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(54)

A SILENCER

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A silencer for reducing airflow noise, comprising:
a first pipe segment having a first section with a first internal dimension and a second section with a second internal dimension, wherein the first internal dimension is larger than the second internal dimension; a second pipe segment having a first section with a third internal dimension and a second section with a fourth internal dimension, wherein the third internal dimension is larger than the fourth internal dimension; wherein the first internal dimension and the third internal dimension are configured such that one of the first section of the first pipe segment and the first section of the second pipe segment tightly fits into the other one of the first section of the first pipe segment and the first section of the second pipe segment; wherein the first section of the first pipe segment is configured to connect to the first section of the second pipe segment to form a sealed air passage; and wherein the first section of the first pipe segment and the first section of the second pipe segment are arranged such that the internal space of the first section of the first pipe segment and the first section of the second pipe segment has a substantially uniform internal dimension and is free from any components obstructing airflow.

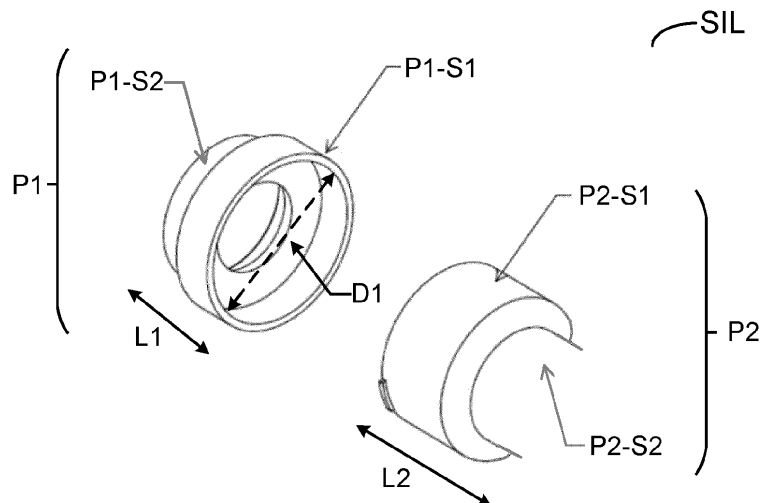


Fig. 1A

Description

FIELD OF THE INVENTION

[0001] The present invention generally relates to a silencer for reducing airflow noise, and in particular a silencer used to reduce airflow noise in a gas boiler.

Background to the Invention

[0002] Domestic gas boilers, including non-condensing gas boilers and more energy efficient condensing gas boilers, rely on the process of combustion to heat water so as to provide central heating and hot water for homes. In a domestic gas boiler, fuel (e.g., natural gas) is burned to produce hot gases which subsequently pass through a heat exchanger where much of their heat is transferred to water, thus raising the water's temperature. To facilitate the combustion process, fuel is often premixed with air to form a gas/air mixture which is then fed into a burner for combustion. Surrounding air is normally sucked into a fuel mixer of the boiler by a fan. Airflow noise is produced when air enters into the fuel mixer via an air pipe and flows therein. Such airflow noise corresponds to acoustic waves in the frequency range of e.g., 500 hertz (Hz) to 2000 Hz and the noise volume can be perceived as disturbingly loud in particular due to acoustic resonances formed in the air pipe in combination with resonances generated in other parts of the system, such as for example the mixer, burner and fan. The perceived noise level depends on many factors, such as the dimensions of each of the parts or components of the system in which airflow noise is produced, the flow rate of the air or gas/air mixture within each of those parts or components of the system, etc., and as such it can vary from system to system or from configuration to configuration.

[0003] Existing industrial silencers (or noise reduction devices) that are suitable for reducing airflow noise in gas boilers obtain acoustic attenuation through acoustic absorption and/or acoustic scattering. Absorptive silencers use fibrous and porous materials (e.g., cotton) to absorb sound waves so as to dampen the noise volume. The sound energy is at least partially transformed into heat energy which is then dispersed throughout the atmosphere. Whereas, scattering silencers (also known as reactive silencers) comprise multiple chambers and perforated structures (e.g., perforated tubes, or perforated plates). These perforations are designed to redirect sound waves away from their original path (e.g., reflect them back to the source of the sound), effectively reducing the volume of the noise. Existing silencers are bulky and complex and are not flexible and convenient to install, particularly in the case of wall-hung boilers where space around the air inlet is usually limited. Moreover, sound-absorbing materials and/or sound-scattering structures used in existing silencers impose a restriction in the airflow, thereby limiting the maximum airflow rate.

