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(54) ACOUSTIC NOISE REDUCTION DEVICE FOR REDUCING THE RADIATION OF NOISE GENERATED BY A FAN OF A HEAT PUMP SYSTEM

(57) The present invention relates to an acoustic noise reduction device for reducing the radiation of noise generated by a fan of a heat pump system, wherein the fan is creating an air flow and the acoustic noise reduction device comprises a housing that provides at least one first flow path for the air flow through the acoustic noise reduction device and at least one second flow path for the air flowthrough the acoustic noise reduction device, the first flow path and the second flow path are fluidically separated from each other, wherein the first flow path has a first length and the second flow path has a second length, the first length being different from the second length

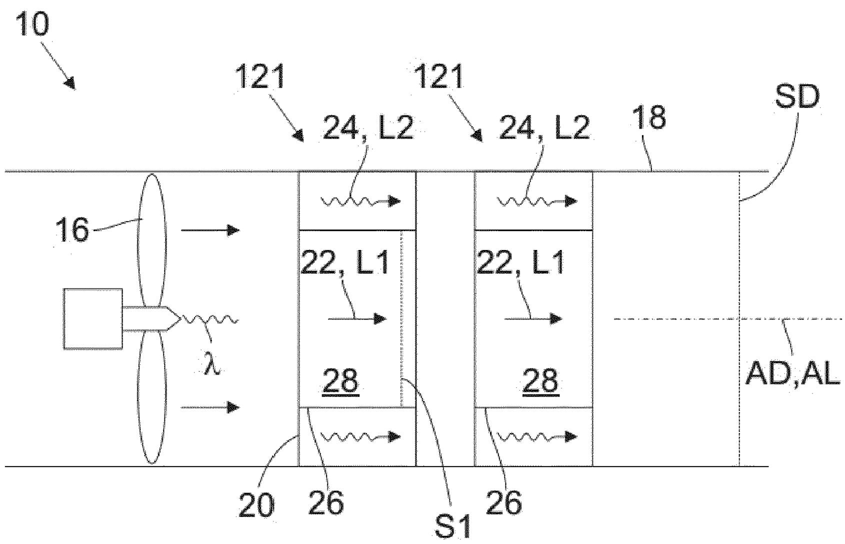

Fig.1

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Description

[0001] The present invention relates to an acoustic noise reduction device for reducing the radiation of noise generated by a fan of a heat pump system. Moreover, this invention is drawn to a heat pump system comprising such an acoustic noise reduction device and to the use of such an acoustic noise reduction device in or for a heat pump system.

[0002] A heat pump is a device that uses work to transfer heat from a first medium to a second medium by transferring thermal energy using a refrigeration cycle, thereby cooling the first medium and warming the second medium. As a heat pump transfers heat, it is more energy-efficient than other ways of heating. The energy needed in particular for operating the compressor can be provided in form of electrical energy without the need to combust fossil fuels. Heat pumps may help reducing the CO2-emission and can also be used for cooling in an efficient way which are some reasons why heat pumps are becoming more and more popular.

[0003] A heat pump comprises noises sources such as compressors and fans. The operation of a heat pump may therefore be considered as disturbing not only for the residents of a house equipped with a heat pump but also for the residents of houses located in the vicinity. For reducing the noise radiation from the heat pump it is known to employ sound or noise absorbing walls, in the following referred to as acoustic dampening walls. However, to sufficiently reduce the noise radiation , the acoustic dampening walls need to be provided with a fairly large thickness and need to be made of dense material which leads to an increase of the weight and installation space. In this respect, reference is made to DE 20 2022 105 887 U1.

[0004] The noise is directly linked to the fan speed and its number of blades. To reduce the noise, one may use an air duct with acoustic treatment, in particular vibro-acoustic treatments, such as vibration plots or foam, or reduce the fan and/or compressor speed, However, the latter leads to a reduction of the heating or cooling power.

[0005] It is one object of the present invention to provide an acoustic noise reduction device in ducts which is easy to install, also retroactively, and by which a high noise reduction performance can be obtained.

[0006] The object is solved by the subject-matter of claim 1. Advantageous embodiments are the subject of the dependent claims.

[0007] One embodiment of the present invention is directed to an acoustic noise reduction device for reducing the radiation of noise generated by a fan of a heat pump system, wherein the fan is creating an air flow and the acoustic noise reduction device comprises :

- a housing that provides at least one first flow path for the air flow through the acoustic noise reduction device and at least one second flow path for the air flow through the acoustic noise reduction device,
- the first flow path and the second flow path are fluidically separated from each other, wherein
- the first flow path has a first length and the second flow path has a second length, the first length being different from the second length.

[0008] The air flow created by the fan is split up into at least two paths of a different length. The sub-air flows are then brought back together after exiting the device. Due to the combination of the sub-air flows,, interferences are introduced into the noise frequencies which reduce the perceived noise generated by the fan. The noise disturbance caused by the heat pump system that is equipped with such an acoustic noise reduction device is thereby reduced.

[0009] The acoustic noise reduction device may particularly be an airborne fan noise reduction device.

