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(54) Electronic device with variable sound chamber

(57) There are various types of electronic devices available on the market that comprise integrated loudspeakers. Integrated loudspeakers are advantageous with respect to production costs, electrical connections and the space requirement of the device. Unfortunately, these advantages are often connected with the restriction that the user cannot combine a device with integrated loudspeakers with a loudspeaker of his choice.

The invention provides an electronic device 1 equipped with at least one loudspeaker 4 mounted in a loudspeaker cabinet 6 for audio reproduction characterized in that the volume of the loudspeaker cabinet 6 is adjustable by the user.

In the inventive device, the volume of the loudspeaker cabinet can be adjusted by the user in that the sound characteristics of the loudspeaker cabinet are in accordance with the preferences of the user.

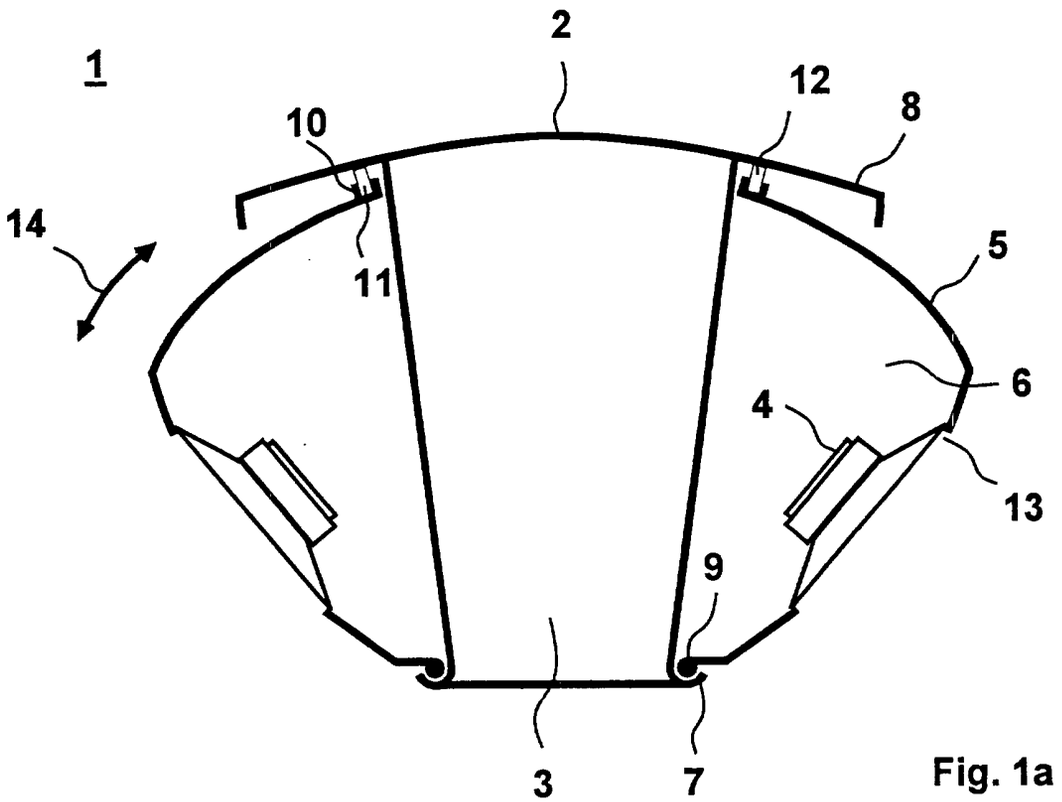

Fig. 1a

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Description

[0001] The present invention is related to consumer electronic devices equipped with integrated loudspeakers. Examples for such devices are audio equipment like CD players, tape recorders, radios, active or passive loudspeaker boxes and television receivers.

[0002] There are various types of electronic devices available on the market that comprise integrated loudspeakers. In contrast to devices with external loudspeakers, these devices can be transported very easily. Even if the device is not designed to be a portable one like a TV with a big cathode ray tube, integrated loudspeakers are advantageous also with respect to production costs, electrical connections and the space requirement of the device. Unfortunately, these advantages are often connected with the following restrictions for the design and the use of the electronic device.

