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

(11) **EP 3 454 568 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
13.03.2019 Bulletin 2019/11

(51) Int Cl.:
H04R 1/04 *(2006.01)* ***H04R 3/00*** *(2006.01)*
H04R 1/08 *(2006.01)*

(21) Application number: **17190512.8**

(22) Date of filing: **12.09.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(71) Applicant: **G.R.A.S. Sound & Vibration A/S**
2840 Holte (DK)

(72) Inventors:
- **Bække, Jørgen**
  2950 Vedbæk (DK)
- **Oksbjerg, Morten**
  3460 Birkerød (DK)
- **Marbjerg, Kresten**
  2920 Charlottenlund (DK)

(74) Representative: **Röggla, Harald**
Schwarz & Partner
Patentanwälte
Wipplingerstraße 30
1010 Wien (AT)

(54) MICROPHONE PRE-AMPLIFIER WITH POLARIZATION VOLTAGE SUPPLY

(57) A system (1) of at least one microphone (2) and a remote signal analyzer (3) connected to the microphone (2) with two wires (5, 6) to transmit an audio signal (U_{aud}) back to the analyzer (3) and to receive a constant input current (I_{in}) on one of the wires (5) from the analyzer (3), which microphone (2) comprises an acoustic sensor (7) and a pre-amplifier (9) powered with the constant input current (I_{in}) to amplify the audio signal (U_{aud}) from the acoustic sensor (7), wherein the microphone (2) comprises a polarization voltage supply (8) connected to the two wires (5, 6) to polarize the microphone (10), which polarization voltage supply (8) comprises: a transformation stage (11) to transform a partial part of the constant input current (I_{in}) on the one wire (5) from the remote signal analyzer (3) into an output voltage (U_{stab}) with a first voltage level and a voltage increaser stage (12) to increase the voltage level of the output voltage (U_{stab}) into an increased output voltage (U_{high}) with a second voltage level and a noise reduction stage (13) to provide a polarization voltage (U_{pol}) to the acoustic sensor (7).

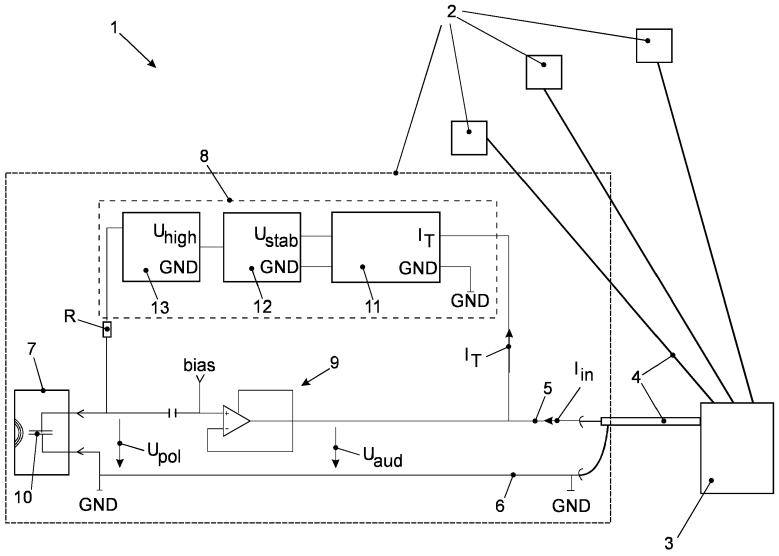

FIG.1

EP 3 454 568 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a system of at least one microphone and a remote signal analyzer connected to the microphone with two wires to transmit an audio signal back to the analyzer and to receive a constant input current on one of the wires from the analyzer, which microphone comprises an acoustic sensor and a pre-amplifier powered with the constant input current to amplify the audio signal from the acoustic sensor.