[0010] According to a further embodiment the fluidical separation of the first flow path from the second flow path is provided by an air-tight wall. The air-tight wall may be an integral part of the housing or a separate part. An air-tight wall is easy to manufacture at low costs. Moreover, the air-tight wall generates a reliable fluidical separation which is necessary to ensure the correct phase shift effect of the noise frequencies and the desired reduction of the perceived noise.

[0011] In a further embodiment the difference between the first length and the second length equals λ/2. The difference may be defined as follows:

$$\Delta = |L1 - L2| = \frac{1}{2}\lambda$$

[0012] Alternatively, the difference may also be defined as

$$\Delta = |L1 - L2| = a\,\lambda + \tfrac{1}{2}\,\lambda + \text{c}$$

wherein a is an integer. Preferably, to have a compact device with the same efficiency, a = 0. λ is the wavelength of the frequency of the noise that should be reduced, or the speed of sound divided by the frequency of the noise that should be reduced. It has been found that the perceived noise is efficiently reduced at this ratio. "c" corresponds to a correction coefficient and can be lower than 0.1, in particular can have the value 0.

[0013] In another embodiment the volumetric ratio of the air flow flowing through the shorter flow path compared to the air flow flowing through both shorter and longer flow path is between 0.5 to 0.8, preferably between 0.6 and 0.7. It has been found that the perceived noise is efficiently reduced at this volumetric ratio. At the same time the pressure drop of the air flow caused by the acoustic noise reduction device is still within an acceptable range. Likewise, the same advantages can be achieved when a ratio of a cross section of the shorter flow path to a cross section of the air duct (addition of shorter flow path cross section and longer flow path cross section) is between 0.5 to 0.8, preferably between 0.6 and 0.7.

[0014] According to a further embodiment the first flow path is formed or delimited by a cylindrical tube. In this embodiment, the first flow path can be defined in a simple way which is easy to manufacture.

[0015] According to another embodiment the second flow path runs along a helical course. The length of the second flow path can be chosen in a flexible way by means of the helical course. At the same time, the second flow path can be significantly prolonged at a limited axial extension. Thus the axial extension of the acoustic noise reduction device can be kept small such that the acoustic noise reduction device can also be employed at limited installation space.

[0016] In accordance with a further embodiment the first flow path defines a longitudinal axis and the helix axis of the helical course runs parallel to the longitudinal axis or coincides with the longitudinal axis. In particular when the helix axis coincides with the longitudinal axis, the acoustic noise reduction device has a high degree of symmetry and/or revolution geometry which facilitates its production.

[0017] In accordance with another embodiment a plurality of second flow paths run along a helical course. The second lengths of the second flow paths may differ from each other. The noise of a fan of heat pump system may have several maxima at different frequencies. Each helical course of the second flow paths may be optimized to these frequencies. As a result, the perceived noise can be efficiently reduced. In particular, several second flow paths of identical length forming a multiple revolution helix allow for a better management of the air flow and ensure that the distance of the flow will be compliant with the requirement. For example, the embodiment can have, 3 to 10, in particular 6, second flow paths. An embodiment having a multiple revolution helix is better than an embodiment having a simple revolution helix. Compared to one second flow path running along a helical course, the air flow using the longest path will have a large deviation because it will not be ducted properly due to internal disturbances and obstacles of the air flow along the helical course.

[0018] In a further embodiment the helical course forms a helix angle which is between 5° and 20° with reference to the helix axis. It has been found that an efficient reduction of the perceived noise can be obtained by such a helix angle. At the same time the axial extension of the entire acoustic noise reduction device can be kept low.

[0019] In another embodiment the acoustic noise reduction device is made of plastic. In this embodiment the acoustic noise reduction device can be made by injection molding and thus in large quantities at low costs. Moreover, the use of plastic enables a lightweight embodiment of the acoustic noise reduction device and a qualitative sealing between parts and flows. Other manufacturing methods like foaming, extrusion and 3D printing may also be used, in particular, when the acoustic noise reduction device is made of plastic.

[0020] Another aspect of the present invention is directed to a heat pump system comprising a fan for creating an air flow, the fan being arranged within an air duct, wherein at least one acoustic noise reduction device according to one of the embodiments previously presented is arranged inside the air duct. The air flow created by the fan is split up into two paths of a different length. Consequently, interferences are introduced into the noise frequencies which reduce the perceived noise generated by the fan. The noise disturbance caused by the energy transformation system is thereby reduced.

[0021] The inventive acoustic noise reduction device makes sense for all heat pump systems having an air flow as a source or destination medium and/or for any heat pump system having a fan (for example for safety reason to avoid refrigerant stagnation if leakage). It can be a heat pump system for cooling (such as airconditioner) or for heating installation sites or both. It includes for example air source heat pump systems for heating and/or cooling application.

[0022] The inventive acoustic noise reduction device is particularly suited for heat pump systems having air as a destination or source medium and having an air duct. In particular, this invention is relevant for heat pump systems which are used as heat pump water heaters. A heat pump water heater is a device to heat domestical hot water and using at least a heat pump to heat the water. This type of device is installed indoor but most of them need air duct for air inlet and/or air outlet. This device can be included in the air duct of such product or directly in the heat pump water heater.

[0023] According to a further embodiment the housing and the air duct flush with each other. The entire circumference of the air duct can be used for fastening the housing to the same. Thus a very stable and sealed connection between the housing and the air duct can be established.

