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Amended claims in accordance with Rule 137(2) EPC.

(54) **MEASUREMENT MICROPHONE AND METHOD TO ASSEMBLE AND CALIBRATE THE MEASUREMENT MICROPHONE**

(57) A measurement microphone (10) comprising:
a case (18) to protect the microphone (10);
an acoustic sensor (13) to transform sound waves into an analog microphone input signal (24); an equalizer stage (27) built to achieve a substantial equal microphone sensitivity for all frequencies in a given frequency range of the microphone (10);
an amplifier stage (31) built to provide an amplified analog microphone output signal (32);
an electrical connector (16) built to provide the amplified analog microphone output signal (32), wherein an ADC stage (25) built to convert the analog microphone input signal (24) into digital data (26);
the equalizer stage (27) built to filter the digital data (26) to achieve the substantial equal microphone sensitivity for all frequencies in the given frequency range of the microphone (10);
an DAC stage (28) built to convert the filtered digital data (29) into an analog microphone output signal (30).

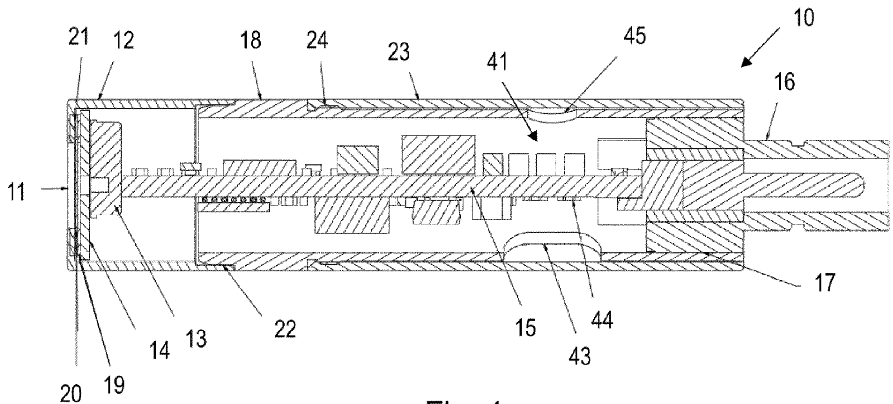


Fig. 4

EP 4 351 163 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a measurement microphone comprising:

- a case to protect the microphone;
- an acoustic sensor to transform sound waves into an analog microphone input signal;
- an equalizer stage built to achieve a substantial equal microphone sensitivity for all frequencies in a given frequency range of the microphone;
- an amplifier stage built to provide an amplified analog microphone output signal;
- an electrical connector built to provide the amplified analog microphone output signal.

BACKGROUND OF THE INVENTION

[0002] Such a measurement microphone 1 has been sold by the applicant as product G.R.A.S. 46D - Serial No. 62077 as disclosed in figure 1. This is a measurement microphone 1 that comprises a cylindrical case with a ¼ inch diameter and a length of 34 mm. The measurement microphone 1 is intended for testing and monitoring in production, facilities and machines with an as much uniform acoustic curve as possible.

[0003] Figure 2 discloses the principle mechanical elements of such a prior art measurement microphone 1, which comprises a case 2, to protect the elements of the microphone 1, and a MEMS acoustical sensor 3 and a printed circuit board 4 that carries an amplifier stage 5 and an electrical connector 6. The amplifier stage 5 receives an analog microphone input signal from the MEMS acoustical sensor 3 and is built to provide an amplified analog microphone output signal to the electrical connector 6. A filter is realized on the printed circuit board 4 as well to filter the analog microphone input signal or the analog microphone output signal in a for the measurement microphone 1 defined or given frequency range, what could for instance be 5Hz to 20kHz. To avoid Helmholtz resonance as much as possible in the mechanical construction a Poron packaging and Saarti mesh is used as mechanical acoustic filter in front of the acoustic inlet of the MEMS acoustical sensor 3.

[0004] Figure 3 shows a frequency diagram 7 of a typical intrinsic frequency response 8 of the analog microphone input signal, if the MEMS acoustical sensor 3 during an acoustic sweep test is exposed to a test signal with a fixed amplitude A and a frequency sweep within the given frequency range of the measurement microphone 1. Each and every measurement microphone 1 has a slightly different intrinsic frequency response 8 depending on minor different physical parameters within given tolerances of the electrical and mechanical elements which cause this different behavior. As it is desirable that the sensibility of the measurement microphone 1 is equal for all frequencies of the sound wave, a reference intrinsic frequency response 9 is shown in figure 3, which is flat and equal for all frequencies within the given frequency range of the measurement microphone 1, is the goal to be achieved.

[0005] To achieve this reference intrinsic frequency response in production, each and every measurement microphone 1 has to be manually adapted after the acoustic sweep test during a calibration step of the manufacturing process. This manual adaption is processed by adding a more or less or thicker or thinner Saarti cloth or other cloth as mechanical pre-filter to filter the acoustic sound wave that gets into the MEMS acoustic sensor 3. These pre-filters form some kind of an equalizer stage built to achieve a substantial equal microphone sensitivity for all frequencies in a given frequency range of the microphone 1. After adding one or more of these pre-filters another acoustic sweep test is processed and this is repeated as try and error until the intrinsic frequency response 8 of the measurement microphone 1 is close to the reference intrinsic frequency response 9. This is a time consuming manual iteration process what limits the number of measurement microphones 1 that can be manufactured.

