

(21) Application No: 1605226.8

(22) Date of Filing: 29.03.2016

(71) Applicant(s):  
**Avid Hifi Ltd**  
1 Kym Road, Kimbolton, HUNTINGDON,  
Cambridgeshire, PE28 0LW, United Kingdom

(72) Inventor(s):  
**Mas Conrad**  
**Simon David Rae**

(74) Agent and/or Address for Service:  
**Avid Hifi Ltd**  
1 Kym Road, Kimbolton, HUNTINGDON,  
Cambridgeshire, PE28 0LW, United Kingdom

(51) INT CL:  
**H04R 1/02** (2006.01) **H04R 1/28** (2006.01)  
**H04R 5/02** (2006.01)

(56) Documents Cited:  
**GB 2519573 A** **GB 0370225 A**  
**WO 2008/082304 A1** **WO 2002/045460 A2**  
"Überraschung: Avid HiFi präsentiert Reference-  
Lautsprecher" dated 02/02/2016, available from:  
[http://www.i-fidelity.net/news/details/  
c/626d4df7e27324dfbb2680d70a52f47a/article/  
ueberraschung-avid-hifi-praesentiert-  
lautsprecher.html](http://www.i-fidelity.net/news/details/c/626d4df7e27324dfbb2680d70a52f47a/article/ueberraschung-avid-hifi-praesentiert-lautsprecher.html) [Accessed 04/08/2016]

(58) Field of Search:  
INT CL **H04R**  
Other: **WPI, EPODOC**

(54) Title of the Invention: **Improvements to loudspeaker drive unit performance**  
Abstract Title: **Loudspeaker Drive Unit and Cabinet Assembly**

(57) A loudspeaker drive unit is rigidly mounted to a rigid loudspeaker enclosure 1 with an aperture by means of a clamping plate 3 around the circumference of the drive unit front ring. This gives mechanical resistance to vibration in the drive unit chassis 2 entering the enclosure. A mass damping element 8 is attached via a decoupling pad to the rear of the drive unit and magnet assembly 7, and fixed resiliently with decoupling spacers 11 to the enclosure via a standoff 10 so that the vibration is quickly dissipated from the whole drive unit and magnet assembly. The mass damping element also reduces magnet oscillation caused by vibration in the chassis. The mass damping element may be a metal plate, such as an aluminium alloy casting. There may be more than one mass damping element. The mass dampers can be tuned to damp different frequencies by altering the mass and density of the decoupling material.