BACKGROUND OF THE INVENTION

[0002] Prior art systems often comprise a large number of sensors like microphones mounted in different locations of an area to measure analogue sensor signals, which signals are analyzed in the analyzer to which all sensors are connected. Measurement microphones are known with two different microphone versions: one pre-polarized and one that requires external polarization. The pre-polarized is more complicated and expensive to make in a measurement quality. Furthermore measurement microphones are known in two different interface versions:

The first version is a multi-wire interface with separate wires for power, which includes polarization voltage which enables use of both microphone versions.

[0003] In a second interface version used for accelerometers and microphones a two wire interface is used, here the power is sourced to the transducer on the same two wires as a constant current and the transducer signal is being overlaid as a voltage on the same two wires. A pre-amplifier of the microphone is powered by the constant current of typically 2 to 4mA applied between the wires and the acoustic sensor signal is transmitted back to the analyzer as a voltage on the two wires. The applied current is required to drive the preamplifier and capacitive load from the cable; any use of the available current for other purposes will degrade the capability to drive the cable. As it requires about 200V polarization voltage with high stability to polarize an un-polarized microphone, only pre-polarized microphone capsules may be used in state of the arte microphones with this second interface version. Known power supplies used in these microphones are not able to generate the stabile and high voltage needed from this small input current, which voltage in addition varies with the audio signal of the acoustic sensor. This is a problem as microphones with pre-polarized microphone capsules are more complicated and expensive to make in a measurement quality.

SUMMARY OF THE INVENTION

[0004] It is an object of the invention to provide a system of at least one microphone and a remote analyzer that enables to use un-polarized microphones and a two wire interface between the analyzer and the microphone. This object is achieved with a system with a microphone that comprises a polarization voltage supply connected to the two wires to polarize the microphone, which polarization voltage supply comprises:

a transformation stage to transform a partial part of the constant input current on the one wire from the remote signal analyzer into an output voltage with a first voltage level and a voltage increaser stage to increase the voltage level of the output voltage into an increased output voltage with a second voltage level and a noise reduction stage to provide a polarization voltage to the acoustic sensor.

[0005] The polarization voltage supply of the claimed system is able to generate the polarization voltage of about 200V from the very limited input current available to power the microphone, by taking only approx. 0.25mA from the available input current. The power source for this polarization voltage supply is from a voltage between the two wires varying with the audio signal and the very limited current available primary reserved for the analog pre-amplifier and the driving of the capacity load of the two wires. This provides the advantage that un-polarized microphones may be used in combination with a two wire interface. This reduces the technical complexity and costs for larger systems with a substantial number of microphones connected to the analyzer and increases the reliability and quality of the audio signals. Although the stages of the claimed polarization voltage supply may be known as such and even may be used in combination in other technical fields to generate a stabilized power, this never has been done for constant current power supplied microphones due to limited space and available power, where precision and low noise is a core specification and in particular for microphones connected to an analyzer. There was a long felt need to solve above identified problem of the state of the art systems, but no technical solution has been found by the man skilled in the art until the invention was made.

[0006] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. The person skilled in the art will understand that various embodiments may be combined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

Figure 1 shows a system of several microphones connected to a remote analyzer to analyze the audio signals of the microphones.

Figure 2 shows the polarization voltage supply of the

system shown in Figure 1.

Figure 3 shows part of the signal analyzer of the system shown in Figure 1.

DETAILED DESCRIPTION OF EMBODIMENTS

[0008] Figure 1 shows a system 1 of four sensors realized as microphones 2 and a remote signal analyzer 3, wherein one of the microphones 2 is shown in detail. All four microphones 2 are connected with a coax-cable 4 that comprises two wires, a signal wire 5 and a shield wire 6. Other two wire cables could be used as well as interface between the microphones 2 and the analyzer 3. Each of the microphones 2 comprises an acoustic sensor 7, that is built as acoustic transducer with a membrane to measure the physical parameter of noise or sound.

