April 14, 1936. E. C. WENTE 2,037,187

SOUND TRANSLATING DEVICE

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FIG. 1

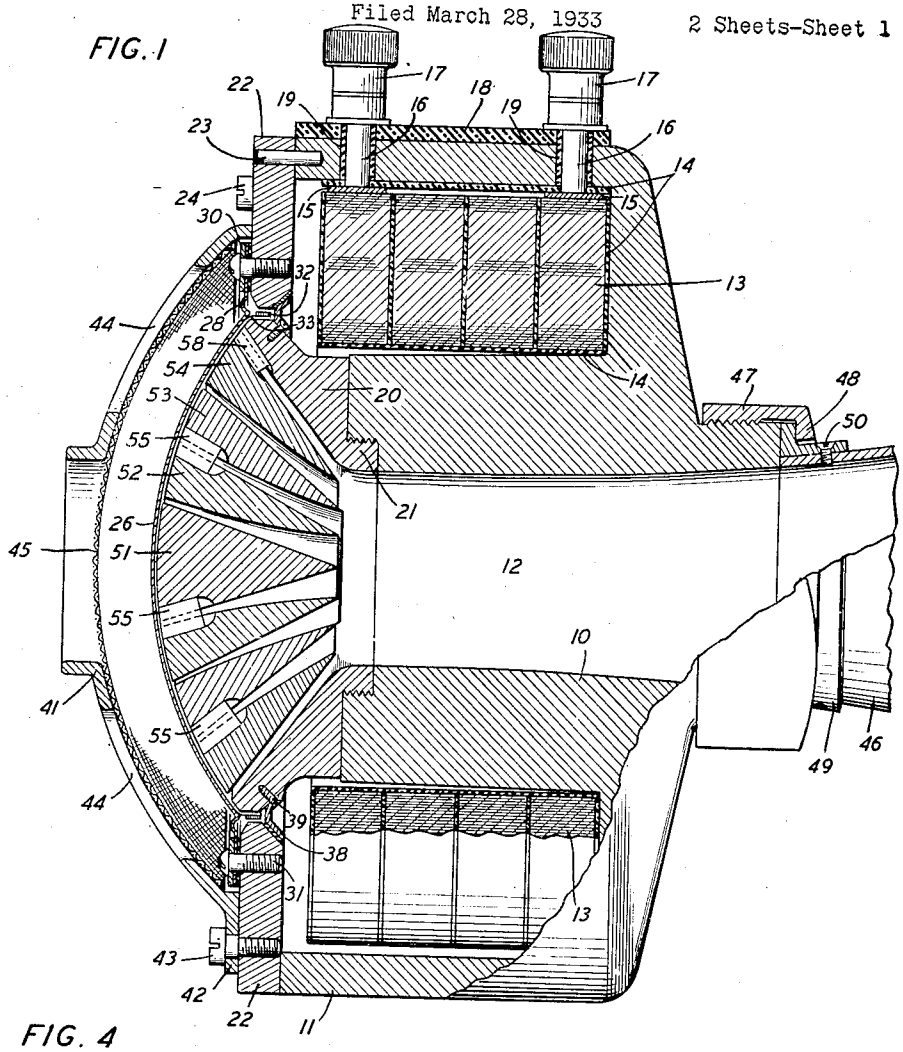
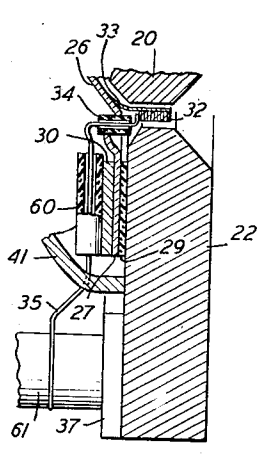


