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(54) IMPROVEMENTS IN OR RELATING TO LOUDSPEAKER SYSTEMS

(71) I, IVOR SIGMUND TIEFENBRUN, 1 Castle Court, Broomhill Avenue, Newton Mearns, Renfrewshire, Scotland, a British subject, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to loudspeaker systems.

Conventional loudspeaker systems, for example, sealed box, horn, electrostatic, bass reflex, and transmission line systems all employ a speaker which may include a diaphragm to produce frequencies including bass frequencies. The speaker will normally have a much lower resonant frequency in free air than in an enclosure, for example, a bass speaker may have a free air resonance at about 20 Hz but in an enclosure its resonance would occur at typically 25—35 Hz or higher. This raising of the speaker resonance results in a peak in the loudspeaker system response curve resulting in "booming" and other undesirable resonance effects within the audible spectrum.

Furthermore, in order to reproduce audible frequencies, and especially bass frequencies, most loudspeaker systems employ a fixed mass of air enclosed or restricted behind the speaker. This means that the speaker is constantly compressing and rarifying this restricted mass of air which has the effect of causing colouration and distortion in the sound produced. A bass reflex cabinet attempts to overcome this problem but the reflex action is found to only occur at around one frequency. However, even with this solution the response, especially the bass response, is subject to distortion, colouration and its frequency range is limited.

It is an object of the present invention to obviate or mitigate the disadvantages outlined above.

According to the present invention there is provided a loudspeaker system comprising a casing, a first loudspeaker diaphragm having front and rear faces, said first loudspeaker diaphragm being so mounted in the casing that the front face of the said first loudspeaker diaphragm faces outwardly of the casing, a second loudspeaker diaphragm having front and rear faces, said second loudspeaker diaphragm being mounted in the casing behind said first loudspeaker diaphram with its front face opposite the rear face of said first loudspeaker diaphragm so as to define a chamber of air between said first and second loudspeaker diaphragms, and operating means arranged so that said first and second loudspeaker diaphragms are operated in phase by the same audio frequency signal source such that the pressure of air in the chamber remains substantially constant, and a sound absorbing curtain located in said chamber between the rear face of said first loudspeaker diaphragm and the front face of said second loudspeaker diaphragm.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a section through a loudspeaker cabinet mounting a system according to the invention;

Figure 2 is a section through a modified unit for mounting in a cabinet; and

Figure 3 is a section through another embodiment of a unit for mounting in a cabinet.

Referring to Figure 1 of the drawings, a loudspeaker system which allows a sound producing bass loudspeaker to behave virtually as if it were in free air, i.e. independently of a cabinet housing the loudspeaker, while at the same time producing substantially no anti-phase sound, includes a cabinet 10 having an internal partition 12 defining chambers 14a,

14b. Mounted within the chamber 14a on a front wall 16 of the cabinet 10 is a front bass loudspeaker 18, and mounted within the chamber 14b on the partition 12 behind the driver 18, is a rear bass loudspeaker 20. Each loudspeaker 18, 20 includes a conical diaphragm 22, the front face of which is mounted by means of a resilient surround 24 on a chassis 28 which, in turn, is mounted on the respective wall 16 and partition 12. A cylindrical hollow former 26 extends axially outwards from the apex of the diaphragm 22 and is mounted on the chassis 28 by a resilient suspension 30. A coil 32 is wound on the former 26 and has leads 34 connecting to terminals 36 on the chassis 28. Audio-frequency signals from an amplifier (not shown) are fed to the coil 32 through the terminals 36.

A permanent magnet assembly 38 is secured to the chassis 28 and defines an annular flux gap 40 with a cylindrical central core 42. The magnet assembly 38 and the coil 32 are mounted relative to each other such that the coil 32 is disposed within the flux gap 40, the core 42 of the magnet assembly 38 extending into the hollow former 26.

In operation, the audio-frequency signals from the amplifier cause the coil 32 to set up a magnetic field which interacts with the magnetic field of the permanent magnet and causes the coil 32 and the diaphragm 22 to move.

The rear face of the front loudspeaker 18 is linked to the front face of the rear loudspeaker 20 by an enclosure of air in the chamber 14a. Both loudspeakers 18, 20 are driven independently but in phase, with the result that substantially no sound pressure is produced within the chamber 14a and for this reason the effect will be hereinafter referred to as the "Isobaric" Effect and the chamber will be hereinafter referred to as the "Isobaric" Chamber. Consequently the front loudspeaker 18 is mounted in the cabinet 10 under almost ideal conditions. The rear chamber may be a sealed enclosure, transmission line, labyrinth or reflex cabinet, it being most desirable to use a sealed enclosure since the response of the front loudspeaker 18 can be almost perfect or as good as is theoretically possible.

If the rear loudspeaker 20 is mounted at a distance from the front loudspeaker 18 considerably less than half the wavelength of the highest frequency to be produced by the drivers there will be little or no phase shift cancellation effects produced.

