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(54) **HEADPHONES WITH STRUCTURE BORNE NOISE DECOUPLING**

(57) Headphones comprising: a housing 14, an electroacoustic sound generator inside the housing 14 configured to radiate sound, a connection element 16 configured to receive an electrical signal associated with sound to be radiated by the electroacoustic sound gen-

erator, and an elastic element 18 arranged between a wall 13 of the housing 14 and the connection element 16, wherein the elastic element 18 is configured to attenuate vibrations transitioning from the connection element 16 into the wall 13 of the housing 14.

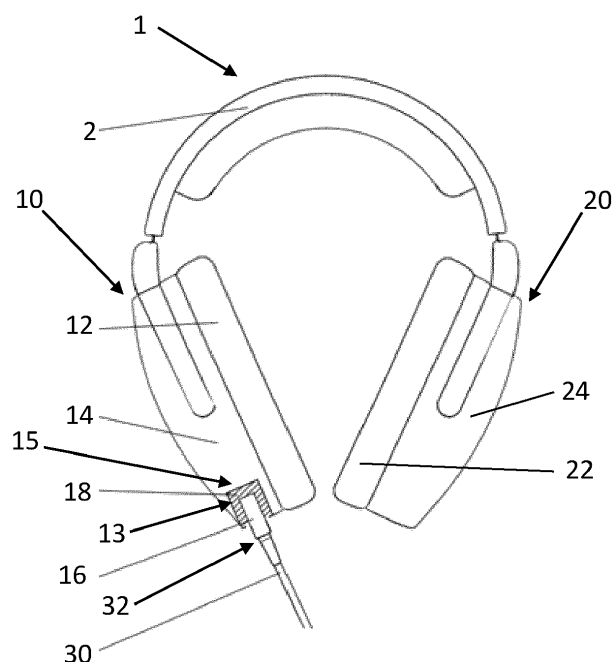


Fig. 1

Description

TECHNICAL FIELD

[0001] Embodiments of the present disclosure relate to headphones.

BACKGROUND

[0002] In a typical design, headphones comprise a housing which contains an electroacoustic sound generator. The sound generator contains an active area, sometimes referred to as a membrane, which is deflected when electrical signals are applied to it, so that a sound is generated.

[0003] In some examples, headphones can be on-ear headphones or over-ear headphones. These headphones comprise one or two earcups which can have an ear pad ring which surrounds or lies over the ear of a user during normal use of the headphones. In other examples, headphones can be in-ear headphones which are at least partially inserted into the ear of a user. Headphones can be open to their environment or closed.

[0004] Sound is generated by the headphones due to an electrical signal which may be transferred from a cable inside the headphones. However, vibrations coming from structure-born noise may be fed through the cable into the headphones causing unwanted vibration and sound.

[0005] Therefore, further improvements are necessary.

SUMMARY

[0006] In light of the above, headphones and a system including headphones and a cable are suggested. The invention is defined by the appended claims. Further aspects, advantages, and features are apparent from the dependent claims, the description, and the accompanying drawings.

[0007] Headphones are suggested comprising: a housing, an electroacoustic sound generator inside the housing configured to radiate sound, a connection element configured to receive an electrical signal associated with sound to be radiated by the electroacoustic sound generator, and an elastic element arranged between a wall of the housing and the connection element, wherein the elastic element is configured to attenuate vibrations transitioning from the connection element into the wall of the housing. In particular, the elastic element has a spring constant which forms together with a mass of the connection element a natural frequency configured to attenuate the ingress of vibrations from the connection element into the wall of the housing.

[0008] Headphones are suggested comprising: a housing, an electroacoustic sound generator inside the housing configured to radiate sound, a connection element configured to receive an electrical signal associated

with sound to be radiated by the electroacoustic sound generator, and an elastic element arranged between a wall of the housing and the connection element, wherein the elastic element is configured to attenuate vibrations traveling from the connection element into the wall of the housing. In particular, vibrations may be attenuated at a transition from the connection element into the wall by reflecting or absorbing the vibrations.

[0009] Headphones are suggested comprising: a housing, an electroacoustic sound generator inside the housing configured to radiate sound, a connection element configured to receive an electrical signal associated with sound to be radiated by the electroacoustic sound generator, and an elastic element arranged between a wall of the housing and the connection element, wherein the elastic element is configured to decouple vibrations in the connection element from vibrations in the wall of the housing.

[0010] The elastic element is preferably configured to prevent or inhibit the ingress of vibrations coming from structure-born noise into the housing. In other words, the elastic element decouples vibrations in the connection element from vibrations in the wall of the housing.

