(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 732 351 A1

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**13.12.2006 Bulletin 2006/50**

(51) Int Cl.:
***H04R 1/28*** *(2006.01)*

(21) Application number: **05291248.2**

(22) Date of filing: **09.06.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
**AL BA HR LV MK YU**

(71) Applicant: **TCL Thomson Electronics Europe SAS**
**49002 Angers Cedex 01 (FR)**

(72) Inventors:
- **Sperle, Cornelius**
  **49002 Angers Cedex 01 (FR)**
- **Evenisse, Michel**
  **49002 Angers Cedex 01 (FR)**
- **Bremaud, Auguste**
  **49002 Angers Cedex 01 (FR)**

(74) Representative: **Le Dantec, Claude**
**46, Quai Alphonse Le Gallo**
**92100 Boulogne-Billancourt (FR)**

## (54) Acoustic enclosure and corresponding device

(57) The invention concerns an acoustic enclosure (11) comprising at least one active loudspeaker, characterised in that it comprises at least two passive loudspeakers (315, 316) that have different resonant frequencies and are located in the same resonant room as at least one active loudspeaker

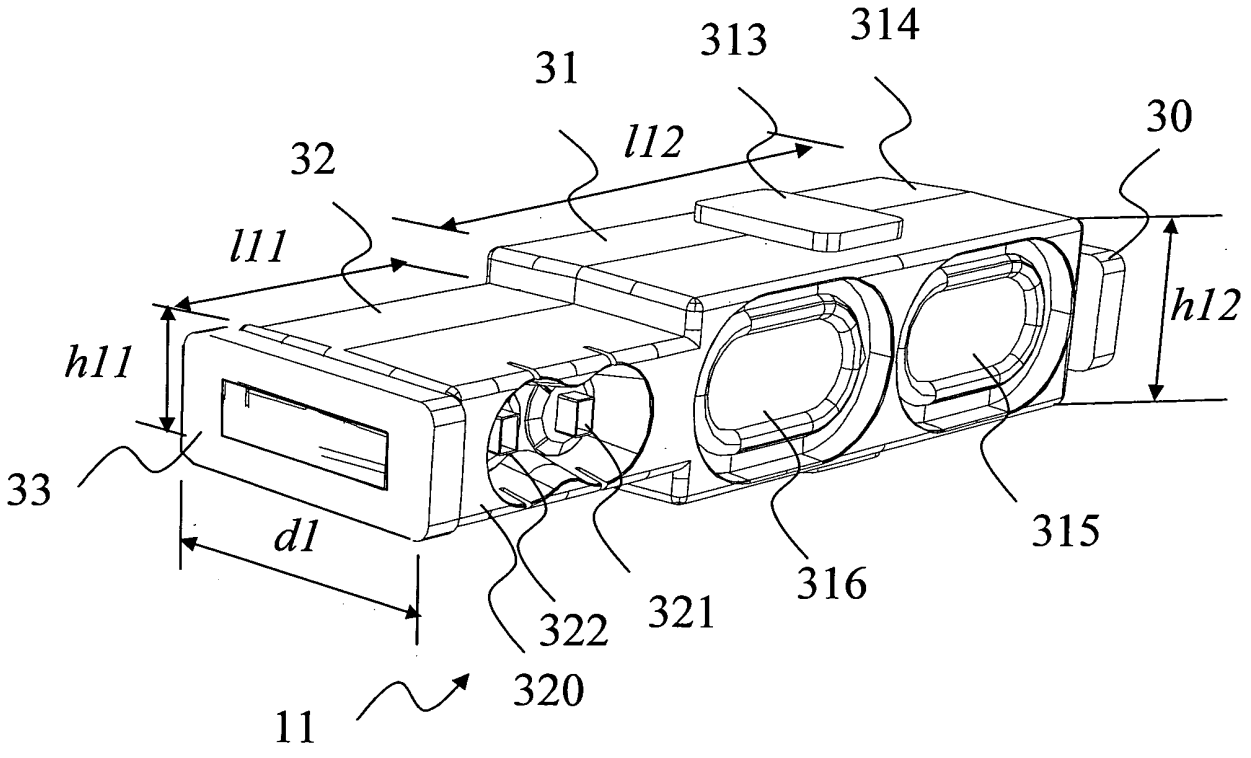


**Fig 4**

EP 1 732 351 A1

## 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 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 a boomer, one or several active loudspeakers for medium and high frequencies and, sometimes, one passive loudspeaker. Such a system 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, especially in bass frequencies.

### 3. Summary of the invention.

**[0003]** 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.

**[0004]** The invention proposes an acoustic enclosure comprising at least one active loudspeaker and at least two passive loudspeakers that have different resonant frequencies and are located in the same resonant room as at least one active loudspeaker.

**[0005]** Then, the passive loudspeakers are activated by active loudspeakers and emphasize different frequencies, so that the sound produced by the enclosure has a good level in a large spectrum of frequencies.

**[0006]** According to a preferred feature, the resonant frequencies of at least two of said passive loudspeakers are separated by at least one third of octave.

**[0007]** Advantageously, the resonant frequencies of at least two of said passive loudspeakers are equal to or lower than 200Hz.

**[0008]** According to advantageous features, the mass of membranes, the emissive surface and/or the suspension of at least two passive loudspeakers is different.

**[0009]** According to a specific feature, the enclosure is a boomer.

**[0010]** Preferably, the enclosure comprises at least two active loudspeakers with different acoustic responses.

**[0011]** According to a particular feature, the enclosure comprises at least three passive loudspeakers that are located in the same room as at least one active loudspeaker.

