency than that would be attenuated should the internal acoustic path be equal in length to the external dimension of the interference tube.

**[0006]** These as well as other novel advantages, details, examples, features and objects of the present disclosure will be apparent to those skilled in the art from following the detailed description, the attached claims and accompanying drawings, listed herein, which are useful in explaining the concepts discussed herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0007]** Some features are shown by way of example, and not by limitation, in the accompanying drawings. In the drawings, like numerals reference similar elements.

**[0008]** FIG. **1***a* illustrates an example interference tube.

**[0009]** FIG. **1***b* illustrates another example interference tube.

**[0010]** FIG. **2** further illustrates the example interference tube of FIG. **1***b*.

**[0011]** FIG. **3** illustrates another example interference tube.

**[0012]** FIG. **4** illustrates an example flow chart of a method that may be performed to implement one or more illustrative aspects described herein.

## DETAILED DESCRIPTION

**[0013]** In the following description of the various examples, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration various examples in which aspects may be practiced. References to "embodiment," "example," and the like indicate that the embodiment(s) or example(s) of the invention so described may include particular features, structures, or characteristics, but not every embodiment or example necessarily includes the particular features, structures, or characteristics. Further, it is contemplated that certain embodiments or examples may have some, all, or none of the features described for other examples. And it is to be understood that other embodiments and examples may be utilized and structural and functional modifications may be made without departing from the scope of the present disclosure.

**[0014]** Unless otherwise specified, the use of the serial adjectives, such as, "first," "second," "third," and the like that are used to describe components, are used only to indicate different components, which can be similar components. But the use of such serial adjectives is not intended to imply that the components must be provided in given order, either temporally, spatially, in ranking, or in any other way.

**[0015]** Also, while the terms "front," "back," "side," and the like may be used in this specification to describe various example features and elements, these terms are used herein as a matter of convenience, for example, based on the example orientations shown in the figures and/or the orientations in typical use. Nothing in this specification should be construed as requiring a specific three dimensional or spatial orientation of structures in order to fall within the scope of the claims.

**[0016]** As shown in FIG. **1***a*, linear interference tube **100** (hereinafter referred to as "tube **100**") may have a linear length, or linear footprint, of **100***d*. Linear interference tube **100** may include a hollow channel **108** that defines an internal acoustic path defined by arrow **110**. Internal acoustic path **110** may have the same length as the overall linear length **100***d* of tube **100**.

**[0017]** Tube **100** may be open-ended and may be appended to the front of microphone capsule **101**. Tube **100** may allow sound directly in front of microphone capsule **101** (i.e., "on-axis" sound) to enter tube **100**. Tube **100** may be configured to "reject" or dampen sounds coming from directions other than directly in front of the microphone capsule (i.e., sounds that are "off-axis"). Off-axis sounds may enter the tube at various lengths from the capsule and may consequently arrive at the capsule out of phase with one another and experience phase interference or phase cancellation (also known as deconstructive interference).

**[0018]** As discussed above, tube **100** may be configured to cancel, or attenuate, sounds off-axis to capsule **101**. For example, tube **100** may include a plurality of sound entrance holes **112** (hereinafter referred to as "holes **112**") disposed along tube **100**. Holes **112** may provide channels through which sound waves propagate into channel **108**. That is, holes **112** may permit off-axis sound waves to enter channel **108** at various lengths relative to microphone capsule **101**. Sound waves that enter channel **108** at different lengths relative to microphone capsule **101** may arrive at microphone capsule **101** out of phase with one another. Consequently, due to destructive interference, those unwanted off-axis sounds may be attenuated by the time they reach microphone capsule **101**. However, the lowest frequency that tube **100** can effectively attenuate is a function of length **100***d* of tube **100**. That is, the lower the frequency a user wishes to attenuate, or cancel, the longer dimension **100***d* must be. Additionally, certain applications often dictate the permissible maximum linear footprint, or length, of an interference tube. Therefore, it might not be practical in some applications to use an interference tube with a given dimension **100***d*.

**[0019]** FIG. **1***b* illustrates an example interference tube **200** (hereinafter referred to as "tube **200**") that may be used to implement one or more illustrative aspects described herein. As shown in FIG. **1***b*, tube **200** may include an internal acoustic path **210** (illustrated by the line) defined by channel **212**. Tube **200** may have an overall linear length, or linear footprint, represented by **200***d*. Dimension **200***d* may be the same or substantially the same length as **100***d*. Alternatively, dimension **200***d* may be shorter or longer than **100***d*.

