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(54) Monolithic device with an acoustic system

(57) The invention concerns a monolithic device including a sound source providing a sound signal and an acoustic system comprising at least one enclosure with two active loudspeakers.

In order to provide good quality sound, the acoustic system comprises:

- at least two amplifiers (71, 72);

- at least a first active loudspeaker (311) dedicated to bass frequencies being fed with a low frequency signal amplified by a first amplifier (71); and
- at least a second active loudspeaker (312) adapted to produce at least medium frequencies, the second active loudspeaker being fed with at least medium frequency signal amplified by a second amplifier (72), that is different of said first amplifier.

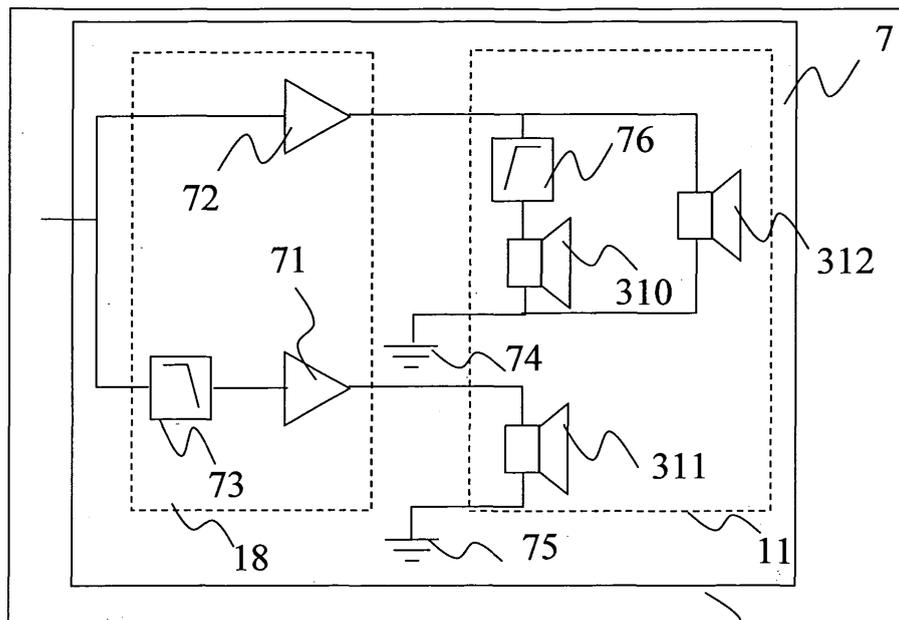


Fig 7

Description

1. Field of invention.

[0001] The present invention concerns acoustic systems, and more specifically acoustic system that are small and present good efficiency in bass frequencies. In particular, the invention is advantageously applied to monolithic devices including a small location for such an acoustic system (for example devices fitted with a flat screen).

2. State of the art.

[0002] According to state of the art, an acoustic system for a device including a small location for it includes generally one or several active loudspeakers for medium and high frequencies and sometimes a boomer. As illustrated in figure 6, a TV set 6 fitted with a flat screen comprises such an acoustic system 60. The acoustic system 60 includes itself:

- an amplifier 610 amplifying a sound signal;
- a band pass filter (or high pass filter) 613 and a low pass filter receiving each the same sound signal amplified by the amplifier 610;
- a medium loudspeaker (and/or tweeter) 611 producing a medium and high frequency sound from the signal filtered by filter 613;
- a boomer loudspeaker 621 producing a bass frequency sound from the signal filtered by filter 623; and
- a mass 612 (common to loudspeaker 611 and 621).

[0003] The amplifier 610 has a 8Ω impedance and both speakers 611 and 621 have a 16Ω impedance.

[0004] The system 60 has the drawbacks that either the big volume of its loudspeakers does not suit well to their destination device or they have a bad sound quality and/or level, especially in bass frequencies.

3. Summary of the invention.

[0005] The invention aims at providing a small acoustic system, that is well adapted to devices including a small location for the acoustic system (e.g. devices including a flat screen such as plasma or LCD screen) and that has a good sound quality especially in bass frequencies.

[0006] The invention concerns a monolithic device including a sound source providing a sound signal and an acoustic system comprising at least one enclosure with two active loudspeakers. According to the invention, the acoustic system comprises:

- at least two amplifiers;
- at least a first active loudspeaker dedicated to bass frequencies being fed with a low frequency signal amplified by a first amplifier; and

- at least a second active loudspeaker adapted to produce at least medium frequencies, the second active loudspeaker being fed with at least medium frequency signal amplified by a second amplifier, that is different of said first amplifier.

[0007] Then, the invention enables to emphasize bass frequencies so that one or several small enclosures can be easily implemented in a monolithic device.

[0008] According to an advantageous feature, the first and second active loudspeakers are in the same enclosure.

[0009] According to a specific feature, the acoustic system comprises at least a low pass filter implemented before the first amplifier, the low pass filter(s) being adapted to filter a sound signal to the first amplifier.

[0010] According to another specific feature, the acoustic system comprises at least a low pass filter implemented between the first amplifier and the first active loudspeaker, the low pass filter(s) being adapted to filter a sound signal provided by the first amplifier to provide a low pass amplified signal to the first active loudspeaker.

