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(54) **SILENCER**

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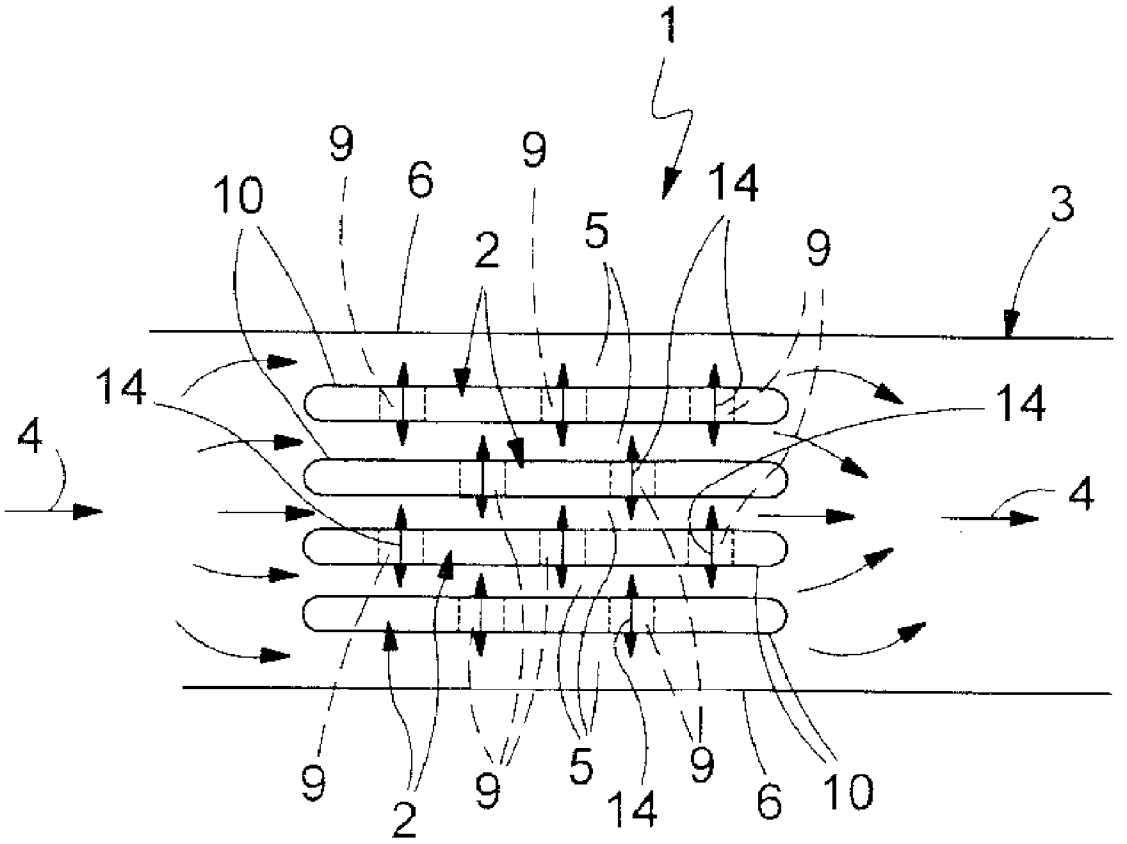
(57) **ABSTRACT**

In a silencer (**1**) for a flow passage (**2**) of a turbomachine, in particular of a power plant, a plurality of walls (**2**) are arranged in the flow passage (**3**), extend parallel to a gas flow (**4**) directed in the flow passage (**3**), and are spaced apart transversely to the direction of the gas flow (**4**). The walls (**2**) are designed so as to absorb airborne noise. In order to reduce the vibration tendency of the walls (**2**), at least one of these walls (**2**) is provided with at least one connecting passage (**9**) which passes completely through the wall (**2**) transversely to the direction of flow.