SUMMARY OF THE INVENTION

[0006] It is an object of the invention to provide a measurement microphone that may be manufactured in high volumes and that always comprises a intrinsic frequency response 8 that is more or less equal to the reference intrinsic frequency response. This object is achieved with a measurement microphone that comprises the elements of claim 1 and/or is manufactured with a method as claimed in claim 7.

[0007] A microphone according to the invention transforms the analog microphone input signal into the digital area with an ADC stage. A test station processes the frequency sweep test with the measurement microphone and a reference measurement microphone and, based on the differences of the tested intrinsic frequency response 8 and the reference intrinsic frequency response 9 generates filter parameter, which are stored in a parameter stage of the reference microphone. A digital filter is used as equalizer stage and the stored filter parameters are used to adapt the filter curve of this equalizer stage for each and every manufactured measurement microphone to achieve the reference intrinsic frequency response 9 for all manufactured and calibrated measurement microphones. This comprises the advantage that it is no more a try and error approach with several consecutive acoustic sweep tests needed as with only one acoustic sweep test the digital filter parameters may be evaluated. Furthermore is the sensibility of the claimed measurement microphone improved, as there is no need to add further mechanical filter in front of the MEMS acoustic sensor in the calibration step, which damp the sound wave.

[0008] As the intrinsic frequency response of the microphone depends on the different mechanical and electrical elements of the particular microphone such acoustic sweep tests may only be processed successful for a ready to be used assembled measurement microphone. "Ready to be used" means that most or all for the acoustic relevant mechanical elements and all for processing of the analog microphone input signal relevant electrical elements have already been assembled to enable a meaningful acoustic sweep test. The claimed microphone comprises a programming opening arranged at the location of electrical contacts of the parameter stage, used to store the filter parameters, to enable the test station to store the filter parameters into the parameter stage at the ready to be used assembled microphone. This enables a more or less automated manufacturing process where electrical elements of the test station through the programming opening contact the parameter stage via its electrical contacts to store the filter parameters in the parameter stage during the calibration step.

[0009] To ensure the proper positioning of a main printed circuit board, that holds the parameter stage, at the programming opening the case comprises a positioning opening arranged on the case at the location of the parameter stage substantially opposite to the programming opening. During assembling the main printed circuit board into the case, the positioning opening is used to position the main printed circuit board in a way that the programming opening is arranged to enable the storage of the filter parameters by the test station. This improves the manufacturing process and ensures that all manufactured measurement microphones indeed may be programmed through the programming opening without production waste.

[0010] To ensure manufacturing quality and maybe bring the intrinsic frequency response exact into the reference intrinsic frequency response a second or third acoustic sweep test may be processed. It is furthermore advantageous to finalize the assembly of the microphone after the calibration of the measurement microphone has been processed by covering the positioning opening and the programming opening with a sleeve. This improves the mechanical robustness of the measurement microphone against dust and humidity.

[0011] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter. A person skilled in the art will understand that various embodiments may be combined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Figure 1 shows a diagonal view of a prior art product G.R.A.S. 46D - Serial No. 62077.

Figure 2 shows the principle mechanical elements of such a prior art measurement microphone of figure 1.

Figure 3 shows a frequency diagram of a typical intrinsic frequency response of the measurement microphone as a result of an acoustic sweep test.

Figure 4 shows a cross section view of a measurement microphone according to a first embodiment of the invention.

Figure 5 shows an exploded diagonal view of the measurement microphone disclosed in figure 1.

Figure 6 shows the principle electrical elements of the measurement microphone disclosed in figure 4.

Figure 7 shows a test device to process an acoustic sweep test to calibrate the measurement microphone disclosed in figure 4.

Figure 8 shows physical parameter achieved during the calibration of the measurement microphone disclosed in figure 4.

DETAILED DESCRIPTION OF EMBODIMENTS

[0013] Figure 4 shows a cross section view of a measurement microphone 10 according to a first embodiment of the invention with all of its key components and mechanical features. The acoustic pathway 11 is located on the front 12 giving a short tunnel the widens from an input hole of a MEMs acoustic sensor 13 to the front 12 input, each mechanical "step" is slightly larger to help funnel the sound into the MEMs acoustic sensor 13. In front of the MEMs acoustic sensor 13 is a daughter print 14 (daughter printed circuit board), which is soldered into a main print 15 (main printed circuit board), wherein the daughter print 14 has a small hole as part of the "funnel" that leads sound into the MEMs acoustic sensor 13.

[0014] A connector 16 is soldered onto the main print 15 before being press fit 17 into a housing or case 18 of the measurement microphone 10. The MEMs acoustic sensor 13 is soldered onto the daughter print 14, where after the MEMs acoustic sensor 13 and daughter print 14 are assembly is soldered onto the main print 15 assembly, giving an assembly comprised of the MEMs acoustic sensor 13, daughter print 14, main print 15, the case 18 and the connector 16.