FIG. 4



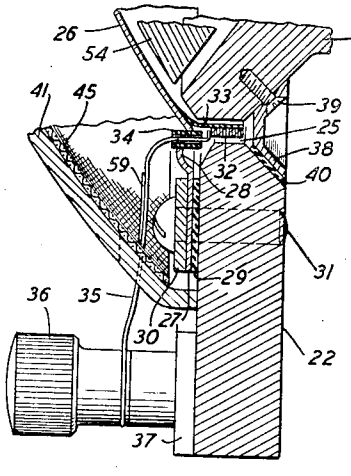


FIG. 3

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FIG. 2

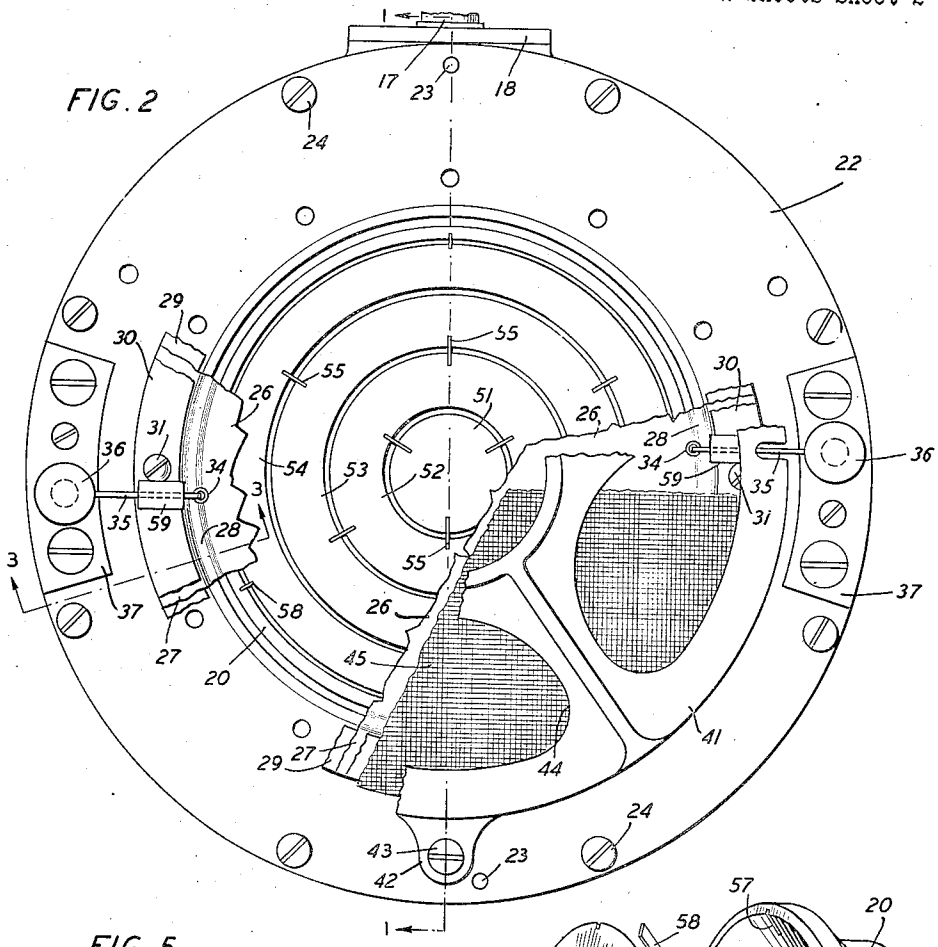
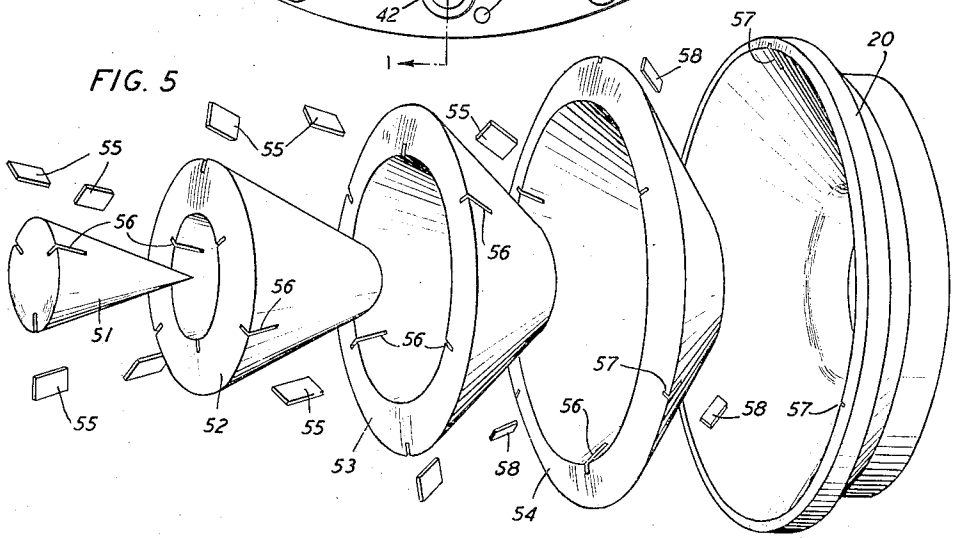