**[0012]** According to another feature, at least one passive loudspeaker and one active loudspeaker are located in the same room and on the same side and/or on opposite side of the enclosure.

**[0013]** According to a preferred feature, the total emissive surface of passive loudspeakers is larger than the total emissive surface of active loudspeakers located in the same room.

**[0014]** The invention concerns also a device with a flat screen comprising an acoustic enclosure as disclosed above, the acoustic enclosure producing a good sound and being well adapted to small location that is available for an enclosure in a flat screen device.

### 4. Brief description of figures.

**[0015]** 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 figure 1;
- figures 6 and 7 represent a perspective view of a loudspeaker according to a first variant of the invention;
- figure 8 gives some examples of acoustic response of different acoustic systems including the systems implementing the loudspeaker of figures 6 and 7; and
- figures 9 and 10 represent a perspective view of a loudspeaker according to a second variant of the invention.

### 5. Detailed description of the invention.

**[0016]** **Figures 1 and 2** present a television set 1 including an acoustic system according to the invention, respectively in front and rear view.

**[0017]** The television set 1 comprises:

- an acoustic system including a left acoustic enclosure 10 and a right acoustic enclosure 11;
- a flat screen 12 (eg 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.

**[0018]** The control part 18 comprises electronic means to adapt and/or 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.

**[0019]** 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.

**[0020]** 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.

**[0021]** 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.

**[0022]** **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.

**[0023]** 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;
- 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;
- 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.

**[0024]** 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.

**[0025]** 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 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 (eg bigger than 20Ω). Thus, loudspeaker 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. 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 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 the active speakers (eg 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", ie 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.

**[0026]** The acoustic amplifiers and filters are preferably in the control part 18. Indeed, according to a variant of the invention, they can be implemented inside the enclosures 10 and/or 11.

**[0027]** 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.

**[0028]** 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 (ie the surface of the active membrane is around 12 $cm^2$); and
- dimension of the passive loudspeakers 315 and 316 is about 50mmx90mm (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 $cm^2$).

**[0029]** 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.

**[0030]** 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.

**[0031]** 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.

**[0032]** The compliance (or Cms 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.

**[0033]** More generally, the resonant frequencies of passive loudspeakers is not the same. Their difference is preferably comprised between 1/3 octave and one octave: ie, 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.

**[0034]** **Figure 5** illustrates the frequency response (amplitude vs frequencies) of different configurations of enclosures comprising two passives loudspeakers, (these responses have been obtained by experiments or simulations) :

- the curve 53 is related to an enclosure comprising the same passive loudspeaker (both having a resonant frequency at 150 Hz): the response of this enclosure is bad below 95 Hz and the curve is not flat over 100Hz;
- the curve 52 corresponds to an enclosure with an added mass equal to 5g added on one of passive loudspeaker (having a resonant frequency at 100 Hz; the ratio of resonant frequency is then 150/100 =1,5): the frequency range is better than the one of curve 53 (their is a 2dB gain below 100Hz and a 0dB level corresponds to 90Hz instead of 95Hz) ; in addition, between 90 and 200Hz, the level is closer to the average (flatter response);
- the curve 51 is related to an enclosure with an added mass equal to 7g added on the other passive loudspeaker (having a resonant frequency at 75 Hz; the ratio of resonant frequency is then 150/75 =2): the frequency range is even better than the one of curve 52 (their is a 2dB gain at 90Hz and a 0dB level corresponds to 82Hz) ; between 95 and 200Hz, the responses corresponding to curves 51 and 52 are similar; and
- the curve 50 corresponds to an enclosure with an added mass equal to 5g added on one passive loudspeaker and 7g on the other one (the ratio of resonant frequency is then 100/75 =4/3): again, the frequency range is improved compared to curve 51 even better than the one of curve 52 (their is a 1dB gain at 85Hz and a 0dB level corresponds to 77Hz) ; between 100 and 200Hz, the response corresponding to curve 50 is lower than the response corresponding to curve 51.

**[0035]** For all curves, the passive loudspeakers are the same except the mass of their membrane (in particular they have the same size around 50mmx90mm and the same suspension). If the diameter of loudspeaker is larger, the SPL and/or the high pass cut of the corresponding loudspeaker is or are increased.

**[0036]** The embodiment corresponding to a mass equal to 7g added on one of passive loudspeaker (curve 51) offers a good compromise between the response in low frequencies and the flatness of the response between 100 and 200 Hz.

**[0037]** **Figures 6 and 7** represent a perspective view of a boomer enclosure 6 (or bass acoustic enclosure used for frequencies below 200 Hz) according to a variant of the invention, respectively from the front and rear. The enclosure 6 and two additional medium and high frequencies enclosures (respectively right and left side) can replace the enclosures 10 and 11 of set 1 (the enclosure 6 fit well to device of big size). Medium and high frequencies enclosures can be implemented in the lower part, higher part, or side parts of the set and are not described.

**[0038]** The bass acoustic enclosure 6 comprises:

- a cabinet 60, made of injected plastic;
- one active bass loudspeaker 61 (with its protection) in the front face of the enclosure 6;
- three passive loudspeakers 62 to 64 in the front face of the enclosure 6; and
- one connector 65 (e.g. of Lumberg UF type) in the rear face of the enclosure 6.

**[0039]** Active loudspeaker 61 and passive loudspeakers 62 to 64 are located in the same resonant room, so that passive loudspeakers 62 to 64 are controlled by active loudspeaker 61.

**[0040]** The loudspeaker 61 is a 8Ω loudspeaker linked to the connector 65. Thus, it is fed with analog signal,

that is amplified preferably with a dedicated amplifier (providing a power equal to or greater than 10Watts rms) and filtered with a low-pass filter.