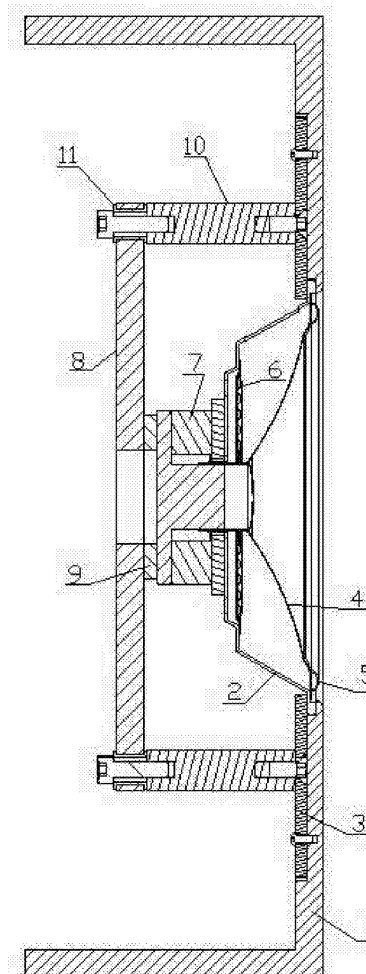


Figure 1



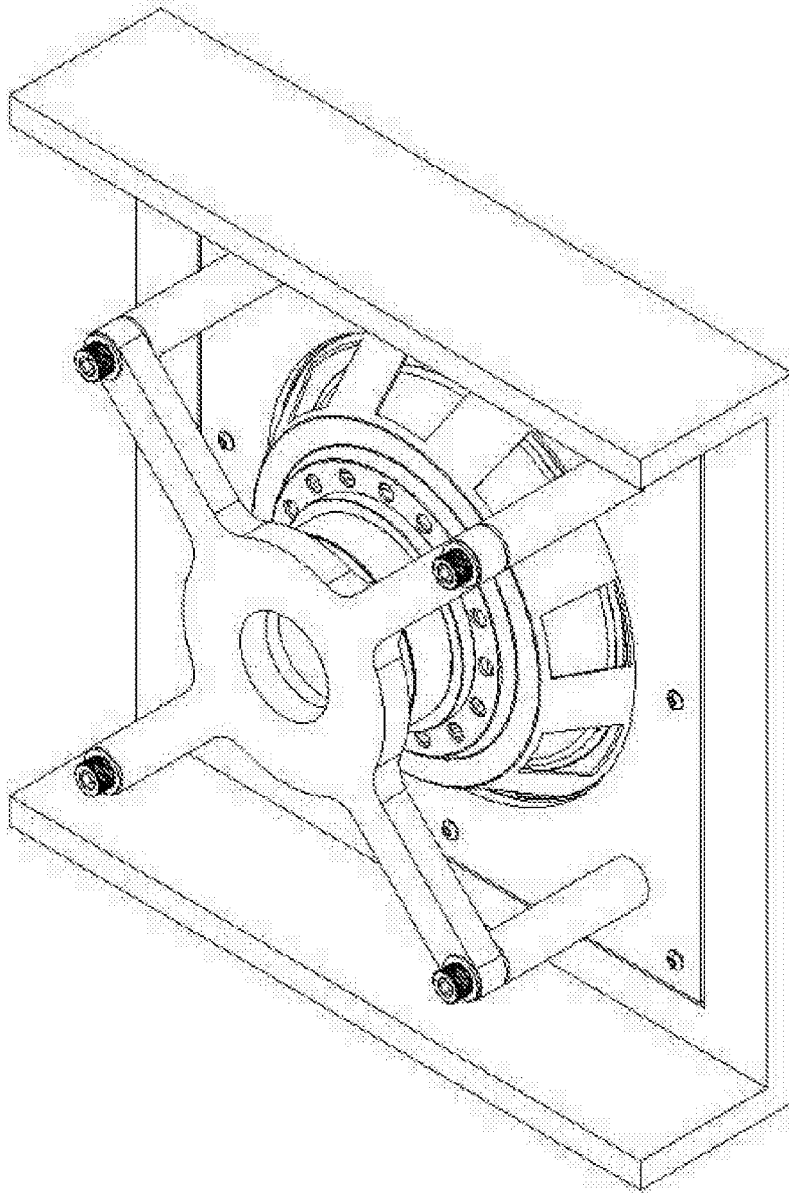


Figure 1

**SPECIFICATION****IMPROVEMENTS TO LOUDSPEAKER DRIVE UNIT PERFORMANCE**

This invention relates to improvements to loudspeakers. More particularly, this invention concerns the improved damping and structural stability of a loudspeaker chassis and magnet assembly which will improve overall acoustic performance.

A loudspeaker drive unit typically includes a diaphragm (also known as a cone), a chassis (also known as a basket or frame), a voice coil and driver magnet. The diaphragm is typically attached to the chassis via a flexible suspension of sort. For example, the diaphragm may be attached to the chassis by a two-part suspension comprising (1) a spider, typically a corrugated disc of flexible material which joins the centre of the diaphragm/voice coil to the chassis and (2) a surround, typically a ring of flexible material which joins the outer circumference of the diaphragm to the chassis. The voice coil is typically attached to the diaphragm so that in use an electrical current is applied to the voice coil generating an electromagnetic field which interacts with the magnetic field of the driver magnet thereby causing the voice coil and consequently the diaphragm to move. The diaphragm movement creates unwanted vibrations in the drive unit chassis which can adversely effect loudspeaker performance, adding unwanted sound colouration and distorting the acoustic response of the loudspeaker.

In order to maintain sound quality in use, when the drive unit is installed in a loudspeaker enclosure such as a loudspeaker cabinet, (closed box, ported or open baffle design), it is desirable for the drive unit to produce a controlled vibration in the diaphragm whilst minimising, or otherwise controlling the unwanted vibration in the other elements of the loudspeaker drive unit and enclosure/cabinet.

Normally loudspeaker drive units are fixed directly to an enclosure, normally with fixing screws. Loudspeaker enclosures are typically manufactured from MDF or wooden fabrications. Such a solution suffers because these fabrications are less rigid than the loudspeaker chassis and vibrations in the drive unit are transferred to the enclosure which then undesirably vibrate, this resulting in a reduced overall acoustic performance.

A method in which undesirable vibrations in the enclosure can be reduced is to decouple the drive unit from the enclosure by means of a suspension system that allows for mounting of the chassis to the enclosure in such a way as to reduce the transmission of vibration in the chassis to the enclosure. Such a solution suffers from the problem that without a rigid connection between chassis and enclosure there tends to be greater vibration in the chassis than would otherwise be the case. This can result in a deterioration in the acoustic performance of the drive unit because, for example, the front ring of the chassis is more prone to vibrate undesirably and thus radiate unwanted sound colouration or otherwise distorting the acoustic response of the loudspeaker. This vibration can also cause the drive unit to move within the enclosure further reducing acoustic performance.