FIG. 5



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Patented Apr. 14, 1936

2,037,187

UNITED STATES PATENT OFFICE

2,037,187

SOUND TRANSLATING DEVICE

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Application March 28, 1933, Serial No. 663,133

16 Claims. (Cl. 179—115.5)

This invention relates to sound translating devices and more particularly to loudspeakers of the horn type.

In the translation of sound, for example, in the transmission or reproduction of speech and music, it is desirable that the translating device be capable of transmitting or reproducing all the frequencies of importance in the audio frequency range with fidelity and with uniform intensity and efficiency. Horn type loudspeakers, in general, have a relatively low cut-off so that the higher sound frequencies and hamonics are in effect suppressed and high quality reproduction of speech and music, therefore, is not obtained. This cut-off characteristic is traceable in a large measure to the fact that the sound waves emanating from the various portions of the diaphragm of the loudspeaker traverse paths of unequal length in passing to the throat of the horn so that the sound waves propagated from all points of the diaphragm do not reach the throat of the horn in phase. For the low frequency waves the disparity in phase is not particularly detrimental but at the higher frequencies the phase difference is sufficient to cause a marked neturalization of the sound waves so that the high frequencies of speech and music are diminished in intensity or materially suppressed.

One object of this invention is to reproduce speech and music efficiently and faithfully throughout a wide range of frequencies.

In accordance with a feature of this invention, a plurality of sound ducts of substantially equal length are provided between one surface of a diaphragm in a loudspeaker and the throat of a horn acoustically coupled therewith, so that sound waves emanating from all parts of the radiating portion of the diaphragm traverse paths of substantially equal length in passing to the thoat of the horn and hence reach the throat substantially in phase.

In a specific embodiment of this invention, a loudspeaker comprises a magnet having coaxial pole pieces disposed one within the other, the inner of said pole pieces having a bore therein adapted to be coupled at one end to the throat of a horn. A diaphragm is mounted adjacent the other end of the bore and is provided with a dome-shaped portion in axial alignment with the bore. A tapered or conical and a plurality of hollow tapered or substantially frusto-conical members are disposed intermediate the dome-shaped portion of the diaphragm and the adjacent end of the bore in the inner pole piece and are spaced to provide a plurality of annular sound ducts extending from immediately adjacent the surface of the diaphragm directed toward the bore, and converging with respect to the axis of the bore. The conical members may be so designed that the area of the sound ducts increases exponentially toward the bore and preferably with the same taper as the horn.

The invention and the various features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawings in which:

Fig. 1 is a side view partly in cross-section of a horn type loudspeaker illustrative of one embodiment of this invention;

Fig. 2 is an end view of the loudspeaker shown in Fig. 1 with portions broken away to show details of construction more clearly;

Fig. 3 is an enlarged detail view in cross-section illustrating the manner in which the leading-in conductors for the driving coil are brought out to external terminals; and

Fig. 4 is a fragmentary view showing another way in which the leading-in conductors for the driving coil may be brought out to external terminals.