[0015] On the opposite side of the MEMs acoustical sensor 13 on the daughter print 14 is a Poron packing, which is composed of double-sided tape 19, Saarti mesh 20 and a thin slice of Poron 21 cut into a "donut shape", the Saarti mesh 20 is sandwiched between the Poron 21 and the double-sided tape 19, where after it is stuck onto the daughter print 14. In other embodiments of the invention only less mechanical filter elements may be used as some of these filter goals are moved into digital data filtering. After assembly of these mechanical filters the front 12 is pressed 22 onto the case 18.

[0016] At this step of the manufacturing process the measurement microphone 10 is ready to be used and undergoes testing and calibration before a sleeve 23 is screwed on with glue in a hole 24 of the sleeve 23, which gives the fully assembled measurement microphone 10, tested and calibrated, for use.

[0017] Figure 5 shows an exploded diagonal view of the front 12, the Poron 21, the Saarti mesh 20, the double-sided tape 19, the daughter print 14, and the MEMs acoustic sensor 13, as well as the assembled main print 15, sleeve 23, case 18 and the connector 16. On this figure 5 it is possible to see the "buildup" of the different parts that make up the acoustic pathway 11 to the input of the MEMs acoustic sensor 13 of measurement microphone 10.

[0018] Figure 6 shows the principle electrical elements of the measurement microphone 10 disclosed in figure 4. The MEMS acoustical sensor 13 is a semiconductor element to transform sound waves into an analog microphone input signal 24. The MEMS acoustical sensor 2 is built to capture sound waves in a predefined given frequency range of e.g. 1Hz to 20kHz what covers the frequency range of a person. Other frequency ranges like 10Hz to 30kHz or 1kHz to 10kHz could be predefined as well. An ADC stage 25 is built to convert the analog microphone input signal 24 into digital data 26. Such digital data could comprise 1.152 Bit/Second up to 4.608 Bit/Second as one practical example.

[0019] An equalizer stage 27 is built to filter the digital data 26 to achieve the substantial equal microphone sensitivity like the reference intrinsic frequency response 9 in figure 3 for all frequencies in the given frequency range of the measurement microphone 10. This will be explained in more detail below. An DAC stage 28 is built to convert the filtered digital data 29 into an analog microphone output signal 30. An amplifier stage 31 is built to provide an amplified analog microphone output signal 32 at the electrical connector 16 built to provide the amplified analog microphone output signal 32.

[0020] As explained above, figure 3 shows a frequency diagram 7 of a typical intrinsic frequency response 8 of the analog microphone input signal 24, if the MEMS acoustical sensor 13 during an acoustic sweep test is exposed to a test signal with a fixed amplitude A and a frequency sweep within the given frequency range of the measurement microphone 10. This figure 3 used to explain the effect for measurement microphone 1 according to the state of the art is true for the measurement microphone 10 according to the invention as well.

[0021] Figure 7 discloses a test station 33 to process the acoustic sweep test and calibrate measurement microphone 10 with filter parameter. A reference measurement microphone 34, which has the reference intrinsic frequency response 9 shown in figure 3, is arranged together with the to be tested and calibrated measurement microphone 10 in a test box 35, that has standardized acoustic properties. During the acoustic sweep test an analyzer or LabView card 37 of computer 38 provides the test signal 39 with a fixed amplitude A and a frequency sweep within the given frequency range of the measurement microphone 10 to a speaker 36 that generates sound waves. LabView card 37 and computer 38 capture the intrinsic frequency response of measurement microphone 10, what is the frequency spectrum of the amplified analog microphone output signal 32 at connector 16, and the equivalent reference intrinsic frequency response 9 of reference measurement microphone 34. Furthermore, LabView card 37 and computer 38 analyze the differences of these responses, like as an example shown in figure 3, and calculate filter parameter 40 to be stored in a parameter stage 41 which is arranged on the main print 15 as shown in figures 4 and 6. The test station 33 comprises pins 42 that are built to reach through a programming opening 43 of the case 18 to electrical contacts 44 of the parameter stage 41 to store the filter parameter 40 in the parameter stage 41 as result of the acoustic sweep test. After that acoustic sweep test and until other filter parameters 40 are stored in the parameter stage 41, the equalizer stage 27 is built to adapt its digital data filter based on these stored filter parameters 40. If after that a second acoustic sweep test would be processed with the measure microphone 10 the result would be, that the intrinsic frequency response 8 of the amplified analog microphone output signal 32 would already be ident or close to be ident with the reference intrinsic frequency response 9. In a preferred embodiment this second and maybe a third acoustic sweep test could be processed in an iterative process to get even closer to the reference intrinsic frequency response 9.

[0022] For measurement microphone 10 the ADC stage 25 and the equalizer stage 27 and the DAC stage 28 are arranged on the main print 15, which main print 15 is arranged substantially in the axis of the case 18. Case 18 furthermore is built in the form of a cylinder and comprises a positioning opening 45 arranged on the case 18 at the location of the parameter stage 41 substantially opposite to the programming opening 43. This enables to position the main print 15 during the assembly process in a way that pins 42 of test station 33 can always reach electrical contacts 44 of parameter stage 41.