[0024] According to another embodiment the duct has an air duct cross sectional surface and the first flow path has a first flow path cross sectional surface, wherein the area ratio between the first cross sectional surface and the air duct cross sectional surface is between 0.5 and 0.8. It has been found that this ratio leads to a very efficient reduction of the perceived noise. At the same time the pressure drop of the air flow caused by the acoustic noise reduction device is still within an acceptable range because the main part of the flow, using the shortest path, is not disturbed.

[0025] In accordance with a further embodiment the air duct defines an air duct axis, wherein two or more acoustic noise reduction devices are arranged along the air duct axis. Two or more acoustic noise reduction devices may either be arranged in parallel or in series or in a combination of both. One acoustic noise reduction device may be optimized to a first frequency range while a second one may be optimized to a second frequency range. Thus, the perceived noise may be reduced along a broad frequency range.

[0026] The heat pump system comprises a heat pump. As initially discussed, heat pumps are becoming more and more popular as they may help to reduce the CO2-emissions generated for heating and/or cooling. However, the noise produced by heat pumps is not only disturbing for residents of the given house equipped with a heat pump but also for the residents of neighboring houses. The perceived noise generated by heat pumps equipped with the present acoustic noise reduction device can be significantly reduced which may lead to an increased acceptance of heat pumps. In some countries or federal states, heat pumps must be compliant with noise-emission standards which may be fulfilled with the noise reduction device according to the present invention. Otherwise, heat pumps may not legally be operated in the respective countries or federal states for certain installation site configurations.

[0027] Another aspect of the present invention is directed to the use of an acoustic noise reduction device according to one of the embodiments discussed above in or for a heat pump system. The technical effects and advantages as discussed with regard to the present device to a large extent also apply to the heat pump system.

[0028] The present invention is described in detail with reference to the drawings attached wherein

Figure 1 shows a principle sectional view through a heat pump system comprising a first acoustic noise reduction device and a second acoustic noise reduction device according to a first embodiment of the present invention,

Figure 2A is a perspective view of a second embodiment of the acoustic noise reduction device of the present invention,

Figure 2B is a top view on the acoustic noise reduction device shown in Figure 2A,

Figure 2C is a principle view of the acoustic noise reduction device shown in Figure 2A for illustrating the helix angle,

Figure 3 is a perspective view of a third embodiment of the acoustic noise reduction device of the present invention,

Figure 4 is a perspective view of a fourth embodiment of the acoustic noise reduction device of the present invention,

Figure 5 is a perspective view of a fifth embodiment of the acoustic noise reduction device of the present invention,

Figure 6 is a perspective view of a sixth embodiment of the acoustic noise reduction device of the present invention,

Figure 7 is a perspective view of a seventh embodiment of the acoustic noise reduction device of the present invention, and

Figure 8 shows a principle sectional view through a heat pump system according to a second embodiment of the present invention.

[0029] Figure 1 shows a principle sectional view through a heat pump system 10 having a fan 16 that is located inside an air duct 18 of a cylindrical shape. It should be noted that in a non-shown alternative embodiment the fan 16 may be included in the heat pump system 10 and the air duct 18 connected to the heat pump system by a channel (not shown).

[0030] The air duct 18 defines an air duct axis AD. The heat pump system 10 is equipped with first acoustic noise reduction device 121 and a second acoustic noise reduction device 121 according to a first embodiment of the present invention. However, in most cases the use of only one acoustic noise reduction device 121 may be sufficient and desirable. The first acoustic noise reduction device 121 is arranged spaced apart from the second acoustic noise reduction device 121 with reference to the air duct axis AD. Thus, the first acoustic noise reduction device 121 and the second acoustic noise reduction device 121 are arranged in series. In Figure 1 there is an axial distance between the first acoustic noise reduction device 121 and the second acoustic noise reduction device 121. The first acoustic noise reduction device 121 and the second acoustic noise reduction device 121 are arranged flush and/or coaxial with the air duct 18.

[0031] In operation, the fan 16 is creating an air flow through the air duct 18, thereby generating noise. The air flow hits the first acoustic noise reduction device 121 which has a housing 20 that provides a first flow path 22 and a second flow path 24. The housing 20 comprised an air-tight wall 26 by with the first flow path 22 is separated from the second flow path 24. The first flow path 22 defines a longitudinal axis AL which coincides with the air duct axis AD.

[0032] The second flow path 24 is annularly enclosing the first flow path 22. The first flow path 22 has a first length L1 and the second flow path 24 has a second length L2. The second length L2 is bigger than the first length L1. The radially inner part of the air flow passes through the acoustic noise reduction device 121 via the first flow path 22 while the radially outer part passed through the acoustic noise reduction device 121 via the second flow path 24. When the two parts of the air flow are merged to each other when exiting the acoustic noise reduction device 121destructive interferences are induced that reduce the perceived noise generated by the fan 16. This phenomenon is repeated when the air flow passes through the second acoustic noise reduction device 121 such that the perceived noise is further reduced. The second device could be of the same design than first, i.e. with same lengths path, or could be different with two different length paths, in orderto reduce noise on different frequencies. In other words, the acoustic noise reduction device 121 is constructed such that the exiting flows meet at the end of the respective flow path in phase opposition. When two waves in phase opposition meet, they at least partially destroy each other. The longest channel therefore has a length that is a multiple of the wavelength of the targeted frequency divided by 2.