[0004] Objects and aspects of the present claimed in-

vention seek to alleviate at least these problems with the prior art.

Summary of the Invention

[0005] According to a first aspect of the present invention, there is provided a silencer for reducing airflow noise, comprising: a first pipe segment having a first section with a first internal dimension and a second section with a second internal dimension, wherein the first internal dimension is larger than the second internal dimension; a second pipe segment having a first section with a third internal dimension and a second section with a fourth internal dimension, wherein the third internal dimension is larger than the fourth internal dimension; wherein the first internal dimension and the third internal dimension are configured such that one of the first section of the first pipe segment and the first section of the second pipe segment tightly fits into the other one of the first section of the first pipe segment and the first section of the second pipe segment; wherein the first section of the first pipe segment is configured to connect to the first section of the second pipe segment to form a sealed air passage; and wherein the first section of the first pipe segment and the first section of the second pipe segment are arranged such that the internal space of the first section of the first pipe segment and the first section of the second pipe segment has a substantially uniform internal dimension and is free from any components obstructing airflow.

[0006] According to a second aspect of the present invention, there is provided a kit for assembling into one or more silencers according to the first aspect comprising: a plurality of the first pipe segment with one or more different dimensions; and a plurality of the second pipe segment with one or more different dimensions.

[0007] According to a third aspect of the present invention, there is provided a gas boiler comprising: a venturi mixer for mixing fuel and air; and a silencer according to the first aspect for reducing airflow noise in the venturi mixer.

Brief Description of the Drawings

[0008] Embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1A depicts schematically a perspective view of a silencer in accordance with an embodiment;

Figure 1B depicts schematically a side view of the silencer in accordance with an embodiment; and

Figure 2 depicts schematically an example wall-hung boiler in which the proposed silencer (circled) is connected to the air pipe of the venturi mixer to reduce airflow noise produced therein.

Detailed Description of the Embodiments

[0009] Figures 1A, 1B and 2 are associated with embodiments of the silencer SIL, which may comprise a first pipe segment P1 and a second pipe segment P2. The first pipe segment P1 may comprise a first section P1-S1 with a first internal dimension D1 and a second section P1-S2 with a second internal dimension D2. The first internal dimension D1 of the first section P1-S1 of the first pipe segment P1 is larger than the second internal dimension D2 of the second section P1-S2 of the first pipe segment P1. The second pipe segment P2 may comprise a first section P2-S1 with a third internal dimension D3 and a second section P2-S2 with a fourth internal dimension D4. The third internal dimension D3 is larger than the fourth internal dimension D4. The first internal dimension D1 and the third internal dimension D3 are configured such that one of the first section P1-S1 of the first pipe segment P1 and the first section P2-S1 of the second pipe segment P2 fits tightly into the other of the first section P1-S1 of the first pipe segment P1 and the first section P2-S1 of the second pipe segment.

[0010] The type of the internal dimension may depend on the internal cross-section of the first pipe segment P1 and the second pipe segment P2. In the case where the internal cross-section of the first pipe segment P1 and the second pipe segment P2 is substantially circular, the internal dimension may correspond to the internal diameter of the pipe segments. Whereas, in the case where the internal cross-section of the first pipe segment P1 and the second pipe segment P2 is non-circular (e.g., elliptical or polygonal such as square or rectangular), the internal dimension may correspond to the biggest distance between the opposing points of the cross section, or as the case may be, an average distance between the opposing points of the cross-section. For example, the internal dimension of a square or rectangular cross-section may correspond to the diagonal of the cross-section. The internal dimension of an elliptical cross-section may correspond to the average of the diameter along the major axis and the diameter along the minor axis of the cross-section.