[0011] According to a particular feature, the acoustic system comprises a high pass or band pass filter adapted to filter the signal amplified by the second amplifier.

[0012] Preferably, the second active loudspeaker is fed with a signal amplified by a second amplifier, where bass frequencies are not filtered.

[0013] Advantageously, the first active loudspeaker dedicated to bass frequencies that are equal to or lower than 200Hz and in that the second active loudspeaker being fed with at least medium frequency signal that are equal or bigger than 200 Hz.

[0014] According to a specific feature, it comprises a screen, and in a preferred embodiment, a flat screen.

[0015] According to a particular feature, the monolithic device belongs to the set comprising:

- television sets;
- radio receivers;
- MP3 station;
- communication terminals; and
- multimedia terminals.

4. Brief description of figures.

[0016] Other features of the invention will appear in light of the following description made with reference to the appended drawings, where:

- figures 1 and 2 present a television set including an acoustic system according to the invention, respectively in front and rear view;
- figures 3 and 4 represent a perspective view of an acoustic enclosure of the acoustic system of figures 1 and 2, respectively from the front and rear;
- figure 5 gives some examples of acoustic response of different acoustic systems including the system of

- figures 1 and 2;
- figure 7 represents a schematic view of the acoustic system of figures 1 and 2; and
- figure 6 represents a schematic view of the acoustic system of the state of the art.

5. Detailed description of the invention.

[0017] Figures 1 and 2 present a television set 1 including an acoustic system according to the invention, respectively in front and rear view.

[0018] The television set 1 comprises:

- an acoustic system including a left acoustic enclosure 10 and a right acoustic enclosure 11;
- a flat screen 12 (e.g. a plasma or a LCD screen);
- a control part 18 surrounded by a metallic box for protection against electromagnetic noise; and
- a mechanical plate 13 that support the cabinet including the screen 12, acoustic enclosures 10 and 11, control part 18.

[0019] The control part 18 comprises electronic means to adapt and/or acoustic signal to be provided to the enclosures 10 and 11. Connections that enable the transmission of an analog acoustic signal from the control part 18 to the enclosures 10 and 11 are made of wires and dedicated connectors and are not represented on figure 2 for clarity reasons.

[0020] The acoustic enclosures 10 and 11 are maintained on the TV cabinet through foam parts that absorb vibrations and are positioned on opposite end surfaces of the enclosures. These foam parts are respectively inserted in rigid guides 14 to 17 of the TV set cabinet. Then, the acoustic enclosures 10 and 11 are easy to position in the cabinet during manufacturing operations and the links between the enclosures 10 and 11 and the cabinet remain soft, so that vibrations are efficiently absorbed.

[0021] A protection grid in front of the enclosures 10 and 11 is assumed to be transparent on figures 1 and 2, also for clarity reasons.

[0022] In addition, other part of the television set 1, that are well known by those skilled in flat screen TV set, are not described and/or represented on the figures 1 and 2.

[0023] Figures 3 and 4 represent a perspective view of the acoustic enclosure 11, respectively from the front and rear. In the preferred embodiment acoustic enclosure 11 and 10 are the same, mainly for cost and maintenance reasons.

[0024] The acoustic enclosure 11 comprises:

- a cabinet divided in two parts 31 and 32, made of injected plastic;
- two foams 30 and 33 positioned in the end of the cabinet that are inserted in rigid guides respectively 17 and 16, thus enabling an easy manufacturing and a soft link with the TV set 1;
- two foams 313 that are positioned on each side of

the part 31 (for symmetry reason as the enclosures 10 and 11 are identical), and that enable to prevent rough contact with the screen 12 or any other element of the TV set 1;

- 5 - two active bass and medium loudspeakers 311 and 312 (with their protection) in the front face of the part 31;
- one active tweeter 310 with Ti dome, small cavity and shaped horn, in the front face of the part 31;
- 10 - two passive loudspeakers 315 and 316 in the rear face of the part 31; and
- two connectors 321 and 322 (e.g. of Lumberg UF type) in the rear face of the part 32.

15 **[0025]** Active loudspeakers 311 and 312 and passive loudspeakers 315 and 316 are located in the same resonant room, so that passive loudspeakers 315 and 316 are controlled by active loudspeakers 311 and 312.