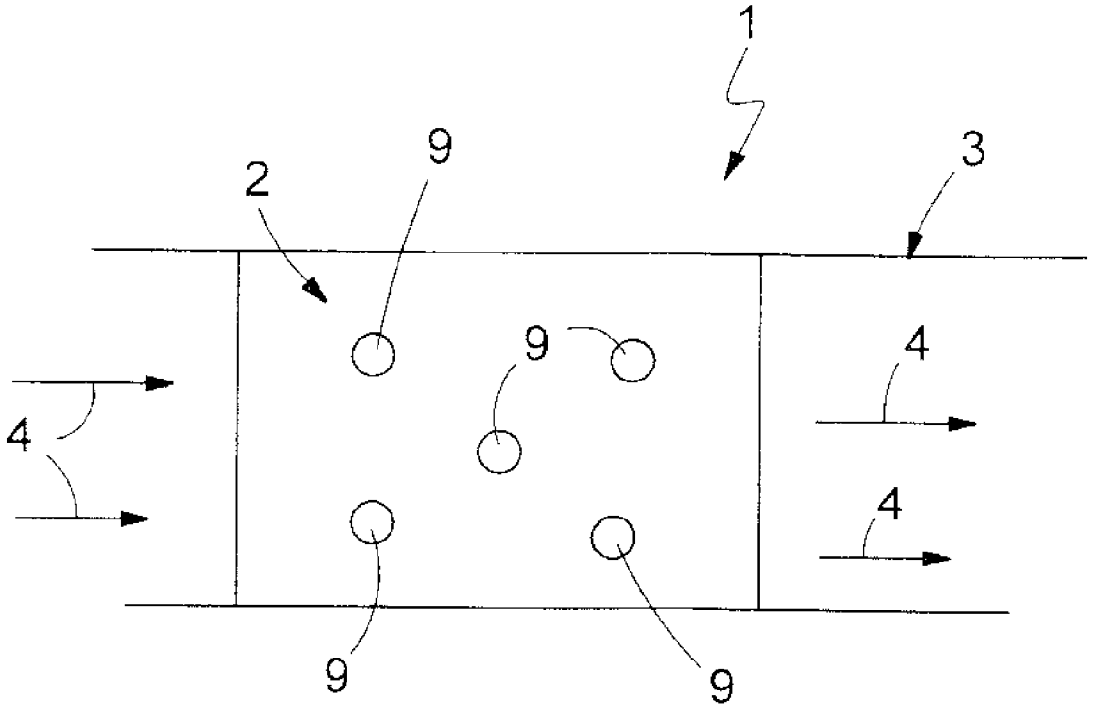


Fig.1

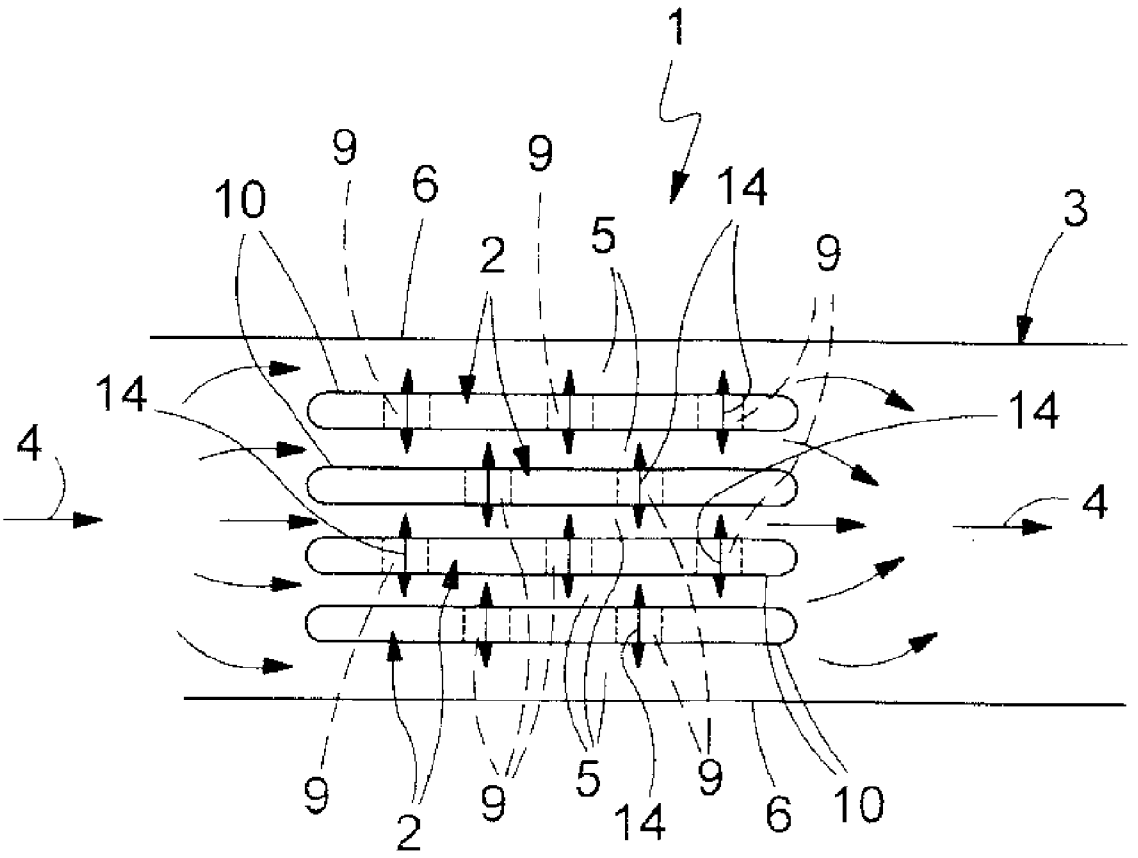


Fig.2

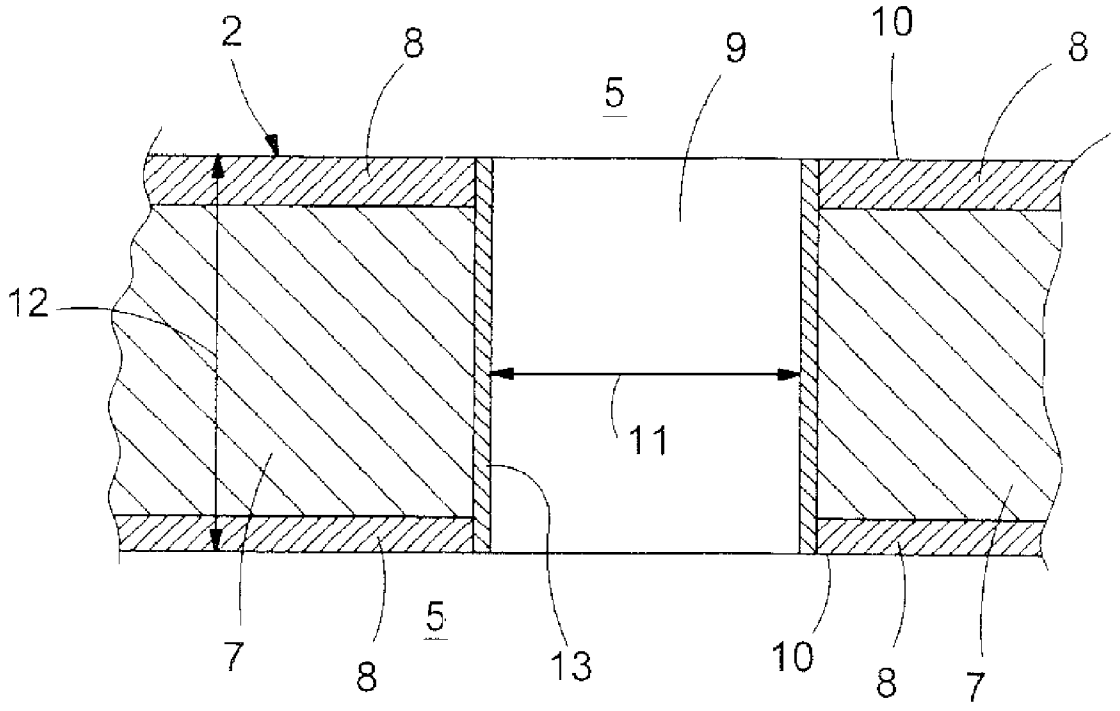


Fig.3

SILENCER

[0001] This application claims priority under 35 U.S.C. § 119 to Swiss application number No. 00955/05, filed 7 Jun. 2005, the entirety of which is incorporated by reference herein.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to a silencer for a flow passage of a turbomachine, in particular of a power plant.