[0011] With reference to Figure 1A and Figure 1B, in an embodiment, the first pipe segment P1 and the second pipe segment P2 of the silencer SIL may each comprise a substantially circular cross-section. The first internal dimension D1, the second internal dimension D2, the third internal dimension D3 and the fourth internal dimension D4 may correspond respectively a first internal diameter D1, a second internal diameter D2, a third internal diameter D3 and a fourth internal diameter D4.

[0012] In an embodiment, the fourth internal diameter D4 may be equal to the second internal diameter D2.

[0013] In an embodiment, the fourth internal diameter D4 may be different from the second internal diameter D2. Allowing the possibility to select components with the internal diameters D2 and D4 being different from each other improves the installation flexibility of the si-

lencer SIL. For example, the silencer SIL may be connected to an air pipe at each end of the silencer, i.e. a first pipe (not shown) may connect to the second section P1-S2 of the first pipe segment P1 and a second pipe (not shown) may connect to the second section P2-S2 of the second pipe segment P2, respectively. The first pipe P1 and the second pipe P2 may be provided with different internal diameters. The second internal diameter D2 and the fourth internal diameter D4 of the silencer SIL may therefore be arranged to match the internal diameters of the first and the second air pipe, respectively. The difference between the second internal diameter D2 and the fourth internal diameter D4 may be chosen based on the difference between the diameters of the first pipe and the second pipe, respectively. This difference may be for example at least 10%, at least 20%, at least 40%, at least 50%, at least 60%, or at least 80%.

[0014] The first internal diameter D1 may be for example between 20 millimetre (mm) and 100 mm, between 20 mm and 90 mm, between 20 mm and 80 mm, between 30 mm and 70 mm, between 30 mm and 60 mm, between 40 mm and 60 mm, or between 40 mm and 50 mm. The second internal diameter D2 may be for example between 10 mm and 80 mm, between 10 mm and 60 mm, between 20 mm and 50 mm, between 20 mm and 40 mm, or between 20 mm and 30 mm. The third internal diameter D3 may be for example between 20 millimetre (mm) and 100 mm, between 20 mm and 90 mm, between 20 mm and 80 mm, between 30 mm and 70 mm, between 30 mm and 60 mm, between 40 mm and 60 mm, or between 40 mm and 50 mm. The fourth internal diameter D4 may be for example between 10 mm and 80 mm, between 10 mm and 60 mm, between 20 mm and 50 mm, between 20 mm and 40 mm, or between 20 mm and 30 mm.

[0015] Referring back to Figure 1B, in an embodiment, the first section P1-S1 of the first pipe segment P1 may be configured to connect to the first section P1-S2 of the second pipe segment P2 to form a sealed air passage (not shown). When the first section P1-S1 of the first pipe segment P1 is connected to the first section P1-S2 of the second pipe segment P2, the first section P1-S1 of the first pipe segment P1 and the first section P1-S2 of the second pipe segment P2 may be arranged such that the internal space formed by the first section P1-S1 of the first pipe segment P1 and the first section P1-S2 of the second pipe segment P2 has a substantially uniform internal dimension (e.g., D1 and D3 are substantially equal to each other) and is free from any components obstructing airflow. In other words, when the first section P1-S1 of the first pipe segment P1 is connected to the first section P1-S2 of the second pipe segment P2, a hollow chamber is created between the first section P1-S1 of the first pipe segment P1 and the first section P1-S2 of the second pipe segment P2.

[0016] In an embodiment, the second pipe segment P2 may comprise a first section P2-S1, which has an internal dimension D3 chosen such that the first pipe seg-

ment P1 tightly fits into or around the first section P2-S1 of the second pipe segment P2 and the segments P1, P2 can be assembled and held together by friction between the corresponding portions of the pipe segments P1, P2. In an embodiment, the first pipe segment P1 and/or the second pipe segment P2 may comprise additional features (not shown) (e.g., a snap-fit connection interface, a clamp, a clip, etc.) allowing the first and second pipe segments P1, P2 to be assembled together.

[0017] The full length L of the silencer SIL may be chosen based on various considerations (further discussed below). The length L may be for example between 20 mm and 100 mm, between 20 mm and 80 mm, between 20 mm and 60 mm, between 20 mm and 40 mm, or between 20 mm and 30 mm. In an embodiment, the length L1 of the first pipe segment P1 may be equal to the length L2 of the second pipe segment P2. In an embodiment, the length L1 of the first pipe segment P1 may be different from the length L2 of the second pipe segment P2. The length L1 or L2 may be for example between 10 mm and 50 mm, between 10 mm and 40 mm, between 10 mm and 30 mm, between 10 mm and 20 mm, or between 10 mm and 15 mm.