[0033] The air duct 18 may only run between the fan 16 and the acoustic noise reduction device 121 (not shown).

[0034] In a non-shown embodiment, the heat pump system 10 can comprise merely one acoustic noise reduction device 121. In embodiments, in which the heat pump system 10 comprises more than one acoustic noise reduction device 121, the acoustic noise reduction devices 121 can be identical to each other. Alternatively, the acoustic noise reduction devices 121 could differ in the lengths of the flow paths from each other to reduce noise on different frequencies.

[0035] It has been found that a difference between the first length L1 and the second length L2 that is a multiple of $\lambda/2$ results in an efficient reduction of the perceived noise. λ is the wavelength of the frequency of the noise that should be reduced, or the speed of sound divided by the frequency of the noise that should be reduced.

[0036] The air duct 18 has an air duct cross sectional surface SD and the first flow path 22 has a first flow path cross sectional surface S1. Based on acoustic principles, the best efficiency of the reduction of the perceived noise can be obtained when the area ratio between the first flow path cross sectional surface S1 and the air duct cross sectional surface SD is 0,5. However, when considering pressure drops, disturbances and obstacles along the helical course, an area ratio between 0.5 and 0.8 has been found to be advantageous. This area ratio influences the volumetric ratio between the part of the air flow flowing through the second flow path 24 and the part of the air flow flowing through the first flow path 22. It has been found that an efficient reduction of the perceived noise can also be obtained when the volumetric ratio is between 0.6 and 0.7.

[0037] Figures 2A and 2B show a second embodiment of an acoustic noise reduction device 122 according to the present invention. The air-tight wall 26 has the shape of a cylindrical tube 28 such that the first flow path 22 also has the shape of a cylindrical tube 28. However, it may be possible that the air-tight separation wall has the shape of a truncated cone, of a polyhedron, of a truncated polyhedron or an ellipsoidlike, paraboloid-like or similar shape.

[0038] In total six second flow paths 24 run along a helical course 30 like a multi thread screw, thereby defining a helix axis AH. The helix axis AH coincides with the longitudinal axis AL.

[0039] In Figure 2C one second flow path 24 is principally shown in a flat projection not true to scale. The flat projection reveals that the second flow path 24 is inclined by a helix angle θ with respect to the longitudinal axis AL. Helix angles θ between 5° and 20° were found to be a good compromise which on the one hand lead to an effective reduction of the perceived noise but on the other hand still to a compact design of the acoustic noise reduction device 122..

[0040] Figure 3 is a perspective view of a third embodiment of the acoustic noise reduction device 123 of the present invention. The principle design of the acoustic noise reduction device 123 according to the third embodiment is the same as the one of the acoustic noise reduction device 122 of the second embodiment. However, the acoustic noise reduction device 123 according to the third embodiment only comprises one second flow path 24 that runs along a helical course 30.

[0041] In Figure 4 a fourth embodiment of the acoustic noise reduction device 124 according to the present invention is shown. The principle design of the acoustic noise reduction device 124 according to the fourth embodiment is the same as the one of the acoustic noise reduction device 122 of the second embodiment. However, the housing 20 forms a further air-tight wall 26 that is arranged radially outwardly such that the acoustic noise reduction device 124 of the fourth embodiment comprises two first flow paths 22, namely a central, cylindrically shaped first flow path 22 and an annular first flow path 22 enclosing the six second flow paths 24. The longitudinal axis AL of the central first flow path 22 and the annular first flow path 22 coincide. Also the helix axes AH of the second flow paths 24 coincide with the longitudinal axis AL such that the first flow paths 22 and the second flow paths 24 of the acoustic noise reduction device 124 according to the fourth embodiment are concentrically arranged.

[0042] In Figure 5 a fifth embodiment of the acoustic noise reduction device 125 according to the present invention is shown which comprises one second flow path 24 running along a helical course 30 and one annular first flow path 22 enclosing the second flow path 24. The longitudinal axis AL of the first flow path 22 and the helix axis AH of the second flow path 24 coincide with each other.

[0043] In Figure 6 a sixth embodiment of the acoustic noise reduction device 126 according to the present invention is illustrated. The basic design of the acoustic noise reduction device 126 according to the sixth embodiment is the same as the one of the acoustic noise reduction device 125 of the fifth embodiment. However, the helix axis AH runs parallel to the longitudinal axis AL but displaced therefrom. Thus, the second flow path 24 runs eccentrically regarding the first flow path 22. The air-tight wall 26 that separates the first flow path 22 from the second flow path 24 is touching the further air-tight wall

26 that encloses the first flow path 22. It should be noted that the housing 20 is also air-tight. This is also true for the other embodiments shown in fig. 1 to 5.