[0003] In contrast to devices with external loudspeakers, the customer is not able to combine a device having integrated loudspeaker with loudspeakers of his choice. For example, a customer who likes to listen to classical music prefers loudspeakers with different sound characteristics than a person who likes pop music that requires e.g. enhanced bass reproduction. Accordingly, a person who likes a loud reproduction of sound would prefer bigger loudspeakers than a person who is forced to operate the device only at low volume level. For that reason many people buy devices without integrated loudspeakers and combine it with external loudspeakers in accordance with their personal needs. However, if the person wants to buy a TV or a portable radio recorder, he cannot do so. Designers of devices with integrated loudspeakers face the problem as well when they have to estimate the needs of their customers. Whatever the design of the loudspeaker cabinet is like, the design cannot fulfill all the different customer expectations at the same time.

[0004] On the other hand, there has been a strong trend on the market to miniaturize devices and to make especially portable devices as small or flat as possible. Engineers have been very successful in reducing the size of electronic boards e.g. by using highly integrated circuits or smaller compounds like surface mounted devices. Thus, the size of portable devices like for example mobile phones has been decreased drastically. However, it has not been possible to reduce the size of portable devices with integrated loudspeakers accordingly, because the sound output of the loudspeaker is strongly connected to the volume of the loudspeaker cabinet. The loudspeaker cabinet has to be preferably big if the customer prefers sound reproduction with enhanced bass or at high volume. However, big sized loudspeaker cabinets are in contradiction to an easy portability.

[0005] On the other hand, the preferences of the customer may depend on the purpose he wants to use the device for. For example, a customer may prefer a portable radio recorder with big sized loudspeaker cabinets when the device is used in a large room at high volume level. If the customer intends to use the same device on travel e.g. during sitting in a train, it may not be allowed to turn the music loud nor be comfortable to transport a device with big sized loudspeakers cabinets.

[0006] To minimize the space requirement, devices with retractable or removable loudspeaker cabinets have been designed. In these devices, the loudspeakers have a separate housing that can be detached from the main housing of the electronic device or can be retracted therein. However, there has been no development to overcome the restriction that the sound characteristic of an integrated loudspeaker cabinet cannot be changed in accordance with the preferences of the user.

[0007] Thus it is desired to have an electronic device with integrated loudspeakers that alleviates the aforementioned problems.

[0008] Such a desired electronic device is provided by the invention described in claim 1. The inventive electronic device comprises at least one loudspeaker cabinet wherein the volume of the loudspeaker cabinet can be adjusted to the preferences of the user.

[0009] In the inventive device, the volume of the loudspeaker cabinet can be adjusted by the user such that the sound characteristics of the loudspeaker cabinet are in accordance with the preferences of the user. In contrast to a loudspeaker cabinet with a fixed volume, the invention allows to adapt the loudspeaker characteristics e.g. to the sound volume or to the type of sound being reproduced. On the other hand, the space requirement of the electronic device can be varied as well. I.e., if the user wants to transport the device, he can reduce the volume and at the same time the size of the loudspeaker cabinet to its minimum for an easy portability. This is also advantageous with respect to the packing and shipping costs of the electronic device on its way from the factory to the user.

[0010] In one embodiment of the invention, the housing of electronic device may at least comprise one movable or pivotable element to expand the volume of the loudspeaker cabinet.

[0011] Another embodiment of the invention may comprise at least one part made of a flexible or expandable material that allows not only to vary the size of the loudspeaker cabinet but also to vary its shape.

[0012] In yet another embodiment of the invention electromechanical means to adjust the size of the loudspeaker cabinet may be provided, for example a motor can be used to drive the movable parts of the loudspeaker cabinet into the desired position.

[0013] There is also the possibility to link the size of a cabinet to that of another one by electromechanical means. This is especially interesting for devices with stereo sound. In these devices, it would be annoying to the user to adjust every single loudspeaker. At the same time, the stereo effect may be hampered if the volume of the left loudspeaker cabinet is different from that of the right one. For the case that the volume of the loud-

speaker cabinet is adjusted by hand, the volume adjustment of different loudspeaker cabinets may be linked together by using mechanical coupling elements like rods or levers arms that transfer the changes applied by the user to other loudspeaker cabinets. If the adjustment of the loudspeaker cabinet is done electrically, the driving circuit can be constructed in a way that the volume of other loudspeaker cabinets is changed at the same time. This does not necessarily mean that the volume of all loudspeaker cabinets has to be adjusted in exactly the same way.