**[0020]** Internal acoustic path **210** may be longer in overall length than internal acoustic path **110** due to the non-linearity of internal acoustic path **210**. A line connecting the midpoints of front opening **204** and rear opening **206** may define an axis about which internal acoustic path **210** may be formed. Internal acoustic path **210** may be formed by routing tube **200** off-axis in one or multiple dimensions, that is, arranging internal acoustic path **210** non-linearly with respect to said axis defined by the line having endpoints at front opening **204** and rear opening **206**. Internal acoustic path **210** may be constructed with any number of non-linear geometries, or shapes, such a sinusoidal waveform (as is shown in FIG. **1***b*), a helical geometry, and the like. Internal acoustic path **210** may be unidimensional (or monoplanar) with respect to the axis defined by the line connecting front opening **204** and rear opening **206**. Internal acoustic path **210** may occupy one or more planes with respect to the axis defined by the line connecting front opening **204** and rear opening **206** (i.e., the non-linearity of internal acoustic path **210** may occur in one or more planes with respect to the axis defined by the line connecting front opening **204** and rear opening **206**).

**[0021]** For purposes of illustrating the relationship between the lowest frequency that an interference tube can effectively cancel and the length of the interference tube, consider the following formulas. The wavelength of a sound wave is given by Formula (1) below, where v is the speed of sound in air and f is the frequency of the sound wave.

$$\lambda = \frac{v}{f}. \qquad \text{Formula (1)}$$

**[0022]** The path difference required for maximum destructive interference of two sound waves with a known frequency is given by Formula (2) below, where x is the path difference to cause destructive interference.

$$x = \frac{\lambda}{2}. \qquad \text{Formula (2)}$$

**[0023]** Using a target frequency of 1000 Hz as an example, and assuming that v=343 meters per second (m/s) at 21° C., it follows from Formulas (1) and (2) that the minimum path difference required for destructive interference is 0.1715 meters, or approximately 6.75 inches. Assuming also for purposes of illustration only that dimension **100***d*=5.2 inches, interference tube **100** may only be effective in reducing off-axis sound down to about 1,300 Hz. Therefore, because half the wavelength of a 1000 Hz sound wave is greater than exterior dimension **100***d*, interference tube **100** may not effectively reduce off-axis sound waves having at least a frequency of 1000 Hz. Regarding tube **200**, sound waves must travel along an internal acoustic path **210**, which may have a distance longer than exterior dimension **200***d*. Accordingly, tube **200** may approximate a "longer" interference tube while having the same or similar exterior dimension **200***d* as dimension **100***d* of tube **100**, which translates to a lower frequency at which tube **200** may effectively attenuate (or cancel, reduce, reject, etc.) off-axis sound waves. For illustration only, assume the length of the internal acoustic path **210** is about 0.191 m, or 7.5 inches. Accordingly, because the length of the internal acoustic path **210** is greater than half the wavelength of a 1000 Hz sound wave, tube **200** may effectively reduce off-axis sound waves having at least a frequency of about 1000 Hz by providing a distance, or internal acoustic path **210**, sufficient for the sound waves to deconstructively interfere with one another in channel **212**. The above values for target frequency, exterior dimension **100***d*, exterior dimension **200***d*, and internal acoustic path **210** are merely examples. As such, any value for target frequency, exterior dimension **100***d*, exterior dimension **200***d*, and internal acoustic path **210** may be used in examples, such as 100 Hz, 200 Hz, 300 Hz, 400 Hz, 1100 Hz, 1200 Hz, etc., for target frequency; 3 inches, 4 inches, 4.5 inches, 5 inches, 5.5 inches, 6 inches, etc. for exterior dimension **100***d;* 3 inches, 4 inches, 4.5 inches, 5 inches, 5.5 inches, 6 inches, 7 inches etc. exterior dimension **200***d*; and 4 inches, 4.5 inches, 5 inches, 5.5 inches, 6 inches, 6.5 inches, 7 inches, 8 inches, 8.5 inches, etc. for internal acoustic path **210**.