[0044] In Figure 7 a seventh embodiment of the acoustic noise reduction device 127 according to the present invention is illustrated. The first flow path 22 has an elliptical cross section and the shape of an elliptical cylinder. The acoustic noise reduction device 127 according to the seventh embodiment comprises two second flow paths 24. Each of the second flow paths 24 are separated by its own air-tight wall 26 from the first flow path 22. The helical axes AH of the second flow paths 24 are laterally displaced. The direction of rotation of the helical courses 30 is opposite. The second length L2 of the two second flow paths 24 is the same, however, could also be different.

[0045] In particular by the choice of the first length L1, the second length L2, the helix angle θ, the number of the first flow paths 22 and second flow paths 24 and the size of the air duct cross sectional surface SD and the first flow path cross sectional surface S1 the perceived noise of certain frequencies can be reduced.

[0046] Figure 8 shows a principle sectional view through a heat pump system 10 according to a second embodiment. Said heat pump system 10 differs from the heat pump system 10 shown in figure 1 in that the heat pump system 10 comprises merely one acoustic noise reduction device 121. As the embodiment has only one fan, the acoustic noise, i.e. the frequency, is mainly determined by the fan 16, in particular by the fan rotation speed and the number of blades. The acoustic noise reduction device 121 is configured to reduce said acoustic noise generated by the fan.

Reference list

[0047]

10	heat pump system
121 - 127	acoustic noise reduction device
16	fan
18	air duct
20	housing
22	first flow path
24	second flow path
26	air-tight wall
28	cylindrical tube
30	helical course

AD	air duct axis
AH	helix axis
AL	longitudinal axis
L1	first length
L2	second length
SD	air duct cross sectional surface
S1	first flow path cross sectional surface

θ helix angle

Claims

1. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) for reducing the radiation of noise generated by a fan (16) of a heat pump system (10), wherein the fan (16) is creating an air flow and the acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) comprises

- a housing (20) that provides at least one first flow path (22) for the air flow through the acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) and at least one second flow path (24) for the air flow through the acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127),
- the first flow path (22) and the second flow path (24) are fluidically separated from each other, wherein
- the first flow path (22) has a first length (L1) and the second flow path (24) has a second length (L2), the first length (L1) being different from the second length (L2).

2. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the claims 1, **characterized in that** the fluidical separation of the first flow path (22) from the second flow path (24) is provided by an air-tight wall (26).

3. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the claims 1 or 2, **characterized in that** the difference between the first length (L1) and the second length (L2) is function of $\lambda/2$, in particular equals $\lambda/2$..

4. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the preceding claims, **characterized in that** the volumetric ratio of the air flow flowing through the shorter flow path (L1) compared to the cumulative flow flowing through the shorter and longer flow path (L1 +L2) is between 0.5 and 0.8, in particular between 0.6 and 0.7.

5. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the preceding claims, **characterized in that** the first flow path (L1) is formed by a cylindrical tube (28).

6. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the preceding claims, **characterized in that** the second flow path (24) runs along a helical course (30).

7. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to claim 6, **characterized in that** the first flow path (22) defines a longitudinal axis (AL) and the helix axis (AH) of the helical course (30) runs parallel to the longitudinal axis (AL) or coincides with the longitudinal axis (AL).

8. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the claims 6 or 7, **characterized in that** a plurality of second flow paths (20) run along a helical course (30).

9. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the claims 6 to 8, **characterized in that** the helical course (30) forms a helix angle (θ) which is between 5° and 20° with reference to the helix axis (AH).

10. Acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the preceding claims, **characterized in that** the acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) is made of plastic.

11. Heat pump system (10) for heating and cooling, comprising a fan (16) for creating an air flow, the fan (16) being arranged within an air duct (18) or cooperating with the air duct (18), **characterized in that** at least one acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the preceding claims is arranged inside the air duct (18).

12. Heat pump system (10) according to claim 11, **characterized in that**

a. the housing (20) and the air duct (18) are arranged coaxially to each other and/or **in that**
b. the longitudinal axis (AL) and/or the helix axis run parallel or is coaxial to the air duct axis (AD)..

13. Heat pump system (10) according to one of the claims 11 or 12, **characterized in that** the air duct (18) has an air duct cross sectional surface (30) and the first flow path (22) has a first flow path cross sectional surface (32), wherein the area ratio between the first flow path cross sectional surface (32) and the air duct cross sectional surface (30) is between 0.5 and 0.8.

14. Heat pump system (10) according to one of the claims 11 to 13, **characterized in that** the air duct (18) defines an air duct axis (AD), wherein two or more acoustic noise reduction devices (121, 122, 123, 123, 124, 125, 126, 127) are arranged along the air duct axis (AD) and/or **in that** the heat pump system (10) comprises a heat pump (14).

15. Use of an acoustic noise reduction device (121, 122, 123, 123, 124, 125, 126, 127) according to one of the claims 1 to 10 in or for an heat pump system (10), in particular for a heat pump water heater.