[0011] In particular, the elastic element is preferably configured to attenuate vibrations in the human hearing range, which is commonly given as about 20 Hz to 20,000 Hz. For example, the elastic element can be configured to define an oscillation system together with the connection element having a natural frequency of 100 Hz or lower. This creates a low-pass filter for vibrations traveling from the connection element into the housing.

[0012] The elastic element can also be described as a mechanical isolation between the connection element and the wall of the housing. Specifically, the transmission of vibrations from the connection element into the housing is significantly reduced or prevented. Preferably, the elastic element can reduce vibrations like a low pass filter, so that vibrations having a frequency above a threshold frequency are reflected and/or absorbed.

[0013] Mechanical vibrations in cables of headphones are produced if the cable has contact to its environment, for example, if the cable touches the body of a user wearing the headphones. The vibrations are known as structure born noise. The resulting vibrations travel through the cable into the headphones and produce unwanted sound at the user's ear. With the present invention the vibrations are significantly reduced and the sound experience of the user is increased.

[0014] The elastic element is arranged between a wall of the housing and the connection element and can be described as a vibration barrier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] A more particular description of the disclosure, briefly summarized above, is given below. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

- Fig. 1 shows a schematic drawing of headphones;
- Fig. 2 shows a schematic connection element arrangement;
- Fig. 3 shows a detailed cross section view of a connection element arrangement of headphones; and
- Fig. 4 shows the connection element arrangement of Fig. 3 from another perspective.

DETAILED DESCRIPTION OF EMBODIMENTS

[0016] Reference will now be made in detail to the various embodiments, one or more examples of which are illustrated in each figure. Each example is provided by way of explanation and is not meant as a limitation.

[0017] Within the following description of the drawings, the same reference numbers refer to the same or to similar components. Generally, only the differences with respect to the individual embodiments are described. Unless specified otherwise, the description of a part or aspect in one embodiment can apply to a corresponding part or aspect in another embodiment as well.

[0018] Headphones comprise a housing 14, an electroacoustic sound generator inside the housing 14 configured to radiate sound, and a connection element 16 configured to receive an electrical signal associated with sound to be radiated by the electroacoustic sound generator.

[0019] An elastic element 18 arranged between a wall 13 of the housing 14 and the connection element 16, wherein the elastic element 18 is configured to attenuate vibrations transitioning from the connection element into the wall of the housing. In particular, the elastic element 18 together with the connection element 16 has a natural frequency configured to attenuate the ingress of vibrations from the connection element 16 into the wall 13 of the housing 14.

[0020] Fig. 1 exemplary shows over-ear headphones 1. However, headphones may as well be in-ear headphones or on-ear-headphones.

[0021] With exemplary reference to Fig. 1, headphones 1 are shown. Headphones 1 comprise with at least one earcup 10. In Fig. 1, headphones 1 comprise two earcups 10, 20. At least one of the earcups 10, 20 comprises: a housing 14, an electroacoustic sound generator configured to radiate sound (not shown in Fig. 1), and a connection element 16 configured to receive an electrical signal associated with sound to be radiated by the sound generator.

[0022] Housing 14 can comprise a cavity 15, wherein at least a portion of the connection element 16 is arranged in the cavity 15, wherein an elastic element 18 is arranged between a wall 14 of the cavity 15 and the connection element 16. The elastic element 18 is configured to prevent or inhibit the ingress of acoustic sound waves from

the connection element 16 into the wall of the cavity 15 of the housing 14.

[0023] Headphones 1 can have exactly two earcups 10, 20 and a band 2 as shown in Fig. 1, wherein the band 2 is connected to the two earcups 10, 20 and carries the earcups 10, 20 when the headphones are used. The two earcups 10 can each have a sound generator, a membrane, housing 14, 24, and a baffle 12, 22 as shown in Fig. 1.

[0024] In some examples, headphones 1 comprise a cable 30 which is permanently attached to headphones 1 via connection element 16. In other examples, connection element 16 is configured to releasably attached to a cable 30. Connection element 16 can be a plug or a jack and cable 30 can have a corresponding jack or a plug. Jack or plug of the headphones and the plug or jack of the cable 30 can be 3.5 mm headphone jack and 3.5 mm jack plug. In general, connection element 16 can be male or female or a combination, for example, a female jack with one or more inner male or female pins or pin connectors.