20 **[0026]** Loudspeaker 311 dedicated to bass frequencies is connected to the connector 321. Loudspeaker 312 dedicated to bass and medium frequency and tweeter 310 are connected in parallel to connector 322, the tweeter 310 being fed with a high-pass filtered signal (a high-pass filter being connected to the input of the tweeter 310). Loudspeaker 311 and 312 are preferably the same 25 8 Ω loudspeakers (at bass and medium frequencies). At bass and medium frequencies, the impedance of tweeter 310 is very big. At higher frequencies, the impedance of tweeter 310 is 8 Ω and the impedance of loudspeaker 312 is very high (e.g. bigger than 20 Ω). Thus, loudspeaker 30 311 and 312 are fed with analog signals, that are amplified independently with two different amplifiers (each providing a power equal to or greater than 10 Watts rms) the output impedance of each amplifiers being adapted to the input impedance of corresponding loudspeakers. 35 Indeed, a low-pass filter filters the input of loudspeaker 311 to enhance the bass frequencies, whereas the low frequencies are preferably not filtered at the input of loudspeaker 312, so that loudspeaker 312 covers both bass and medium frequencies. The filter can be implemented 40 before or after the corresponding amplifier. The bi-amplification of the two speakers 311 and 312 enables a gain of 6dB all over (even with small bass loudspeaker (typically of diameter lower than 60 mm, this size corresponding more usually to midrange and treble frequencies)), compared to a system including a single amplifier and two 16 Ω speakers in parallel. Additionally, it enables to "shape" the response curve to the needs of the acoustics and to overcome, at least partially, the drawbacks of 45 the active speakers (e.g. low level in low frequencies, bad response curve) or the too small enclosure. More generally, such a system provide a better result than some bigger enclosures, higher SPL (or "Sound Pressure Level", i.e. sound level at a given frequency) at low frequencies and potentially more bass (front and back response), than other acoustic enclosures which has more than the double volume.

[0027] The acoustic amplifiers and filters are prefera-

bly in the control part 18. Indeed, according to a variant of the invention, they can be implemented inside the enclosures 10 and/or 11.

[0028] As a variant of the invention, bass loudspeakers 311 of enclosures 10 and 11 have a 4Ω impedance and are fed with the same 8Ω amplifiers. According to this variant, the bass/medium loudspeakers 312 of enclosures 10 and 11 have a 8Ω impedance and are fed with two different 8Ω amplifiers.

[0029] As illustration, the enclosure 11 has, for example, the following features:

- a depth $d1$ equal to 75 mm ;
- length $l11$ (without foam) and height $h11$ of part 31 equal respectively 172 mm and 55 mm, that enables an 0.7 liter net volume;
- length $l12$ (without foam) and height $h12$ of part 32 equal respectively 85 mm and 39 mm; and
- diameters of loudspeakers 311 and 312 equal 53 mm (i.e. the surface of the active membrane is around 12 cm^2); and
- dimension of the passive loudspeakers 315 and 316 is about $50\text{mm} \times 90\text{mm}$ (their is shape is preferably oval or rectangular in the middle and circular in the end as illustrated in figure 4) (the surface of the corresponding membrane is around 25 cm^2).

[0030] More generally, according to the invention, the depth and the height of parts 31 and 32 is advantageously less than 60 mm to be compliant with devices with a small location for acoustic system, especially devices with flat screen.

[0031] The frequency response of passive loudspeakers 315 and 316 is advantageously not the same. This can be achieved, for instance, as follows:

- the weight of their respective membrane is different (e.g. an added mass being added on the loudspeaker membrane and/or the thickness or matter of the membrane being different);
- their suspension can be stiffer for one of the loudspeaker; and/or
- the emissive surface is different.

[0032] Preferably, the emissive surface of the passive loudspeakers is rather big. More generally, the surface of membrane of each passive loudspeaker is equal or larger the surface of membrane of each active loudspeaker and preferably equal or larger than 1.5 times the surface of membrane of each active loudspeaker and more preferably equal or larger than twice the surface of membrane of each active loudspeaker.

[0033] The compliance (or C_{ms} that equals the inverse of the stiffer or, the shift of membrane relative to an applied force) is advantageously comprised between 0.5 and 1.2 mm/N.

[0034] More generally, the resonant frequencies of passive loudspeakers are not the same. Their difference

is preferably comprised between 1/3 octave and one octave: i.e., the higher frequency is equal or greater than 4/3 times the lower frequency and equal or lower than twice the lower frequency. This enables to enlarge the frequency band, that it reproduced by passive loudspeakers. The furthest the resonant frequencies are, the lowest the sound level is and the largest the useful band of the passive loudspeakers is.

[0035] Figure 7 illustrates a schematic view of the acoustic system associated to loudspeaker 11.

[0036] As mentioned above, the control part 18 comprises the amplifiers and filters associated to enclosure 11. More precisely, the control part 18 comprises one amplifier 71 associated to active loudspeaker 311 and one amplifier 72 associated to active loudspeakers 310 and 312. The amplifier 72 amplifies a sound signal and transmits it to the medium loudspeaker 312 and to a high pass filter 76 positioned before the tweeter 310, the loudspeaker 312 and 310 being connected in parallel to the output of the amplifier 72. The loudspeaker 71 amplifies a sound signal filtered by a low pass filter 73 and transmits it to the loudspeaker 311 dedicated to bass frequencies. The loudspeaker 312 is fed with bass frequencies (i.e. frequencies that are lower than 200Hz) that are not filtered or attenuated. Then, the bass frequency sound is provided by both loudspeakers 311 and 312 and is, then, of good quality and of sufficient level compared to medium frequency. Loudspeakers 310 to 312 are connected to an electrical mass 74 or 75.

[0037] As a variant, amplifiers and/or filters are implemented inside the acoustic enclosure.

[0038] In another variant (which can be combined with the previous variant), the sound feeding the loudspeaker 312 can be also filtered by a pass-band or high-band filter.