[0004] 2. Brief Description of the Related Art

[0005] A turbomachine, such as, for example, a turbine or a compressor of a turboset, in particular of a power plant, can develop disturbing noises during operation. These noises can spread into the environment of the turbomachine through the flow passages of the turbomachine, which, for example, feed fresh air to the compressor or discharge exhaust gases from the turbine. In order to reduce the noise emission into the environment, it is conventional practice to arrange a silencer of the aforementioned type in the flow passage. Such a silencer normally has a plurality of walls which are arranged in the flow passage, extend parallel to a gas flow directed in the flow passage and are spaced apart transversely to the direction of the gas flow. In this way, the gas flow is passed through between the walls, in the course of which a tangential flow occurs around the walls. The walls are designed to absorb airborne noise. As a result, airborne noise which spreads within the gas flow in the flow passage is correspondingly damped when passing through the silencer.

[0006] So that the walls absorb airborne noise, they can be provided, for example, with a perforated outer skin which encloses a damper material absorbing airborne noise. The airborne noise entrained in the gas flow enters the damper material through the perforated outer skin and is damped as a result.

[0007] During operation of the turbomachine, a change in the physical properties of the wall absorbing airborne noise may occur in the course of time. For example, deposits of dirt on the outer skin and in the damper material occur. As a result, firstly the airborne-noise permeability of the outer skin may be impaired. Secondly, the damping capacity of the damper material may be impaired. Since relatively large volumetric flows are directed through the respective flow passage during operation of turbomachines, dynamic pressure changes may occur between the walls. It has been found that in silencers which are in operation for a prolonged period, e.g. for 1 to 2 years, vibrations may be excited in the walls by these pressure changes. This is attributed to the change in the physical properties of the walls which is explained above and occurs in the course of time. These vibrations of the walls are transmitted to the respective flow passage, so that an increasing vibration tendency of the walls puts the reliable operation of the turbomachine at risk.

SUMMARY OF THE INVENTION

[0008] One aspect of the present invention deals with the problem of specifying, for a silencer of the aforementioned type, an improved embodiment in which, in particular, a vibration tendency is also reduced during prolonged operation.

[0009] Another aspect of the present invention generally includes providing the walls with connecting passages which pass through the walls transversely to the direction of flow. At each wall, the two outer sides facing away from one another and exposed to the gas flow are connected to one another in a communicating manner by these connecting passages. In this way, pressure differences between these two outer sides can be balanced through the connecting passages. In this case, the invention uses the knowledge that the vibration excitation of the respective wall can be attributed to pressure differences at their outer sides. The driving force for the vibration excitation of the walls is reduced by balancing these pressure differences. As a result, the vibration excitation and vibration tendency of the walls also decreases.

[0010] Further important features and advantages of the silencer according to the invention follow from the drawings and the associated description of the figures with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Preferred exemplary embodiments of the invention are shown in the drawings and are described in more detail below, the same designations corresponding to identical or similar or functionally identical components. In the drawings, in each case schematically:

[0012] **FIG. 1** shows a greatly simplified, diagrammatic side view of a silencer according to the invention arranged in a flow passage,

[0013] **FIG. 2** shows a greatly simplified, diagrammatic plan view of the silencer,

[0014] **FIG. 3** shows an enlarged sectional illustration through a wall of the silencer in the region of a connecting passage.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0015] According to **FIGS. 1 and 2**, a silencer **1** embodying principles of the present invention includes a plurality of walls **2** which are arranged in a flow passage **3** of a turbomachine (otherwise not shown), preferably of a power plant. Here, by way of example, the individual walls **2** each extend in one plane. The individual walls **2** extend parallel to one another and are also oriented in parallel in the flow passage **3** relative to a gas flow **4** which is directed in the flow passage **3** and is indicated here by arrows. Furthermore, the walls **2** are spaced apart transversely to the direction of the gas flow **4**, that is to say transversely to a longitudinal direction of the flow passage **3**. A tangential flow around the walls **2** is therefore produced during operation of the respective turbomachine.