**[0041]** The acoustic amplifier and filter are preferably in the control part 18. Indeed, according to a variant of the invention, they can be implemented inside the enclosure 6.

**[0042]** As illustration, the enclosure 6 has, for example, the following features:

- depth d2 equal to 73 mm ;
- length 12 equal to 620 mm;
- height h2 equals 95 mm; and
- a different added mass is added on each of passive loudspeakers 62 to 64; these added mass are respectively equals to 6, 8 and 10g;
- diameters of loudspeaker 61 equal 80 mm (ie the surface is around 50 $cm^2$); and
- dimension of the passive loudspeakers 62 to 64 is about 80mmx150mm (their is shape is preferably oval or rectangular in the middle and circular in the end as illustrated in figure 6) (ie the surface is around 116 $cm^2$).

**[0043]** The enclosure 6 has a net volume, which is below two litres.

**[0044]** More generally, according to the invention, the depth and the height of parts 31 and 32 is advantageously less than 100 mm to be compliant with devices with flat screen.

**[0045]** According to an important feature of the invention, the frequency response of passive loudspeakers 62 to 64 is not the same. This can be achieved, for instance, as follows:

- their weight is different;
- their suspension can be stiffer for one of the loudspeaker; and/or
- the emissive surface is different.

**[0046]** Preferably, the emissive surface of the passive loudspeakers is rather big. More generally, when there are two, three or more passive loudspeakers, according to the invention, the total surface of membranes of passive loudspeakers is equal or larger the total surface of membranes of active loudspeakers and preferably equal or larger than 1.5 times the total surface of membranes of active loudspeakers and more preferably twice the total surface of membranes of active loudspeakers.

**[0047]** **Figure 8** illustrates the frequency response (amplitude vs frequencies) of different configurations of enclosures.

**[0048]** Curves 80 to 82 correspond respectively to enclosures having three, two and one passive loudspeakers and same active loudspeakers (having a resonant frequency equal to 75 Hz).

**[0049]** As clearly shown, the enclosures corresponding to bigger number of passive loudspeakers provide better responses between 65 and 100Hz:

- an enclosure with two different passive loudspeakers with respectively 5g and 7g added mass and resonant frequency respectively equal to 150 Hz and 75 HZ (curve 81) enables a 2dB gain over an enclosure with only one passive loudspeaker with a 16 g added mass and having a resonant frequency equal to 75 Hz (curve 82); and
- an enclosure with three different passive loudspeakers with respectively 24, 26 and 34g added mass (two passive loudspeakers having a resonant frequency at 65Hz and the other one at 120 Hz) (curve 80) enables a 2dB gain over an enclosure with only one passive loudspeaker (curve 82)

**[0050]** Thus, an enclosure with three different passive loudspeakers provides a better response than similar size enclosures with less passive loudspeakers.

**[0051]** **Figures 9 and 10** represent a perspective view of boomer enclosure 7, which is a variant of the boomer enclosure 6, respectively from the front and rear.

**[0052]** The bass acoustic enclosure 6 comprises:

- a cabinet 70, made of injected plastic;
- one active bass loudspeaker 71 (with its protection) in the front face of the enclosure 7;
- three passive loudspeakers 72 to 74 in the rear face of the enclosure 7; and
- one connector (e.g. of Lumberg UF type) in the rear face of the enclosure 7 (not mentioned on the drawing).

**[0053]** Then, the major difference between the enclosures 6 and 7 is that the passive loudspeakers are not on the same face than the active loudspeaker, that enables to have more place for passive loudspeakers.

**[0054]** Active loudspeaker 71 and passive loudspeakers 72 to 74 are located in the same resonant room, so that passive loudspeakers 72 to 74 are controlled by active loudspeaker 71.

**[0055]** The active loudspeaker 71 and passive loudspeakers 72 to 74 are similar to loudspeaker 61 and 62 to 64. In a variant, passive loudspeaker 72 to 74 can be longer than loudspeaker 62 to 64.

**[0056]** Of course, the invention is not limited to embodiments that have been presented above.

**[0057]** In particular, the invention concerns different devices having a small location for acoustic system (especially devices including a screen (especially a flat screen)) such as TV sets, computers, radio receiver, Hi-Fi acoustic enclosures, audio system for cars or transportation means.

**[0058]** 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 dif-

ferent sizes (especially, enclosures with are deeper or higher than disclosed enclosures). Moreover, the invention is compliant with enclosure comprising bigger active loudspeakers.

**[0059]** 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 (eg. 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. The invention is also compliant with acoustic enclosures having at least two active loudspeakers (eg 2, 3, 4 or more 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. More generally, when there are several passive loudspeakers, according to the invention, the total surface of membranes of passive loudspeakers is equal or larger the total surface of membranes of active loudspeakers and preferably equal or larger than 1.5 times the total surface of membranes of active loudspeakers and more preferably twice the total surface of membranes of active loudspeakers (eg. the total surface of membranes (or active surface) of passive loudspeakers is twice or three time the active surface of active loudspeakers).

**[0060]** The invention is also compliant with acoustic systems that have an enclosure comprising several resonant rooms, at least one room comprising at least two passive loudspeakers, and at least one active loudspeaker, the passive loudspeaker having different resonant frequencies. More generally, according to the invention, the active loudspeakers entail resonance of passive loudspeakers, that have two different resonant frequencies. That can be obtained by an air communication inside one room comprising active and passive loudspeakers with specific resonant frequencies.

## Claims

1. Acoustic enclosure (10, 11, 6, 7) comprising at least one active loudspeaker (311,312, 61, 71), **characterised in that** it comprises at least two passive loudspeakers (315, 316, 62 to 64, 72 to 74) that have different resonant frequencies and are located in the same resonant room as at least one active loudspeaker.