[0014] In another embodiment of the invention means can be provided to adjust the volume of the loudspeaker cabinet in dependence on one or several other operation parameters of the device. For example, the volume of the loudspeaker cabinet can be adjusted to the sound volume level currently set by the user or to the settings of an equalizer to optimize the quality of the sound output. Apart from various other operation parameters, the volume of the loudspeaker cabinets can also be automatically adjusted in dependence on the type of sound being reproduced. In many electronic devices, information about the type of sound being reproduced is electronically available. For example, broadcasting stations use technologies like RDS (Radio Data System) or EPG (Electronic Program Guide) to provide information about the current program. The information may also be provided by a storage device used for the reproduction of the sound. Depending on the type of program the loudspeaker cabinet can be adjusted for optimized sound reproduction of classical music, sports reports, pop music etc.

[0015] On the other hand, it is possible to adjust the operation parameters of the electronic device in dependence on the adjusted size of the loudspeaker cabinet. For example, the maximum output volume of the electronic device can be limited in dependence on the size of the loudspeaker cabinet. This might be important for electronic devices that comprises a CD player. If the size of the loudspeakers cabinets is too small in relation to the adjusted sound volume, heavy resonances might hamper the reliable operation of the CD player.

[0016] The information about the current setting of the volume of the loudspeaker cabinet can be either provided as a parameter set by the user or it can be determined by a sensor. The latter one is at least necessary if the size of the loudspeaker cabinet is adjusted by hand. Such a sensor may comprise components like electrical or optical switches or variable resistors that detect the position of variable elements of the loudspeaker cabinet. Such sensors may also be used in devices where the adjustment of the volume of the loudspeaker cabinet is done electrically e.g. by motors to have a feedback of the current position of movable elements. The current position may differ from the electronically set position if the user performs changes by hand while the device is turned off, or if a motor is not able to move a part of the loudspeaker cabinet due to a barrier located in the environment of the device. Further advantages of the invention will become apparent when reading the detailed description.

[0017] For a better understanding two simple exemplary embodiments of the invention are described with reference to the attached drawings.

Figures 1 and 2 show schematic cross sectional views of two different embodiments of the invention for a portable audio device.

Fig. 1a shows a portable audio device wherein the size of the speaker cabinet can be adjusted by a pivotable sidewall,

Fig. 1b shows the same device while the loudspeaker cabinets are fully expanded,

Fig. 2a shows a portable audio device wherein the size of the speaker cabinet can be adjusted in a way known from a telescope,

Fig. 2b shows the same device while the loudspeaker cabinets are fully expanded.

[0018] Portable audio devices usually comprise an amplifier, a tuner, a tape recorder, a CD-player and integrated loudspeaker boxes. For stereo reproduction of the sound, usually two loudspeakers are used. However, the number of loudspeakers is not important for the present invention.

[0019] Fig. 1 gives a schematic cross sectional top view of a portable audio device, wherein parts a and b are to illustrate how the size of the loudspeaker cabinet can be changed. The portable audio device 1 comprises a housing 2. The inner part 3 of the housing 2 may contain electrical and mechanical components. These components may comprise power supply and signal processing circuits and/or devices like a CD player or a tape recorder. For the sake of simplicity, all these components as well as the electrical connections between said components and the loudspeakers 4 have been omitted in the drawings. The connection between the loudspeakers 4 and the signal processing and amplifying circuits are made by conventional plug connections or simply by wires penetrating the sidewalls of the housing 2. The housing 2 is designed to support a side wall 5 of the speaker cabinet 6 by providing protrusions 7 and the guiding walls 8. Each side wall 5 of the loudspeaker cabinet 6 provides an enlargement 9 at one end that fits to the protrusion 7 and that allows the sidewall 5 to be pivoted away from the inner part 3 of the housing 2. At the opposite end of the side wall 5 a protrusion 10 with a groove 11 is provided to carry a gasket 12 that supports the movement of the sidewall 5 along the guiding wall 8 and that makes the loudspeaker cabinet 6 tight to prevent sound leakage and the penetration of dust from the environment. The sidewall 5 further comprises an opening 13 for a loudspeaker 4 that is attached to the sidewall 5. The sidewall 5 can be moved between the two positions shown in parts a and b along the direction indicated by the arrow 14.