[0025] Fig. 2 shows a schematic connection element arrangement. Connection element 16 is connected the wall 13 of the housing 14 at least at two points by the elastic element 18. The volume between walls 13 is defined as a cavity 15 of housing 14. Connection element 16 is placed at least partially inside cavity 15. Elastic element 18 is illustrated as springs. In some examples, elastic element can be a mechanical spring. In other examples, elastic element can be formed by an elastic material.

[0026] Figs. 3 and 4 show a detailed schematic cross section view of a connection element arrangement of headphones. Fig. 2 shows a cut through the line A-A shown in Fig. 4. Figs. 3 and 4 show an elastic element 18 and a connection element 16 which is configured to releasably attached to a cable 30. A plug of a cable could be inserted from the top right in Fig. 3. An electrical connection between the electroacoustic sound generator and the connection element 16 is not shown in the figures.

[0027] In some examples, housing 14 comprises a hollow tube 19. Cavity 15 of housing 14 can be at least partially formed by hollow tube 19 as shown in Figs. 3 and 4. The rest of housing 14 is not shown in Figs. 3 and 4. Hollow tube 19 forms wall 13 of housing and may also form an inner wall of cavity 15. The outer wall of hollow tube 19 can be permanently attached to housing 14.

[0028] Connection element 16 can be at least partially surrounded by elastic element 18. In particular, elastic element 18 can circumferentially isolate the connection element 16 from the wall of cavity 15 to prevent or inhibit the ingress of acoustic sound waves from the connection element 16 into the housing 14. In some examples, connection element 16 comprises a tube-like housing with conductors arranged in the tube-like housing, for example 4 pin connectors. Fig. 4. shows a tube in tube arrangement, wherein outer tube is hollow tube 19 and inner tube is connection element 16. Connection element

16 and hollow tube 19 are separated by elastic element 18.

[0029] Connection element 16 can comprise a multi-pin connector having at least 2 pins, specifically at least 4 pins. The example of Figs. 2 and 3 shows a 4-pin connector, wherein two pins are used as ground conductors and each of the remaining two pins correspond to the sound of one of the two electroacoustic sound generator (left and right). In that case, the two stereo signals are transmitted independently from each other, each via a pair of signal and ground conductors.

[0030] In the example shown in Figs 3 and 4, connection element 16 comprises a longitudinal groove as best seen in Fig. 4. The corresponding connection element or plug 32 of the cable 30 may comprise a protrusion configured to extend into the groove. In other examples, connection element 16 comprises a protrusion and the connection element or plug 32 of the cable 30 comprises the groove. The groove and the protrusion limit a connection between connection element 16 and connection element or plug 32 of the cable 30 to a single possible radial position. This is particularly helpful if the connection element 16 is not radially symmetric, for example, if it comprises a multi-pin connector having at least 2 pins spaced from each other as shown best in Fig. 4. It is also advantageous if the connection element 16 and the elastic element 18 are not completely radial symmetric, so that a preferred radial position is defined to maximize the attenuation of vibrations transitioning from the connection element 16 into wall 13 of housing 14.

[0031] Connection element 16 is connected to wall 13 via elastic element 18. Elastic element has a spring constant which forms together with a mass of connection element 16 a natural frequency. Said natural frequency is configured to attenuate the ingress of vibrations from the connection element into the wall of the housing. The natural frequency is preferably below the human hearing range, which is commonly given as 20 to 20,000 Hz. The oscillation system of connection element 16 and elastic element acts as a low-pass filter for hearable sound. Vibrations or noise created by a cable which physically contacts its environment is thereby reduced. The vibrations are known as structure born noise. The resulting vibrations travel through the cable into the headphones and produce unwanted sound at the user's ear. With the present invention the vibrations are significantly reduced and the sound experience of the user is increased.

[0032] Housing 14 can comprise a first material forming wall 13 of housing and elastic element 18 can comprise a second material having a smaller rigidity than the first material. The second material of elastic element 18 can, for example, comprise an elastomer. Housing 14 can comprise a metal or plastic material forming the wall. In cases in which the wall is formed by a hollow tube 19, hollow tube 19 can comprise a metal or a plastic or can consist of metal or plastic.

[0033] The material of elastic element 18 can comprises silicon rubber or ethylene-propylene rubber (EPDM).

In some examples, elastic element 18 is formed by an overmold. Elastic element 18 may be formed by at least partially overmolding connection element 16.