Fig. 5 is an exploded view in persepctive showing the form of the members forming a plurality of sound ducts extending from adjacent one surface of the diaphragm to the sound passageway or bore in the magnet.

Referring now to the drawings, the loudspeaker shown therein comprises a magnet having inner and outer poles 10 and 11, the pole 10 having a cylindrical opening or bore 12 extending therethrough. The lateral cross-sectional area of the bore may increase exponentially toward the outer end, i. e., toward the right in Fig. 1. An excitation or field coil 13, which may be of a construction disclosed in a copending application of Albert L. Thuras, Serial No. 622,191, filed July 13, 1932, encircles the inner pole 10 and is insulated from the magnet by insulators 14. Metallic extensions 15 of the coil 14 are engaged by extensions 16 of the terminals 17 which are mounted on an insulating block 18 secured to the outer pole 11. The extensions 16 pass through apertures in the pole 11 and are insulated from the pole by bushings or sleeves 19. An annular pole piece 20 is provided with a shoulder 21 threaded into the pole 10. Another annular pole piece 22 is positioned on the outer pole 11 by dowel pins 23 and is secured thereto by screws 24. The pole pieces 20 and 22 are coaxially disposed and are spaced to form a narrow, annular air gap 25.

A diaphragm is mounted upon the magnet and comprises a central dished or dome-shaped portion 26, a flat peripheral portion 27, and a troughed flexible portion 28 intermediate the central and peripheral portions. The diaphragm may be of a single piece of lightweight material, such as duralumin. The peripheral portion 27 of the diaphragm is fixed on the outer pole piece 22 together with an insulating washer 29, by a

clamping ring 30 which is secured to the pole piece 22 by a plurality of screws 31.

The diaphragm is actuated by an annular driving coil 32 which is carried by a cylindrical sleeve 33 secured to the diaphragm at substantially the base of the dished or dome-shaped portion 26, and is disposed in the air gap 25. The driving coil 32 may be of the construction disclosed in Patent 1,707,544 granted April 2, 1929 to Albert L. Thuras. The diaphragm is provided with a pair of small apertures at substantially the intersection of the central and flexible portions 26 and 28, respectively in each of which an insulating bushing or sleeve 34 is secured. Leading-in conductors 35 for the driving coil, which may be integral extensions of the coil, extend loosely through a corresponding one of the sleeves 34 and outwardly to terminals 36 which are mounted on an insulating member 37 secured to the pole piece 22. This construction insures a distribution of the flexing stresses in the conductors 35, occasioned by the vibrations of the diaphragm, throughout a large portion of the conductors so that rupture of the conductors is prevented. To further insure against breakage of the conductors, damping means, for example thin vanes 59, of paper or the like, are provided to prevent local and resonant vibrations in the conductors. Breakage of the leads may be prevented also as shown in Fig. 4 by enclosing a portion of the leading-in conductors in an inflexible tubular member or sleeve 60 fixedly mounted adjacent a terminal 61. The inner diameter of the tubular member 60 is appreciably greater than the dimensions of the leading-in conductors so that the conductor will have limited freedom of movement.

In order to prevent the passage of sound waves through the air gap, the gap is sealed at the end remote from the diaphragm by an annular troughed member 38 of non-magnetic material such as brass which is secured to the pole piece 20 by a plurality of screws 39 and is spaced from the pole piece 22 by a washer or shim 40.

The surface of the diaphragm remote from the magnet may be encased by a dome-shaped cover 41 which is provided with a plurality of lugs or flanges 42 and is secured upon the pole piece 22 by screws 43 extending through the lugs or flanges. The cover is provided with a plurality of relatively large apertures 44 of sufficient area to prevent the air in the space between the cover and the diaphragm from materially affecting the vibrations of the diaphragm, and carries a protective screen 45.