[0023] Measurement microphone 10 furthermore comprises the sleeve 23 to cover the programming opening 43 and the positioning opening 45 of the case 18 at the final assembled microphone 10. This ensures best acoustic parameters and protection against dust and humidity for the then complete closed case 18 of microphone 10.

[0024] The microphone 10 furthermore comprises the daughter print 14 arranged perpendicular to the main print 15 at the front 12 of the cylinder of the case 18, which daughter print 14 carries the MEMS acoustic sensor 13.

[0025] Figure 8A shows a real measurement signal 46 of an intrinsic frequency response of calibrated measurement microphone 10. Figure 8B shows physical parameter achieved during the calibration of the measurement microphone 10 disclosed in figure 4. Figure 8C shows a real measurement of a phase spread 47 or phase error of an uncalibrated measurement microphone 10, bevor the filter parameters 40 that result from the acoustic sweep test are used. Figure 8C furthermore shows a phase spread 48 or phase error of the calibrated measurement microphone 10 after the filter parameters 40, that result from the acoustic sweep test, are stored in the parameter stage 41 and used by the calibrated measurement microphone 10.

[0026] As described above, the measurement microphone 10 is assembled and calibrated according to the following steps:

- assemble the main print 15 and the daughter print 14 into the case 18 to bring the microphone 10 into a ready to be used status;
- process an acoustic sweep test, wherein a reference microphone 34, with an equal microphone sensitivity / reference intrinsic frequency response 9 for the given frequency range, and the to be calibrated measurement microphone 10 are exposed to a test signal 39 with a frequency sweep within the given frequency range of the measurement microphone 10;
- compare the filtered digital data 29 and/or the analog microphone output signals 32 and/or the intrinsic frequency responses 8 and 9 of the reference microphone 34 and the to be calibrated measurement microphone 10 to evaluate filter parameter 40 to improve the equalizer stage 27 of the to be calibrated measurement microphone 10;
- store the evaluated filter parameter 40 into the parameter stage 41 of the ready to be used assembled microphone 10 by contacting the electrical contacts 44 of the parameter stage 41 through the programming opening 43.

[0027] Further advantageous steps of this method are:

- use the positioning opening 45 during the assemble step to locate and position the parameter stage 41 with its electrical contacts 44 at the programming opening 43 and fix the main print 15 in that position at the case 18 and/or

- process a second and/or third acoustic sweep test to bring the intrinsic frequency response 8 closer to the reference intrinsic frequency response 9 and/or

- use the sleeve 23 to cover the programming opening 43 and/or the positioning opening 45 of the case 18 to finalize the assembly of the microphone 10 after the calibration of the measurement microphone 10 has been processed.

Claims

1. Measurement microphone (10) comprising:

a case (18) to protect the microphone (10);
an acoustic sensor (13) to transform sound waves into an analog microphone input signal (24);
an equalizer stage (27) built to achieve a substantial equal microphone sensitivity for all frequencies in a given frequency range of the microphone (10);
an amplifier stage (31) built to provide an amplified analog microphone output signal (32);
an electrical connector (16) built to provide the amplified analog microphone output signal (32),
characterized in, that
an ADC stage (25) built to convert the analog microphone input signal (24) into digital data (26);
the equalizer stage (27) built to filter the digital data (26) to achieve the substantial equal microphone sensitivity for all frequencies in the given frequency range of the microphone (10);
an DAC stage (28) built to convert the filtered digital data (29) into an analog microphone output signal (30).

2. Microphone (10) according to claim 1, wherein the microphone (10) comprises a parameter stage (41) to store filter parameters (40) and wherein the equalizer stage (27) is built to adapt the filter based on the stored filter parameters (40).

3. Microphone (10) according to claim 2, wherein the case (18) comprises an programming opening (43) arranged at the location of electrical contacts (44) of the parameter stage (41) to enable the storage of the filter parameters (40) into the parameter stage (41) at the ready to be used assembled microphone (10).

4. Microphone (10) according to claim 3, wherein the ADC stage (25) and the equalizer stage (27) and the DAC stage (28) are arranged on a main printed circuit board (15), which main printed circuit board (15) is arranged substantially in the axis of the case (18), which is built in the form of a cylinder and which case (18) comprises a positioning opening (45) arranged on the case (18) at the location of the parameter stage (41) substantially opposite to the programming opening (43).

5. Microphone (10) according to claim 3 or 4, wherein the microphone (10) comprises a sleeve (23) to cover at least the programming opening (43) and/or the positioning opening (45) of the case (18) at the final assembled microphone (10).

6. Microphone (10) according to claim 5, wherein the microphone (10) comprises a daughter printed circuit board (14) arranged perpendicular to the main printed circuit board (15) at the front (12) of the cylinder of the case (18), which daughter printed circuit board (14) carries the acoustic sensor, and in particular a MEMS acoustic sensor (13).