[0034] In some further examples, headphones may additionally further comprise an elastic ring element 17. Elastic ring element 17 can be arranged in cavity 15 on or at an inner wall of cavity 15. Elastic ring element 17 can be configured to act as a mechanical buffer between the inner wall of cavity 15 and a plug or of cable 30. Elastic ring element 17 can be spaced from the elastic element 18. Specifically, elastic ring element 17 can be arranged at an opening of cavity 15 or closer to an opening than elastic element 18 as shown in Fig 3.

[0035] The elastic ring element 17 prevents a direct contact of the more rigid inner wall of cavity 15 and/or hollow tube 19 and a connection element 32 of a cable 30. This prevents acoustic sound waves from propagating from the connection element 32 of a cable 30 into the wall of cavity 15.

[0036] Elastic ring element 17 can comprise an elastomer or silicon rubber.

[0037] Elastic ring element 17 can be arranged partially in a groove in the inner wall of the cavity 15. The groove can be circumferential. If the cavity is formed by a hollow tube 19, hollow tube 19 can contain the groove at an inner wall as shown in Fig. 3.

[0038] A system can comprise headphones and a cable 30 attached to the connection element 16 of the headphones. Vibrations may be created due to mechanical contact of cable 30 with its environment. Elastic element 18 can be configured to define an oscillation system together with connection element 16 having a natural frequency of, for example, 200Hz or lower or 100 Hz or lower. This creates a low-pass filter for vibrations traveling from the connection element into the housing. Elastic element 18 can be configured to block higher frequencies according to a typical low pass filter characteristic.

[0039] The low pass filter acts like an acoustic barrier for frequencies above the cutoff frequency. Low frequencies as described herein should be known as low in the frequencies of the human hearing range, which is commonly given as 20 to 20,000 Hz. Preferably, the low pass filter has a cutoff frequency of 200 Hz or lower or 100 Hz or lower, so that hearable frequencies of acoustic sound waves traveling along the cable into the headphones are significantly reduced when passing the elastic element 18 or blocked completely.

Claims

1. Headphones comprising:

- a housing (14),
- an electroacoustic sound generator inside the housing (14) configured to radiate sound,
- a connection element (16) configured to receive

- an electrical signal associated with sound to be radiated by the electroacoustic sound generator, and
 an elastic element (18) arranged between a wall (13) of the housing (14) and the connection element (16), wherein the elastic element (18) is configured to attenuate vibrations transitioning from the connection element (16) into the wall (13) of the housing (14).
2. Headphones according to claim 1, wherein the connection element (16) is connected to the wall (13) of the housing (14) at least at two points by the elastic element (18).
 3. Headphones according to any of the preceding claims, wherein the connection element (16) is at least partially surrounded by the elastic element (18).
 4. Headphones according to any of the preceding claims, wherein the housing (14) comprises a cavity (15) and the wall (13) is an inner wall of the cavity (15).
 5. Headphones according to any of the preceding claims, wherein the connection element (16) is a plug or a jack and is configured to releasably attached to a cable (30) having a jack or a plug.
 6. Headphones according to claim 5, wherein the jack or plug (16) of the headphones and the plug or jack (32) of the cable (30) are 3.5 mm headphone jack and 3.5 mm jack plug.
 7. Headphones according to any of the claims 1 to 4, wherein the connection element (16) is permanently attached to a cable (30).
 8. Headphones according to any of the preceding claims, wherein the elastic element (18) comprises an elastic material.
 9. Headphones according to claim 8, wherein the elastic material comprises an elastomer.
 10. Headphones according claim 8 or 9, wherein the elastic material comprises silicon rubber or ethylene-propylene rubber (EPDM).
 11. Headphones according to any of the preceding claims, wherein the elastic element (18) is formed by an overmold.
 12. Headphones according to any of the preceding claims, wherein the wall (13) is an inner wall of a hollow tube (19).
 13. Headphones according to any of the claims 2 to 12, further comprising an elastic ring element (17) spaced from the elastic element (18).
 14. Headphones according to claim 13, wherein the housing (14) comprises a cavity (15) and the wall (13) is an inner wall of the cavity (15) or wherein the housing comprises a hollow tube (19) and the wall (13) is an inner wall of the hollow tube (19), and wherein the elastic ring element (17) is arranged at an opening of the cavity (15) or at an opening of the hollow tube (19).
 15. A system comprising the headphones of any of the preceding claims and a cable (30) attached to the connection element (16) of the headphones.