2. Acoustic enclosure according to claim 1, **characterised in that** the resonant frequencies of at least two of said passive loudspeakers are separated by at least one third of octave.

3. Acoustic enclosure according to any of claims 1 and 2, **characterised in that** the resonant frequencies of at least two of said passive loudspeakers are equal to or lower than 200Hz.

4. Acoustic enclosure according to any of claims 1 to 3, **characterised in that** the mass of membranes of at least two passive loudspeakers is different.

5. Acoustic enclosure according to any of claims 1 to 4, **characterised in that** at least the emissive surface of at least two passive loudspeakers is different.

6. Acoustic enclosure according to any of claims 1 to 5, **characterised in that** at least the suspension of at least two passive loudspeakers is different.

7. Acoustic enclosure according to any of claims 1 to 6, **characterised in that** it is a boomer.

8. Acoustic enclosure according to any of claims 1 to 7 **characterised in that** it comprises at least two active loudspeakers with different acoustic responses.

9. Acoustic enclosure according to any of claims 1 to 8 **characterised in that** it comprises at least three passive loudspeakers that are located in the same room as at least one active loudspeaker.

10. Acoustic enclosure (6) according to any of claim 1 to 9, **characterised in that** at least one passive loudspeaker (62 to 64) and one active loudspeaker (61) are located in the same room and on the same side of the enclosure.

11. Acoustic enclosure (10, 11, 7) according to any of claim 1 to 10, **characterised in that** at least one passive loudspeaker (315, 316, 72 to 74) and one active loudspeaker (311, 312, 71) are located in the same room and on the opposite side of the enclosure.

12. Acoustic enclosure according to any of claims 1 to 11, **characterised in that** the total emissive surface of passive loudspeakers is larger than the total emissive surface of active loudspeakers located in the same room.

