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SOUND REPRODUCING SYSTEM

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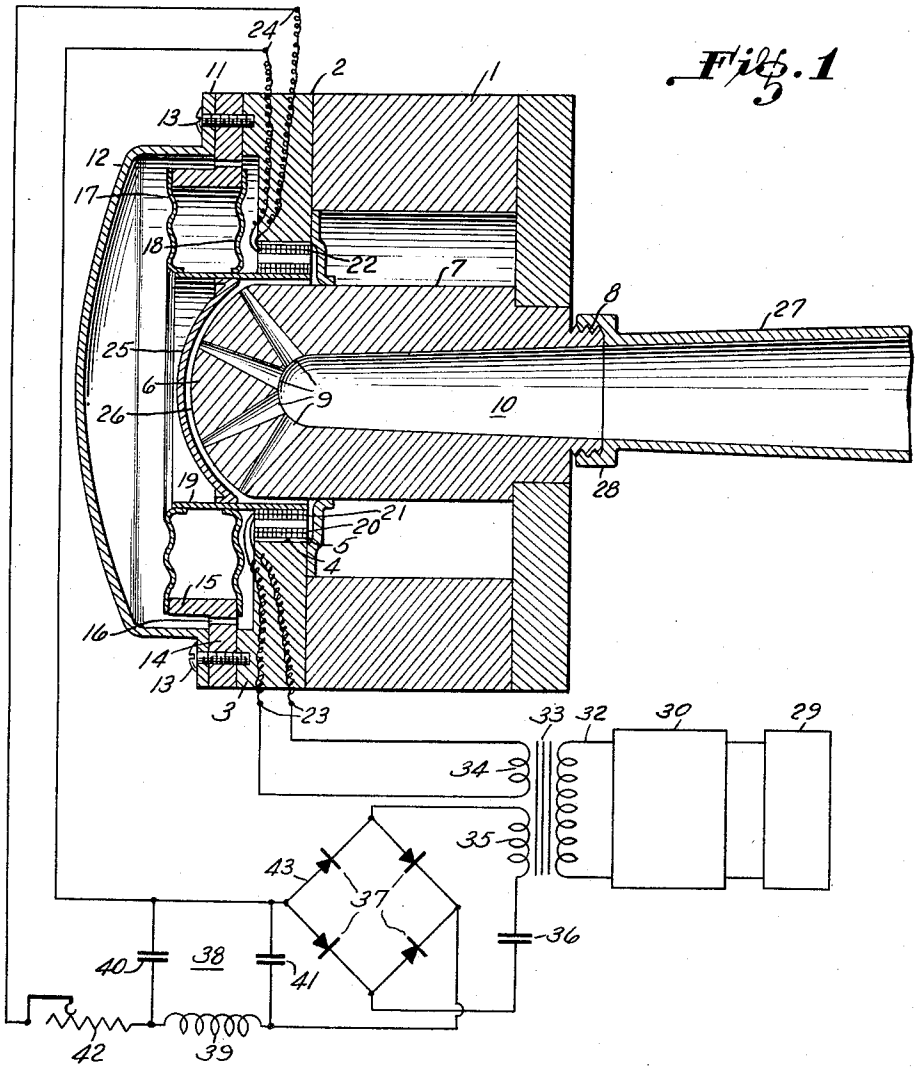


Fig. 1

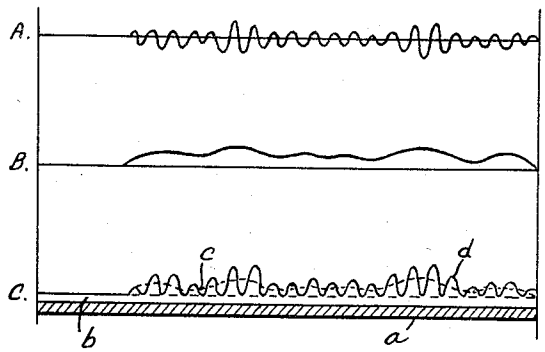


Fig. 2

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SOUND REPRODUCING SYSTEM

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The invention relates to devices for translating sound currents into sound waves and more particularly to loud-speakers of the compression chamber type.