[0016] In this case, intermediate spaces **5** are formed between adjacent walls **2**. Such intermediate spaces **5** are also obtained between the two outer walls **2** and adjacent passage walls **6**, provided the outer walls—as here—are arranged at a distance from the passage walls **6** transversely to the direction of flow.

[0017] The walls **2** of the silencer **1** are configured in such a way that they act to absorb airborne noise. According to **FIG. 3**, this is achieved, for example, by the respective wall

2 containing a damper material 7 in its interior, this damper material 7 acting so as to absorb airborne noise. The damper material 7 used may be, for example, mineral wool or a foam plastic, preferably open-pored foam plastic, or any other suitable material. Furthermore, the respective wall 2 has an outer skin 8 which is permeable to airborne noise and encloses the damper material 7. The airborne-noise permeability of the outer skin 8 may be achieved, for example, by perforation (not shown here) of the outer skin 8. The outer skin 8 preferably consists of a metallic sheet, in particular a metallic perforated sheet. The perforation of the outer skin 8 is formed in the case of the perforated sheet by the respective hole pattern.

[0018] The walls 2, shown in FIGS. 1 and 2 and arranged side by side with respect to the direction of the gas flow, form a wall group (not designated in any more detail). It is clear that the silencer 1 may also have a plurality of such wall groups, which are then arranged one behind the other in the flow passage 3 with respect to the direction of the gas flow 4.

[0019] According to another principle of the present invention, at least one of these walls 2 is now provided with at least one connecting passage 9. In the exemplary embodiment shown, each wall 2 is provided with a plurality of such connecting passages 9. Each passage 9 passes through the respective wall 2 transversely to the direction of the gas flow 4, that is to say transversely to the respective wall plane. In addition, each connecting passage 9 is designed in such a way that it makes possible a pressure balance between the two intermediate spaces 5 separated from one another by the respective wall 2. To this end, the connecting passages 9 are preferably open on both sides. In principle, however, an embodiment is also possible in which the respective connecting passage 9 is closed by at least one vibratory diaphragm, which, on account of its elasticity, likewise makes possible a pressure balance, at least as far as dynamic pressure fluctuations are concerned.

[0020] The connecting passages 9 in the walls 2 therefore enable pressure fluctuations which may occur between the intermediate spaces 5 separated from one another by the walls 2 to be balanced. By these pressure fluctuations being balanced, pressure-force differences which act on longitudinal sides or outer sides 10, facing away from one another, of the walls 2 are reduced. This leads to a reduction in the vibration tendency of the walls 2.

[0021] The pressure balance which can take place between the intermediate spaces, separated from one another by the respective wall 2, due to the connecting passages 9 is symbolized in FIG. 2 by arrows 14 which extend through the respective longitudinal passage 9 parallel to its longitudinal direction.

[0022] As can be seen from FIGS. 1 and 2, the individual connecting passages 9 inside the respective wall 2 may be arranged, for example, side by side transversely to the direction of the gas flow 4, that is to say one above the other in FIG. 1. Additionally or alternatively, the individual connecting passages 9 may also be arranged one behind the other in the direction of the gas flow 4. In this case, the distribution of the individual connecting passages 9 inside the respective wall 2 is selected, for example, as a function of the pulsation centers to be expected of the pressure fluctuations which possibly occur. The distribution of the connecting passages 9 which is shown here is therefore purely exemplary. In particular, the distribution of the connecting passages 9 may vary at the individual walls 2.

[0023] In the exemplary embodiments shown here, the connecting passages 9 each have a circular cross section. It is clear here that the connecting passages 9 may in principle have any desired cross section. The connecting passages 9 are expediently dimensioned here in such a way that their cross section has a clear width 11 which is in a ratio of between 0.5 to 1.5 with respect to a wall thickness 12 of the respective wall 2. However, the variant shown here, in which the clear width 11 is approximately the same size as the wall thickness 12, is preferred.