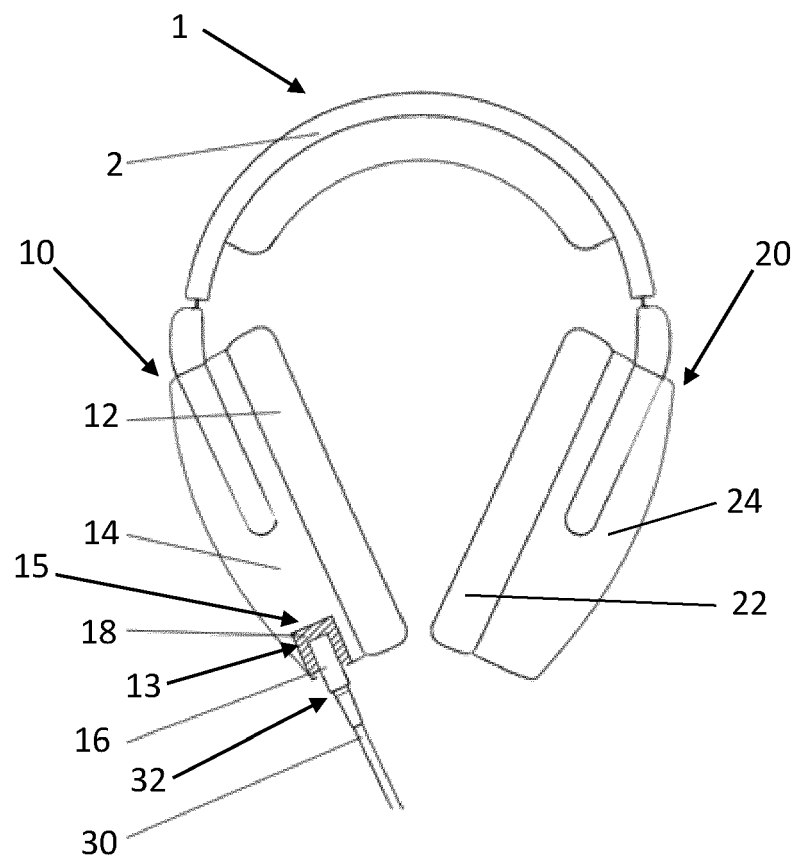


Fig. 1

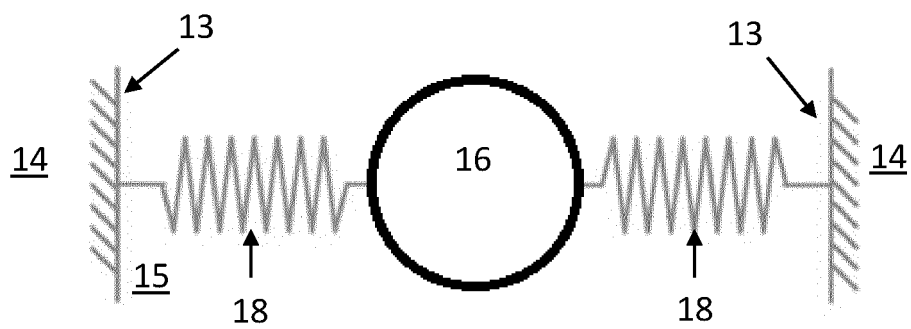
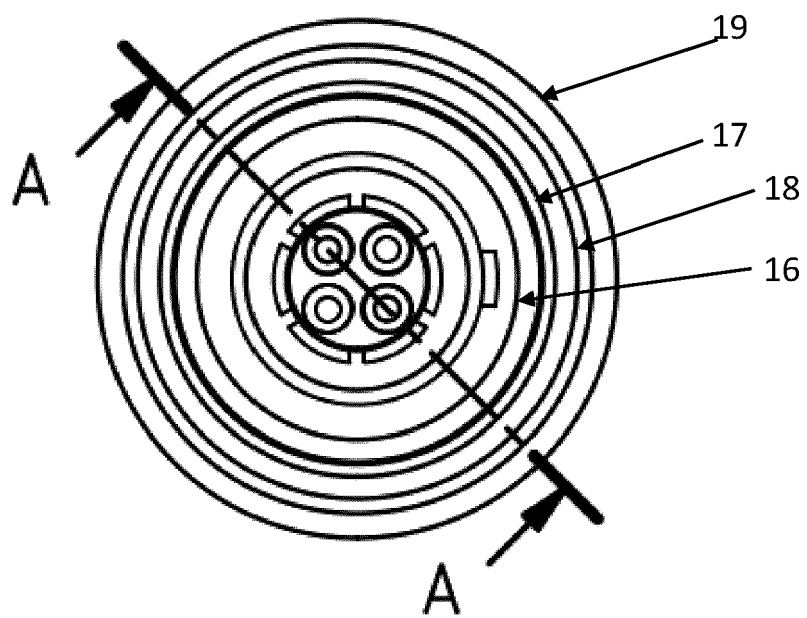
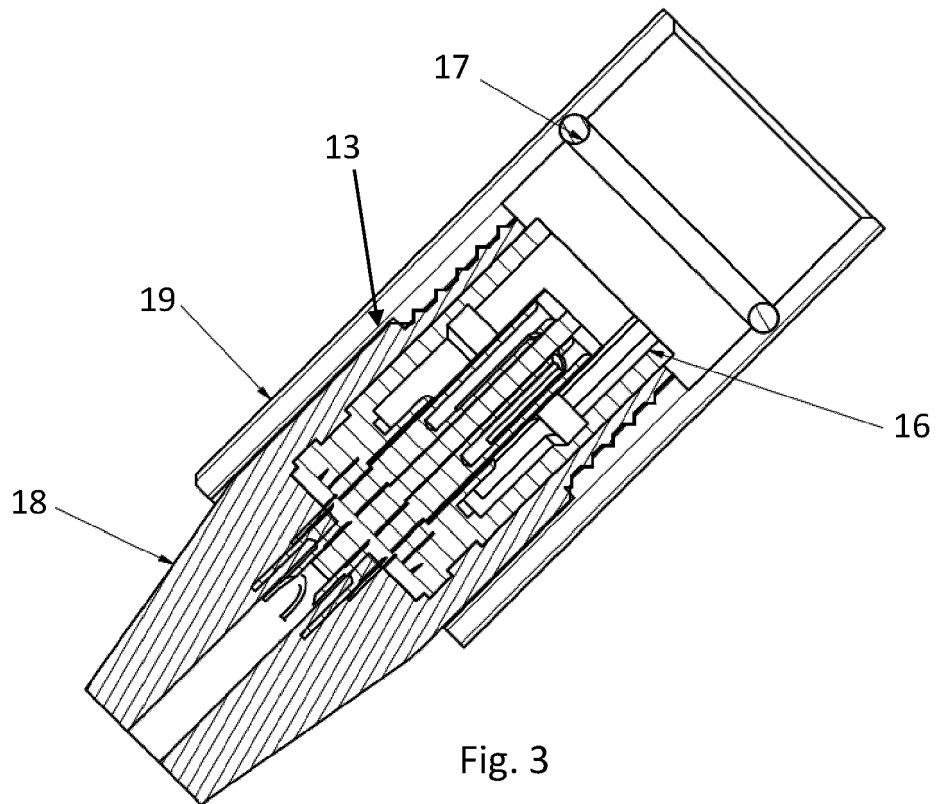


Fig. 2





EUROPEAN SEARCH REPORT

 Application Number
 EP 21 18 0292

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EPO FORM 1503 03.82 (P04C01)

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 2013/343592 A1 (SCHMIDT AXEL [DE] ET AL) 26 December 2013 (2013-12-26) * paragraph [0049] - paragraph [0057]; figures 5A-5C *	1-15	INV. H04R1/10
X	----- CN 111 615 032 A (WANG SHENGUO) 1 September 2020 (2020-09-01) * the whole document *	1-12,15	
X	----- EP 3 376 775 A1 (ONKYO KK [JP]) 19 September 2018 (2018-09-19) * paragraphs [0016], [0027]; figures 1, 3 *	1-6, 8-12,15	
A	----- CN 106 303 792 A (MA GENCHANG) 4 January 2017 (2017-01-04) * the whole document *	1-15	
A	----- JP 2010 154465 A (D & M HOLDINGS INC) 8 July 2010 (2010-07-08) * the whole document *	1-15	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			H04R
Place of search		Date of completion of the search	Examiner
The Hague		1 December 2021	Betgen, Benjamin
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			

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 21 18 0292

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013343592 A1	26-12-2013	DE 102010006927 A1	04-08-2011
		US 2011194721 A1	11-08-2011
		US 2013343592 A1	26-12-2013

CN 111615032 A	01-09-2020	NONE	

EP 3376775 A1	19-09-2018	EP 3376775 A1	19-09-2018
		JP 6332239 B2	30-05-2018
		JP 2017092779 A	25-05-2017
		WO 2017081967 A1	18-05-2017

CN 106303792 A	04-01-2017	NONE	

JP 2010154465 A	08-07-2010	NONE	