Any distortion components, which the rear loudspeaker 20 produces from its front face resulting from different response characteristics between said front and rear loudspeakers will constitute virtually the only sound pressure in the "Isobaric" Chamber and this is absorbed by a curtain 44 of absorbent material.

Several practical limitations apply to the above described loudspeaker system, for example, the loudspeakers must not be too close together or the magnetic fields may interact unfavourably; each chamber may require a vent to atmosphere, either directly or indirectly, to neutralise unequal effects resulting from pressure changes brought about by temperature or atmospheric changes; and normal considerations of cabinet rigidity and internal damping and absorption apply as in any other loudspeaker system.

It is envisaged using this arrangement of bass loudspeakers with normal mid range and treble units, or with a combined mid range/treble unit. It is also possible to produce a combined mid range/bass unit or even a full range unit, utilising an "Isobaric" Chamber. Furthermore, it is possible to utilise additional treble and mid range units or one combined unit pointing in another direction to give the total enclosure omnidirectional characteristics.

In a modification as shown in Figure 2, a unit 46 is provided which comprises a housing 48 adapted to be mounted in a cabinet (not shown) by means of a mounting flange 50. A front bass loudspeaker 52, having similar components, and operating in a similar fashion to the loudspeakers 18 and 20 described hereinbefore, is mounted by means of a resilient surround 54 directly on the front of the housing 48. By virtue of there being no chassis provided, a resilient suspension 56 for the former is mounted on the magnet assembly and the leads from the coil are connected to terminals 57 provided externally on the housing 48.

A rear bass loudspeaker 58, identical to the front loudspeaker 52 is mounted within the housing 48 and its permanent magnet assembly is secured to a rear wall 60 of the housing 48. A supporting spider 62 is mounted in the housing 48 intermediate of the loudspeakers 52, 58 and has openings 64 defined therein. The rear wall 60 also has openings 66.

The "Isobaric" Chamber is defined between the drivers 52, 58 and is provided with a sound absorbent curtain 55.

Referring to Figure 3, a housing 68 with an annular flange 70 for mounting on a cabinet (not shown) mounts two cone diaphragms 72, 74 driven independently on one another. The cone diaphragms 72, 74 have formers 76, 78 located around a common central core 80 of a permanent magnet assembly 82, coils 84, 86 being wound on the respective formers 76, 78.

The cone diaphragms 72, 74 are mounted on the housing by means of a resilient suspension 88 and the formers 76, 78 are

mounted on the magnet assembly 82 by suspensions 92, 94. Leads 96, 98 from the coils 84, 86 connect with terminals 100, 102 mounted externally on the housing 68. The magnet assembly 82 is supported on a rear wall 104 of the housing 68, the latter being provided with openings 106.

The "Isobaric" Chamber is defined between the cone diaphragms 72, 74 and is provided with a sound absorbent curtain 108. A seal 110 extends between the cones 72, 74.

It should be appreciated that flat diaphragms or diaphragms of other shapes can be utilised in place of conical diaphragms.

Virtually all of the output from the rear loudspeaker is absorbed in creating almost ideal conditions for the front loudspeaker. The resultant effect is the production of virtually undistorted sound which is extended downwards to the free air resonance of the front loudspeaker and to even below that level. The sound is also virtually free from colouration and anti-phase effects. The full potential of the above-described system is realised when the relative sizes of the various chambers are optimised. This takes into account the separation of the relative resonances of the chambers as well as the sizes and characteristics of the units employed. An additional advantage of the system is that it enables with minimum compromise realistic and clean bass sound from a cabinet very much smaller than that which would normally be required to even remotely approximate the purity and clarity of the sound produced by employing the "Isobaric" effect.

The salient feature of the above-described system is that the loudspeakers respond in such a way as to maintain the "Isobaric" Chamber free from sound pressure and it is conceivable that this can be done with dissimilar bass drivers or by specially built composite loudspeakers built for this purpose. In this way the front loudspeaker can perform under almost ideal conditions which optimise its performance capabilities.

WHAT I CLAIM IS:—

1. A loudspeaker system comprising a casing, a first loudspeaker diaphragm having front and rear faces, said first loudspeaker diaphragm being so mounted in the casing that the front face of the said first loudspeaker diaphragm faces outwardly of the casing, a second loudspeaker diaphragm having front and rear faces, said second loudspeaker diaphragm being mounted in the casing behind said first loudspeaker diaphragm with its front face opposite the rear face of said first loudspeaker diaphragm so as to define a chamber of air between said first and second loudspeaker diaphragms, and operating means arranged so that said first and second loudspeaker diaphragms are operated in phase by the same audio frequency signal source such that the pressure of air in the chamber remains substantially constant and a sound absorbing curtain located in said chamber between the rear face of said first loudspeaker diaphragm and the front face of said second loudspeaker diaphragm.

2. A loudspeaker system as claimed in Claim 1, wherein the casing includes an internal partition and a front wall, said first loudspeaker diaphragm being mounted on said front wall and said second loudspeaker diaphragm being mounted on said internal partition.