A horn 46 abuts against the end of the pole 10 remote from the diaphragm and is secured to the magnet by a clamping ring 47 which is threaded to the magnet and is provided with a flange 48 which bears against a shoulder on a flange member 49 secured to the horn by screws 50.

In order to insure uniform reproduction of a wide range of frequencies of importance in speech and music, means are provided, in accordance with this invention, for preventing suppression of any, particularly the higher, frequencies. To this end, a multisection acoustic transducer or plug is provided intermediate one surface of the diaphragm and the end of the horn in acoustic communication with the surface.

As shown more clearly in Fig. 5, in one form, such a transducer or plug comprises a central substantially conical member 51 and a plurality of hollow substantially frusto-conical members 52, 53 and 54, disposed one within the other and coaxial with the conical member 51. The conical member 51 and frusto-conical members 52, 53 and 54 are rigidly secured together in spaced relationship by a plurality of keys 55 which fit into slots 56 in the several members. The inner surface of the pole piece 20 is dished to conform approximately to the outer surface of the frusto-conical member 54 and is provided with a plurality of slots 57 into which keys 58 may be fitted. The end of the conical and frusto-conical members toward the diaphragm is smoothly rounded to correspond accurately to the portions of the diaphragm in juxtaposition thereto. Preferably the conical and frusto-conical members are so positioned that the clearance between the diaphragm and the ends of the members thereadjacent is but slightly greater than the maximum displacement of the driving coil.

As will be seen more clearly from Fig. 2, the conical member 51 and the frusto-conical members 52, 53 and 54 together with the pole piece 20 provide a plurality of coaxial annular sound ducts extending from the diaphragm, toward the opening or bore 12 in the pole 10 and converging away from the diaphragm. The several elements noted are so proportioned that the passageways formed thereby are of substantially equal length and are equally spaced at the ends toward the diaphragm. Preferably these elements are so proportioned that the aggregate cross-sectional area thereof in planes at right angles to the sound paths increases exponentially away from the diaphragm. This construction provides a plurality of paths of substantially equal length so that sound waves emanating from all points of the central portion 26 of the diaphragm traverse paths of substantially the same length in passing to the throat of the horn 46 and hence arrive at the throat of the horn substantially in phase. Another feature of this construction is that a substantially plane wave front is obtained at the end of the bore 12 directed toward the diaphragm. Neutralization of the waves at the higher frequencies of speech and music is therefore prevented and speech and music may be reproduced with uniformity and fidelity throughout a wide range of frequencies.

Although a specific embodiment of the invention has been shown and described, it will be understood of course, that modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. A sound translating device comprising a diaphragm, and means adjacent one surface of said diaphragm forming a plurality of sound ducts of substantially equal length disposed one within another and converging away from said surface.

2. A sound translating device comprising a diaphragm, and at least three nested tapered members adjacent one surface of said diaphragm, spaced to form a plurality of annular sound passageways of substantially equal length disposed one within another and converging away from said surface.

3. A sound translating device comprising a diaphragm and at least three conical members disposed one within another each having one end adjacent said diaphragm, said ends jointly conforming to substantially one entire surface of said diaphragm, said members being spaced to form a plurality of coaxial sound passageways converging away from said diaphragm.

4. A sound translating device comprising a

diaphragm having a central radiating portion, and at least three spaced members adjacent said central portion having portions conforming to and substantially coextensive with said central portion forming a plurality of annular sound passageways disposed one within another and converging away from said central portion.

5. A sound translating device comprising a diaphragm having a dished central portion, and a plug member having one end in immediate juxtaposition to and substantially coextensive with one surface of said central portion and conforming thereto, said plug member including at least three sections spaced to form a plurality of tubular sound ducts acoustically associated with said central portion and converging away therefrom.

6. A sound translating device comprising a diaphragm having a dome-shaped central portion, and an acoustic transducer having one end conforming to and substantially coextensive with said central portion, said transducer including at least three nested tapered members spaced to form a plurality of coaxial sound passageways terminating adjacent said central portion and converging away therefrom.