Such loud-speakers comprise a horn communicating with a sound chamber formed between a wall and a diaphragm. Electrodynamically actuated by the sound currents, this diaphragm produces sound waves by compressing and expanding the enclosed air of the sound chamber. The horn projects these sound waves in the open air.

For the reason that they deliver much more sound power for the same electrical energy, compression chamber loud-speakers are more efficient than direct radiating loud-speakers. They are also more convenient for outdoor uses because of their sturdy and weatherproof design.

However, in spite of their successive developments, loud-speakers of that type have not until now permitted to obtain a high-fidelity, wide-range sound reproduction. In fact, if they reproduce satisfactorily the high frequencies, they are inefficient for the low register.

This inability of compression chamber loud-speakers to reproduce the entire sound frequency range results from the following difficulties.

With a narrow sound chamber, the low frequencies, owing to their great amplitudes of vibration, make the diaphragm to bump against the wall of the chamber, causing in addition to disagreeable knockings in the reproduction, the more or less rapid deterioration of the said diaphragm.

With a wide sound chamber instead, the high frequencies, due to the inutilized wide space of air, are almost completely absorbed and consequently poorly reproduced.

In view of these difficulties, conventional compression chamber loud-speakers have been designed so as to sacrifice the low frequencies for the benefit of the high frequencies which, all the same, permit a passable reproduction of the speech and music; consequently their sound chamber is made narrow and their diaphragm is supported by a relatively stiff suspension which, while permitting the high frequency vibrations, limits the amplitudes to avoid the bumpings.

The goal of the present invention is to improve compression chamber loud-speakers so that they can reproduce with high fidelity the entire sound frequency range.

The invention proceeds from the idea that the wideness of the sound chamber of compression chamber loud-speakers must vary as a function of the amplitudes of vibration of the diaphragm, so that the suitable sound chamber is provided at each instant, for each amplitude.

A first means for achieving the aforesaid principle may consist in replacing the usual fixed wall facing the diaphragm, by a movable wall which is moved back from the vibrating diaphragm as a function of its amplitudes, by means of electromechanical means fed with rectified currents deducted from the sound currents.

The invention prefers, however, to utilize another simpler and more effective means. This system, which constitutes the first object of the invention, consists in maintaining the conventional fixed wall, and causing the diaphragm to vibrate by unilateral vibrations, in a direction opposite to the wall; thus, it is the diaphragm which, while vibrating, moves back from the wall, as a function of its amplitudes, to vary the wideness of the sound chamber.

A means for obtaining unilateral vibrations may consist in superimposing the sound currents to rectified currents obtained by rectifying a portion from said sound currents, and feeding the voice coil driving the diaphragm, with these mixed currents.

Another preferred means for obtaining unilateral vibrations, consists merely in using a voice coil with two separated windings, respectively fed with the sound currents and the corresponding rectified currents.

As a result of the elimination of the bumpings by the system of the invention, the sound chamber can be made very narrow for a better reproduction of the high frequencies, and the diaphragm can be supported very flexibly for a correct reproduction of the low frequencies. Hence, a second object of the invention is a system of a double suspension providing the diaphragm with a free axial movement.

Although the present invention may be applied to the existing types of compression chamber loud-speakers, a third object of the invention, is a specially-designed model which is more appropriate to the particular working of the invention.

Thanks to the improvements of the invention, compression chamber loud-speakers become able to reproduce with high fidelity the entire sound frequency range and also to deliver a considerable amount of sound power.

The invention, which embraces many other improvements and particular arrangements, has other advantages and objects which may be made more apparent from an attentive consideration of the following description and the accompanying drawing which illustrates the general principle of the invention; but it is understood that this description and drawing are not to be taken in the limiting sense, since the scope of the invention is best defined in the appended claims.

Referring to the drawing: Figure 1 is a sectional view of the compression chamber loud-speaker of the invention, accompanied by its special electrical feeding system; and Figure 2, the diagrams of the working of the compression chamber loud-speaker of the invention.

