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(73) Patenthaver: **Köck, Gerd, Remsstrasse 1, 70806 Kornwestheim, Tyskland**

(72) Opfinder: **Köck, Gerd, Remsstrasse 1, 70806 Kornwestheim, Tyskland**

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

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Description

The invention relates to a loudspeaker having an enclosure, having at least one sound transducer mounted in the enclosure, and having a plurality of channels formed in the enclosure but which run separately from each other, for the sound waves produced by the front and/or back of the at least one sound transducer.

Loudspeakers of this type are usually manufactured as essentially rectangular-shaped boxes, having a front wall facing the listener, on which one or more loudspeaker chassis are mounted as a sound transducer. The loudspeaker chassis is thereby mounted on the front wall or fitted flush into it, since the sound is to be emitted as freely as possible into the room. Loudspeakers of this type generally have comparatively high distortions or distortion factors which impair sound reproduction. Furthermore, based on the open arrangement, there is the danger of damage to the mechanically sensitive loudspeaker chassis, which is often attempted to be countered with a cloth cover or the like. On the one hand, these measures often constitute only insufficient mechanical protection and, on the other hand, the frame of the covers placed on the loudspeaker enclosure can lead to disturbing rattling noises.

Furthermore, the enclosures of conventional loudspeaker boxes which are manufactured of wood or wood-like materials such as MDF are not sufficiently sound-proofed, i.e., despite internal reinforcements, the rattle of the distorting sound is emitted from the enclosure walls. A honeycombed reinforcement of a loudspeaker enclosure is known from EP 0191595 B1, which is intended to counteract this problem, but does not solve it completely in practice. DE 297 16 471 U1 describes an apparatus for reproducing sound in which the sound is conducted from a loudspeaker enclosure into the room via a plurality of channels, wherein the channels are mounted mainly outside the loudspeaker enclosure and are not able to effect a distortion reduction of the sound signal or are not designated for

this purpose. A structure for a loudspeaker is known from EP 1 292 170 A2, which is used for the prevention of standing waves. However, the distortion of the sound reproduction is not entirely minimized by this structure.

Finally, it is to be noted that the sound waves produced by mid-range drivers and woofers influence one another depending on their radiation position on the respective diaphragm, which likewise leads to a sound distortion.

An object of the present invention is to provide a loudspeaker of the type mentioned at the outset, which allows a sound reproduction which is as distortion-free as possible.

To achieve this object, the feature combination indicated in patent claim 1 is proposed. Advantageous embodiments and further developments of the invention result from the dependent claims.

The invention is based primarily on the recognition that, in the case of open sound radiation of a mid-range loudspeaker, mutual interference, that is, a sound distortion, occurs in the sound waves produced by different locations of the loudspeaker diaphragm. According to the invention, it is therefore proposed that two sound transducers are provided, of which the first is designed as a mid-range driver and the second is designed as a tweeter, and that the channels arranged in front of the mid-range driver have a contour extending, taking into account the diaphragm stroke of the mid-range driver, to the diaphragm and have a shape which is complementary to the diaphragm. A feedback of the sound waves emitted from a location of the diaphragm to a different location of the diaphragm is thereby avoided, thus reducing the distortions of the loudspeaker.

In a preferred embodiment of the invention, the at least one sound transducer is disposed behind a front wall of the enclosure, which has a

plurality of sound passage openings. The front wall of the enclosure thus forms the protective device for the sound transducers, so that additional protective elements are dispensable. The sound passage openings are advantageously designed as the channels separated from one another and each having a width which is smaller than half the wavelength of the highest frequency produced by the at least one sound transducer. In this context, the term width is to be seen in relation to the operating position of the loudspeaker in the room. Sound propagation is more critical in the horizontal direction than in the vertical direction. Said limitation of the dimension of the sound passage openings in the width prevents resonances of the sound waves within the openings. This is further supported by the fact that the channels, in a preferred embodiment of the invention, extend essentially perpendicularly to the plane of the front wall and are formed as slot holes conically tapered in the direction of a back of the front wall. The mid-range driver is preferably designed as a cone driver and the high-frequency driver is preferably designed as a ringhorn driver. The enclosure of the loudspeaker can be made compact when the bass range is reproduced by a separate bass speaker module. Such a design with two compact mid-range/high-frequency drivers and separate bass module is generally known as a satellite system.

