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(54) **Title**: A GAS FILTERING DEVICE AND A METHOD OF MANUFATURING A GAS FILTERING DEVICE

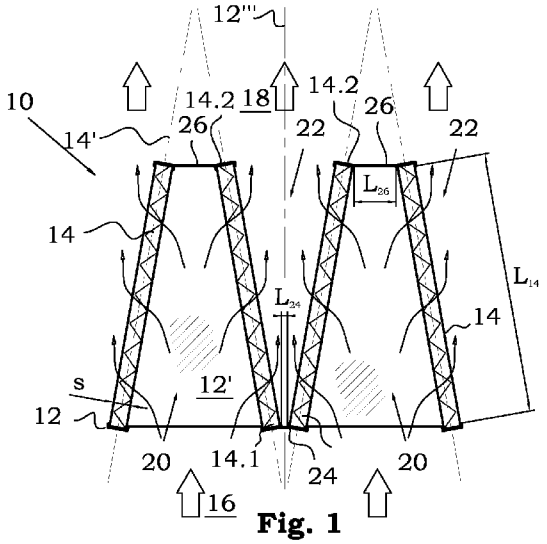

Fig. 1

(57) **Abstract**: The object of the present invention is a gas filtering apparatus which comprises an substantially gas-tight roof section (12") and a bottom section (121) between which planar filter elements (14) have been arranged so that the filter elements form several wedge-shapedly closing, adjacent spaces (20) to the gas flow inlet side (16) and simultaneously several wedge-shapedly opening, adjacent spaces (22) to the gas flow outlet side, and wherein adjacent filter elements (14) have been joined at their first edge together in the gas flow direction in the first end section (24) extending from the roof section (12") to the bottom section (12'), and at their second edge in the gas flow direction in the second end section (26) extending from the roof section to the bottom section, and wherein filter elements (14) separating breadth (L_{26}) of the second end section (36) is wider than filter elements (14) separating breadth (L_{24}) of the fist end section (24).

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A GAS FILTERING DEVICE AND A METHOD OF MANUFATURING A GAS FILTERING DEVICE

[001] The invention is directed to a gas filtering apparatus according to the preamble of the claim 1 and to a method of the manufacture of the gas filtering apparatus according to the preamble of the claim 5.

[002] A gas filtering apparatus of prior art comprising a frame structure comprising an substantially gas tight roof section and bottom section, between which several planar filter elements have been arranged obliquely in relation to the main flowing direction of gas such that the filter elements form adjacent spaces which close/open wedge-shapedly and are defined on one hand by the roof section and the bottom section and on the other hand by the filter elements. A gas filtering apparatus of this type is known from US 4,129,429.

[003] Several apparatuses using air as the working material or wherein air participates in the process executed in the apparatus constrict the amount of impurities in the air used. For example, a gas turbine apparatus with its machinery arranged to rotate at a fairly high velocity, is extremely sensitive to the presence of solids in the combustion air. The same applies to many other thermal power devices. For this reason, these devices are often equipped with large combustion air filtering apparatuses which remove the particles in the air as required in each case.

[004] Especially when filtering large air flow volumes, the influence of pressure loss is significant for in such cases the influence of pressure loss on the operating efficiency is significant, too. The pressure loss in filter elements increases as the impurities accumulate on the filter surfaces, which also increases the force subjected to the filter element. Because filter elements are changed only after certain time periods, for example, only after pressure difference reaches a certain maximum allowable limit, it is preferable that the

effect of accumulation of impurities on the pressure loss of the filter element is minimized.

[005] On the other hand, the filter element also has to withstand the extra force of increased pressure difference inevitably subjected to the filter element during its use and caused by the accumulation of impurities. A thicker filter element is more resistant to the above mentioned extra force, however, the increasing pressure loss might become a problem.

[006] The object of the invention is to create a gas filter for purging the flowing air of impurities, the filter creating a smaller pressure loss than before without significantly decreasing the filter's capacity to separate impurities.

[007] An object of the invention is also to create a method for manufacturing a gas filtering apparatus which comprises creating a gas filtering apparatus which removes impurities from flowing air and creates a smaller pressure loss than before without significantly decreasing the filter's capacity to separate impurities.