As shown in Figure 1, 1 is a magnetic structure of the permanent magnet type, comprising among other parts, a lower plate 2 having a marginal shoulder 3 and a central aperture 4 making an annular air gap 5 with one end of a central core 7 having a spherical extension 6, terminating at the other end by a threaded extension 8 and provided with converging radial ducts 9 continued by an axial duct 10.

Sandwiched between a flange 11 of a protecting case 12 and the shoulder 3, and clamped by machine screws 13, is a flange 14 of an annular support 15 having peripheral openings 16. At both faces of the annular support 15 are attached by their outer edges, a pair of corrugated and flexible annular suspensions 17 and 18, of which the inner edges are attached respectively to two spaced portions of one end of a tubular support 19. Around the other end of this tubular support 19 is wound a voice coil 20 located in the air gap 5 and comprising two separated and superimposed windings 21 and 22 of which the respective terminals are 23 and 24. A dome-shaped diaphragm 25, marginally and axially attached to an inner portion of the tubular support 19, forms with the spherical extension 6, a sound chamber 26.

A horn 27 (only the throat portion is shown in the figure) having a tapped end 28 screwed on the threaded

extension 8, communicates with the sound chamber 26 through the axial duct 10 and the radial ducts 9.

The electrical feeding system of the above described device comprises a translating apparatus 29 producing sound currents (such as a photoelectric or magnetic sound head, a pick up, a radio-receiver etc.), connected to the input of an amplifier 30 of which the output feeds a primary 32 of a transformer 33 possessing two secondaries 34 and 35. The secondary 34 is directly connected to the terminals 23 of the winding 21 of the voice coil 20. The secondary 35 is connected through a condenser 36 to a rectifying cell 43 of the full-wave type, which, composed of elements 37, has it output connected to a filtering cell 38 composed of a coil 39 and condensers 40 and 41. The output of this filtering cell 38 is connected through a variable resistor 42 to the terminals 24 of the winding 22 of the voice coil 20.

The device of Figure 1 works as following:

The sound currents furnished by the translating apparatus 29 and amplified by the amplifier 30, are transmitted through the primary 32, to the secondaries 34 and 35. While the secondary 35, by feeding the winding 22 with rectified currents corresponding to the sound currents (by means of the rectifying cell 43 and the filtering cell 38) actuates the diaphragm 25 according to an axial movement following the envelope curve of the sound currents, the secondary 34, by feeding the winding 21 with sound currents, imparts corresponding vibrations to the diaphragm 25, which combined with the axial movement, produce unilateral vibrations, in a direction opposite to the spherical extension 6. These unilateral vibrations of the diaphragm 25, by producing air compressions and expansions in the sound chamber 26, create sound waves which are projected by the horn 27 in the open air.

This working is illustrated in Figure 2, in which A is the diagram of the sound currents; B, the diagram of the rectified currents; and C, the diagram of the composite working of the diaphragm 25, in which, the hatched line *a*, represents the wall of the sound chamber 26 (that is the spherical extension 6); the space *b*, the clearance between the diaphragm 25 and the spherical extension 6; the dotted curve C, the axial movement of the diaphragm 25 by means of the rectified currents; and *d*, the resulting unilateral vibrations of the diaphragm 25 produced by the composition of the axial movement due to the rectified currents and the vibrations due to the sound currents.

The secondary 35 has been made, in purpose, more important than the secondary 34, to transmit more sound currents to the rectifying cell 43, so as to compensate the losses in the said rectifying cell 43 and the filtering cell 38.

The variable resistor 42 permits to proportion the amount of rectified currents feeding the winding 22 with regard to the amount of sound currents feeding the winding 21, so as to obtain correct unilateral vibrations of the diaphragm 25.

The row of openings 16, all around the flange 14 of the annular support 15, permits to annihilate the back pressure produced by the vibrations of the annular suspension 18.

The rectifying cell 43 can be of the copper-oxid, selenium, germanium, silicon or thermoionic type.

The horn 27 may be of the straight, reflex or multicellular type.

Instead of being superimposed, the two windings 21 and 22 of the voice coil 20, may be twin-wound in one or more layers.