Due to the contour of the channels mounted in front of the mid-range driver, the sound from the front of the mid-range driver is thus respectively emitted by the flat areas of the mid-range diaphragm corresponding to channels and a mutual influencing of the diaphragm sectors thus formed is prevented.

To increase the efficiency of the mid-range reproduction, the enclosure is advantageously designed as a bass reflex enclosure having a bass reflex opening disposed in the front wall, which communicates with the rear of the mid-range driver via a system of separate bass reflex channels. The bass reflex channels are advantageously dimensioned in such a way that the acoustic load on the front and the rear of the mid-range driver is

balanced, which further reduces distortions of the reproduction. Furthermore, no turbulent flows and/or flow reflections should be produced in the bass reflex channels. Advantageously, they are designed in such a way that their directional changes are smoothly curved in the enclosure, wherein the smallest longitudinal extension of its cross section area is used as the smallest radius of a change in direction. Furthermore, no acoustic resonances should occur in the bass reflex channels. They therefore advantageously have cross section areas whose greatest length is smaller than half the wavelength of the highest frequency of the sound transducer communicating with the bass reflex opening. A practice-oriented tuning of the bass reflex system provides for a centre frequency in the range of 80 Hz to 120 Hz. The mid-range driver stimulates the bass reflex channels to emit frequencies beyond 200 Hz to 5 kHz, but without producing a resonant cavity. Conversely, frequencies of 200 Hz to 5 kHz enter from the space into the bass reflex opening and are prevented by the small structures from producing resonances and/or cancellations in the box volume. This contributes to the avoidance of an uneven diaphragm load on the mid-range driver.

Since the enclosure is to have the highest possible stiffness and the design of the bass reflex channels can have a complex path guide, the enclosure is assembled from a plurality of plate-like formed parts in a particularly advantageous embodiment of the invention. The individual formed parts have recesses, which in assembled form form the bass reflex channels and other free spaces of the enclosure. In particular, the formed parts can be designed as milling parts or milled cast metal parts, preferably from an aluminium alloy, or as a body made by 3D printing, and can be screwed, glued or welded together.

In order to simulate the ideal of an acoustic point source in a typical audio range, the mid-range driver can be inclined in the enclosure by 0.5° to 5°, preferably approximately 2.5°, in the direction of the tweeter. At an angle of 2.5°, the effect is achieved at a distance of about 2.5 m.

The invention is explained in more detail in the following with reference to the exemplary embodiments illustrated schematically in the drawings, in which

Fig. 1 shows a front view of a loudspeaker having a front wall of the enclosure behind which a tweeter and a mid-range driver are arranged;

Fig. 2 shows a section through the loudspeaker according to Fig. 1; and

Fig. 3 shows a view of one of the plate-like formed parts forming the enclosure.

The loudspeaker illustrated in the drawing has an enclosure 10 that is assembled from a plurality of plate-like formed parts 12 - 34.

Fig. 1 shows a front view of the loudspeaker, with the formed part 12 forming the front wall, wherein a tweeter 38 is arranged centrally behind the front wall and a mid-range driver 40 is arranged close in juxtaposition on the edge side. The front wall 12 has a thickness of approximately 10 mm and, like the remaining formed parts 14 - 34, is a milled cast part made of an aluminium alloy and thus has a high mechanical stability. The front wall is penetrated by a plurality of sound passage openings 42 arranged in a regular grid, which are designed as slot holes and are slightly conically tapered in the direction of the enclosure interior side as channels. The openings 42 are so dimensioned such that their width is less than half the wavelength of the highest frequency produced by the tweeter, thus preventing the formation of resonances in the openings 42, which are noticeable in the horizontal listening area. A plurality of outlet openings 44 of bass reflex channels 46 (Fig. 2), which communicate with the rear of the mid-range driver 40, are arranged mirror-symmetrically to the tweeter 38. The bass reflex channels are designed and dimensioned in such a way that no turbulences and/or resonances can arise in them. The

complex form of the bass reflex channels which run separately from each other is made possible by the construction of the enclosure 10 from the plate-like formed parts 12 - 28, each with adjoining recesses.