[0009] Microphones 2 of system 1 may for instance be attached on the surface of a wing of a test airplane to sense turbulences and to improve the surface of the wing.

[0010] Analyzer 3 is built to transfer a constant input current I_{in} over signal wire 5 to the microphones 2. Figure 3 shows that part of analyzer 3 that generates the constant input current I_{in} and amplifies the audio signal U_{aud} received from microphone 2. Microphones 2 comprise a polarization voltage supply 8 connected to signal wire 5 to generate a polarization voltage U_{pol} at a capacity 10 of an acoustic sensor 7 and a pre-amplifier 9 of the microphones 2. The pre-amplifier 9 is used to amplify an audio signal generated by the acoustic sensor 7, which is built with a membrane that forms the capacity 10 that changes with the amount of noise or sound at the membrane. Microphone 2 is capsuled with a housing and needs to be polarized by the high precision low noise polarization voltage U_{pol} of about 200V, which thereby transforms the change in capacity 10 direct proportional into a high impedance voltage signal to be fed to the pre-amplifier 9.

[0011] Polarization voltage supply 8 comprises a transformation stage 11 to transform a partial part of the constant input current I_{in} on signal wire 5, shown in figures 1 and 2 as transformation current IT , from the remote signal analyzer 3 into a stabilized output voltage U_{stab} with a first voltage level, which could be in the rage of e.g. 5V to 15V. Transformation stage 11 could be realized by an integrated precision power supply circuit available on the market as shown in figure 2.

[0012] Polarization voltage supply 8 furthermore comprises a voltage increaser stage 12 to increase the voltage level of the high precision stabilized output voltage U_{stab} into an increased output voltage U_{high} with a second voltage level, which could be in the rage of e.g. 20V to 300V and typically is about 200V. Voltage increaser stage 12 is realized as charge pump circuit known to a man skilled in the art that consists of a row of capacitors and diodes driven by a switching circuit and could be integrated in C-MOS technology. Such a charge pump circuit with an oscillator 13 is shown in figure 2.

[0013] Polarization voltage supply 8 furthermore comprises a noise reduction stage 14, as shown in figure 2, to provide a polarization voltage sourced through resistance R to the microphone 7, which could be in the range of e.g. 10 to 50 GΩ and typically is 20 GΩ. The polarization voltage U_{pol} is used to polarize the un-polarized microphone 2, thereby transforming the change in capacity direct proportional into a voltage signal. This provides that advantage that although only a two wire interface is used between microphones 2 and analyzer 3 an un-polarized microphones 2 may be used.

[0014] In another embodiment of the invention, the sequence of the transformation stage 11 and the voltage increaser stage 12 could be exchanged. This means that a voltage generated from the partial part of the constant input current I_{in} would first be stabilized and then increased and afterwards processed in the noise reduction stage 14. In another embodiment both stages would be combined and processed in one stage. This sequence of generating the polarization voltage U_{pol} would lead to the same advantages as for the embodiment shown in figures 1 to 3.

Claims

1. System (1) of at least one microphone (2) and a remote signal analyzer (3) connected to the microphone (2) with two wires (5, 6) to transmit an audio signal (U_{aud}) back to the analyzer (3) and to receive a constant input current (I_{in}) on one of the wires (5) from the analyzer (3), which microphone (2) comprises an acoustic sensor (7) and a pre-amplifier (9) powered with the constant input current (I_{in}) to amplify the audio signal (U_{aud}) from the acoustic sensor (7), **characterized in, that**
   the microphone (2) comprises a polarization voltage supply (8) connected to the two wires (5, 6) to polarize the microphone (10), which polarization voltage supply (8) comprises:

   a transformation stage (11) to transform a partial part of the constant input current (I_{in}) on the one wire (5) from the remote signal analyzer (3) into an output voltage (U_{stab}) with a first voltage level and
   a voltage increaser stage (12) to increase the voltage level of the output voltage (U_{stab}) into an increased output voltage (U_{high}) with a second voltage level and
   a noise reduction stage (13) to provide a polarization voltage (U_{pol}) to the acoustic sensor (7).