[0018] In an embodiment, the dimensions of the silencer SIL (e.g., internal diameters D1, D2, D3 and D4, and lengths L1, L2 and L) may be determined based on the effectiveness of noise reduction or acoustic attenuation. The dimensions of the silencer SIL may be directly associated with the acoustic resonances of the acoustic waves excited by the air flow travelling through the sealed internal air passage of the silencer SIL. Therefore, if the frequency range of the acoustic noise (e.g., airflow noise) is known (e.g., through measurement), the dimensions of the silencer SIL may be determined such that the attenuation of the acoustic noise is increased, maximised or even eliminated.

[0019] By way of example, to effectively attenuate airflow noise in the acoustic frequency range between 500 Hz and 2000 Hz, the silencer SIL may be designed in such a way that the first internal diameter D1 is between 40 mm and 50 mm, the second internal diameter D2 is between 20 mm and 30 mm, the third internal diameter D3 is between 40 mm and 50 mm, the fourth internal diameter D4 is between 20 mm and 30 mm, and the full length of the silencer SIL is between 20 mm and 30 mm with the first pipe segment P1 and the second pipe segment P2 having an equal length. The internal space or the hollow chamber of the assembled silencer SIL, which is formed by the first section P1-S1 of the first pipe segment P1 and the first section P1-S2 of the second pipe segment P2, has a substantially uniform internal diameter equal to the first internal diameter D1. Such a silencer may be able to provide a sufficient noise attenuation so as to substantially suppress the airflow noise.

[0020] In an embodiment, the silencer SIL may be made of plastic (e.g., nylon, polythene).

[0021] In an embodiment, the silencer SIL may be manufactured by moulding (e.g., injection moulding).

[0022] A silencer kit may be provided for assembling into one or more silencers SIL. In an embodiment, the silencer kit may comprise a plurality of the first pipe segments (P1) with one or more different dimensions (e.g., the same first internal diameters (D1) but different second internal diameters (D2)); and a plurality of the second pipe segment (P2) with one or more different dimensions (e.g., the same third internal diameters (D3) but different fourth internal diameters (D4)).

[0023] In some cases, a user may select a desired pair of the first pipe segment (P1) and the second pipe segment (P2) from the silencer kit according to the sizes of the existing air pipes to which the silencer (SIL) is to be connected. Then, the user may assemble the two selected pipe segments (P1 and P2) into a silencer (SIL). Finally, the user may connect the assembled silencer (SIL) to the air pipes to reduce airflow noise.

[0024] In other cases, a user may select a desired pair of the first pipe segment (P1) and the second pipe segment (P2) from the silencer kit according to the noise frequencies to be attenuated. Then, the user may assemble the two selected pipe segments (P1 and P2) into a silencer (SIL). Finally, the user may connect the assembled silencer (SIL) to the air pipes (the sizes of which are adaptable to the silencer (SIL)) to reduce airflow noise.

[0025] The inventors have found that the above embodiments of the silencer SIL can significantly reduce or suppress airflow noise in domestic gas boilers. With reference to Figure 2, the example gas boiler is a wall-hung condensed gas boiler commonly used in homes. The example gas boiler comprises a venturi mixer VEN where fuel GS (e.g., natural gas) and air AR are premixed to form a gas/air mixture MG, a premix gas blower PGB which directs the gas/air mixture MG from the venturi mixer VEN to a burning unit BU where combustion of the gas/air mixture MG takes place, and a heat exchanging unit HEX where heat generated from the combustion is transferred to water. The water enters into the heat exchanging unit HEX through a cold water hose CWH and exits via a hot water hose HWH. The venturi mixer VEN comprises a short air pipe AP through which ambient air is sucked (by the premix gas blower PGB) into the venturi mixer VEN, and a short gas pipe GP through which fuel (e.g., natural gas) is fed into the venturi mixer VEN.