**[0024]** FIG. **2** illustrates tube **200** coupled to microphone capsule **201** and also illustrates additional features of tube **200**. Tube **200** may be coupled to or appended to microphone capsule **201**. Microphone capsule **201** may be integral to tube **200**. Microphone capsule **201** may be any type of capsule, such as a condenser (such as a large- or small-diaphragm capsule or an electret condenser), dynamic (such as a moving coil or ribbon microphone capsule), and/or micro-electromechanical systems (MEMS), among others.

Microphone capsule **201** may be constructed according to one or more geometries (such as round, oval, elliptical, rectangular, etc.).

**[0025]** Tube **200** may include an outer frame **202**. Outer frame **202** may be constructed according to a number of shapes, or three-dimensional geometries, including cylindrical, square, rectangular, triangular, etc. As discussed above, frame **202** may include a front opening **204** and a rear opening **206**. Frame **202** may include channel **212**. Channel **212** may be formed by a first interior wall, or sidewall, **214** and a second interior wall, or sidewall, **216**. Front opening **204** and rear opening **206** may form the ends of channel **212**. Front opening **204** may permit on-axis sound waves to enter channel **212**. The on-axis sound waves may travel through channel **212** to opening **206** and microphone capsule **201** (i.e., in the direction of arrow **220**). Outer frame **202** may include microphone capsule **201**.

**[0026]** Tube **200** may include a plurality of sound entrance holes **208** (hereinafter referred to as "holes **208**") disposed along outer frame **202** and integral to outer frame **202**. Holes **208** may provide channels through which sound waves outside frame **202** may propagate into channel **212**. That is, holes **208** may permit off-axis sound waves to enter channel **212** at various lengths relative to microphone capsule **201**. Sound waves that enter channel **212** at different lengths relative to microphone capsule **201** may arrive at microphone capsule **201** out of phase with one another. Consequently, due to destructive interference, those unwanted off-axis sounds may be attenuated by the time they reach microphone capsule **201**.

**[0027]** Holes **208** may be disposed along frame **202** according to a number of arrangements. For example, holes **208** may be arranged in a linear fashion (i.e., in a straight line) along the length of frame **202** from opening **204** to opening **206**. Holes **208** may be arranged in a non-linear (i.e., not in a straight line) fashion along the length of frame **202**. Holes **208** may be arranged according to the geometry of internal acoustic path **210**. Holes **208** may be evenly spaced, although they may also be unevenly spaced. Tube **200** may include any number of holes **208** along frame **202**. Holes **208** may be disposed on one or more sides of frame **202**.

**[0028]** Frame **202** may share a similar geometry as channel **212**. That is, if channel **212** has a sinusoidal geometry, frame **202** may also have a sinusoidal geometry. However, the geometries, or shapes, of frame **202** and channel **212** may be different from one another. In other words, if channel **212** has a sinusoidal geometry, frame **202** may have a rectangular, square, etc. geometry.

**[0029]** Channel **212** may form or define an internal acoustic path **210** through which acoustic waves may travel through channel **212** in the general direction of arrow **220** toward microphone capsule **201**. In an example, channel **212** may be arranged with a geometry approximating a sinusoidal waveform with a given wavelength. Consequently, the path that sound waves must take through channel **212** (i.e., along internal acoustic path **210**) may be dictated by the geometry of channel **212**. In other words, channel **212** may prevent sound waves that enter holes **208** from traveling in a linear path from a respective hole **208** through channel **212** to microphone capsule **201**, thus causing the sound waves to travel in a sinusoidal-like path through channel **212** toward microphone capsule **201**.

**[0030]** As discussed above, internal acoustic path **210** may differ in length than an exterior dimension **200*d*** of tube **200**, in this example the linear length of tube **200**. In an example, the length of internal acoustic path **210**, or the distance sound waves must travel from any hole **208** through channel **212** to microphone capsule **201**, may be greater than the corresponding length of tube **200** measured from said hole **208** to microphone capsule **201**. Based on the length of acoustic path **210** being greater than the corresponding exterior dimension **200*d*** of tube **200**, tube **200** may possess similar time and/or phase delay characteristics as a tube with a greater exterior dimension than dimension **200*d***. As a result, tube **200** may have an extended low-frequency attenuation capability than an interference tube having the same linear footprint but lacking the non-linear internal acoustic path of tube **200*d***. Tube **200** may effectively reduce off-axis sound waves having a given frequency or occupying one or more frequency ranges by providing a space sufficient for the sound waves to deconstructively interfere with one another in channel **212** before reaching microphone capsule **201**. A person of ordinary skill in the art would understand that the omission of some or all of these features from tube **200** does not depart from the scope of this disclosure.