2. System (1) according to claim 1, wherein the polarization voltage (U_{pol}) is sourced through a resistor (R) to a microphone capsule used as acoustic sensor.

3. System (1) according to claim 1 or 2, wherein the transformation stage (11) is realized as integrated circuit.

4. System (1) according to one of the claims 1 to 3, wherein the voltage increaser stage (12) is realized as charge pump circuit consisting of a row of capacitors and diodes driven by a switching circuit.

5. System (1) according to one of the claims 1 to 4, wherein the noise reduction stage (13) is realized as RC filter.

6. Microphone (2) according to any of the claims 1 to 5 to be connected to a remote signal analyzer (3) over a two wire interface.

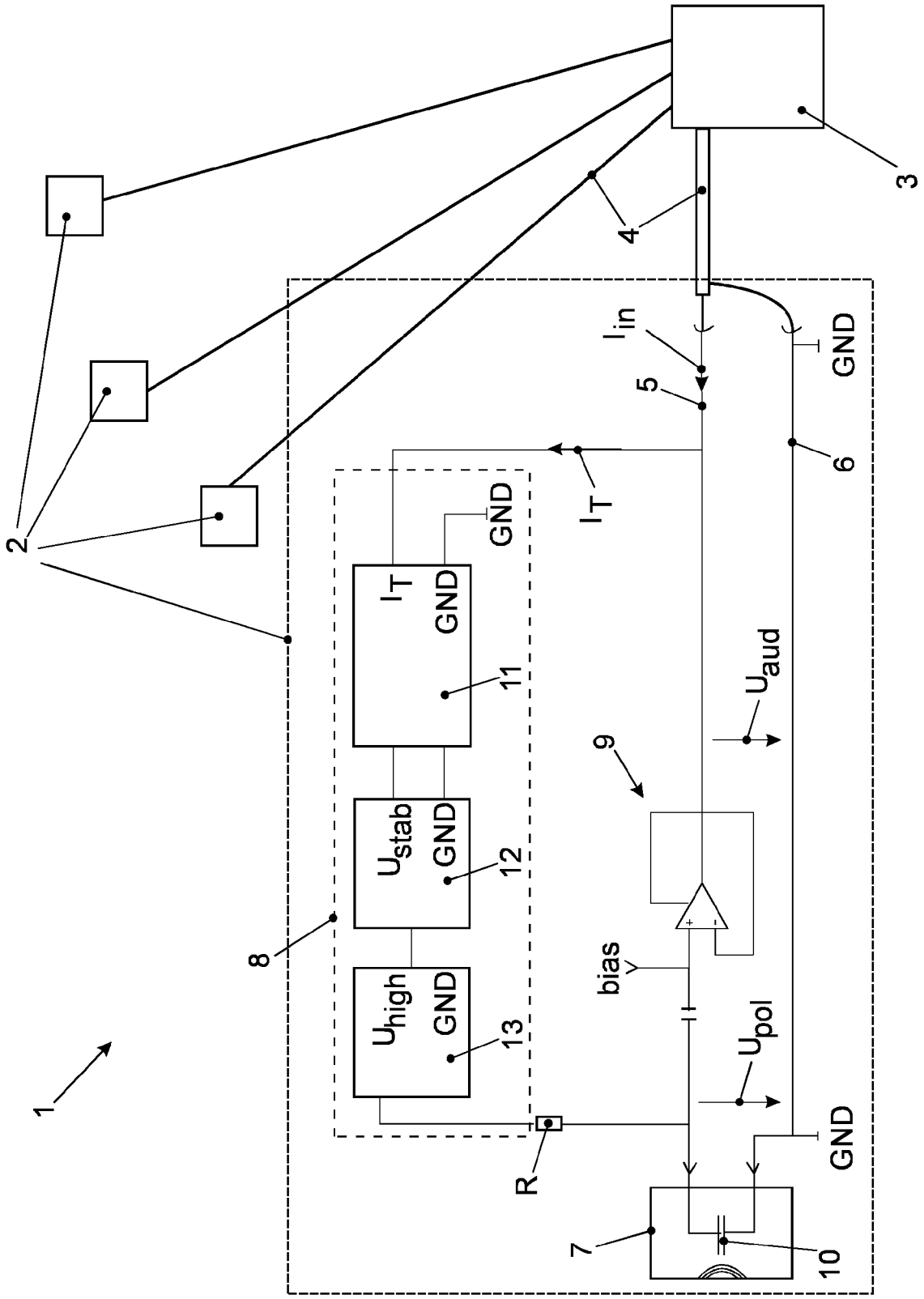

FIG.1