[0024] According to FIG. 3, the respective connecting passage 9 passes through the outer skin 8 on both outer sides 10 and through the damper material 7. The connecting passage 9 shown here is lined by a casing 13 transversely to its longitudinal axis, which is perpendicular to the respective wall plane. The respective connecting passage 9 is separated from the damper material 7 and from the outer skin 8 by this casing 13. Said casing 13 is expediently fastened to the outer skin 8, e.g., pressed into place therein or brazed or welded thereto.

[0025] The flow passage 3 is preferably a fresh-air passage which directs a fresh-air flow to an inlet of the respective turbomachine, which is preferably a compressor of a turboset. In principle, the flow passage 3 may also be an exhaust-gas passage which directs an exhaust-gas flow away from an outlet of the respective turbomachine, which is a turbine of a turboset for example.

List of designations

1	Silencer
2	Wall
3	Flow passage
4	Gas flow
5	Intermediate space
6	Passage wall
7	Damper material
8	Outer skin
9	Connecting passage
10	Outer side of 2
11	Clear width of 9
12	Wall thickness of 2
13	Casing
14	Pressure balance

[0026] While the invention has been described in detail with reference to exemplary embodiments thereof, it will be apparent to one skilled in the art that various changes can be made, and equivalents employed, without departing from the scope of the invention. The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiments were chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments as are suited to the particular use contemplated. It is intended that the

scope of the invention be defined by the claims appended hereto, and their equivalents. The entirety of each of the aforementioned documents is incorporated by reference herein.

What is claimed is:

1. A silencer for a flow passage of a turbomachine, the flow passage defining a gas flow direction, the silencer comprising:

a plurality of walls arranged in the flow passage, extending parallel to the gas flow direction, and spaced apart transverse to the gas flow direction, the plurality of walls configured and arranged to absorb airborne noise; and

at least one of the plurality of walls comprising at least one connecting passage which passes completely through the at least one of the plurality of walls transverse to the gas flow direction.

2. The silencer as claimed in claim 1, wherein the at least one connecting passage comprises two open ends.

3. The silencer as claimed in claim 1, wherein the at least one connecting passage has a clear width cross section between 0.5 to 1.5 times a wall thickness of said at least one of the plurality of walls.

4. The silencer as claimed in claim 1, wherein the at least one connecting passage has a circular cross section.

5. The silencer as claimed in claim 1, wherein the at least one of the plurality of walls comprises a damper material configured and arranged to absorb airborne noise and a perforated outer skin which encloses the damper material, and wherein the at least one connecting passage passes through the perforated outer skin and the damper material.

6. The silencer as claimed in claim 1, wherein the at least one of the plurality of walls comprises a casing that lines the at least one connecting passage.

7. The silencer as claimed in claim 6, wherein the at least one of the plurality of walls comprises a damper material configured and arranged to absorb airborne noise and a perforated outer skin which encloses the damper material, and wherein the at least one connecting passage passes through the perforated outer skin and the damper material; and

(a) wherein the casing separates the at least one connecting passage from the damper material, from the outer skin, or from both; or

(b) wherein the casing is fastened to the outer skin; or

both (a) and (b).

8. The silencer as claimed in claim 1, wherein the at least one of said plurality of walls comprises a plurality of connecting passages arranged in a distributed manner side by side transversely to the gas flow direction, or arranged one behind the other in the gas flow direction, or both.

9. The silencer as claimed in claim 1, wherein:

the damper material comprises mineral wool or a foam plastic; or

the outer skin comprises a sheet or a perforated sheet; or

both.

10. The silencer as claimed in claim 1, wherein the turbomachine includes an inlet and an outlet, and wherein the flow passage is configured and arranged to direct the gas flow to said turbomachine inlet or away from said turbomachine outlet.

11. The silencer as claimed in claim 1, further comprising:

at least one vibratory diaphragm closing the at least one connecting passage.

12. A turbomachine comprising:

a flow passage; and

a silence according to claim 1 positioned in the flow passage.

13. A power plant comprising:

a turbomachine according to claim 12.

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