[008] The above mentioned objects are reached mainly with the solution presented in claims 1 and 5.

[009] Other additional characteristics of the invention are disclosed in the appended patent claims and the following description of the embodiments of the figures.

[0010] According to a preferred embodiment of the present invention, the gas filtering apparatus comprises an substantially gas-tight roof section and a bottom section, between which planar filter elements have been arranged such that the filter elements form several adjacent wedge-shapedly closing spaces to the gas flow inlet side and, at the same time, several adjacent, wedge-shapedly opening spaces to the gas flow outlet side, and such that adjacent filter elements have been joined together at its first edge in the gas

flow direction by the first end section extending from the roof section to the bottom section ,and at its second edge in the gas flow direction by the second end section extending from the roof section to the bottom section, and wherein the filter elements separating breadth of the second end section is wider than filter elements separating breadth of the fist end section

[0011] A gas filtering apparatus of this type, where the distance between the filter elements is larger in the second end section than in the first end section, achieves a relatively low pressure loss as well as simultaneously improves the stiffness to help withstand the force subjected to the filter element due to the pressure difference.

[0012] According to a preferred embodiment, the distance between the filter elements in the second end section is 4 - 10 % of the length of the filter element. Thus, the filter apparatus functions in an especially preferred manner. In this connection, one should understand that the end section is preferably wider than the distance between its filter elements which defines the distance between the filter element surfaces in the ends of the filter elements because the end section is also used in the mounting of the filter element.

[0013] Preferably, filter element consists of a planar element crease folded from the filter material, and its thickness is over 10 % of the length of the filter element.

[0014] Filter apparatus has face areas on the inlet and outlet sides in the flowing direction of gas, and in the face area of the inlet side the surface portion covered by the first end section is smaller than the surface portion covered by the second end section in the outlet side face area.

[0015] One object of the invention is also a method of manufacturing a gas filtering apparatus where the method comprises arranging several planar filter elements between the substantially gastight roof section and the bottom

section in such a manner that the filter elements are arranged to form wedge-shapedly closing, adjacent spaces to the gas flow inlet side, the spaces being defined on the one hand by the roof section and the bottom section and on the other by the filter elements, and in which method the filter elements are arranged to simultaneously form wedge-shapedly opening, adjacent spaces to the gas flow outlet side and in which at least two adjacent filter elements are joined together in the gas flow direction by the first end section extending from the roof section to the bottom section at the first edge, at least two adjacent filter elements are joined together in the gas flow direction by the second end section extending from the roof section to the bottom section at the latter, second edge. In the method, the filter elements separating breadth of the second end section is arranged wider than the filter elements separating breadth separating the filter elements of the first end section.

[0016] Preferably, two adjacent filter elements are joined together in the gas flow direction at the latter, second edge at a distance of 4 - 10% of the filter element length from each other.

[0017] In the following, the invention and its operation is described by referring to the appended schematic drawings wherein:

Figure 1 represents schematically an embodiment of the gas filtering apparatus of the invention,

Figure 2 represents a face view of the gas filtering apparatus of Figure 1 in the gas flow direction, and

Figure 3 represents an example of the operation of the gas filtering apparatus of the invention.

[0018] Figures 1 and 2 represent schematically a preferred embodiment of the gas filtering apparatus 10 of the invention where Figure 1 represents the cross-section I-I of the gas filtering apparatus and Figure 2 represents a face view of the gas filtering apparatus of Figure 1 in the gas flow direction. The gas filtering apparatus presented here is especially an air filtering apparatus

which is especially suitable for filtering the combustion air of a gas turbine machinery. In the following the gas filtering apparatus 10 is accordingly referred to as an air filtering apparatus.

[0019] The air filtering apparatus 10 comprises a frame 12 which is formed by a roof section 12" and a bottom section 12', among other things. Planar filter elements 14 have been arranged in the frame. The quantity of filter elements 14 can vary according to the application.