13. Device (1) with a flat screen (12) comprising an acoustic enclosure according to any of claims 1 to 12.

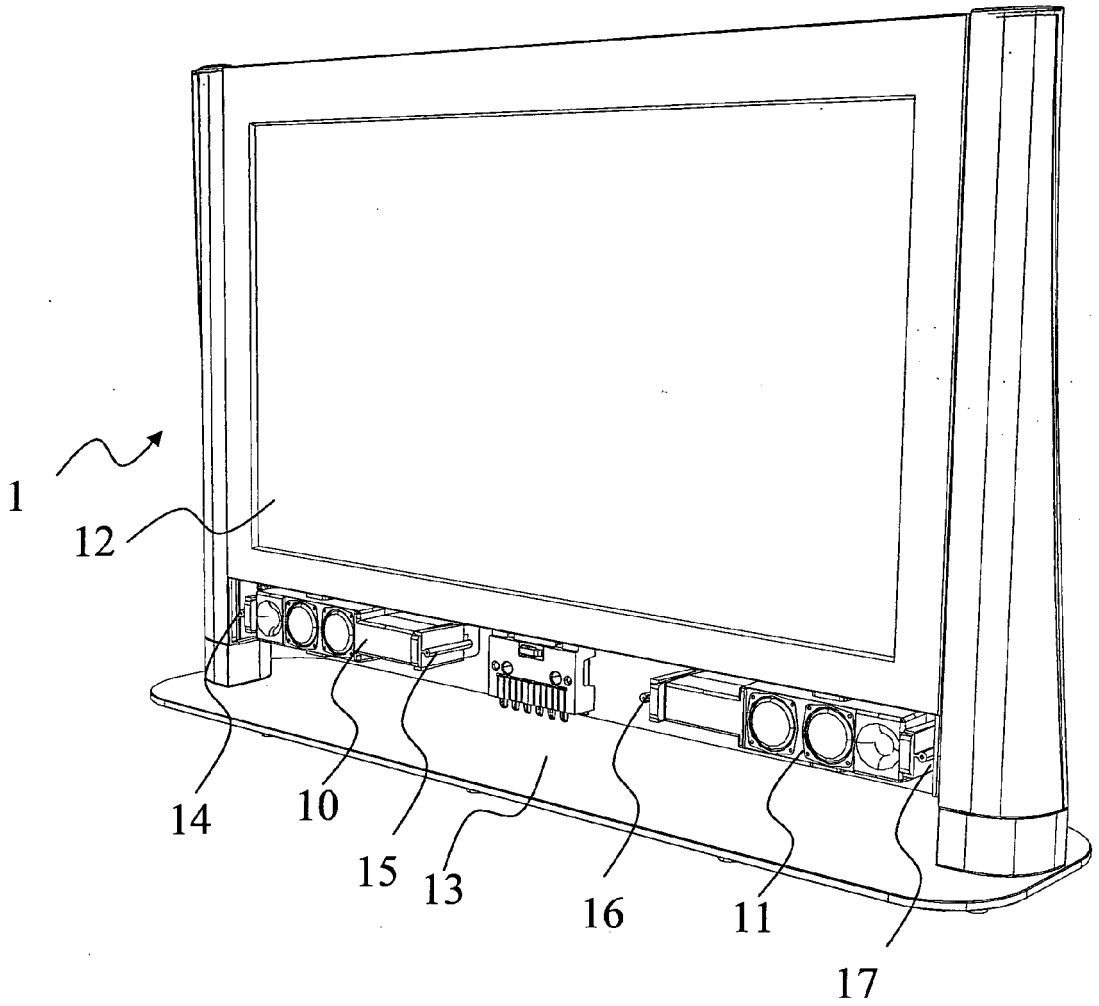


Fig 1

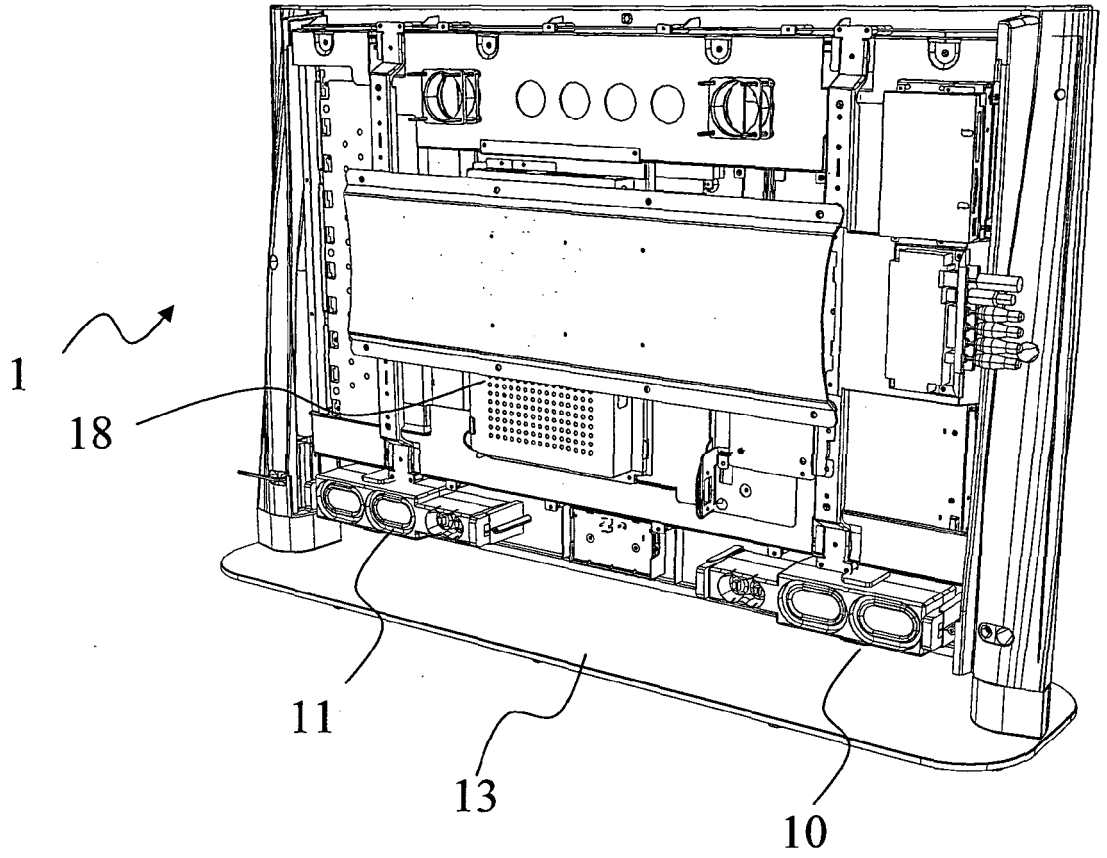