7. A sound translating device comprising a diaphragm, means forming a sound duct having one end acoustically associated with one surface of said diaphragm, and a plurality of nested tapered members intermediate said one end and said surface, said members being spaced to form a plurality of tubular sound passageways of substantially equal length between said surface and said one end.

8. A sound translating device comprising a diaphragm, means forming a sound duct acoustically associated at one end with one surface of said diaphragm, and at least three nested conical members adjacent said one surface, said members being spaced to form a plurality of coaxial annular passageways of substantially equal length between said surface and the one end of said duct.

9. A sound translating device comprising a diaphragm, means forming a sound duct having one end acoustically associated with one surface of said diaphragm, and an acoustic transducer intermediate said one surface and said duct having a portion adjacent said one surface and substantially coextensive and in conformity with the radiating portion of said diaphragm, said transducer comprising at least three sections spaced to form a plurality of annular passageways disposed one within another and extending between said one surface and the one end of said duct.

10. A sound translating device comprising a diaphragm, means forming a sound duct acoustically associated with one surface of said diaphragm, and a plug member intermediate said one surface and said duct, said plug member including at least three nested conical members having their bases adjacent said diaphragm, said conical members being spaced to form a plurality of coaxial sound passageways of substantially equal length extending from said diaphragm and converging toward said duct.

11. A sound translating device comprisng a diaphragm having a dished central portion, means forming a sound duct having a tubular portion in axial alignment with said central portion, and a plug member intermediate said central portion and said duct, said plug member including a plurality of nested conical members having their bases in proximity to and conforming with said central portion, said conical members being spaced to form a plurality of tubular sound passageways of substantially equal length extending between said central portion and said duct and being coaxial therewith.

12. A sound translating device comprising a magnet having inner and outer poles, said inner pole having a bore extending therethrough, a diaphragm adjacent one end of said bore, and a plug member carried by said inner pole and disposed intermediate said diaphragm and said bore, said plug member comprising a plurality of sections spaced to form a plurality of tubular sound passageways disposed one within another, extending from said diaphragm and converging toward said bore.

13. A sound translating device comprising a magnet having inner and outer poles, said inner pole having a bore extending therethrough, a diaphragm adjacent one end of said bore, and at least three nested members carried by said inner pole and disposed adjacent said diaphragm, said members being spaced to form a plurality of annular sound passageways of substantially equal length extending between said diaphragm and the one end of said bore.

14. A loudspeaker comprising a magnet having inner and outer poles, said inner pole having a bore extending therethrough, a pair of pole pieces mounted on said poles and spaced to form an annular air gap, the inner of said pole pieces having an aperture therein in axial alignment with said bore, a diaphragm mounted on the outer of said pole pieces and having a central portion adjacent the aperture in said inner pole piece and substantially coextensive therewith, an actuating coil connected to said diaphragm and disposed in said air gap, and a plurality of conical members having one end in juxtaposition to said central portion, and extending into said aperture, said members being spaced to form a plurality of sound passageways of substantially equal length between said central portion and said bore and coaxial with said bore.

15. A sound translating device comprising a magnet having a bore extending therethrough, a horn connected to one end of said magnet and acoustically coupled to one end of said bore, a diaphragm mounted on the opposite end of said magnet and having one surface acoustically associated with the other end of said bore, and means including a plurality of nested members providing a plurality of sound passageways of substantially equal length between different portions of said surface of said diaphragm and a portion of said bore.

16. A sound translating device comprising a magnet having a sound passageway extending between opposite ends thereof, a horn connected to one end of said magnet and acoustically coupled to one end of said passageway, a diaphragm mounted on the opposite end of said magnet and having one surface acoustically associated with the other end of said passageway, means including a plurality of members disposed one within another and spaced to provide a plurality of sound ducts of substantially equal length between said one surface of said diaphragm and a portion of said bore, and a screen member mounted on said magnet and overlying said diaphragm.

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