[0020] Filter elements 14 are planar and rectangular, and they have been created by pleating a filter mat or like to form a so-called pleat pack. Thus, the filtering surface of the pleat pack increases. At the same time, it becomes thicker which makes its structure stiffer and improves its ability to receive the force caused by the pressure difference generated during its use. The filter elements are essentially of the same size. The thickness of the filter element 14 is defined by many factors, such as the acceptable pressure loss and the required filtering capability.

[0021] The filter elements have been attached at their two opposing sides to the roof section 12" and the bottom section 12' such that the orientation of the filter elements differs from the primary length direction 12" of the frame so that every other filter element is in the opposing direction.

[0022] The filter elements 14 form wedge-shapedly closing spaces 20 to the gas flow inlet side 16, the spaces being defined by both the roof section 12" and the bottom section. The closing space 20 is defined by two filter elements 14. Wedge-shapedly opening spaces 22 are similarly formed to the other side of the filter elements 14 in respect of the gas flow direction, namely to the outlet side 18.

[0023] Except for the outermost filter elements of the filtering apparatus 10, each two adjacent filter elements have been joined together in the gas flow direction at the first edge 14.1 by the first end section 24. The first end section

extends between the roof section 12" and the bottom section 12' so that the connection of the filter elements to each other is substantially gas-tight.

[0024] Similarly, two adjacent filter elements of the filter apparatus 10 have been joined together in the gas flow direction at the second edge 14.2 by the second end section 26. The second end section also extends between the roof section 12" and the bottom section 12' so that the connection of the filter elements to each other is substantially gas tight. In practice, the connection of the filter elements to the frame 12 and to the end sections is preferably performed by gluing, in which case the filter apparatus forms a unified entity. Both the first and the second end section are substantially gas-tight and their connection to the filter elements is substantially gas-tight.

[0025] The breadth L_{26} separating the filter elements in the second end section is wider than the space L_{24} separating the filter elements in the first end section. This affects the flow characteristics of the closing space 20 and the filter elements 14 by decreasing pressure loss. In this case, the thickness of filter element may be selected so that it is thick enough, however, without excessively increasing the pressure difference over the filtering apparatus. Preferably, the distance L_{26} between the filter elements in the second end section is defined in relation to the length of the filter element L_{14}. Preferably, the distance L_{26} is 4 – 10 % of the length of the filter element. By arranging the distance L_{26} between the filter elements in the second end section in this way wider than the distance between the filter elements in the first end section, the thickness of the filter element may be increased to provide greater stiffness without excessively increasing the pressure loss.

[0026] Figure 4 represents an example of the operation of a gas filtering apparatus of the invention. Figure 4 shows the velocity (m/s) of the air flowing through the apparatus on the horizontal axis and the pressure loss on the vertical axis. Reference number 40 represents measuring results for a state of the art gas filtering apparatus. Reference number 42 represents measuring results for a structurally state of the art filter element differing from the one

represented by the reference number 40 in the respect that the thickness of the filter element is approximately twofold. The Figure clearly shows the increasing thickness of the filter element as an increased pressure difference between the measuring sequences 40 and 42.

[0027] Reference number 41 represents measuring results for an embodiment of the gas filtering apparatus of the invention where the thickness of the filter element is the same as in the filtering apparatus yielding the measuring results 42 but where the distance L_{26} separating the filter elements in the second end section is wider than the distance L_{24} separating the filter elements in the first end section. In the filter element yielding the measuring results 41, the distance between the filter elements in the second end section is approximately 5 % of the length of the filter element.

[0028] Reference number 41' represents measuring results for an embodiment of the gas filtering apparatus of the invention where the distance L_{26} separating the filter elements in the second end section is approximately 12 % of the length of the filter element. To make the effects of the invention as advantageous as possible, the distance between the filter elements in the second end section is 4 - 10% of the filter element length L_{14}.

[0029] In the experimental tests illustrated in Figure 4, it has been found that the width separating filter elements in the second end section is preferably approximately 20 - 40 mm.

[0030] It is to be noted that only a few of the most preferred embodiments of the invention have been represented above. Thus, it is obvious that the invention is not limited to the above embodiments but can be applied in many different ways within the limits defined by appended claims. The characteristics represented in connection with the different embodiments may, without differing from the basic idea of the invention, be used with other embodiments, too, and/or the represented characteristics may be combined into different entities if desired and provided that it is technically possible.