Another method is to manufacture ultra rigid enclosures, usually from thick metal sheet or cast polymer based resins. In this instance whilst improved enclosure rigidity helps acoustic performance, the undesirable vibrations then remain in the drive unit.

The vibration always flows in the path of least resistance and rigid enclosures do not offer such a route due to mechanical resistance. With the vibration effectively trapped in the drive unit, it is prone to vibrate undesirably, similar to a decoupled unit, resonating the diaphragm and the heavy magnet also oscillates, this effecting voice coil performance.

An ideal loudspeaker design would be free of all unwanted vibrations in both the enclosure and drive unit assembly and only controlled vibration in the diaphragm.

The present invention seeks to mitigate one or more of the above-mentioned problems. Alternatively or additionally, the present invention seeks to provide improved loudspeaker drive unit performance.

This invention provides an ultra rigid loudspeaker enclosure incorporating a loudspeaker drive unit. An ultra rigid enclosure is one in which the enclosure has significantly greater rigidity than the drive unit chassis. The use of an ultra rigid enclosure greatly reduces enclosure vibration increasing overall loudspeaker performance by preventing said vibration present in the enclosure causing colouration of sound.

Furthermore the drive unit is not fixed in the conventional fashion with screws, but in conjunction with this invention, clamping the drive unit to the enclosure using a clamping plate around the whole circumference of the front of the drive unit chassis, giving an improved rigidity of the front ring of the drive unit chassis. This greatly reduces the chance of radiated vibration effecting diaphragm performance and further inhibits vibration from entering the ultra rigid enclosure. This commonly described as a mechanical impedance.

According to this invention there is provided one or more mass damping elements which is pressed against but decoupled from the rear of the loudspeaker drive unit chassis/magnet assembly. Alternatively the mass damping element could also be manufactured so it surrounds the magnet assembly. This element would also be fixed too, but resiliently decoupled from the enclosure.

The use of the mass damping element in this method achieves two effects;

1. It enables vibration present in the drive unit chassis/magnet, which has been blocked from entering the enclosure to pass into and be dissipated by the mass damping element by offering a route of least resistance.
2. The mass damping element being resiliently coupled to the enclosure would also reduce or prevent the unwanted oscillation of the magnet on the rear of the chassis. This improves voice coil performance which directly effects diaphragm performance.

A mass damping element may reduce vibration by dissipating energy. Thus, using mass damping elements to absorb and damp the vibration of the drive unit chassis and magnet assembly the acoustic performance of both items is improved.

The mass damping element could in practice take the form of a metal plate, although different materials could be used in different circumstances.

The size, shape and physical mass of the damping element could vary depending upon the size, shape or properties of the drive unit and the frequencies to be dissipated. The decoupling material can vary in hardness so as to tune the mass damping element to suit a given drive unit resonant frequency. The mass damping element may also be manufactured so it damps one or more drive units within the same enclosure.

Multiple mass damping elements could be used either acting as one or working against each other to dissipate vibration depending upon the given application. This could simply work by mass damping elements being linked together in a stacked formation or individual strips or shapes of differing mass could be used to damp different frequencies.

Traditional MDF or alternative enclosures could still be used with the invention but a lower performance would be achieved although the mass damping elements effectiveness could be improved by tuning the damping frequency by altering the decoupling material.

One way in which the invention may be performed will now be described with reference to the accompanying drawings.

Figure 1 is a diagrammatic representation shown partly in vertical cross-section and partly in elevation of part of a loudspeaker drive unit and enclosure constructed in accordance with the invention. Figure 2 is an over view of the invention for clarity.

Referring to Figure 1, the illustrated loudspeaker enclosure 1 is designed to rigidly hold the front ring of the drive unit chassis 2 with the clamping plate 3. Vibration in the chassis caused by the movement of the diaphragm 4 is transferred to the chassis 2 through the driver surround 5 and the spider 6. By rigidly coupling the chassis to the ultra rigid enclosure a mechanical resistance is formed and the vibration naturally seeks an easier path of transmission. This is achieved by coupling to the rear of the magnet

assembly 7 a mass damping element 8 where the vibration passes through the decoupling pad 9.

The mass damping element 8 is attached to the enclosure 1, either directly or conveniently to the clamping plate 3 with stand off's 10 but decoupled from them with decoupling spacers 11, however in practice alternative methods of support could be used to the same effect.

The mass damping element 8 is pulled tight to the enclosure 1, so that the mass damping element puts pressure in the rear of the chassis/magnet assembly. This damps any oscillating movement of the magnet and absorbs the vibration transferred from the chassis through the magnet.