[0020] By this movement, the size of the cabinet and in consequence the sound characteristics of the loudspeaker cabinet can be adjusted as desired by the user. For example, the sidewall 5 can be adjusted in the position shown in Fig. 1b to maximize the volume of the loudspeaker cabinet 6 and to enhance the bass reproduction at the same time. On the other hand, the user is able to reduce the size of the loudspeaker cabinet 6 to a minimum as shown in Fig. 1a in order to suppress unwanted bass reproduction. With the invention the user is able to adjust the sound quality and performance of the audio device according to his preferences through a very simple operation. In addition to the adjustment of the sound quality, the user is able to change the space requirement of the device easily. To transport the device, it is comfortable to bring the movable sidewall 5 into the position shown in Fig. 1a where a minimum of space is required.

[0021] Fig. 2 shows another embodiment of the invention wherein the size of the loudspeaker cabinet can be changed in a way as known from a telescope. A cross-sectional view of a portable audio device 21 similar to that shown in Fig. 1 is presented that comprises a housing 22. There are separate housing elements 23 with an opening 24 for a movable element 25 attached to the housing 22. The movable elements 25 provide an opening 26 for a loudspeaker 27 that is attached to the movable element 25. The movable element 25 further comprises protrusions 28 to limit the movement of the element 24 and to provide grooves 29 to carry gaskets 30 in order to make the loudspeaker cabinet 31 tight. The volume of the loudspeaker cabinet 31 can be adjusted by moving the element 24 as indicated by the arrow 32. As the size of the loudspeaker cabinet 31 can be adjusted arbitrarily in between the two positions shown in parts a and b of the figure, similar advantages as already discussed in the context of Fig. 1 are achieved. Besides, the volume of the loudspeaker cabinet can be easily enlarged by additional movable parts, that become smaller and smaller and fit in the opening of the adjacent housing.

[0022] However, it is also possible to enlarge the embodiment shown in Fig. 1 by further movable parts that can be pivoted into each other, or to combine it with the embodiment shown in Fig. 2.

[0023] It should be pointed out that the invention can also be implemented in a stand alone loudspeaker box. Anyway, while certain embodiments of the invention have been described and illustrated, it is to be distinctly understood that the invention is not limited thereto but may be otherwise embodied and practiced within the scope of the following claims.

Reference list

[0024]

1 portable audio device
2 housing
3 inner housing
4 loudspeaker
5 movable side-wall
6 loudspeaker cabinet
7 protrusion
8 guiding wall
9 enlargement
10 protrusion
11 groove
12 gasket
13 opening
14 arrow
21 portable audio device
22 housing
23 separate housing element
24 opening
25 movable housing element
26 opening
27 loudspeaker
28 protrusion
29 groove
30 gasket
31 loudspeaker cabinet
32 arrow

Claims

1. Electronic device (1,21) equipped with at least one loudspeaker (4,27) mounted in a loudspeaker cabinet (6,31) for audio reproduction **characterized in that** the loudspeaker cabinet (6,31) comprises at least one movable part (25) so that the volume of the loudspeaker cabinet (6,31) is adjustable.

2. Electronic device according to claim 1 **characterized in that** the cabinet comprises at least one pivotable part (5).

3. Electronic device according to claim 1 **characterized in that** at least one part of the loudspeaker cabinet comprises an expandable material.

4. Electronic device according to claim 1 **characterized in that** the device comprises electromechanical means to adjusted the volume of the loudspeaker cabinet (6,31).

5. Electronic device according to claim 1 **characterized in that** the electronic device comprises means to automatically adjust the volume of the loudspeaker cabinet (6,31) in dependence on the current operation parameters of the device.