7. Method to assemble and calibrate a measurement microphone (10) according to any of the claims 1 to 6, which method comprises the following steps:

- assemble the main printed circuit board (15) and the daughter printed circuit board (14) into the case (18) to bring the microphone (10) into a ready to be used status;
- process an acoustic sweep test, wherein a reference microphone (34), with an equal microphone sensitivity for the given frequency range, and the to be calibrated measurement microphone (10) are exposed to a test signal (39) with a frequency sweep within the given frequency range of the measurement microphone (10);
- compare the filtered digital data (29) and/or the analog microphone output signals (32) and/or the intrinsic frequency responses (8, 9) of the reference microphone (34) and the to be calibrated measurement microphone (10) to evaluate filter parameter (40) to improve the equalizer stage (27) of the to be calibrated measurement microphone (10);
- store the evaluated filter parameter (40) into the parameter stage (41) of the ready to be used assembled microphone (10) by contacting the electrical contacts (44) of the parameter stage (41) through the programming opening (43).

8. Method according to claim 7, wherein the following further steps are processed:

- use the positioning opening (45) during the assemble step to locate and position the parameter stage (41) with its electrical contacts (44) at the programming opening (43) and fix the main printed circuit board (15) in that position at the case (18).

9. Method according to any of the claims 7 to 8, wherein the following further steps are processed:

- process a second and/or third acoustic sweep test to bring the intrinsic frequency response (8) closer to the reference intrinsic frequency response (9).

10. Method according to any of the claims 7 to 9, wherein the following further steps are processed:

- use the sleeve (23) to cover the programming opening (43) and/or the positioning opening (45) of the case (18) to finalize the assembly of the microphone (10) after the calibration of the measurement microphone (10) has been processed.

Amended claims in accordance with Rule 137(2) EPC.

1. Measurement microphone (10) comprising:

a case (18) to protect the microphone (10);
an acoustic sensor (13) to transform sound waves into an analog microphone input signal (24);
an equalizer stage (27) built to achieve a substantial equal microphone sensitivity for all frequencies in a given frequency range of the microphone (10);
an amplifier stage (31) built to provide an amplified analog microphone output signal (32);
an electrical connector (16) built to provide the amplified analog microphone output signal (32),
characterized in, that
an ADC stage (25) built to convert the analog microphone input signal (24) into digital data (26);
the equalizer stage (27) built to filter the digital data (26) to achieve the substantial equal microphone sensitivity for all frequencies in the given frequency range of the microphone (10);
an DAC stage (28) built to convert the filtered digital data (29) into an analog microphone output signal (30).

2. Microphone (10) according to claim 1, wherein the microphone (10) comprises a parameter stage (41) to store filter parameters (40) and wherein the equalizer stage (27) is built to adapt the filter based on the stored filter parameters (40).

3. Microphone (10) according to claim 2, wherein the case (18) comprises an programming opening (43) arranged at the location of electrical contacts (44) of the parameter stage (41) to enable the storage of the filter parameters (40) into the parameter stage (41) at the ready to be used assembled microphone (10).

4. Microphone (10) according to claim 3, wherein the ADC stage (25) and the equalizer stage (27) and the DAC stage (28) are arranged on a main printed circuit board (15), which main printed circuit board (15) is arranged substantially in the axis of the case (18), which is built in the form of a cylinder and which case (18) comprises a positioning opening (45) arranged on the case (18) at the location of the parameter stage (41) substantially opposite to the programming opening (43).

5. Microphone (10) according to claim 3 or 4, wherein the microphone (10) comprises a sleeve (23) to cover at least the programming opening (43) and/or the positioning opening (45) of the case (18) at the final assembled microphone (10).

6. Microphone (10) according to claim 5, wherein the microphone (10) comprises a daughter printed circuit board (14) arranged perpendicular to the main printed circuit board (15) at the front (12) of the cylinder of the case (18), which daughter printed circuit board (14) carries the acoustic sensor, and in particular a MEMS acoustic sensor (13).

7. Method to assemble and calibrate a measurement microphone (10) according to any of the claims 1 to 6, which method comprises the following steps:

- assemble the main printed circuit board (15) and a daughter printed circuit board (14) into the case (18) to bring the microphone (10) into a ready to be used status;
- process an acoustic sweep test, wherein a reference microphone (34), with an equal microphone sensitivity for the given frequency range, and the to be calibrated measurement microphone (10) are exposed to a test signal (39) with a frequency sweep within the given frequency range of the measurement microphone (10);
- compare the filtered digital data (29) and/or the analog microphone output signals (32) and/or the intrinsic frequency responses (8, 9) of the reference microphone (34) and the to be calibrated measurement microphone (10) to evaluate filter parameter (40) to improve the equalizer stage (27) of the to be calibrated measurement microphone (10);
- store the evaluated filter parameter (40) into the parameter stage (41) of the ready to be used assembled microphone (10) by contacting the electrical contacts (44) of the parameter stage (41) through the programming opening (43).

8. Method according to claim 7, wherein the following further steps are processed:

- use the positioning opening (45) during the assemble step to locate and position the parameter stage (41) with its electrical contacts (44) at the programming opening (43) and fix the main printed circuit board (15) in that position at the case (18).

9. Method according to any of the claims 7 to 8, wherein the following further steps are processed:

- process a second and/or third acoustic sweep test to bring the intrinsic frequency response (8) closer to the reference intrinsic frequency response (9).

10. Method according to any of the claims 7 to 9, wherein the following further steps are processed:

- use the sleeve (23) to cover the programming opening (43) and/or the positioning opening (45) of the case (18) to finalize the assembly of the microphone (10) after the calibration of the measurement microphone (10) has been processed.