Once the vibrational energy is within the mass damping element because it is decoupled and its free to move the harmful vibration is dissipated.

The mass damping element can be tuned by altering its mass and the density of the decoupling material to optimise its effectiveness to suit different drive units.

It will be appreciated that the illustration apparatus is only one example of many ways in which the invention may be implemented and different enclosure and chassis/magnet types may be employed to greater or lesser effect.

A loudspeaker constructed as show in the diagram has however proved in comparison tests with other conventional loudspeakers to provide a remarkable and immediately noticeable advance in performance and sound quality.

## **CLAIMS**

1. A loudspeaker chassis/magnet assembly and one or more mass damping elements, wherein the vibration of the chassis/magnet assembly is damped by means of said one or more mass damping elements.
2. A loudspeaker chassis/magnet assembly according to claim 1, wherein the or each mass damping element includes a resilient decoupling portion.
3. A loudspeaker chassis/magnet assembly according to claim 1, wherein the or each mass damping element is directly attached to the magnet assembly.
4. A loudspeaker chassis/magnet assembly according to any preceding claim, wherein the mass damping element is tuned such that one or more vibrational modes of the chassis/magnet assembly are damped by said damping element.
5. A loudspeaker chassis/magnet assembly according to claim 4, wherein one or more mass damping elements can be tuned to damp different frequencies.
6. A loudspeaker chassis/magnet assembly according to any preceding claim, wherein the resilient decoupling portion is an elastic material.
7. A loudspeaker chassis/magnet assembly according to any preceding claim, wherein the mass damping element is made from metal.
8. A mass damping element according to claim 7 in which the metal is an aluminium alloy casting or plate.
9. A loudspeaker chassis/magnet assembly according to any preceding claim, wherein the mass damping element is made from an alternative material which effectively acts as a tuned mass damping element.
10. A loudspeaker drive unit comprising a chassis and magnet assembly as claimed in any preceding claim.
11. A loudspeaker enclosure comprising a loudspeaker drive unit according to claim 9.
12. A loudspeaker enclosure comprising a loudspeaker drive unit according to claim 10, wherein the enclosure comprises a cabinet with an aperture in which the drive unit assembly is mounted and wherein the chassis is rigidly fixed by means of a coupling plate around the circumference of the front chassis ring.
13. A loudspeaker enclosure including a coupling plate and tuned mass damping element as described with reference to the accompanying drawings and substantially as illustrated therein.



**Application No:** GB1605226.8

**Examiner:** Miss Lisa Robinson

**Claims searched:** 1-13

**Date of search:** 8 August 2016

## Patents Act 1977: Search Report under Section 17

### Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1, 4-5, 7-9, 10-12	WO 02/45460 A2 (NEW TRANSDUCERS LTD) See in particular lines 15-25 and figures.
X	1-10	WO 2008/082304 A1 (VAN DER KLEIJ EDWIN) See entire document
X	1-2, 4-11	GB 2519573 A (B & W GROUP LTD) See entire document
X	1, 12 at least	GB 370225 A (MOSES LICHTENBERG) See entire document
X	1, 12 at least	"Überraschung: Avid HiFi präsentiert Reference-Lautsprecher" dated 02/02/2016, available from: <a href="http://www.i-fidelity.net/news/details/c/626d4df7e27324dfbb2680d70a52f47a/article/ueberraschung-avid-hifi-praesentiert-lautsprecher.html">http://www.i-fidelity.net/news/details/c/626d4df7e27324dfbb2680d70a52f47a/article/ueberraschung-avid-hifi-praesentiert-lautsprecher.html</a> [Accessed 04/08/2016] See the following webpage for machine translation to English: <a href="https://translate.google.com/translate?hl=en&amp;sl=de&amp;tl=en&amp;u=http%3A%2F%2Fwww.i-fidelity.net%2Fnews%2Fdetails%2Fc%2F626d4df7e27324dfbb2680d70a52f47a%2Farticle%2Fueberraschung-avid-hifi-praesentiert-lautsprecher.html">https://translate.google.com/translate?hl=en&amp;sl=de&amp;tl=en&amp;u=http%3A%2F%2Fwww.i-fidelity.net%2Fnews%2Fdetails%2Fc%2F626d4df7e27324dfbb2680d70a52f47a%2Farticle%2Fueberraschung-avid-hifi-praesentiert-lautsprecher.html</a>

### Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

### Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>X</sup> :

Worldwide search of patent documents classified in the following areas of the IPC





H04R

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

**International Classification:**

<b>Subclass</b>	<b>Subgroup</b>	<b>Valid From</b>
H04R	0001/02	01/01/2006
H04R	0001/28	01/01/2006
H04R	0005/02	01/01/2006