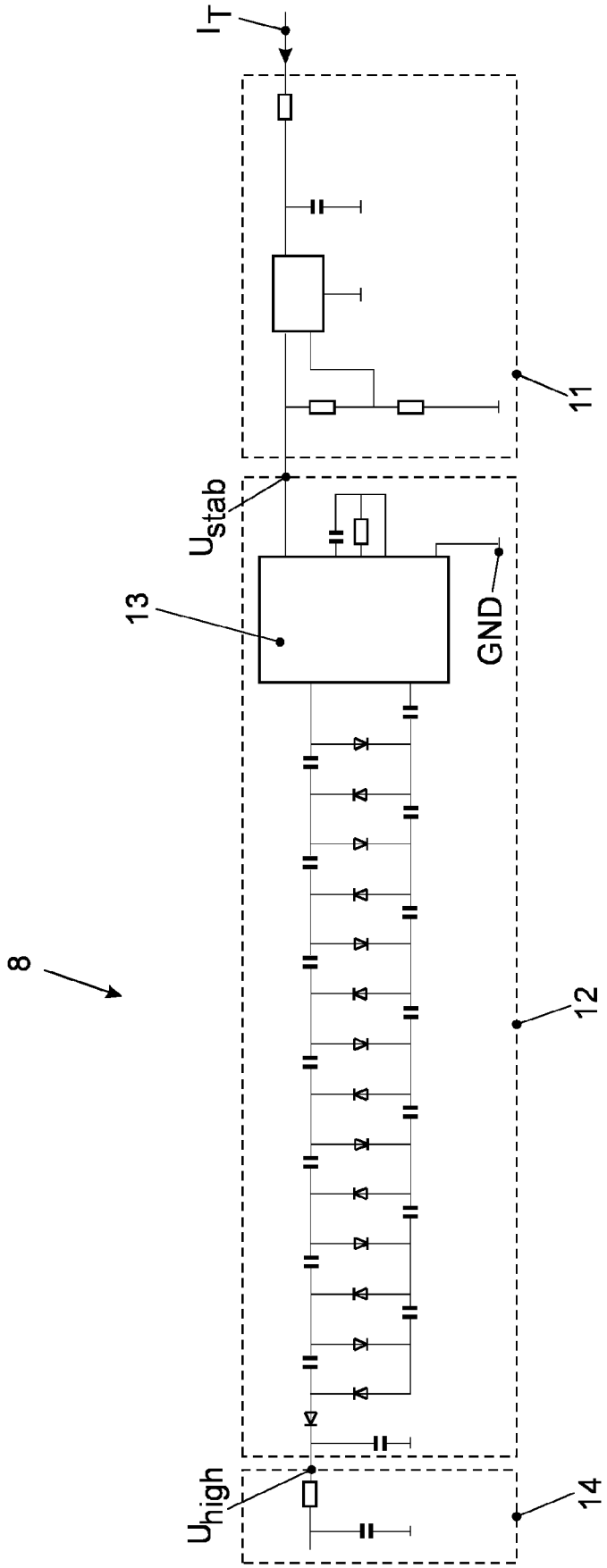

FIG.2

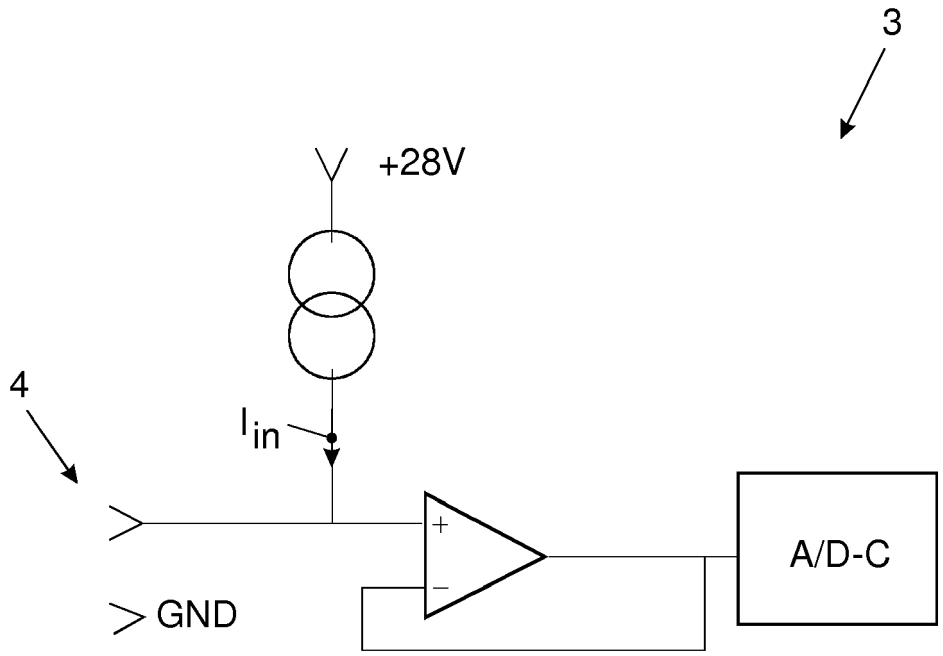

FIG.3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 17 19 0512

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 5 377 273 A (SUTTON CHRISTOPHER K [US]) 27 December 1994 (1994-12-27) * col. 1, l. 5-col. 2,l. 24; col. 2, l. 44-col. 6, l. 35 *	1-6	INV. H04R1/04 H04R3/00 ADD. H04R1/08
X	US 2005/220314 A1 (LANG WERNER [AT] ET AL) 6 October 2005 (2005-10-06) * para. 2-9, 22-84 *	1-6	
X	US 2015/181335 A1 (FLORIAN WILFRIED [AT] ET AL) 25 June 2015 (2015-06-25) * para. 1-6, 17-48 *	1-6	
A	CN 105 072 241 A (HEFEI SIWILL INTELLIGENT CO LTD) 18 November 2015 (2015-11-18) * para. 11-31 *	1-6	

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
Munich	2 February 2018	Peirs, Karel

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)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 19 0512

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.

02-02-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5377273 A	27-12-1994	DE 69327013 D1	23-12-1999
		DE 69327013 T2	24-02-2000
		EP 0562738 A2	29-09-1993
		JP 3152536 B2	03-04-2001
		JP H0654393 A	25-02-1994
		US 5377273 A	27-12-1994
US 2005220314 A1	06-10-2005	US 2005220314 A1	06-10-2005
		US 2005231873 A1	20-10-2005
		US 2005232442 A1	20-10-2005
US 2015181335 A1	25-06-2015	CN 104735587 A	24-06-2015
		DE 102014119018 A1	10-09-2015
		KR 20150073101 A	30-06-2015
		US 2015181335 A1	25-06-2015
CN 105072241 A	18-11-2015	NONE	

EPO FORM P0459

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