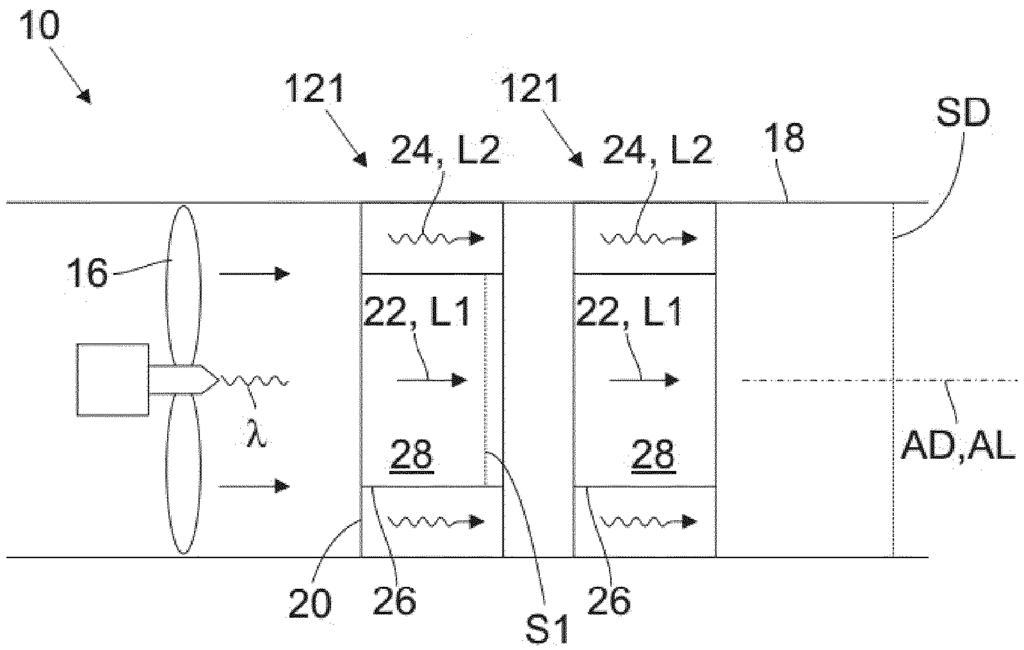


Fig.1

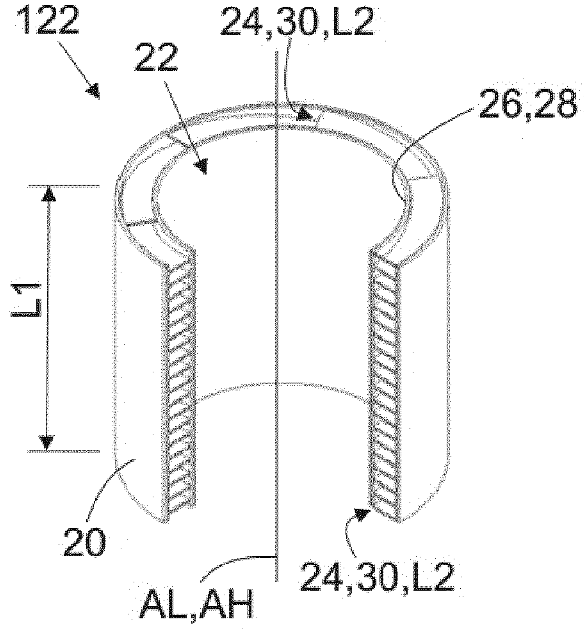


Fig.2A

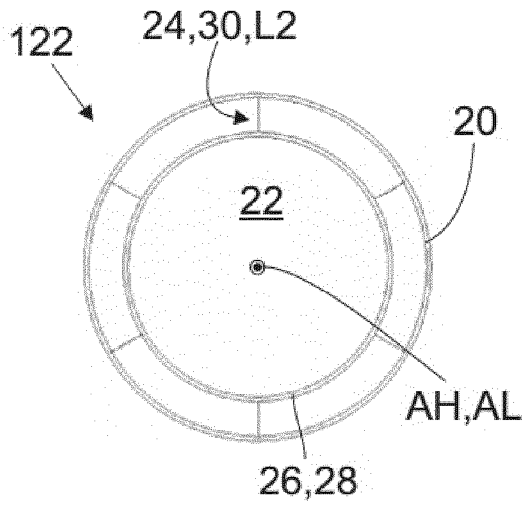


Fig.2B

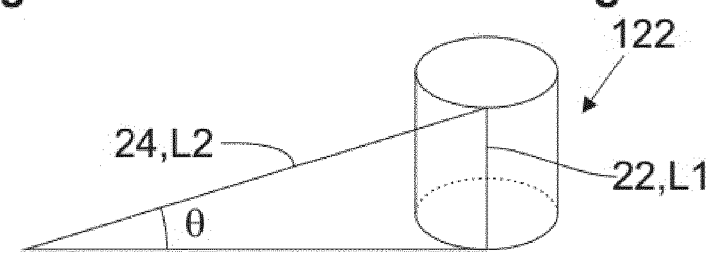


Fig.2C