[0026] High volume airflow noise is produced while the air flows through the air pipe AP and an internal channel of the venturi mixer VEN. The inventors have found that the airflow noise which covers the acoustic frequency range between 500 Hz and 2000 Hz can be effectively dampened or attenuated if the proposed silencer (e.g., as shown in Figure 1A and Figure 1B) is connected to the air pipe AP of the venturi mixer VEN. As shown in Figure 2, one end of the silencer SIL (e.g., the second section P2-S2 of the second pipe segment P2) may be connected to the air pipe AP of the venturi mixer VEN of the gas boiler. And optionally, the other end of the silencer SIL (e.g., the second section P1-S2 of the first pipe seg-

ment P1) may be connected to another air pipe (not shown).

[0027] As described above, the internal diameters of the second sections P1-S2 or P2-S2 of the first pipe segment P1 and the second pipe segment P2 can be chosen in accordance with the diameters of the air pipes of the gas boiler.

[0028] It should be appreciated that the embodiments described above can be used in many other applications where attenuation of airflow noise is desirable. Note that, the above description is for illustration only and other embodiments and variations may be envisaged without departing from the scope of the invention.

Claims

1. A silencer (SIL) for reducing airflow noise, comprising:

a first pipe segment (P1) having a first section (P1-S1) with a first internal dimension (D1) and a second section (P1-S2) with a second internal dimension (D2), wherein the first internal dimension (D1) is larger than the second internal dimension (D2);

a second pipe segment (P2) having a first section (P2-S1) with a third internal dimension (D3) and a second section (P2-S2) with a fourth internal dimension (D4), wherein the third internal dimension (D3) is larger than the fourth internal dimension (D4);

wherein the first internal dimension (D1) and the third internal dimension (D3) are configured such that one of the first section (P1-S1) of the first pipe segment (P1) and the first section (P2-S1) of the second pipe segment (P2) tightly fits into the other one of the first section (P1-S1) of the first pipe segment (P1) and the first section (P2-S1) of the second pipe segment (P2); wherein the first section of the first pipe segment is configured to connect to the first section of the second pipe segment to form a sealed air passage; and

wherein the first section of the first pipe segment and the first section of the second pipe segment are arranged such that the internal space of the first section of the first pipe segment and the first section of the second pipe segment has a substantially uniform internal dimension and is free from any components obstructing airflow.

2. A silencer as claimed in claim 1, wherein the first pipe segment (P1) and the second pipe segment (P2) each comprise a substantially circular cross-section, and wherein the first internal dimension (D1), the second internal dimension (D2), the third internal dimension (D3) and the fourth internal di-

mension (D4) correspond respectively to a first internal diameter (D1), a second internal diameter (D2), a third internal diameter (D3) and a fourth internal diameter (D4).

3. A silencer as claimed in claim 1 or 2, wherein the second internal dimension (D2) is equal to the fourth internal dimension (D4).
4. A silencer as claimed in claim 1 or 2, wherein the second internal dimension (D2) is different from the fourth internal dimension (D4) by at least 10%.
5. A silencer as claimed in any preceding claim, wherein the first internal dimension (D1) is between 20 millimetre (mm) and 100 mm.
6. A silencer as claimed in any preceding claim, wherein the first internal dimension (D1) is between 40 millimetre (mm) and 50 mm.
7. A silencer as claimed in any preceding claim, wherein each of the second internal dimension (D2) and the fourth internal dimension (D4) is between 10 mm and 80 mm.
8. A silencer as claimed in any preceding claim, wherein each of the second internal dimension (D2) and the fourth internal dimension (D4) is between 20 mm and 30 mm.
9. A silencer as claimed in any preceding claim, having a full length of between 20 mm and 100 mm.
10. A silencer as claimed in any preceding claim, wherein the length of the first pipe segment (P1) is equal to the length of the second pipe segment (P2).
11. A silencer as claimed in any preceding claim, wherein the first pipe segment (P1) and the second pipe segment (P2) are made of one or more plastics.
12. A silencer as claimed in claim 11, wherein the first pipe segment (P1) and the second pipe segment (P2) are made of Nylon.
13. A kit for assembling into one or more silencers as claimed in any preceding claim, comprising:
 - a plurality of the first pipe segment (P1) with one or more different dimensions; and
 - a plurality of the second pipe segment (P2) with one or more different dimensions.
14. A gas boiler, comprising:
 - a venturi mixer for mixing fuel and air; and
 - a silencer as claimed in any of claims 1 to 12 for

reducing airflow noise in the venturi mixer.