6. Electronic device according to claim 6 **characterized in that** one of the current operation parameters is the type of sound being reproduced.

7. Electronic device according to claim 7 **characterized in that** the electronic device comprises means to determine the type of sound by an evaluation of data transmitted by the sound source.

8. Electronic device according to claim 1 **characterized in that** the device comprises a sensor to determine the adjusted volume of the loudspeaker cabinet (6,31).

9. Electronic device according to claim 1 **characterized in that** the device comprises means to adapt operation parameters of the device in dependence on the adjusted volume of the loudspeaker cabinet (6,31).

10. Electronic device according to claim 1 **characterized in that** the device is provided with a mechanical coupling between loudspeaker cabinets so that any movement of one of the coupled loudspeaker cabinets is transferred to all other coupled loudspeaker cabinets.

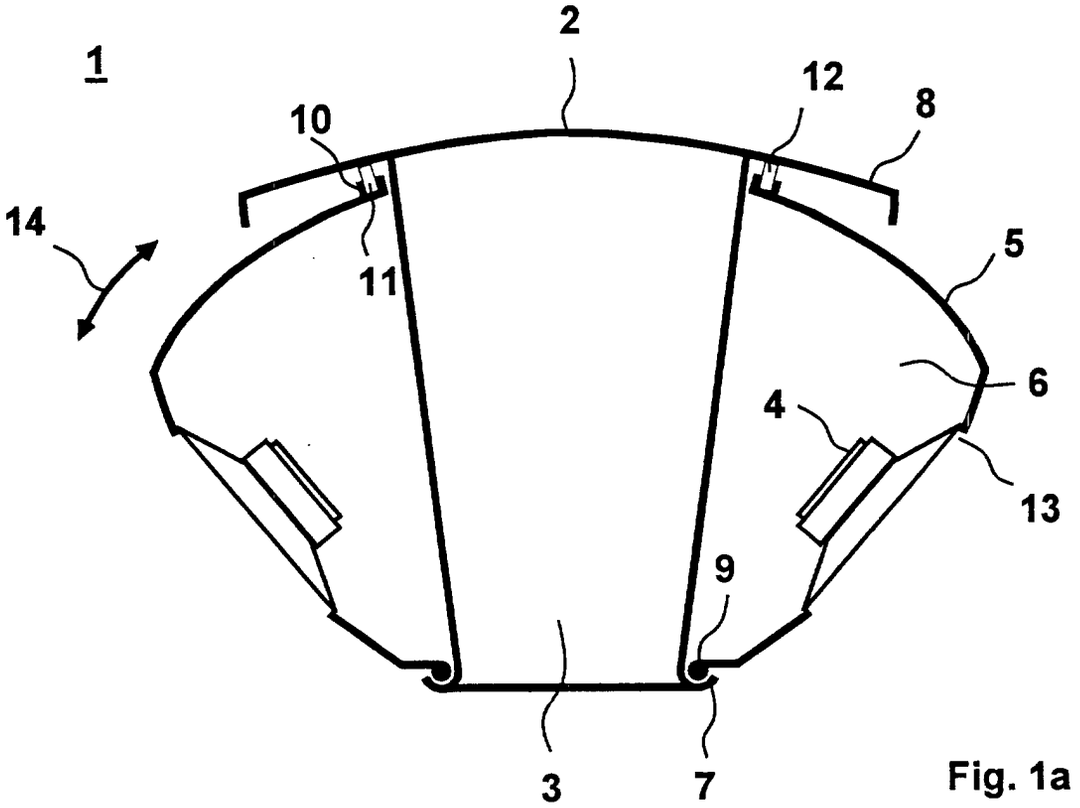

Fig. 1a

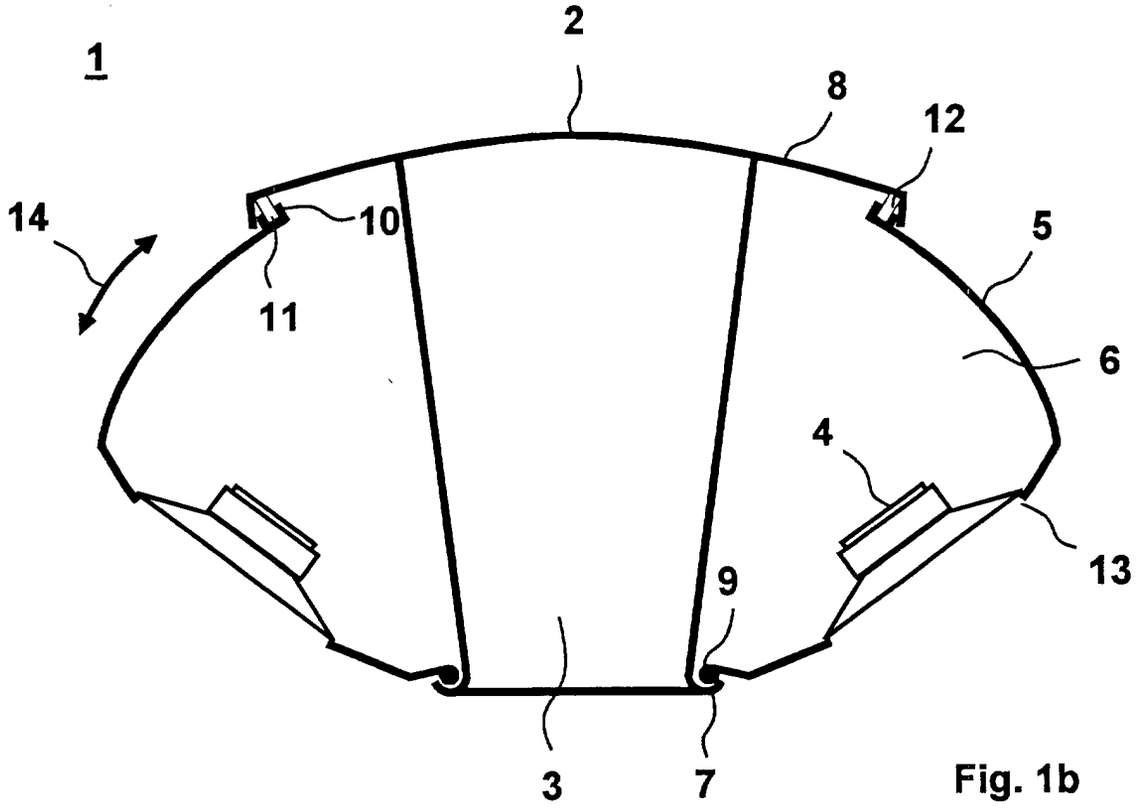

Fig. 1b

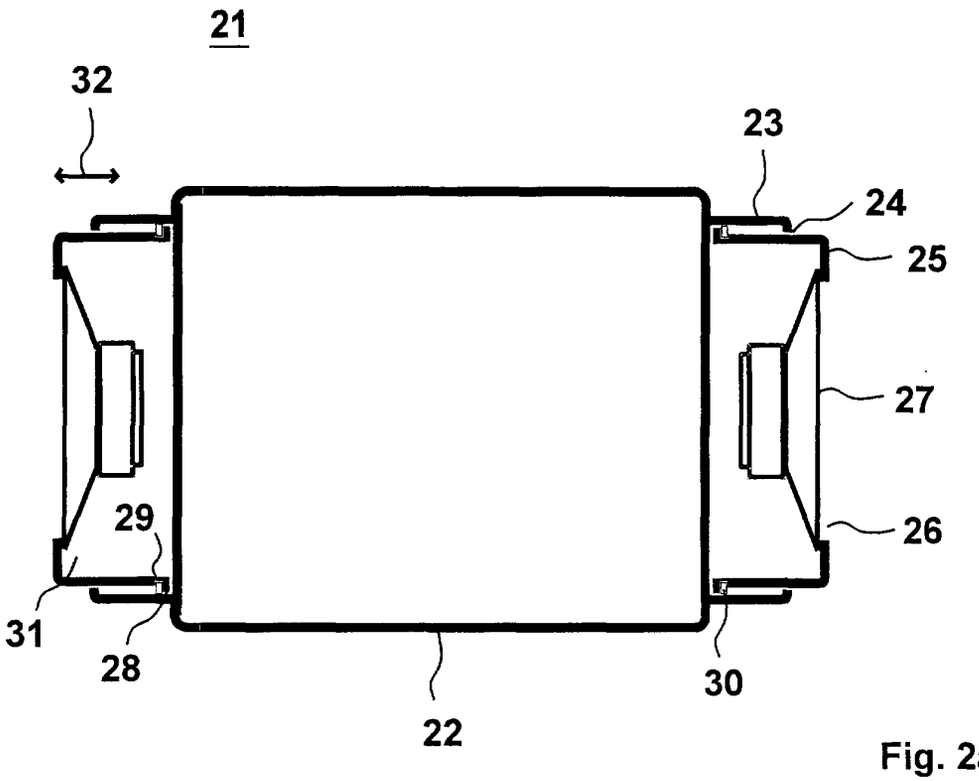

Fig. 2a

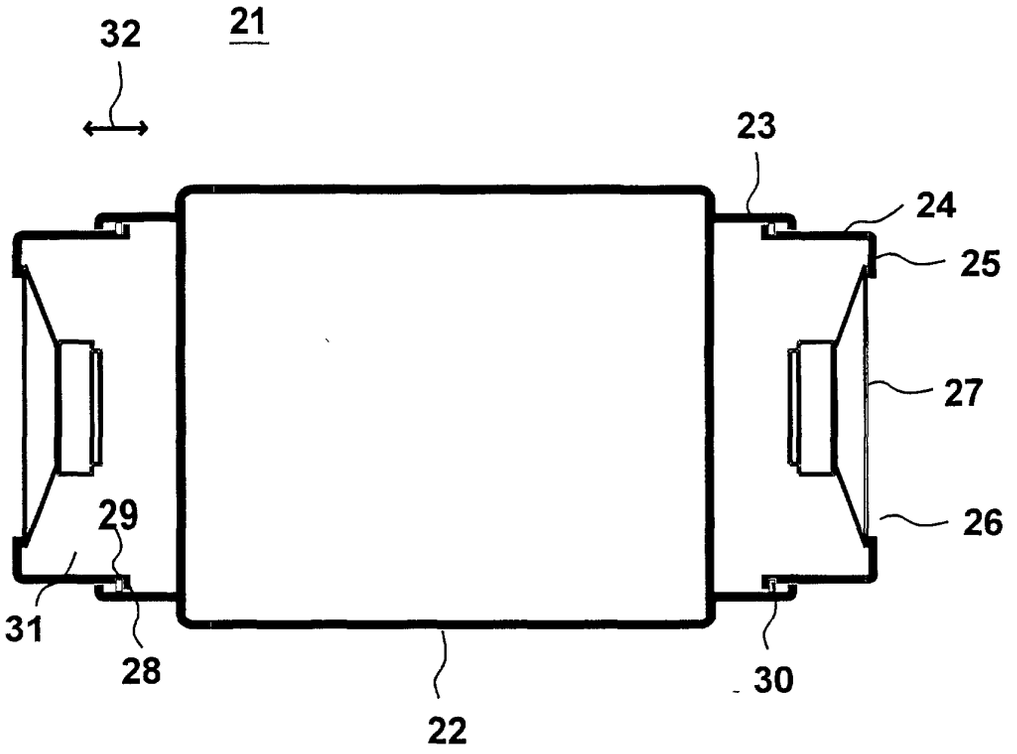

Fig. 2b

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EUROPEAN SEARCH REPORT

Application Number
EP 00 40 3233

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	FR 2 680 295 A (TSAO YE MING) 12 February 1993 (1993-02-12)	1-4	H04R5/02 H04R1/28
A	* page 3, line 10 - page 7, line 2; figures *	5-10	
A	EP 0 356 298 A (LOIRE SEREL ELECTRONIQUE) 28 February 1990 (1990-02-28) * column 2, line 5 - column 3, line 19; figures *	1-4	
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A	EP 0 568 716 A (LANG DIETER) 10 November 1993 (1993-11-10) * page 2, line 50 - page 4, line 4; figures *	5-10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04R H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 July 2001	Gastaldi, G

CATEGORY OF CITED DOCUMENTS

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