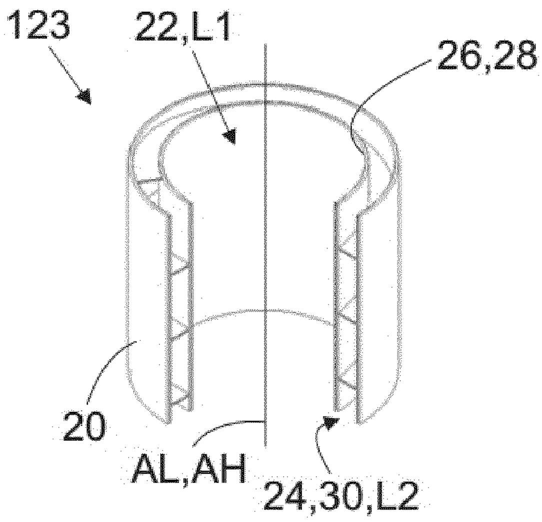


Fig.3

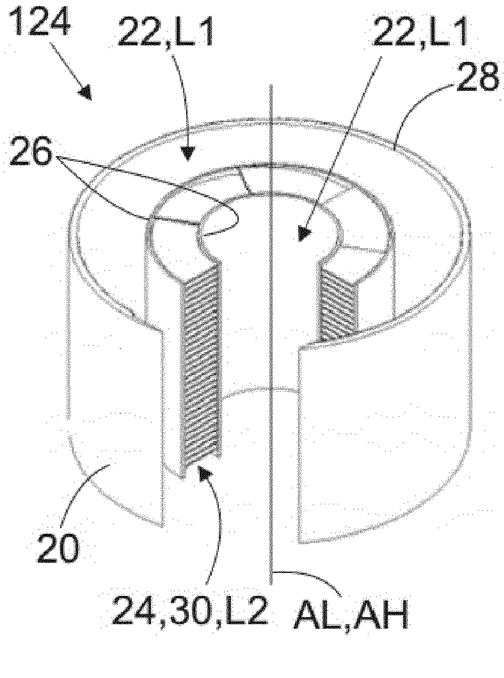


Fig.4

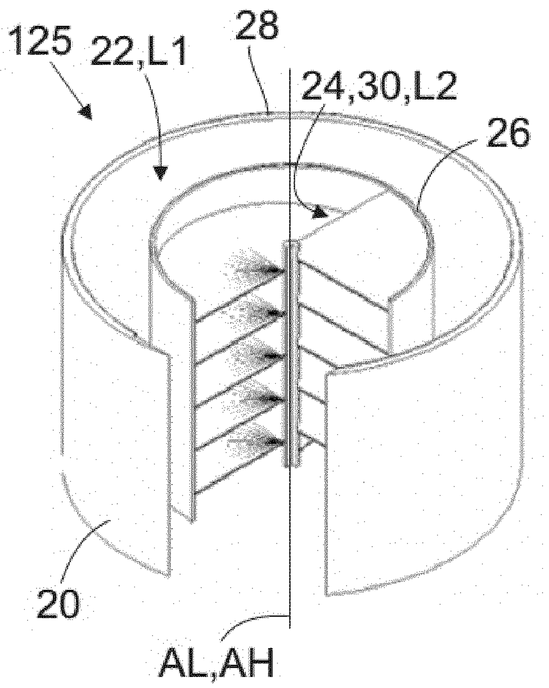


Fig.5

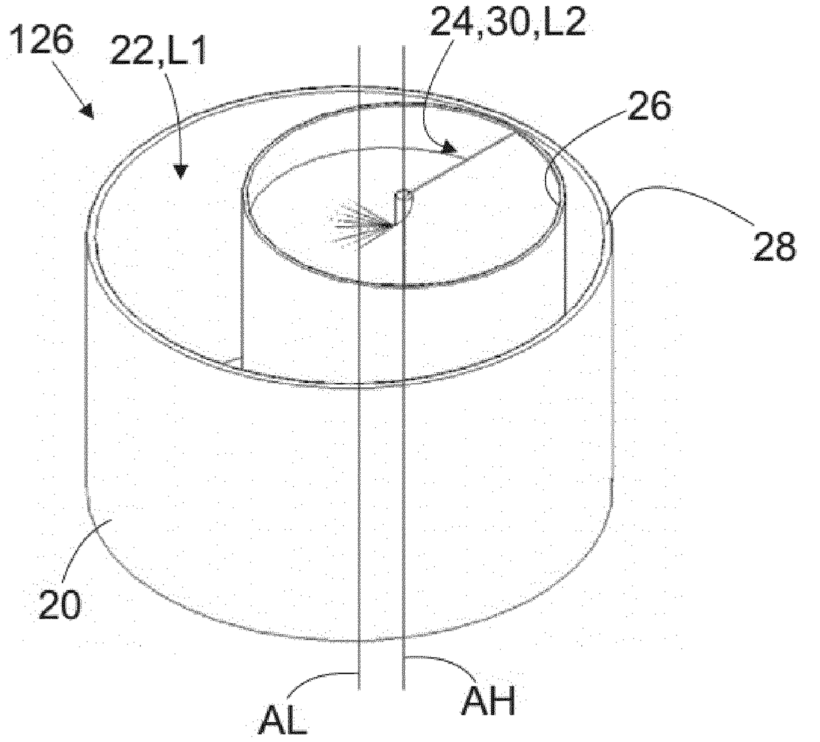
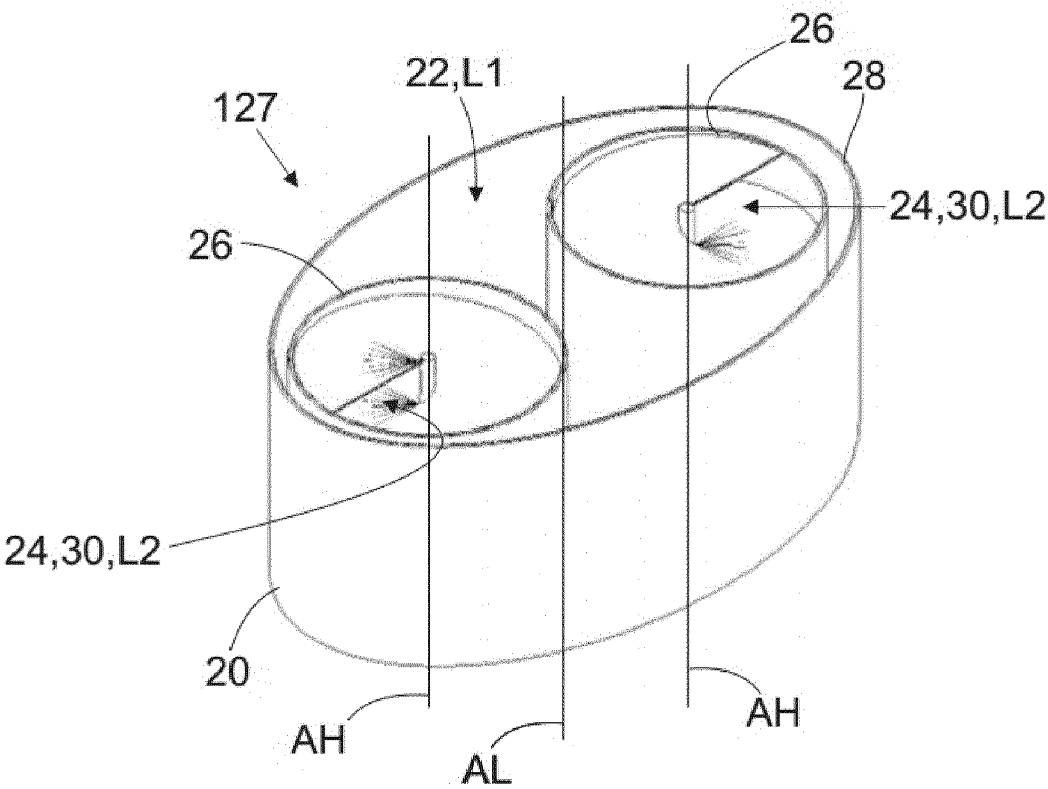