**[0031]** FIG. **3** illustrates a side-view of an example interference tube **300** (hereinafter referred to as "tube **300**") that may be used to implement one or more illustrative aspects described herein. Tube **300** may be coupled to or appended to microphone capsule **301**. As with tube **200**, microphone capsule **301** may be any type of capsule, such as condenser (e.g., including large- and small-diaphragm and electret condenser), dynamic (e.g., including moving coil and ribbon microphones), and/or micro-electromechanical systems (MEMS), among others. Microphone capsule **301** may be constructed according to one or more geometries (e.g., round, oval, elliptical, rectangular, etc.).

**[0032]** Tube **300** may include an outer frame **302**. Outer frame **302** may be constructed according to a number of geometries, including cylindrical, square, rectangular, triangular, etc. Frame **302** may include a front opening **304** and a rear opening **306**. Frame **302** may include channel **312**. Channel **312** may be formed by sidewalls **314** and **316**. Front opening **304** and rear opening **306** may form the ends of channel **312** and may permit on-axis sounds to travel from opening **304**, through channel **312**, to opening **306** and microphone capsule **301** (i.e., in the direction of arrow **320**).

**[0033]** Tube **300** may include a plurality of sound entrance holes **308** (hereinafter referred to as "holes **308**") disposed along outer frame **302** and integral to outer frame **302**. Holes **308** may provide channels through which sound waves outside frame **302** may propagate into channel **312**.

**[0034]** That is, holes **308** may permit off-axis sound waves to enter channel **312**. Holes **308** may be disposed along frame **302** according to a number of arrangements. For example, holes **308** may be arranged in a linear fashion (i.e., in a straight line) along the length of frame **302** from opening **304** to opening **306**. Holes **308** may be arranged in a non-linear (i.e., not in a straight line) fashion along the length of frame **302**. Holes **308** may be evenly spaced, although they may also be unevenly spaced. Tube **300** may include any number of holes **308** along frame **302**. Holes **308** may be disposed on one or more sides of frame **302**.

**[0035]** Tube **300** may include a plurality of obstruction baffles **310** (hereinafter referred to as "baffles **310**"). Tube **300** may include various numbers of baffles **310** (i.e., **1**, **2**, 3, 4, 5, 6, 10, etc.). Baffles **310** may be constructed from a number of materials, including materials that display sound-dampening qualities. Baffles **310** may be constructed from any number of resilient, non-porous materials, such as any number of polymers, metals, and the like. Baffles **310** may be coupled to a first interior wall, or sidewall, **314** and/or a second interior wall, or sidewall, **316**. Baffles **310** may be integrally molded to sidewalls **314** and/or **316**. Baffles **310** may extend lengthwise into channel **312**. Baffles **310** may extend various distances from sidewalls **314** and/or **316** into channel **312**. Some of baffles **310** may extend a first distance from sidewalls **314** and/or **316** into channel **312**, while other baffles **310** may extend a second distance from sidewalls **314** and/or **316** into channel **312**. The first distance may be greater than, equal to, or smaller than the second distance.

**[0036]** Baffles **310** may form or define an internal acoustic path (not shown) through which acoustic waves may travel through channel **312** in the general direction of arrow **320** toward microphone capsule **301**. In other words, baffles **310** may prevent sound waves that enter holes **308** from traveling in a linear path from their entrance point into channel **312** to microphone capsule **301**, thus causing the sound waves to travel in a serpentine-like path around baffles **310**. Accordingly, the internal acoustic path defined by baffles **310** may differ in length than an exterior dimension **300*d*** of tube **300**, in this example the length of tube **300**. In an example, the length of the internal acoustic path, or the distance sound waves must travel from any hole **308** through channel **312** to microphone capsule **301**, may be greater than the corresponding length of tube **300** measured from said hole **308** to microphone capsule **301**. Based on the length of the acoustic path being greater than the corresponding length of tube **300**, tube **300** may possess similar time and/or phase delay characteristics as a tube with a greater exterior dimension **300*d***. As a result, tube **300** may have an extended low-frequency attenuation capability than an interference tube having the same linear footprint but lacking the non-linear internal acoustic path of tube **300*d***.