15. A gas boiler as claimed in claim 14 is a wall-hung condensed gas boiler.

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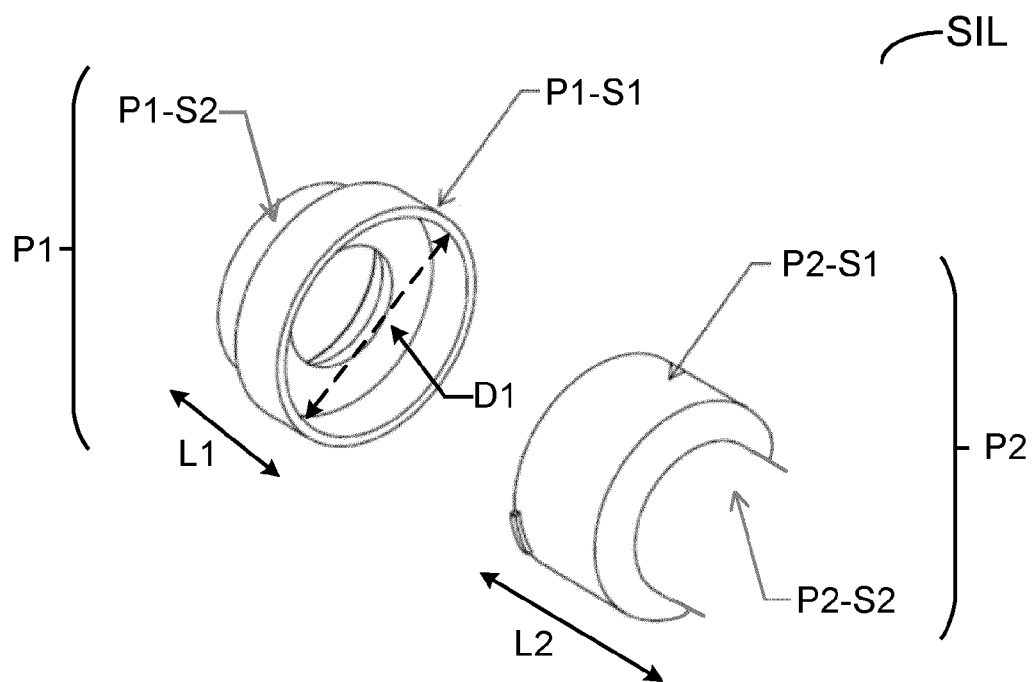