[0039] In another variant (which can be combined with the previous variants), high-pass, low-pass and/or band-pass filter(s) associated to loudspeaker 312 and/or 311 is (are) implemented after the corresponding amplifier 72 and/or 71.

[0040] Figure 5 illustrates the frequency response (amplitude vs frequencies) of two different configurations of enclosures comprising three actives loudspeakers (for bass, medium and treble) (these responses have been obtained by experiments or simulations):

- the curve 50 corresponds to the enclosure 10 or 11 associated to the control part 18 of television set 1, according to the invention, where two different 8Ω amplifiers provide a signal sound to respectively bass and medium 8Ω loudspeakers (without different passive speakers); and
- the curve 51 (in dashed line) corresponds to the acoustic system 8 of state of the art (one 8Ω amplifier feeds two 16Ω loudspeakers in parallel) as described in figure 6.

[0041] In the useful band (from 70 Hz to 20 kHz), the acoustic system according to the invention enables sev-

eral dB gain over the state of the art system.

[0042] Of course, the invention is not limited to embodiments that have been presented above.

[0043] In particular, the invention concerns different monolithic devices (or integrated devices) having a small location for acoustic system (especially devices including a screen (especially a flat screen)) such as TV sets, monitors for computer, radio receiver, MP3 station (or terminal), communication terminals, multimedia terminals, and where the acoustic system (including amplifiers and loudspeakers) is implemented inside the devices.

[0044] In addition, the invention is compliant with other shapes of enclosures. Especially, the invention is not limited to rectangular enclosures and can be adapted to enclosures that have one or several curved sides. The invention is also compliant with enclosures that has different sizes (especially, enclosures with are deeper or higher than disclosed enclosures). Moreover, the invention is compliant with enclosure comprising bigger active loudspeakers.

[0045] Moreover, the invention is compliant with acoustic enclosures having at least two passive loudspeakers that are all positioned on one side of the enclosure (as illustrated in figures) or that are positioned on each side of the enclosure (e.g. one or two passive loudspeaker are on one side of the enclosure and other passive loudspeaker(s) is or are on the other side). Positioning of passive loudspeakers relatively to the side of enclosure (same side or different sides for passive loudspeakers) or to the side of active loudspeaker (same or opposite side) can be determined according to the dimension or volume constraints associated to the device that is to implement the acoustic enclosures.

[0046] The invention applies also to any kind of enclosure comprising at least one loudspeaker dedicated to bass frequencies and at least one loudspeaker that provides higher frequencies sound (medium alone, medium and bass, and possibly with treble frequencies). In particular, the invention applies also to enclosures that have no passive loudspeaker or one passive loudspeaker or several identical passive loudspeakers.

[0047] In addition, the invention applies to monolithic devices with an acoustic system comprising one or several sound channels: e.g. mono or stereo systems, and also multichannel acoustic system including for example 3, 5 or 7 channels.

[0048] When applied to stereo or multichannel acoustic systems, the invention is compliant with systems including a single enclosure comprising a first loudspeaker dedicated to bass frequencies (i.e. below 200 Hz) and a second active loudspeaker or more active loudspeakers (e.g. loudspeakers associated to specific frequency band or channels) adapted to produce at least medium frequencies, the first and second loudspeakers receiving a sound signal respectively amplified by different amplifiers. The invention is also compliant with systems including several enclosures comprising each a first loudspeaker dedicated to bass frequencies and a second active

loudspeaker or more active loudspeakers adapted to produce at least medium frequencies, the first and second loudspeakers of each enclosure receiving a sound signal respectively amplified by different amplifiers.

[0049] The invention is not limited to loudspeakers and amplifiers having a 8 Ω impedance and concerns, more generally, monolithic devices including acoustic systems that comprises at least two amplifiers feeding each different active loudspeaker (one of which being dedicated to bass frequencies), the output impedance of each amplifiers being compliant (i.e. the same as) to the input impedance of corresponding loudspeaker.

15 Claims

1. Monolithic device (1) including a sound source providing a sound signal and an acoustic system comprising at least one enclosure (10,11) with two active loudspeakers (311, 312), **characterised in that** the acoustic system comprises:

- at least two amplifiers (71, 72);
- at least a first active loudspeaker (311) dedicated to bass frequencies being fed with a low frequency signal amplified by a first amplifier (71); and
- at least a second active loudspeaker (312) adapted to produce at least medium frequencies, the second active loudspeaker being fed with at least medium frequency signal amplified by a second amplifier (72), that is different of said first amplifier.

2. Monolithic device according to claim 1, **characterised in that** the first and second active loudspeakers are in the same enclosure.

3. Monolithic device according to any of claims 1 to 2, **characterised in that** the acoustic system comprises at least a low pass filter (73) implemented before the first amplifier, the low pass filter(s) being adapted to filter a sound signal to the first amplifier.

4. Monolithic device according to any of claims 1 to 3, **characterised in that** the acoustic system comprises at least a low pass filter implemented between the first amplifier and the first active loudspeaker, the low pass filter(s) being adapted to filter a sound signal provided by the first amplifier to provide a low pass amplified signal to the first active loudspeaker.

5. Monolithic device according to any of claims 1 to 4, **characterised in that** the acoustic system comprises a high pass or band pass filter adapted to filter the signal amplified by the second amplifier.