To comply with the special working by unilateral vibrations, the suspensions 17 or 18 (or both) may be preformed to have their concentric corrugations arranged in tiers like an amphitheater, in order to afford more flexibility in the direction of the unilateral vibrations.

The system of unilateral vibrations of the invention may also be applied to semi-compression loud-speakers of the type comprising a relatively large conical or exponential diaphragm electrodynamically driven by its apex and working in front of the bottom of a bell-like horn.

The process of the invention is not limited to the model of compression chamber loud-speaker described, that is to say to the rear compression chamber type. It can obviously be adapted to the front compression chamber loud-speaker, in which the compression chamber is formed between the diaphragm and the inner side of a throat-case or the face of a plug contained in this throat-case.

I claim:

1. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; and driving means fed with said rectified currents and said second sound currents, for imparting vibrations to said diaphragm; whereby said diaphragm vibrates by unilateral vibrations.

2. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; first driving means fed with said rectified currents, for actuating said diaphragm according to an axial movement following the envelope curve of the sound currents of said source; and second driving means fed with said second sound currents, for supplementarily imparting vibrations to said diaphragms; whereby said diaphragm vibrates by unilateral vibrations.

3. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; and driving means fed with said rectified currents and said second sound currents, for imparting vibrations to said diaphragm; whereby said diaphragm vibrates by unilateral vibrations in a direction opposite to said means positioned close thereto.

4. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; first driving means fed with said rectified currents, for actuating said diaphragm according to an axial movement following the envelope curve of the sound currents of said source; and second driving means fed with said second sound currents, for supplementarily imparting vibrations to said diaphragm; whereby said diaphragm vibrates by unilateral vibrations, in a direction opposite to said means positioned close thereto.

5. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a clearance space therewith; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; and driving means fed with said rectified currents and said second sound currents, for varying the wideness of said clearance space in accordance with the envelope curve of the sound currents of said source, while imparting vibrations to said diaphragm; whereby said diaphragm vibrates without bumping against said means positioned close thereto.

6. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a clearance space therewith; a source of sound currents; means for deriving from said source, first sound currents and second

sound currents; means for converting said first sound currents, into rectified currents; first driving means fed with said rectified currents, for varying the wideness of said clearance space in accordance with the envelope curve of the sound currents of said source; and second driving means fed with said second sound currents, for imparting vibrations to said diaphragm; whereby said diaphragm vibrates without bumping against said means positioned close thereto.

7. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said sound chamber and the open air; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; and driving means fed with said rectified currents and said second sound currents, for varying the wideness of said sound chamber in accordance with the envelope curve of the sound currents of said source, while imparting vibrations to said diaphragm; whereby said diaphagm vibrates without bumping against said means positioned close thereto.

8. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said sound chamber and the open air; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; first driving means fed with said rectified currents, for varying the wideness of said sound chamber in accordance with the envelope curve of the sound currents of said source; and second driving means fed with said second sound currents, for imparting vibrations to said diaphragm; whereby said diaphragm vibrates without bumping against said means positioned close thereto.

9. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said sound chamber and the open air; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; and driving means fed with said rectified currents and said second sound currents, for actuating said diaphragm according to an axial movement following the envelope curve of the sound currents of said source, while imparting vibrations to said diaphragm; whereby said diaphragm vibrates without bumping against said means positioned close thereto.

10. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said sound chamber and the open air; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; first driving means fed with said rectified currents, for actuating said diaphragm according to an axial movement following the envelope curve of the sound currents of said source; and second driving means fed with said second sound currents, for supplementarily imparting vibrations to said diaphragms; whereby said diaphragm vibrates without bumping against said means positioned close thereto.

11. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said sound chamber and the open air; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; a magnetic structure providing an air gap; and a voice coil associated with said diaphragm, located in said air gap, and fed with said rectified currents and said second sound currents, for actuating said diaphragm; whereby said diaphragm vibrates by unilateral vibrations in a direction opposite to said means positioned close thereto and without bumping therewith.