Fig. 1A

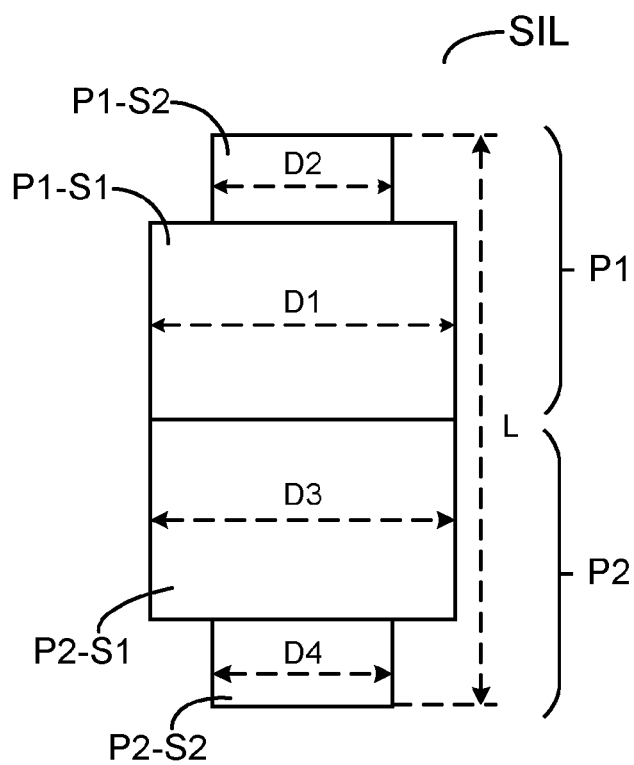


Fig. 1B

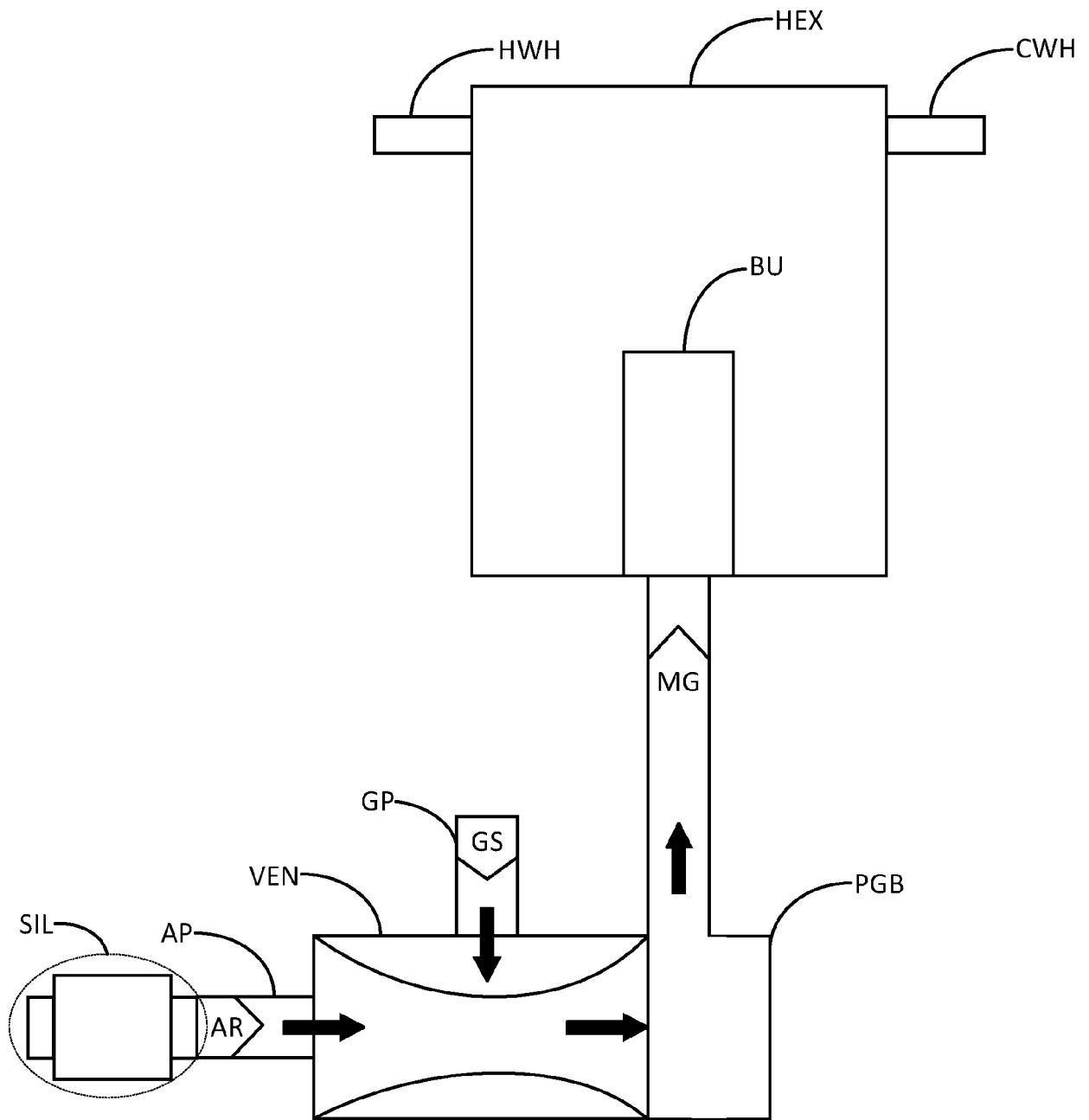


Fig. 2



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 9227

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
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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
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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
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