**[0037]** FIG. **4** illustrates an example flow chart of a method **300** that may be performed. Some or all of the steps may be performed by interference tube **200**. While the method shows particular steps in a particular order, the method may be further subdivided into additional sub-steps, steps may be combined, the steps may be performed in other orders, and some steps may be omitted without necessarily deviating from the concepts described herein.

**[0038]** In operation, interference tubes **200**, **300**, or a structural equivalent (such as any cylindrical, rectangular, triangular, square, etc.) may receive one or more acoustic waves through one or more sound openings **208**, **308**, respectively. For purposes of simplicity, features of tube **200** will be referenced; however, it should be understood that the same applies to similar or equivalent features of tube **300** (i.e., internal acoustic path **208** of tube **200** corresponds to channel **312** of tube **300**, and so on). In an example, tube **200** may receive a first acoustic wave may through a first opening **208**, and a second acoustic wave (of the same or similar frequency) via a second opening **208** (step **402**). The second opening may be closer to microphone capsule **201** or further from microphone capsule **201** than the first opening. The interference tube may route the first and second acoustic waves through internal acoustic path **210** (step **404**). As has been discussed, the length of internal acoustic path **210** may be greater than dimension **200*d*** of tube **200**. As the first and second acoustic wave propagate toward microphone capsule **201**, the waves may experience destructive interference according to the disclosure herein. Accordingly, tube **200** may significantly attenuate or cancel the first and second acoustic waves by the time the first and second acoustic waves reach a terminal end of tube **200** (such as, for example, rear opening **206** of tube **200**) before reaching microphone capsule **201** (step **406**). Microphone capsule **201** may be affixed to the terminal end of tube **200**. Tube **200** may provide to microphone capsule **201** on-axis acoustic waves but might not provide the off-axis first and second acoustic waves due to their significant attenuation or interference with one another.

**[0039]** A method may be provided for attenuating sound received by a microphone. The method may comprise one or more operations. The method may comprise receiving, by an interference tube, a first off-axis acoustic wave through a first sound opening and receiving a second off-axis acoustic wave through a second sound opening. The method may comprise routing the first off-axis acoustic wave and the second off-axis acoustic wave through an internal acoustic path of the interference tube, wherein the internal acoustic path is longer than an external dimension of the interference tube. The method may comprise attenuating the first off-axis acoustic wave and the second off-axis acoustic wave. The first acoustic wave may travel a first distance through the internal acoustic path and the second acoustic wave may travel a second distance through the internal acoustic path, wherein the first distance may be greater than the second distance. The internal acoustic path may be formed with a geometry that approximates a sinusoidal waveform. The internal acoustic path may be formed with a helical geometry. The method may further comprise affixing a terminal end of the interference tube to a microphone. An interference tube may be provided that is configured to perform the above-described method. A microphone may be configured with the above-described interference tube. A system may comprise a microphone that may be configured with the above-described interference tube.

**[0040]** An interference tube for a microphone may comprise one or more components. The interference tube may comprise an internal acoustic path longer than an external dimension of the interference tube. The interference tube may comprise a plurality of sound entrance holes configured to receive a first acoustic wave and a second acoustic wave. The internal acoustic path may be configured to attenuate the first acoustic wave and the second acoustic wave. The internal acoustic path may be non-linear. The internal acoustic path may be disposed in one or more planes about an axis defined by a front opening of the interference tube and a terminal end of the interference tube. The internal acoustic path may be configured as a geometric waveform. The internal acoustic path may be configured with a helical geometry. The interference tube may further comprise a microphone capsule. The interference tube may further comprise a plurality of obstruction baffles disposed along a first interior wall and a second interior wall of the interference tube. The plurality of sound entrance holes may be arranged on an exterior frame of the interference tube according to the shape of the internal acoustic path.

**[0041]** An interference tube for a microphone may comprise a plurality of obstruction baffles disposed along a first interior wall and a second interior wall of the interference tube. An interference tube for a microphone may comprise an internal acoustic path defined by the plurality of obstruction baffles. The internal acoustic path may be longer than an external dimension of the interference tube. An interference tube may comprise a plurality of sound entrance holes. The internal acoustic path may be configured to attenuate at least a first acoustic wave and a second acoustic wave that enter the internal acoustic path through one or more of the plurality of sound entrance holes. The plurality of sound entrance holes may be arranged on an exterior housing of the interference tube according to the shape of the internal acoustic path. The internal acoustic path may be configured as a geometric waveform. The internal acoustic path may be configured to occupy one or more planes about an axis defined by a front opening of the interference tube and a terminal end of the interference tube. The internal acoustic path may be configured with a helical geometry.