The formed parts 14 and 16, which have a central recess for the tweeter 38 designed as a ringhorn, are connected to the front wall, however, in the area of the mid-range driver 40, the sound passage openings 42 continue channel-like and contoured near to the surface of the cone diaphragm of the mid-range driver, wherein the remaining distance is barely larger than required by the diaphragm stroke. This results, so to speak, in a division of the sound-radiating surface of the mid-range driver into sectors which do not acoustically influence each other, and whose size corresponds approximately to the openings 42. As can be seen in Fig. 1, this size is only a few percent of the total area. This leads almost to a rectification of the emitted sound waves and reduces distortion of the acoustic pattern.

The rear area of the enclosure 10 formed by the formed parts 30 - 34 is acoustically decoupled from the formed parts 12 - 28 arranged in front of it, and contains the electronic and mechanical components of a crossover network in recesses provided for it (not shown in detail), including the parts required for the connection of a loudspeaker cable, for dividing the supplied electrical musical signal into a frequency band suitable for the respective loudspeaker chassis. Such a crossover network is fundamentally known and does not require further explanation here.

Fig. 3 shows, as an example for the complex design of the formed parts 18 - 28, the formed part 26 with a series of recesses, which are each part of the bass reflex channels 46. In the edge region of the formed part, a plurality of holes 48 are shown, which serve to screw the formed parts together. Both the formed parts and the enclosure of the tweeter 38 and the mid-range driver 40 can be screwed with high force. This results in a loudspeaker enclosure, which is acoustically dead and thus may not have a disturbing influence on the sound reproduction.

In summary, the following should be stated: the invention relates to a loudspeaker having an enclosure 10 and having at least one sound transducer 38, 40 mounted in the enclosure. In order to enable sound reproduction as free of distortion as possible, it is proposed according to the invention, to provide a plurality of channels 42, 44, 46 formed in the enclosure 10 but which run separately from each other, for the sound waves produced by the front and/or back of the at least one sound transducer 38, 40.

Patentkrav

1. Højttaler med et hus (10), med mindst en lydtransducer (38, 40), der er anbragt i huset, og med en flerhed af kanaler (42, 44, 46), der er udformet i huset (10) og forløber adskilt fra hinanden, til de lydbølger, der genereres fra for- og/eller bagsiden af den mindst ene lydtransducer (38, 40), **kendetegnet ved, at** der er tilvejebragt to lydtransducere, hvoraf den første er udformet som mellemtonehøjttaler (40) og den anden er udformet som højtonehøjttaler (38), og hvor de kanaler (42), der er anbragt foran mellemtonehøjttaleren (40), har et omrids, som strækker sig under hensyntagen til mellemtonehøjttalerens (40) membranslag frem til dennes membran og danner en profil, der er komplementær med membranen.

2. Højttaler ifølge krav 1, **kendetegnet ved, at** mellemtonehøjttaleren (40) er udformet som en dynamisk konushøjttaler.

3. Højttaler ifølge krav 1, **kendetegnet ved, at** højtonehøjttaleren (38) er udformet som en ringhornhøjttaler.

4. Højttaler ifølge et af kravene 1 til 3, **kendetegnet ved, at** den mindst ene lydtransducer (38, 40) er anbragt bagved en forvæg (12) af huset (10), hvilken har en flerhed af lydgennemgangsåbninger (42).

5. Højttaler ifølge krav 4, **kendetegnet ved, at** lydgennemgangsåbningerne (42) danner kanalerne og hver især har en bredde, som er mindre end halvdelen af bølgelængden af den højeste frekvens, der genereres af den mindst ene lydtransducer (38, 40).

6. Højttaler ifølge krav 4 eller 5, **kendetegnet ved, at** kanalerne (42) strækker sig i det væsentlige vinkelret på forvæggens (12) plan og er udformet som langhuller, der forløber tilspidset konisk i retning mod en bagside af forvæggen (12).

7. Højttaler ifølge et af kravene 4 til 6, **kendetegnet ved, at** huset (10) har en basrefleksåbning (44), som fortrinsvis er anbragt i forvæggen (12), og som

kommunikerer med bagsiden af den mindst ene lydtransducer (40) via et system af fra hinanden adskilte basisreflekskanaler (46).