12. A sound reproducing system in accordance with claim 11, in which said means for permitting a progressive communication between said sound chamber and the open air, is a horn.

13. In a sound reproducing system, the combination of a diaphragm mounted for free vibration; means positioned close to said diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said sound chamber and the open air; a source of sound currents; means for deriving from said source, first sound currents and second sound currents; means for converting said first sound currents, into rectified currents; a magnetic structure providing an air gap; and a voice coil associated with said diaphragm, located in said air gap and possessing two windings; the first winding fed with said rectified currents, for actuating said diaphragm according to an axial movement following the envelope curve of the sound currents of said source; and the second winding fed with said second sound currents, for supplementarily imparting vibrations to said diaphragm; whereby said diaphragm vibrates by unilateral vibrations in a direction opposite to said means positioned close thereto and without bumping therewith.

14. A sound reproducing system in accordance with claim 13, in which said means for permitting a progressive communication between said sound chamber and the open air, is a horn.

15. In a sound reproducing system, the combination of a diaphragm mounted for free vibration according to an axis perpendicular to the face thereof; means positioned close to the face of the diaphragm for forming a sound chamber therewith; means for permitting a progressive communication between said chamber and the open air; a source of sound currents; means for deducting from said source, a portion of sound currents; means for rectifying said portion for obtaining rectified currents; a magnetic structure providing an air gap; and a voice coil associated with the diaphragm, located in the air gap, and possessing two windings; the first winding fed with said rectified currents for actuating the diaphragm according to an axial movement following the envelope curve of the sound currents; and the second winding fed with said sound currents for supplementarily actuating the diaphragm; whereby said diaphragm vibrates by unilateral vibration, in a direction opposite to the means positioned close to the face thereof.

16. A sound reproducing system in accordance with claim 15, in which said means for permitting a progressive communication between said chamber and the open air, is a horn.

17. In a sound reproducing system, the combination of an electrical circuit providing electrical currents derived from sound vibrations; a magnetic structure having an air gap at one face thereof; a tubular support; a diaphragm extending inwardly and perpendicularly from an intermediary inner portion of the tubular support; a voice coil wound around one end of the tubular support; a pair of parallel, flexible and generally flat annular suspensions, each one having an inner portion extending perpendicularly and outwardly from the tubular support at substantially the other end and at an intermediary portion thereof, respectively, and each one having an outer portion; means for supporting the outer portion of each suspension on said face of the magnetic structure for

locating the voice coil in the air gap; means comprised of the magnetic structure for forming with the diaphragm, a sound chamber; and a horn connected with the sound chamber; said voice coil being fed with the electrical currents of said circuit for actuating said diaphragm.

18. A sound reproducing system in accordance with claim 17 in which said voice coil comprises two separated windings.

19. In a sound reproducing system, the combination of an electrical circuit providing electrical currents derived from sound vibrations; a magnetic structure comprising a lower plate having a marginal shoulder and a central aperture, and a central core forming with the aperture an annular air gap, said central core having a spherical extension projecting the air gap and possessing converging radial ducts continued by an axial duct; a protecting case having a flanged edge; a supporting annular member having two opposite flat sides, one of which continued by a flange possessing peripheral openings; a tubular support; a pair of parallel and corrugated annular suspensions, each one having an inner portion extending perpendicularly and outwardly from the tubular support at substantially one end and at an intermediary portion thereof, respectively, and each one having an outer portion attached to each side of the supporting annular member; a voice coil wound around the other end of the tubular support; a dome-shaped diaphragm extending inwardly and perpendicularly from an intermediary inner portion of the tubular support; said supporting annular member being sandwiched and clamped by its flange between the

shoulder of the lower plate of the magnetic structure and the flanged edge of the protecting case, for locating the voice coil in the air gap, and forming between the diaphragm and the spherical extension of the central core, a sound chamber communicating with the axial duct through the radial ducts; and a horn connected with the axial duct for communicating with the sound chamber; said voice coil being fed with the electrical currents of said circuit for actuating said diaphragm.

20. A sound reproducing system in accordance with claim 19 in which said voice coil comprises two separated windings.

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