**[0042]** In the foregoing specification, the present disclosure has been described with reference to specific exemplary examples thereof. Although the invention has been described in terms of a preferred example, those skilled in the art will recognize that various modifications, examples or variations of the invention can be practiced within the spirit and scope of the invention as set forth in the appended claims. The specification and drawings are, therefore, to be regarded in an illustrated rather than restrictive sense. Accordingly, it is not intended that the invention be limited except as may be necessary in view of the appended claims.

**1**. An interference tube for a microphone, wherein the interference tube comprises:

an internal acoustic path longer than an external dimension of the interference tube; and

a plurality of sound entrance holes configured to receive a first acoustic wave and a second acoustic wave, wherein the internal acoustic path is configured to attenuate the first acoustic wave and the second acoustic wave.

**2**. The interference tube of claim **1**, wherein the internal acoustic path is non-linear.

**3**. The interference tube of claim **1**, wherein the internal acoustic path is disposed in one or more planes about an axis defined by a front opening of the interference tube and a terminal end of the interference tube.

**4**. The interference tube of claim **1**, wherein the internal acoustic path is configured as a geometric waveform.

**5**. The interference tube of claim **1**, wherein the internal acoustic path is configured with a helical geometry.

**6**. The interference tube of claim **1**, further comprising a microphone capsule.

**7**. The interference tube of claim **1**, further comprising a plurality of obstruction baffles disposed along: a first interior wall of the interference tube, and a second interior wall of the interference tube.

**8**. The interference tube of claim **1**, wherein the plurality of sound entrance holes are arranged on an exterior frame of the interference tube according to a shape of the internal acoustic path.

**9**. A method for attenuating sound received by a microphone, wherein the method comprises:

receiving, by an interference tube, a first off-axis acoustic wave through a first sound opening and a second off-axis acoustic wave through a second sound opening;

routing the first off-axis acoustic wave and the second off-axis acoustic wave through an internal acoustic path of the interference tube, wherein the internal acoustic path is longer than an external dimension of the interference tube; and

attenuating the first off-axis acoustic wave and the second off-axis acoustic wave.

**10**. The method of claim **9**, wherein the routing comprises the first acoustic wave traveling a first distance through the internal acoustic path and the second acoustic wave traveling a second distance through the internal acoustic path, wherein the first distance is greater than the second distance.

**11**. The method of claim **9**, wherein the routing the first off-axis acoustic wave and the second off-axis acoustic wave through the internal acoustic path follows a geometry that approximates a sinusoidal waveform.

**12**. The method of claim **9**, wherein the routing the first off-axis acoustic wave and the second off-axis acoustic wave through the internal acoustic path follows a helical geometry.

**13**. The method of claim **9**, further comprising affixing a terminal end of the interference tube to a microphone.

**14**. An interference tube for a microphone comprising:

a plurality of obstruction baffles disposed along a first interior wall of the interference tube and along a second interior wall of the interference tube; and

an internal acoustic path defined by the plurality of obstruction baffles, wherein the internal acoustic path is longer than an external dimension of the interference tube.

**15**. The interference tube of claim **14**, further comprising a plurality of sound entrance holes.

**16**. The interference tube of claim **15**, wherein the internal acoustic path is configured to attenuate at least a first acoustic wave and a second acoustic wave that enter the internal acoustic path through one or more of the plurality of sound entrance holes.

**17**. The interference tube of claim **15**, wherein the plurality of sound entrance holes is arranged on an exterior housing of the interference tube according to a shape of the internal acoustic path.

**18**. The interference tube of claim **14**, wherein the internal acoustic path is configured as a geometric waveform.

**19**. The interference tube of claim **14**, wherein the internal acoustic path is configured to occupy one or more planes about an axis defined by: a front opening of the interference tube, and a terminal end of the interference tube.

**20**. The interference tube of claim **14**, wherein the internal acoustic path is configured with a helical geometry.

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