8. Højttaler ifølge krav 7, **kendetegnet ved, at** basreflekskanalerne (46) har tværsnitsflader, hvis største længdemål er mindre end halvdelen af bølgelængden af den højeste frekvens af den lydtransducer (40), der kommunikerer med basrefleksåbningen (44).

9. Højttaler ifølge krav 7 eller 8, **kendetegnet ved, at** den mindste radius af en retningsændring af basreflekskanalerne (46) svarer til den mindste længdeudstrækning af deres tværsnitsflade.

10. Højttaler ifølge et af kravene 7 til 9, **kendetegnet ved, at** basrefleksystemet, der er dannet af basrefleksåbningen (44) og basreflekskanalerne (46), er afstemt til en middelfrekvens på mellem 80 Hz og 120 Hz.

11. Højttaler ifølge et af kravene 1 til 10, **kendetegnet ved, at** huset (10) er sammensat af en flerhed af pladelignende formdele (12 - 34).

12. Højttaler ifølge krav 11, **kendetegnet ved, at** formdelene (12 - 34) er udformet som fræsedele eller overfræsede støbedele af metal, fortrinsvis af en aluminiumslegering, eller som elementer, der er fremstillet ved 3D-printning, og er skruet, klæbet eller svejset fast til hinanden.

13. Højttaler ifølge et af kravene 5 til 12, **kendetegnet ved, at** mellemtonehøjttaleren (40) er anbragt i huset (10) med en hældning på 0,5° til 5°, fortrinsvis ca. 2,5°, i retning mod højtonehøjttaleren (38).