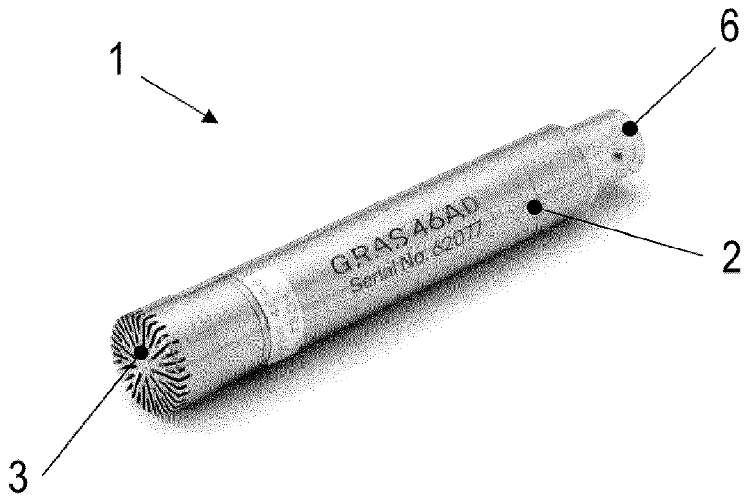


Fig. 1

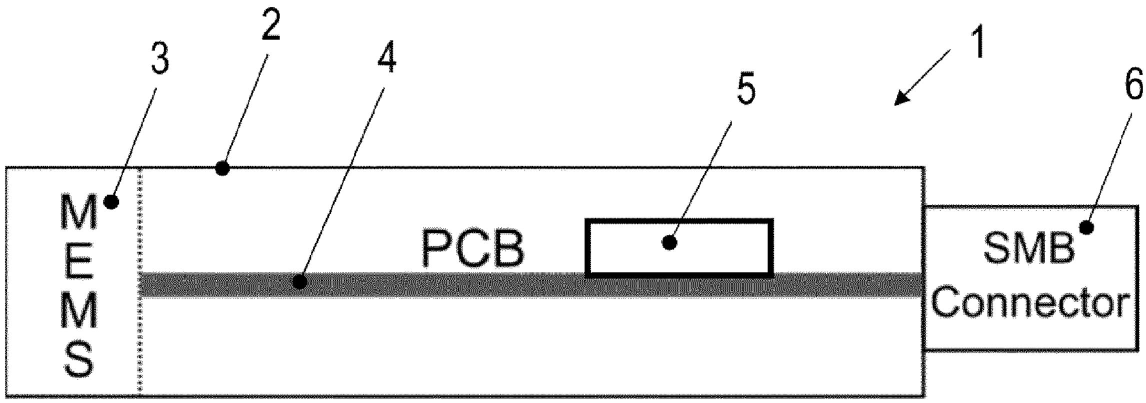


Fig. 2

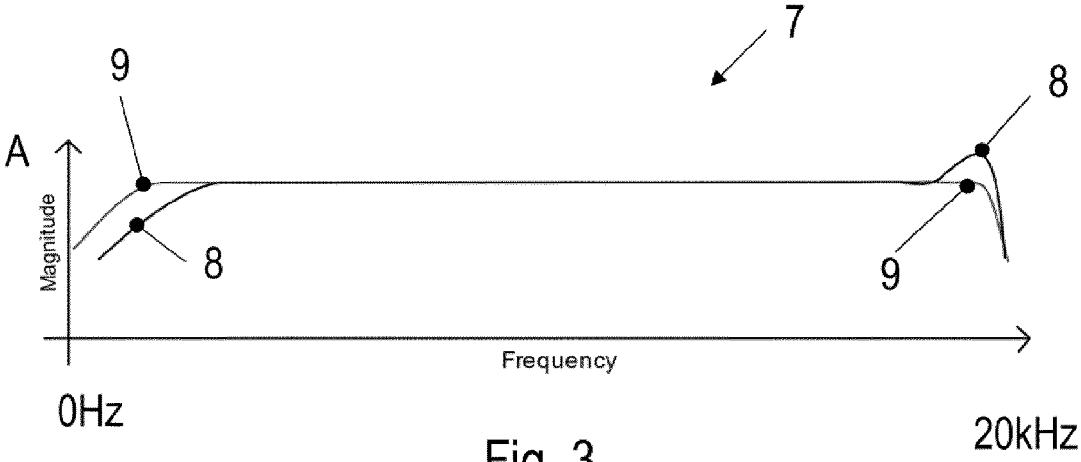


Fig. 3

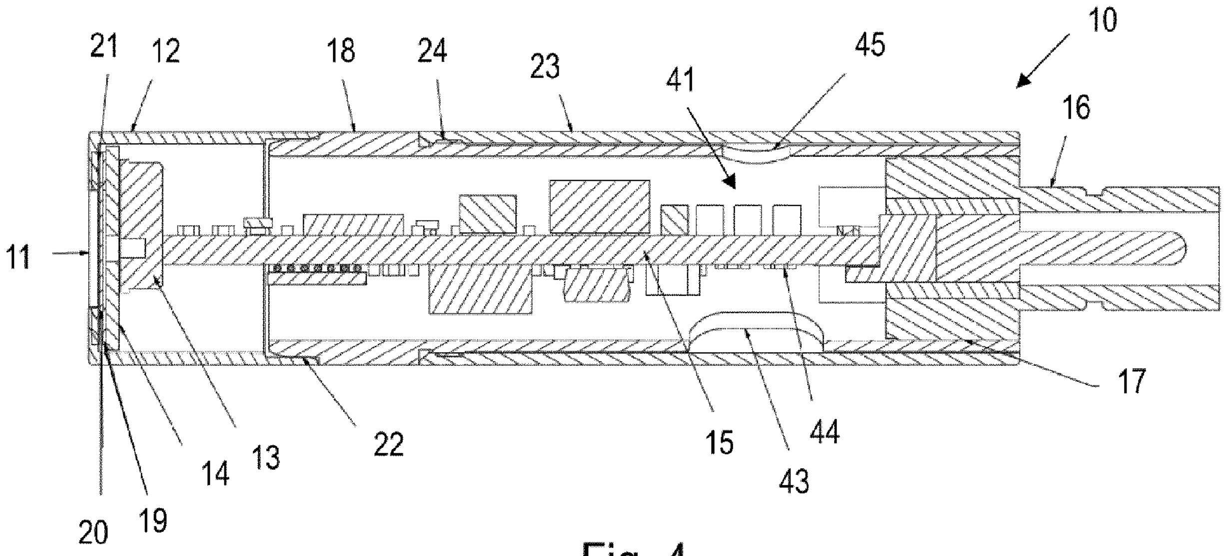


Fig. 4

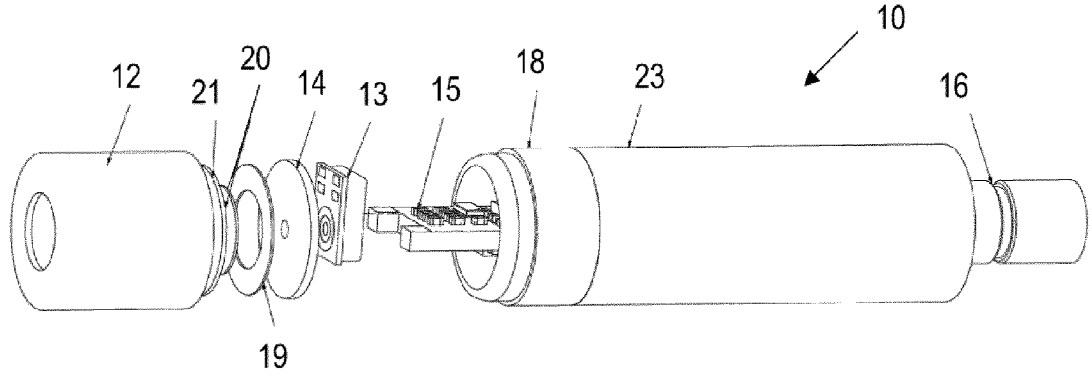


Fig. 5

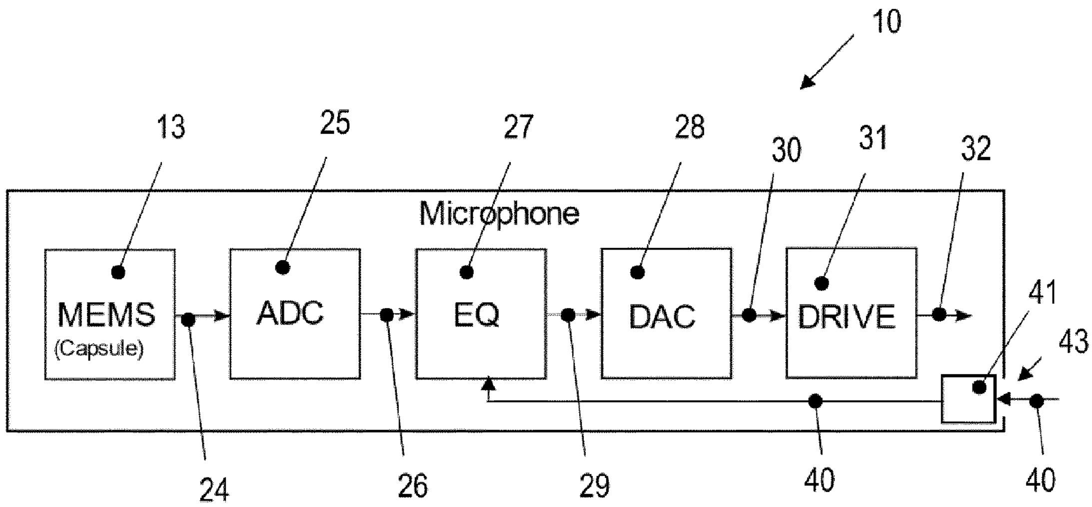


Fig. 6

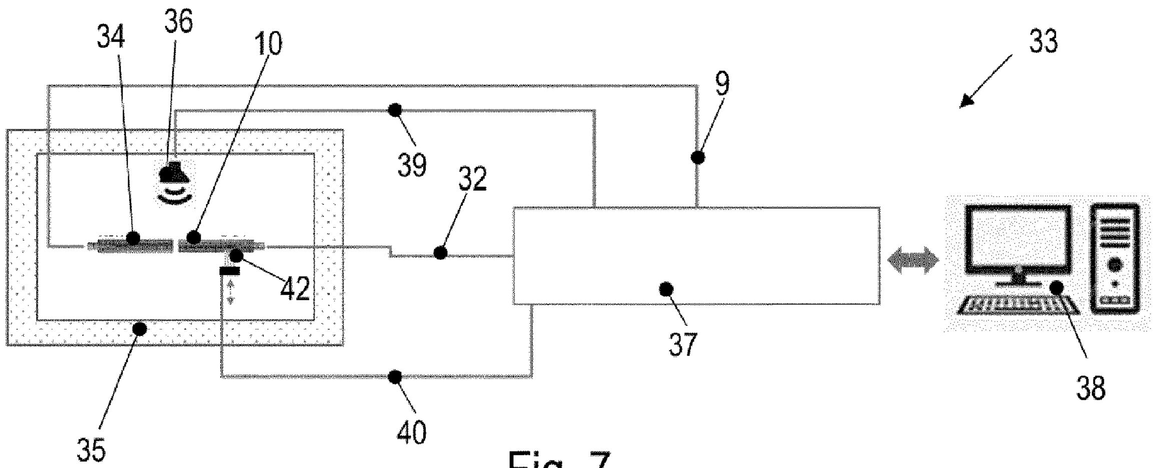


Fig. 7

Fig. 8A

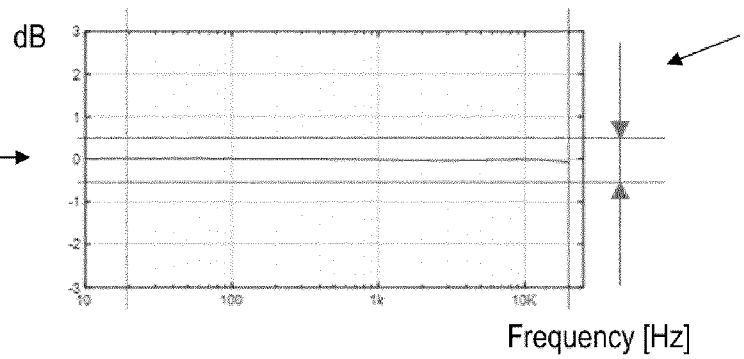
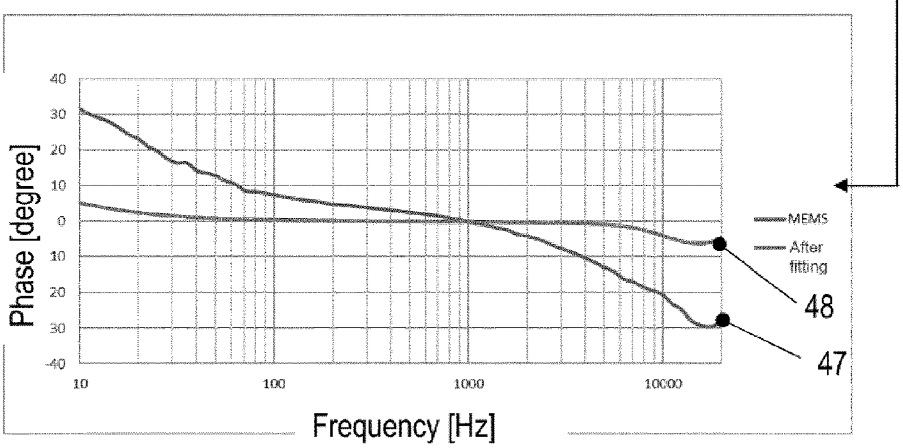


Fig. 8B

<u>System to ensure each mic is:</u>