6. Monolithic device according to any of claims 1 to 4,

characterised in that the second active loudspeaker is fed with a signal amplified by a second amplifier, where bass frequencies are not filtered.

7. Monolithic device according to any of claims 1 to 6, **characterised in that** the first active loudspeaker is dedicated to bass frequencies that are equal to or lower than 200Hz and **in that** the second active loudspeaker being fed with at least medium frequency signal that are equal or bigger than 200 Hz. 5
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8. Monolithic device according to any of claims 1 to 7, **characterised in that** it comprises a screen (12). 15
9. Monolithic device according to claim 8, **characterised in that** it comprises a flat screen (12). 15
10. Monolithic device according to claims 1 to 7, **characterised in that** it belongs to the set comprising: 20
- television sets;
 - radio receivers;
 - MP3 station;
 - communication terminals; and
 - multimedia terminals. 25

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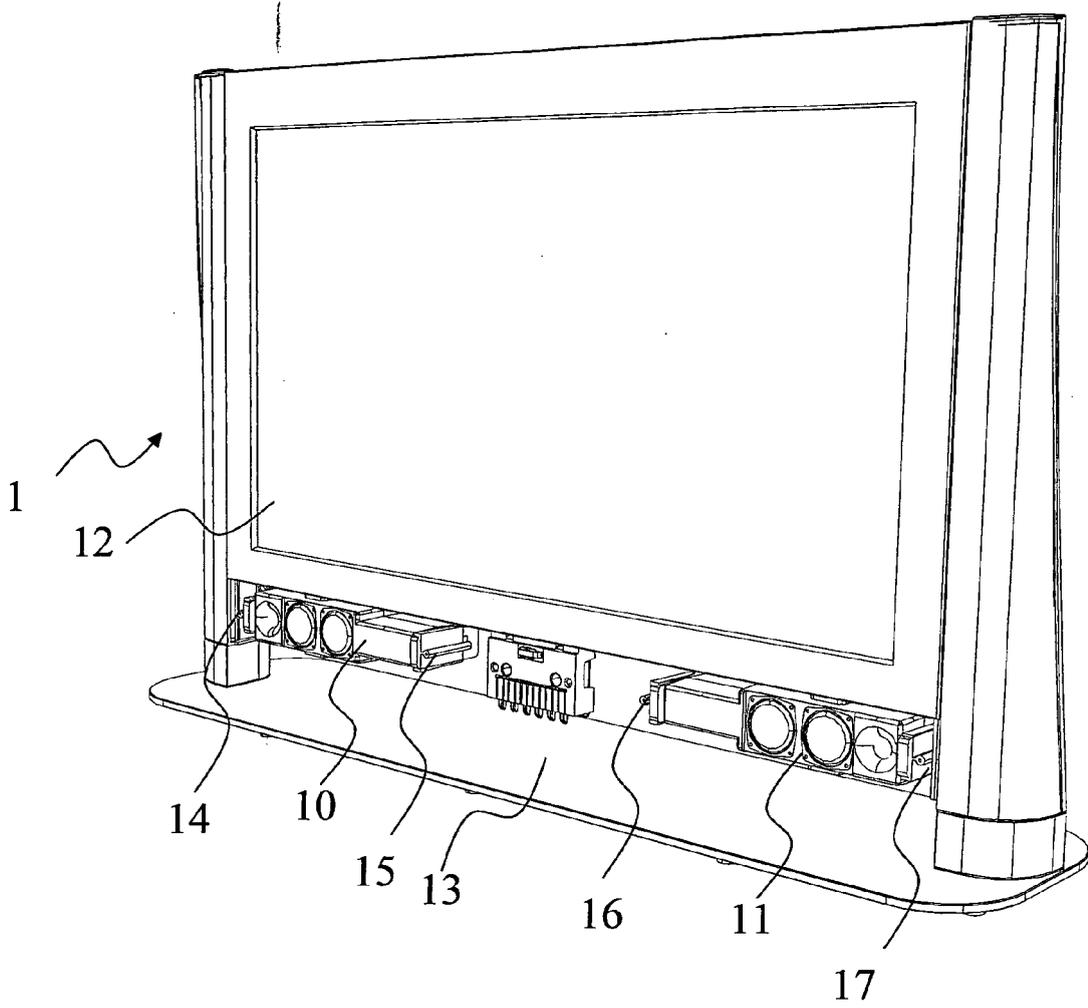