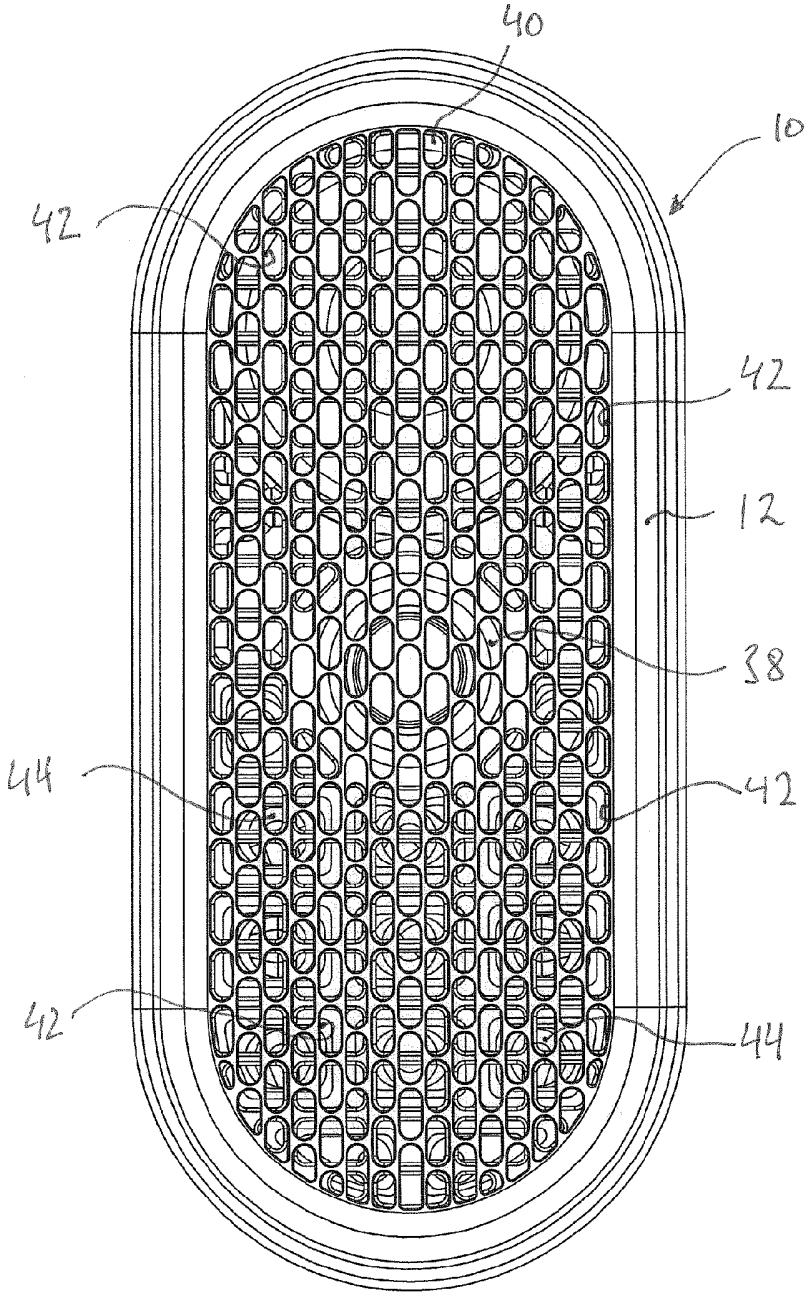

Fig. 1

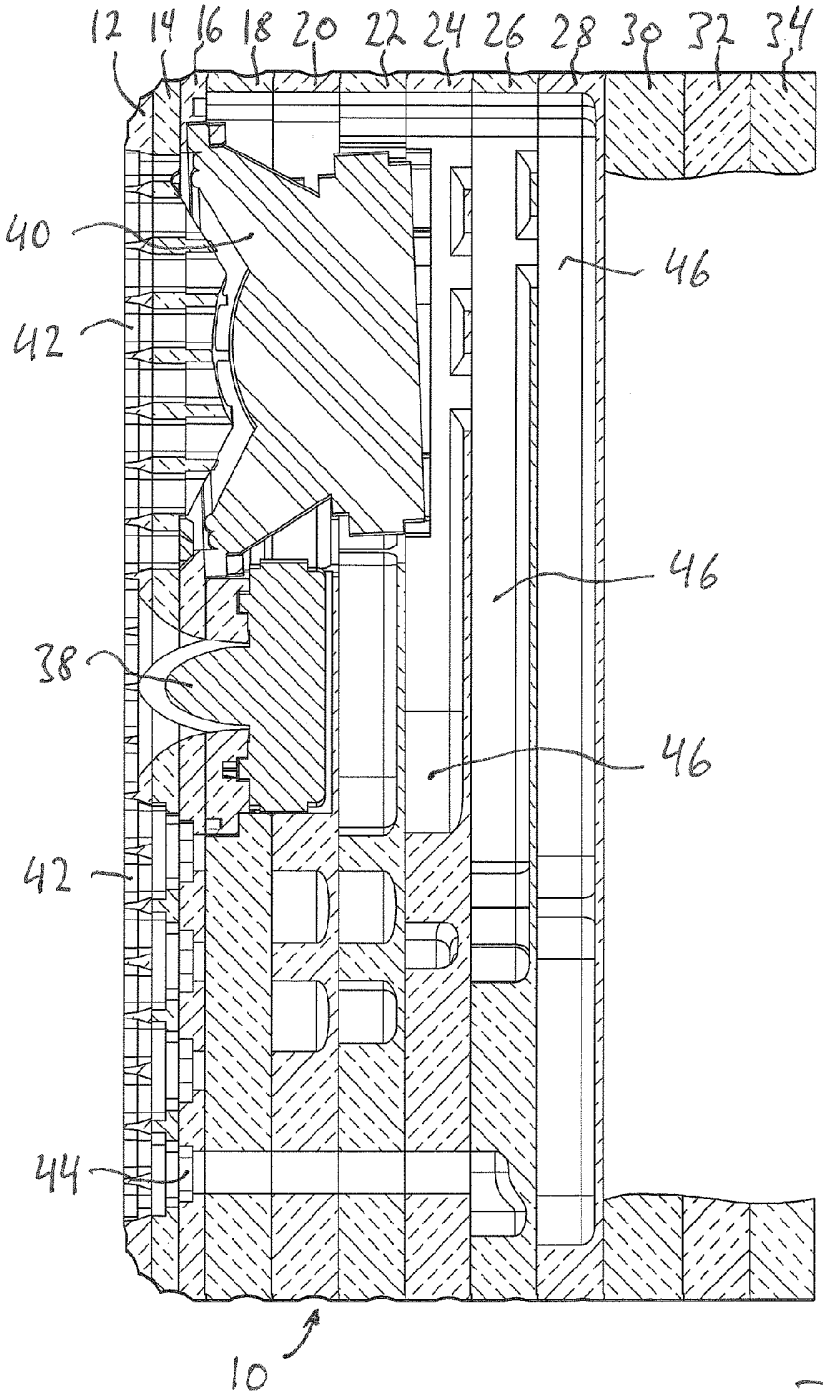