1. Unigain (sensitivity) = 20mV/Pa ±2mV/Pa (±0.7dB)
   Wish is ± 0.5mV (±0.2dB)
2. Curve (fitting) = 20 Hz – 20 kHz, ± 1 dB
   10 Hz – 25 kHz, ± 2 dB
3. Phase (linearity / equality mic to mic) = ??
4. Noise (A-Weighted): <35 dB
   Wish is for <28 dB

Fig. 8C



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EUROPEAN SEARCH REPORT

Application Number
EP 22 19 9332

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 2003/169891 A1 (RYAN JIM G [CA] ET AL) 11 September 2003 (2003-09-11) * paragraphs [0020], [0021], [0044], [0074] - [0078]; figures 3A, 3B, 6 *	1-10	INV. H04R1/08 H04R3/06 H04R19/04 H04R29/00
X	US 2020/154223 A1 (DU YU [US] ET AL) 14 May 2020 (2020-05-14) * paragraphs [0002], [0017], [0035] - [0039], [0044], [0052], [0053]; figures 1, 2A, 2B *	1-10	
A	US 2018/063644 A1 (BACH ELMAR [AT] ET AL) 1 March 2018 (2018-03-01) * the whole document *	1-10	
			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	28 February 2023	Kunze, Holger

2

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