126
22,L1
24,30,L2
26
28
20
AL
AH

Fig.6


26
28
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127
24,30,L2
26
24,30,L2
20
AH
AL
AH

Fig.7

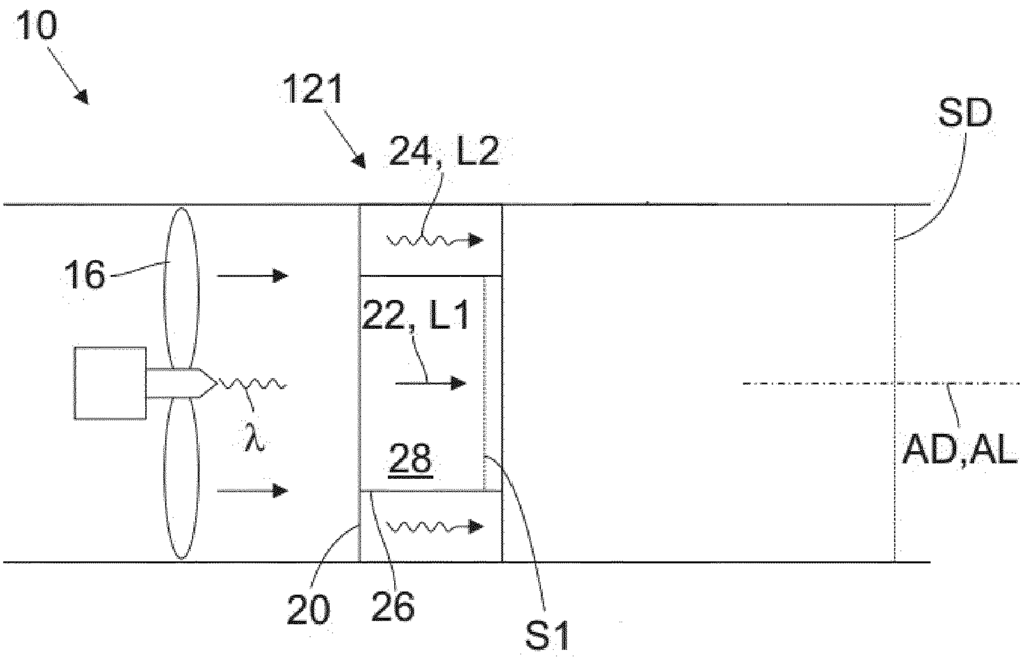

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 5676

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2022/120469 A1 (DOAT BERTRAND [FR] ET AL) 21 April 2022 (2022-04-21) * paragraphs [0006] - [0008], [0037] - [0045] * * figures 1-4 *	1-10 11-15	INV. F04D19/00 F04D29/54 F04D29/66
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B60H
F04D
F24F
F25B

1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 March 2024	De Tobel, David

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13-03-2024

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

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