Fig 2

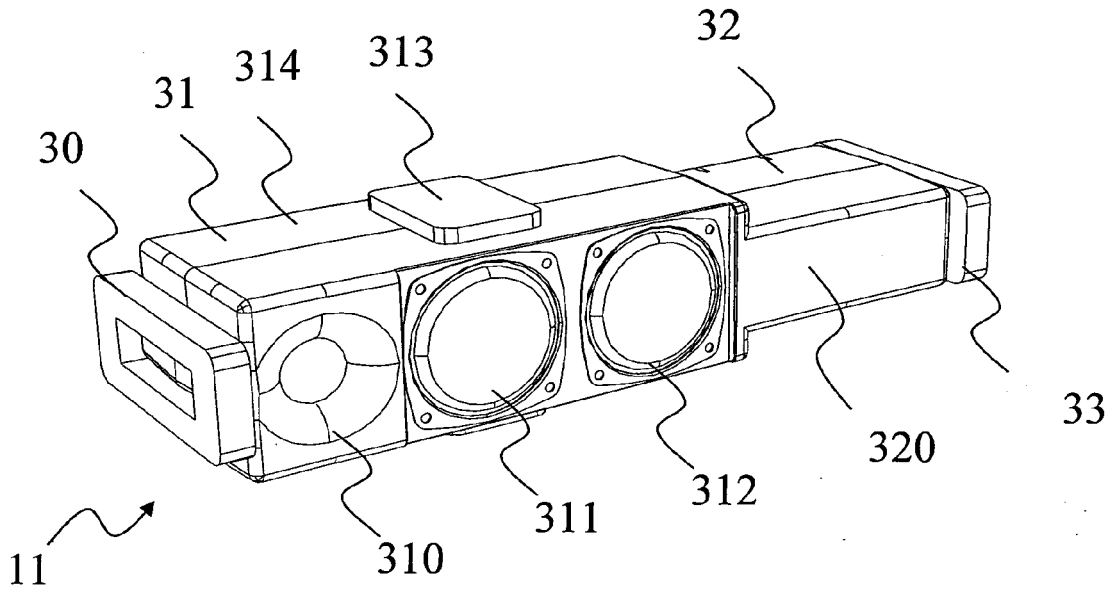
32
313
314
31
30
33
320
312
311
310
11

Fig 3

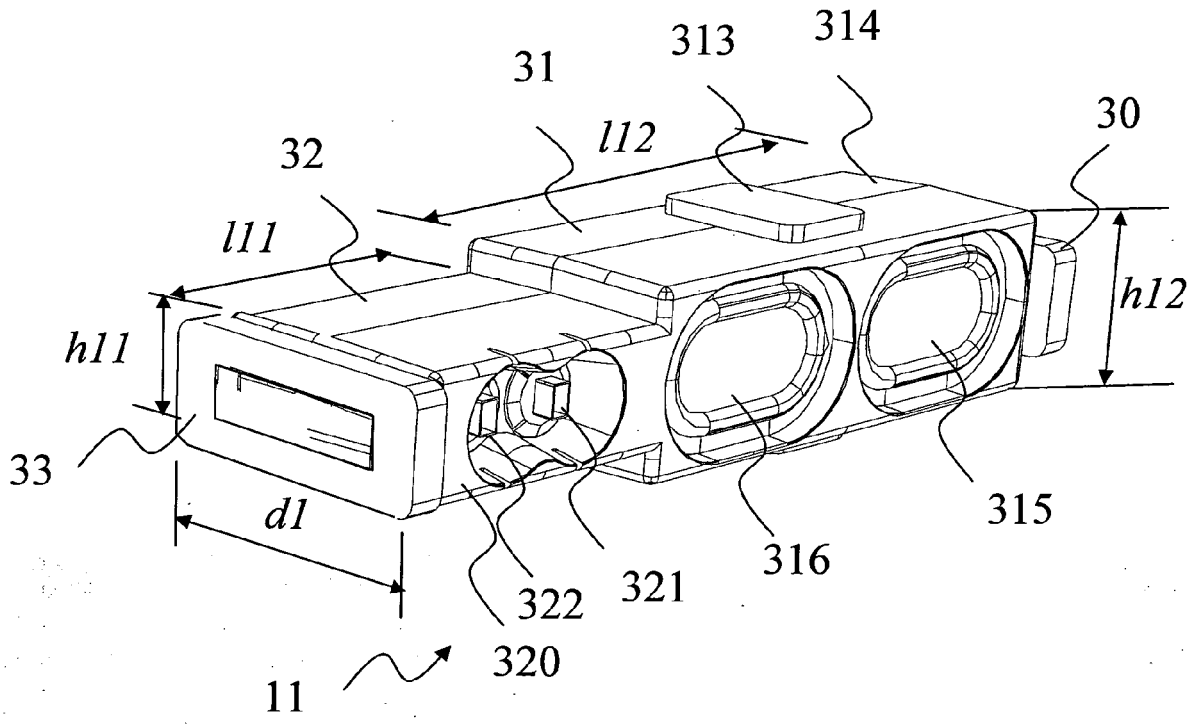
313
314
31
30
l12
32
l11
h12
h11
33
d1
315
316
321
322
320
11