Fig 1

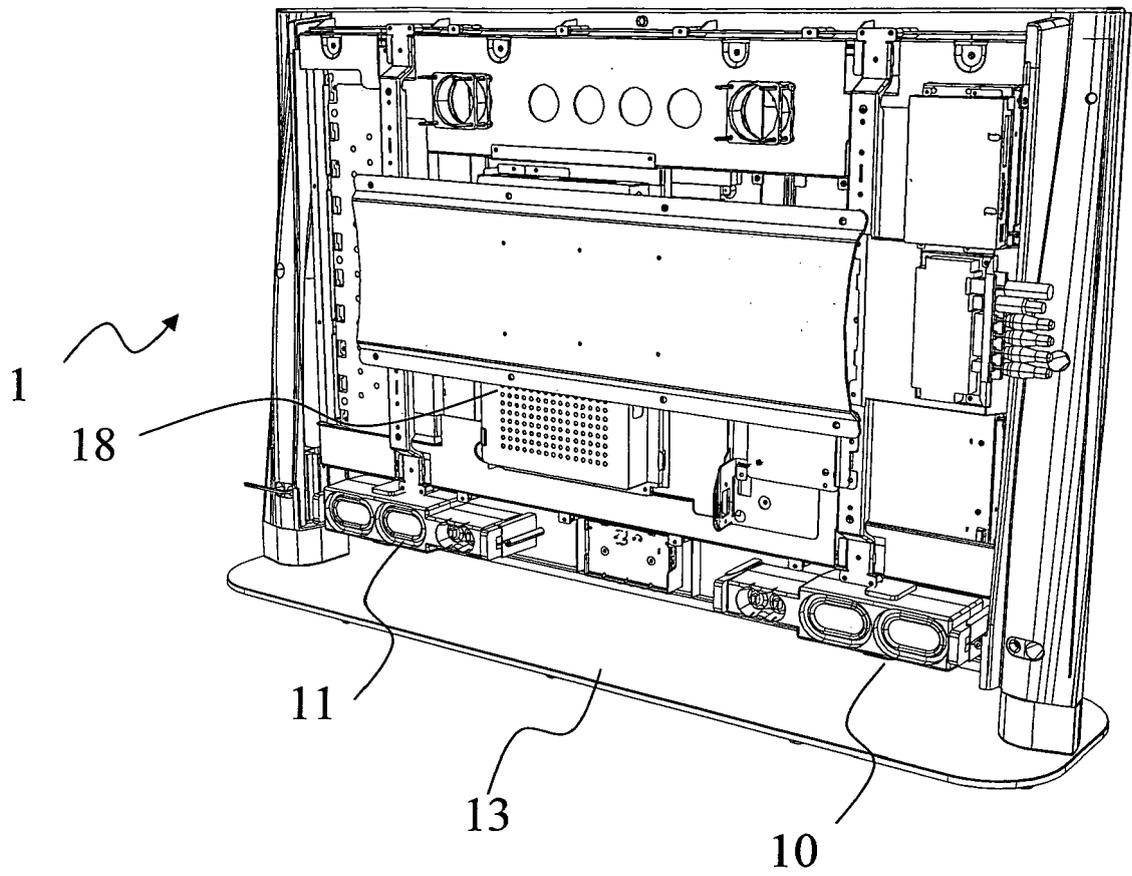


Fig 2

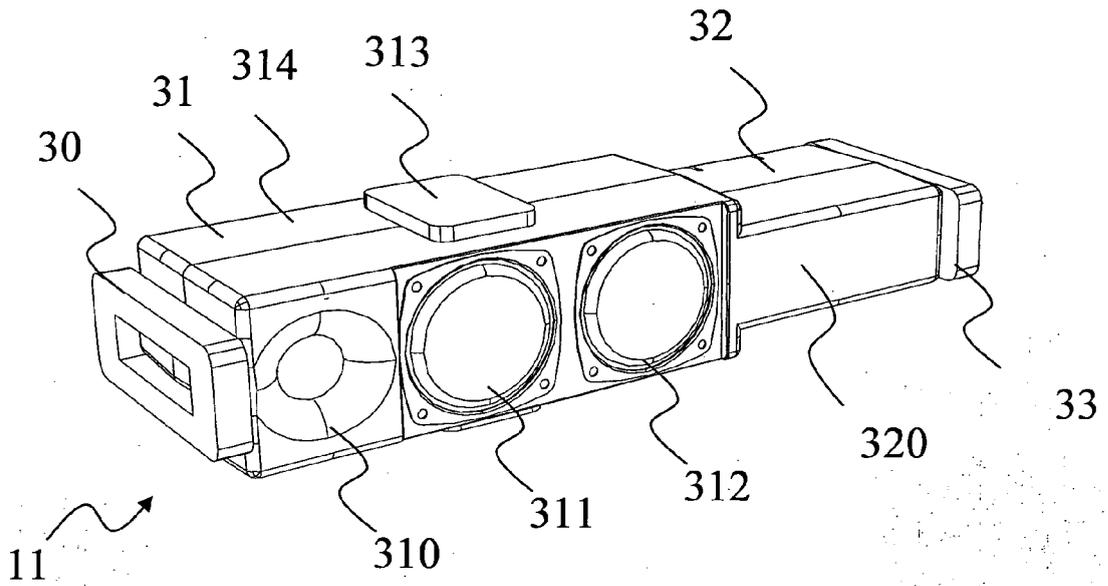


Fig 3

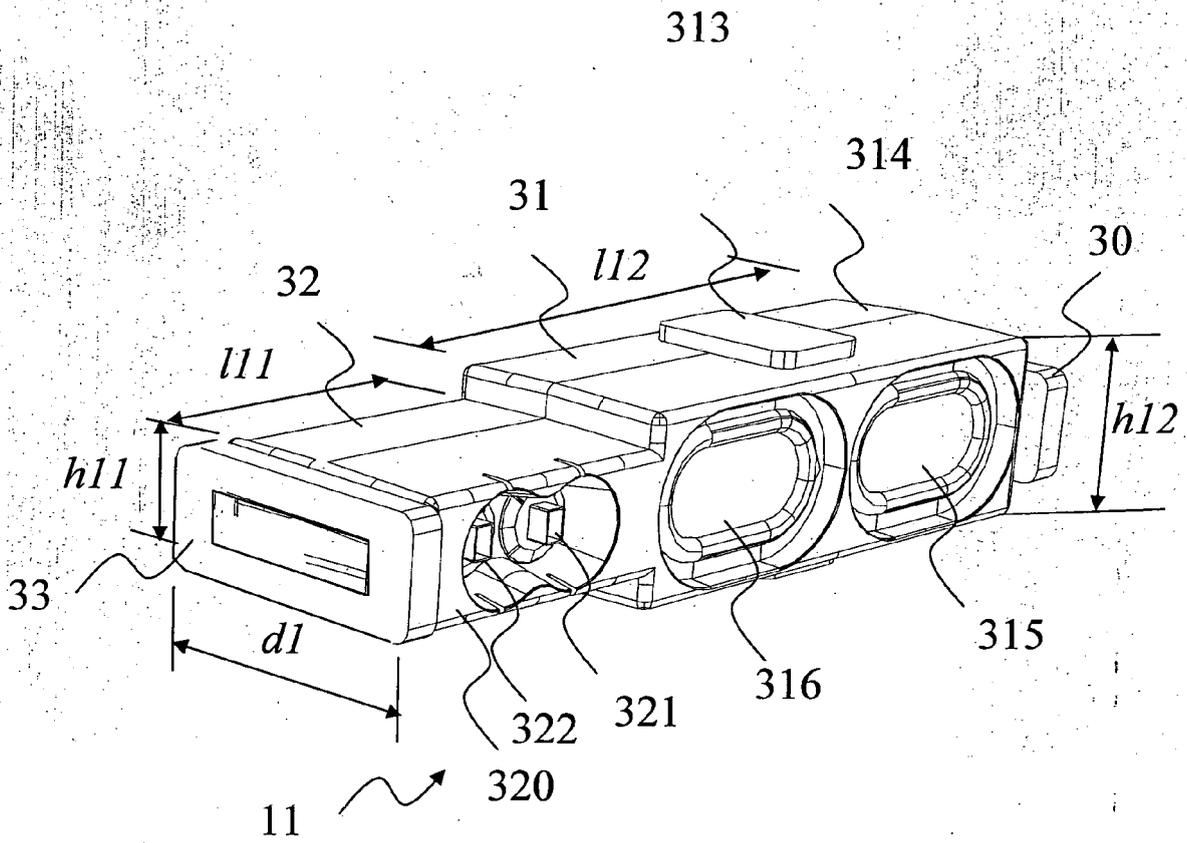


Fig 4

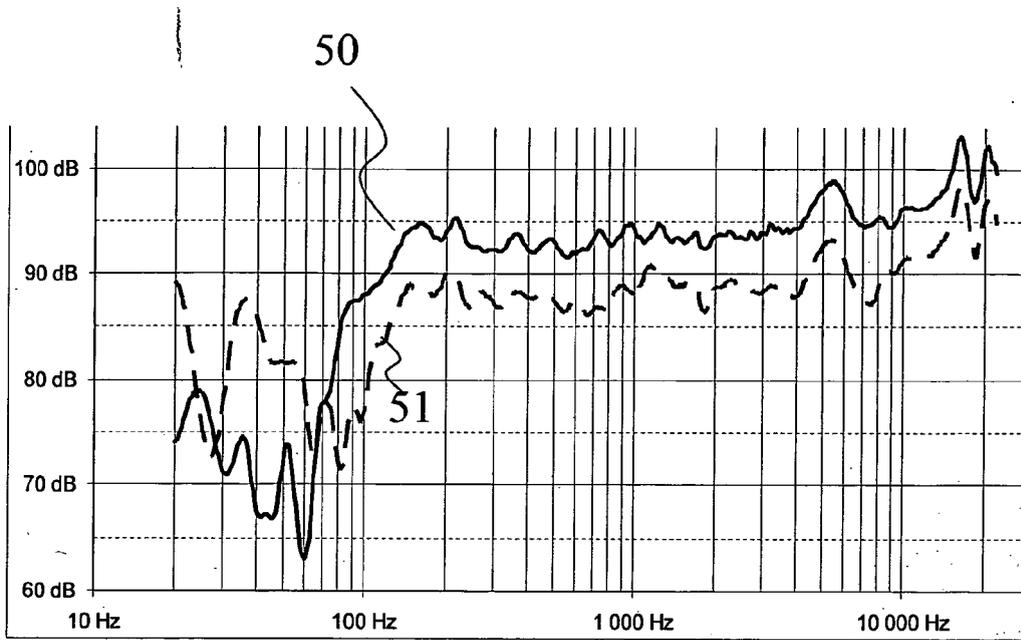


Fig 5

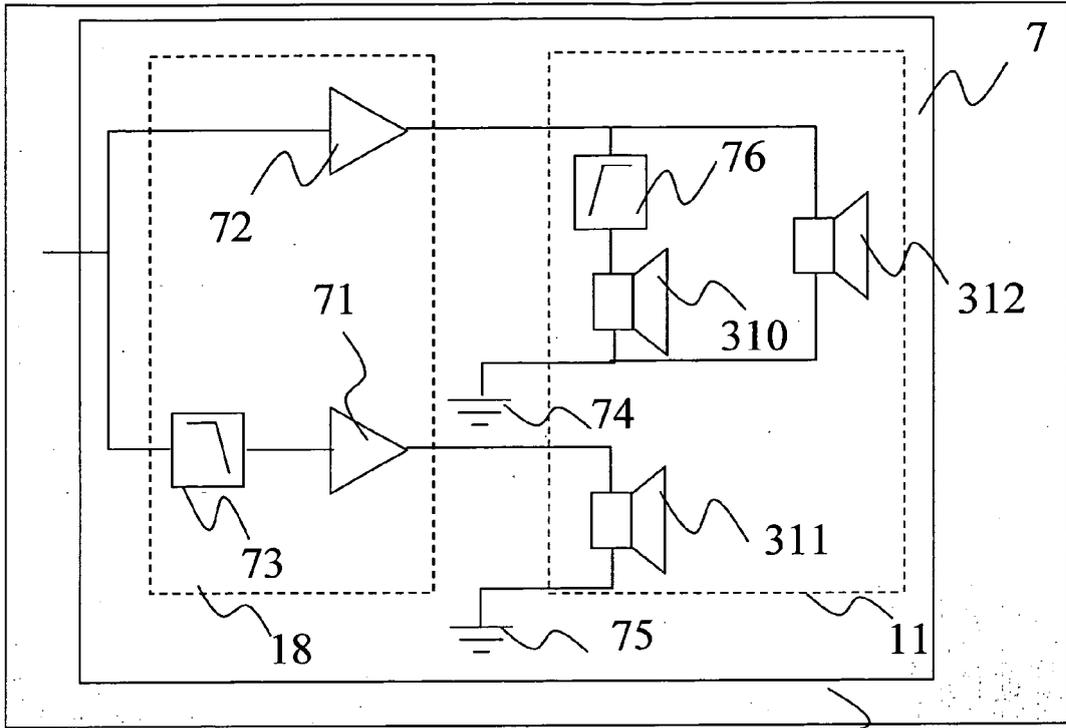
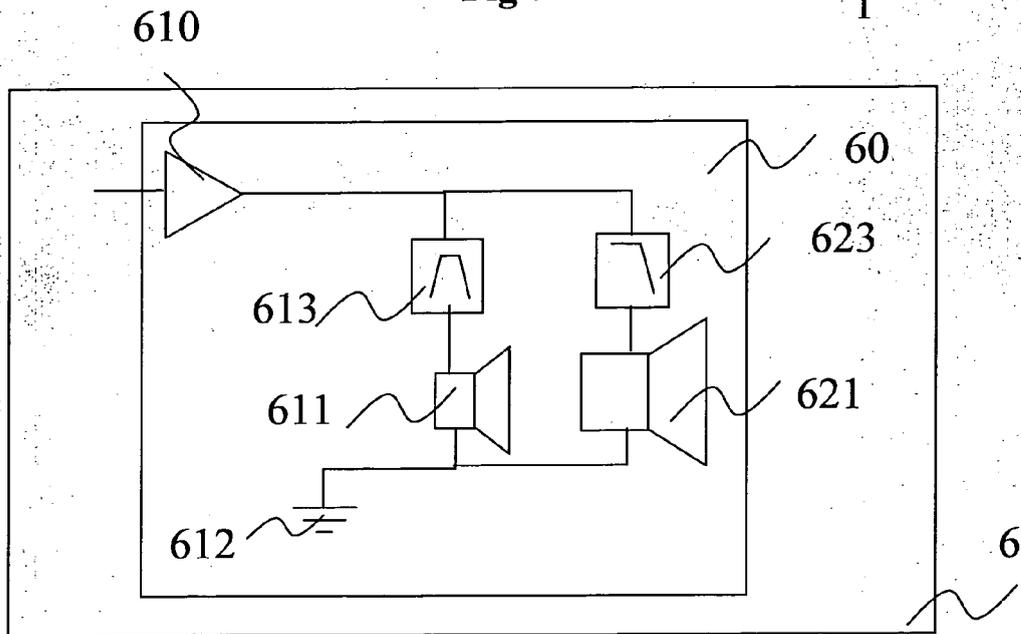


Fig 7



STATE OF THE ART

Fig 6



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) -& JP 2004 032686 A (NEC SAITAMA LTD), 29 January 2004 (2004-01-29) * abstract; figures 1,5,6,10 * -----	1-10	H04R3/12
X	EP 1 194 000 A (MURATA, KENJI) 3 April 2002 (2002-04-03) * paragraph [0018] - paragraph [0023]; figure 1 *	1-10	
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			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		22 November 2005	Brandt, I
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 29 1249

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-11-2005

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82