3. A loudspeaker system as claimed in Claim 1, or 2, wherein a sealed enclosure is defined in the casing externally of the chamber.

4. A loudspeaker system as claimed in Claim 1 or 2, wherein a reflex cabinet is defined in the casing externally of the chamber.

5. A loudspeaker system as claimed in Claim 1 or 2, wherein a transmission line is defined in the casing externally of the chamber.

6. A loudspeaker system as claimed in Claim 1 or 2, wherein a labyrinth is defined in the casing externally of the chamber.

7. A loudspeaker system as claimed in Claim 1, wherein said operating means includes a single permanent magnet assembly having a central core and being mounted in said casing on a rear wall thereof.

8. A loudspeaker system as claimed in Claim 7, wherein said loudspeaker diaphragms are attached to formers located around said central core and separate coils

are wound on the formers of the respective loudspeaker diaphragms.

9. A loudspeaker system as claimed in Claim 7 or 8, wherein openings are provided in said rear wall of the casing.

10. A loudspeaker system substantially as hereinbefore described with reference to the accompanying drawings.

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1500711 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

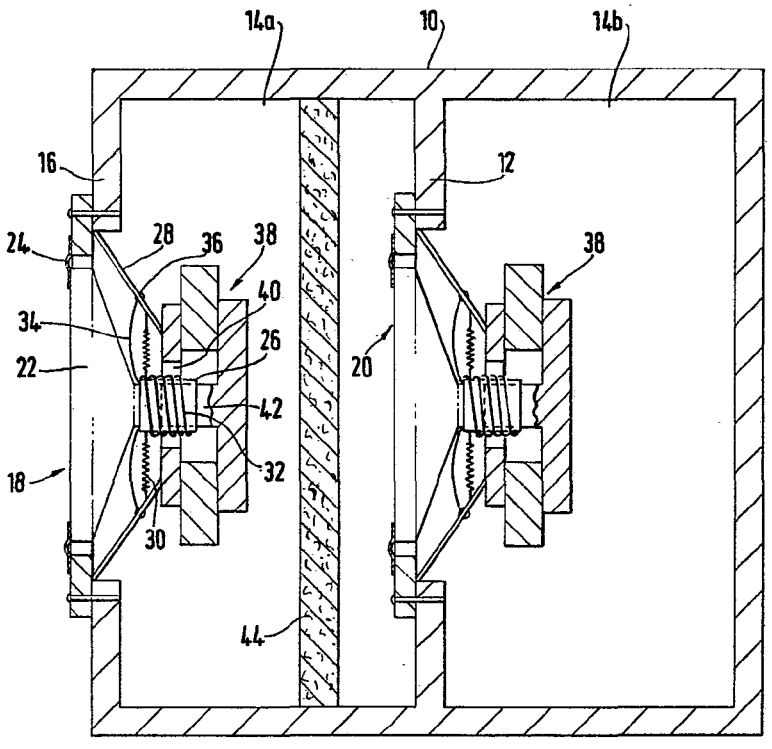

FIG. 1.

1500711 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

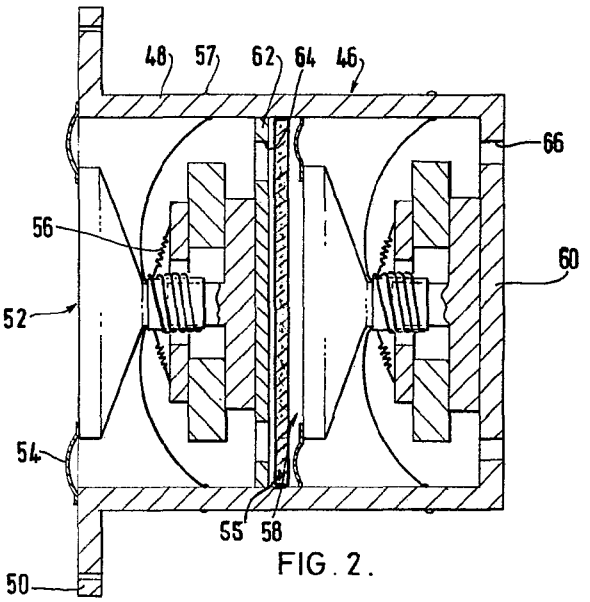

FIG. 2.

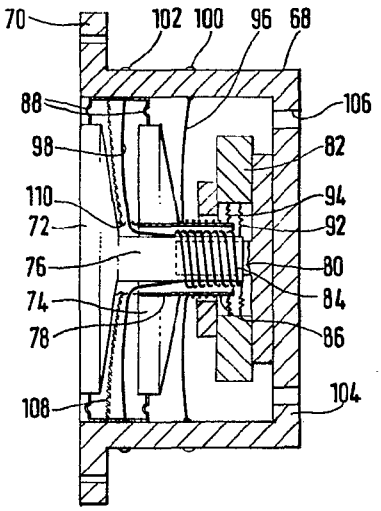

FIG. 3.