Fig 4

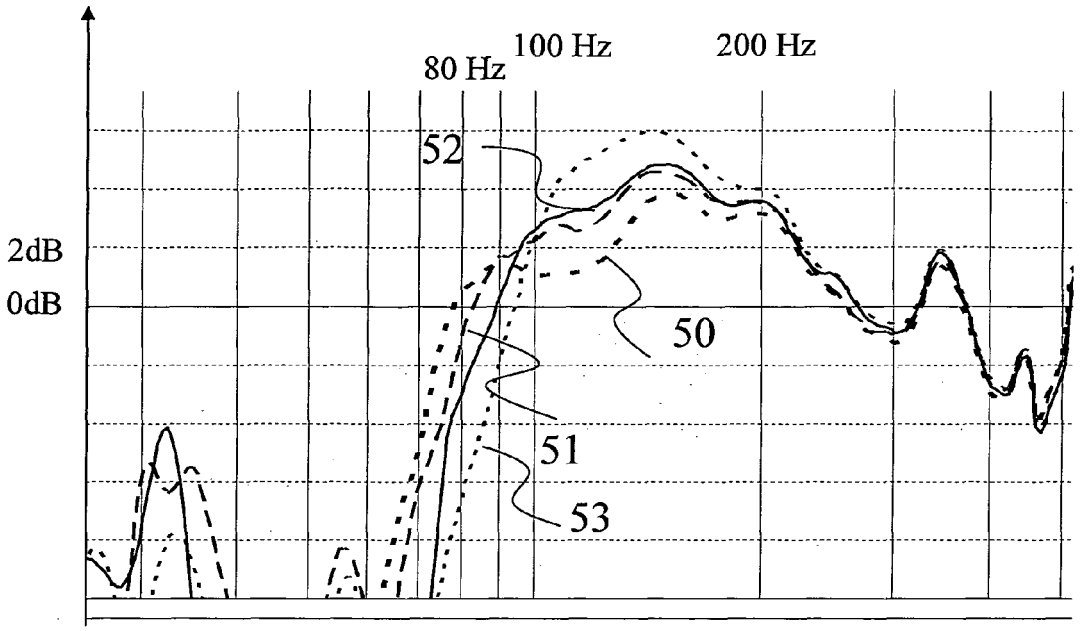
80 Hz
100 Hz
200 Hz
52
2dB
0dB
50
51
53

Fig 5

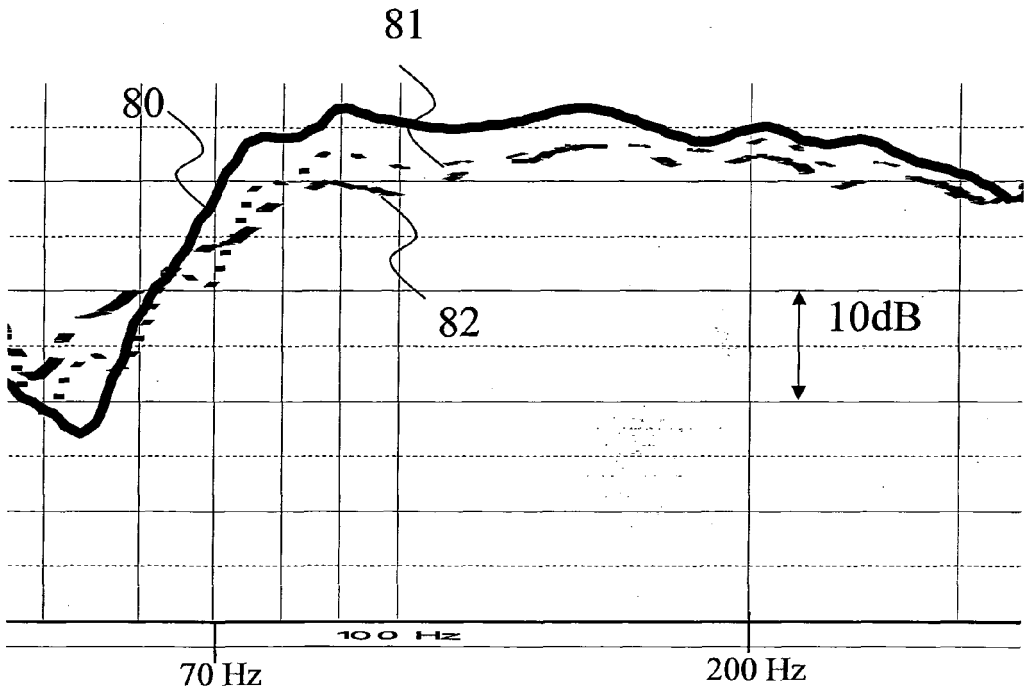
81
80
82
10dB
100 Hz
70 Hz
200 Hz

Fig 8

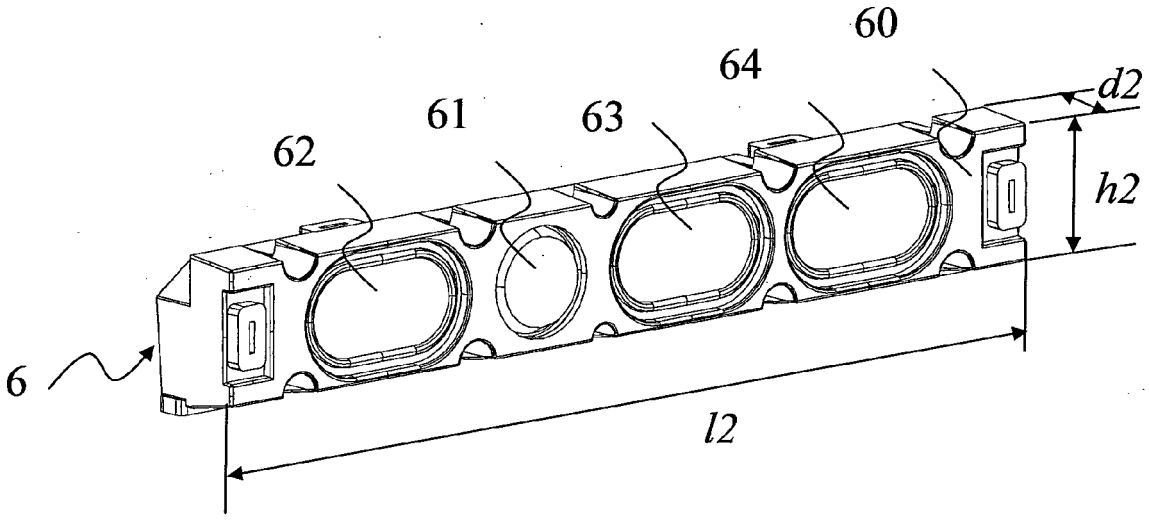


Fig 6

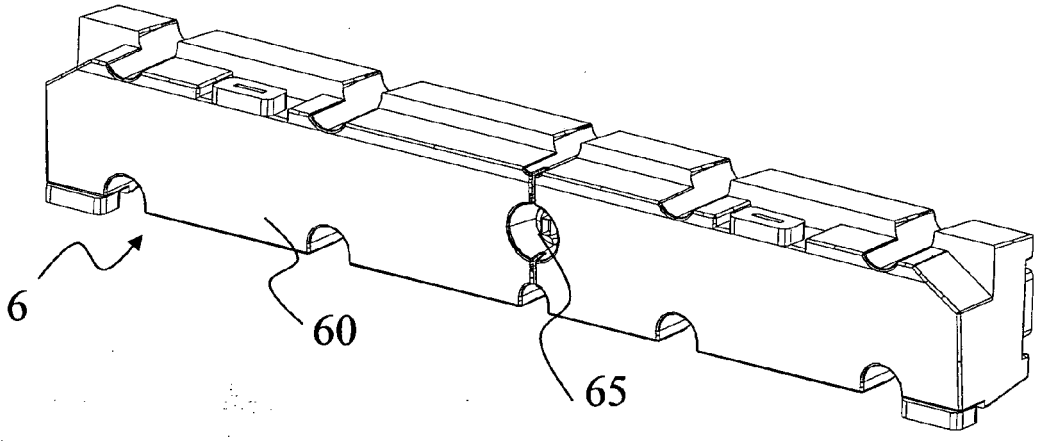


Fig 7

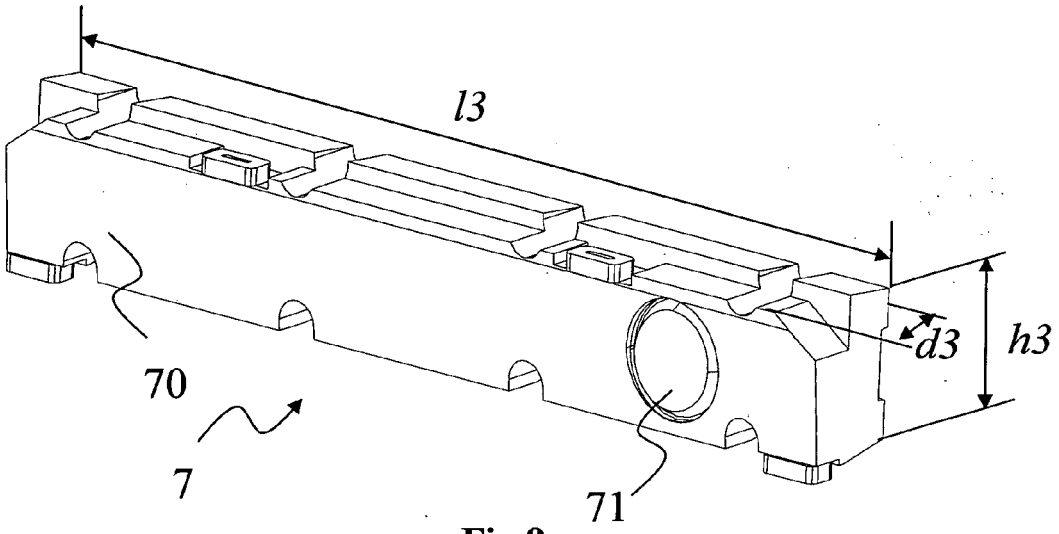


Fig 9

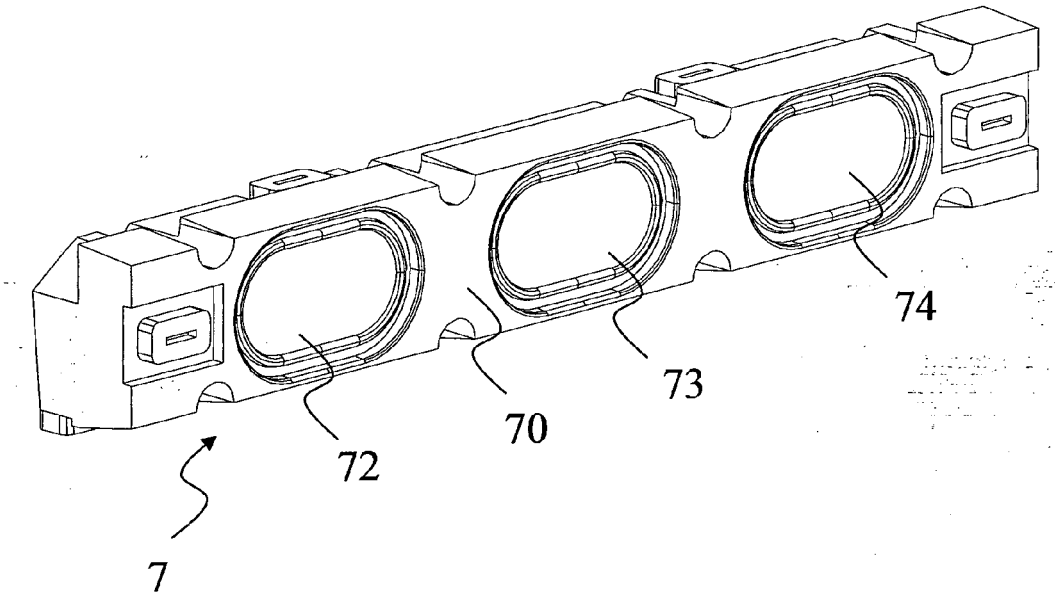


Fig 10

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 05 29 1248

## 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 | US 4 005 278 A (GORIKE ET AL)<br>25 January 1977 (1977-01-25)<br>* the whole document *<br>----- | 1-13 | H04R1/28 |
| X | PATENT ABSTRACTS OF JAPAN<br>vol. 013, no. 092 (E-722),<br>3 March 1989 (1989-03-03)<br>-& JP 63 268396 A (MATSUSHITA ELECTRIC IND CO LTD), 7 November 1988 (1988-11-07)<br>* abstract; figures 1,2,4 *<br>----- | 1,3,7,11 | |
| X | US 3 772 466 A (HOSSBACH E,DT)<br>13 November 1973 (1973-11-13)<br>* column 5, line 4 - column 6, line 2; figure 6 *<br>----- | 1,10,12 | |

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 |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

4

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 05 29 1248

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

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 4005278 A | 25-01-1977 | AU 8453375 A | 10-03-1977 |
| | | CA 1032479 A1 | 06-06-1978 |
| | | CH 600725 A5 | 30-06-1978 |
| | | DE 2540680 A1 | 25-03-1976 |
| | | DK 409175 A | 17-03-1976 |
| | | FR 2285041 A1 | 09-04-1976 |
| | | GB 1483829 A | 24-08-1977 |
| | | IT 1044053 B | 20-03-1980 |
| | | JP 893736 C | 18-01-1978 |
| | | JP 51054423 A | 13-05-1976 |
| | | JP 52023259 B | 23-06-1977 |
| | | NL 7510751 A | 18-03-1976 |
| | | SE 398034 B | 28-11-1977 |
| | | SE 7510191 A | 17-03-1976 |
| JP 63268396 A | 07-11-1988 | NONE | |
| US 3772466 A | 13-11-1973 | DE 2057905 B | 25-05-1972 |
| | | FR 2115331 A5 | 07-07-1972 |
| | | GB 1363759 A | 14-08-1974 |
| | | IT 942887 B | 02-04-1973 |

EPO FORM P0459

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