Fig. 2

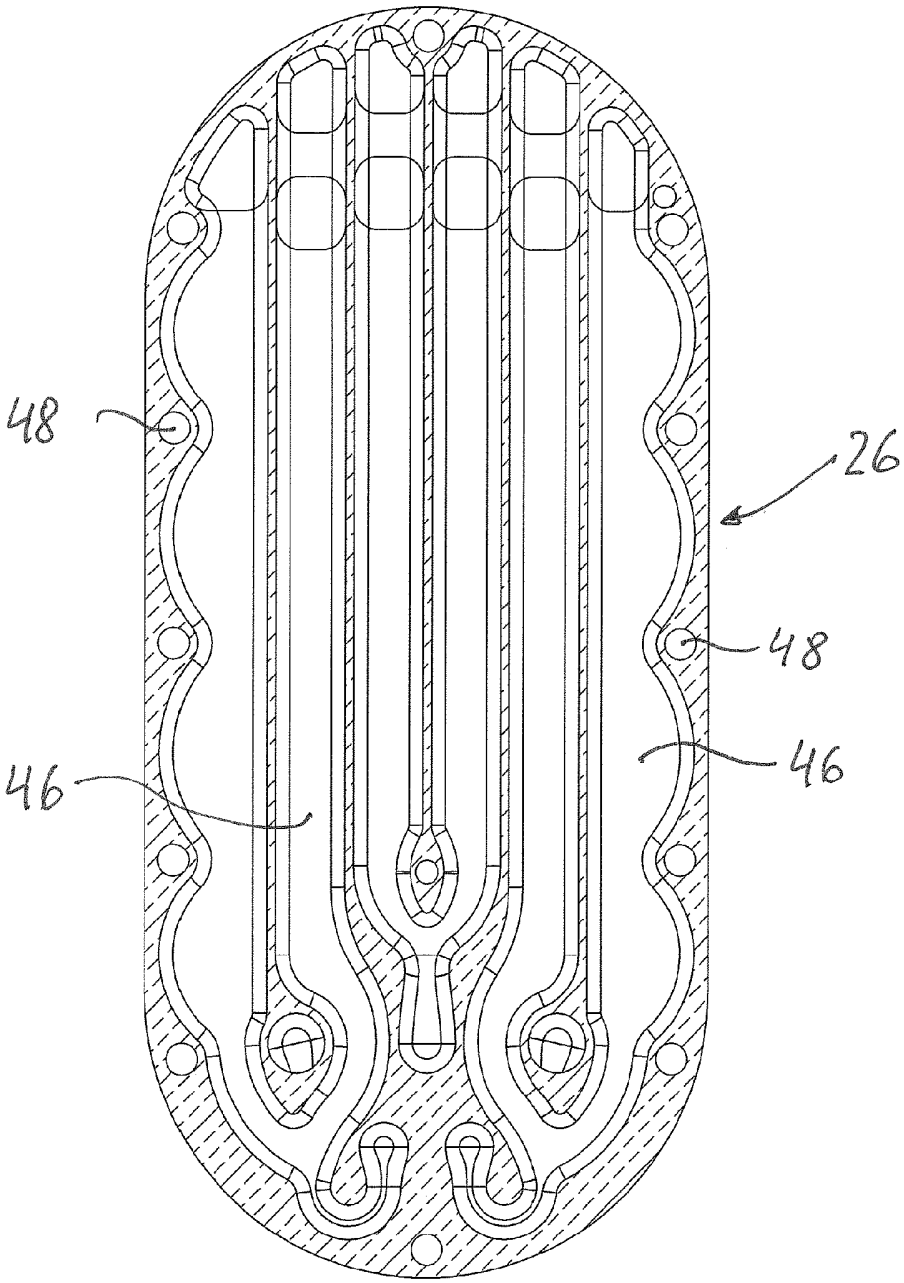

Fig. 3