Claims

1. A gas filtering apparatus which comprises an substantially gas tight roof section (12") and a bottom section (12') in between which planar filter elements (14) have been arranged so that the filter elements form several wedge-shapedly closing adjacent spaces (20) to the gas flow inlet side (16) and, at the same time, several wedge-shapedly opening adjacent spaces (22) to the gas flow outlet side, **characterized** in that adjacent filter elements (14) have been joined together at its first edge in the gas flow direction by the first end section (24) extending from the roof section (12") to the bottom section (12'), and in the gas flow direction by the second end section (26) extending from the roof section to the bottom section at its second edge, and that the filter elements (14) separating breadth (L_{26}) of the second end section (36) is wider than filter elements (14) separating breadth (L_{24}) of the fist end section (24).

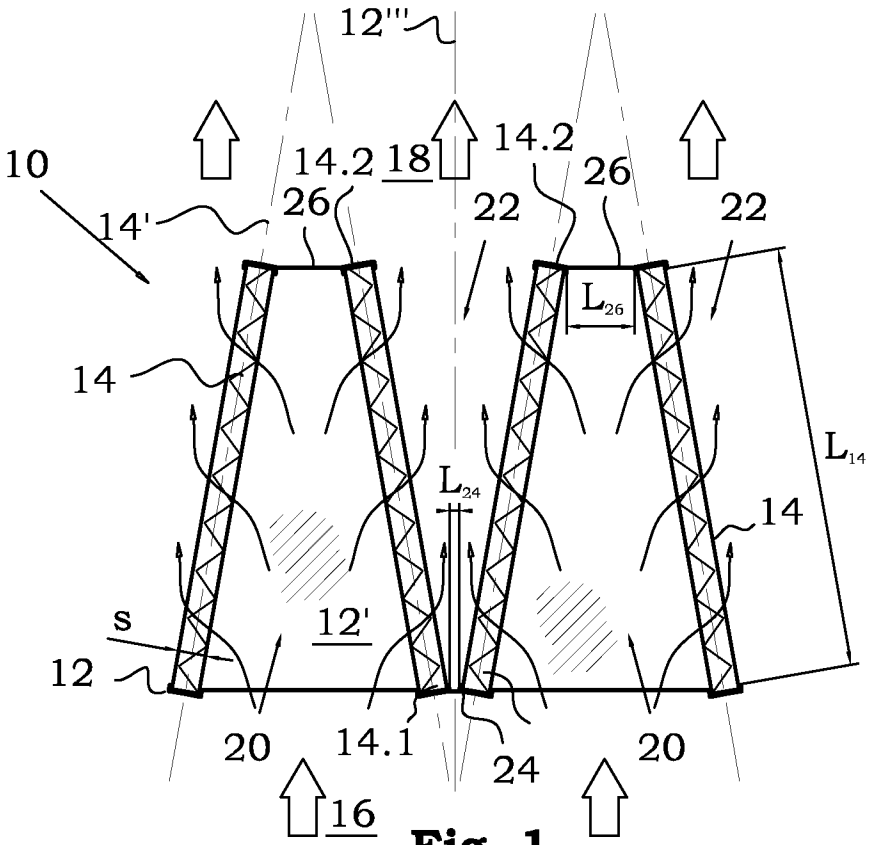
2. An air filtering apparatus of claim 1, **characterized** in that the filter element (14) is formed of a planar element pleated from the filter material, the thickness (S) of which element is over 10% of the filter element length (L_{14}).

3. An air filtering apparatus according to any preceding claim, **characterized** in that the filter apparatus has face areas on the inlet (16) and outlet (18) sides in the gas flow direction, and that the proportion of the surface of the face area on the inlet side covered by the first end section (24) is smaller than the proportion of the surface of the face area on the outlet side covered by the second end section (26).

4. An air filtering apparatus according to any preceding claim, **characterized** in that the filter elements (14) separating breadth (L_{26}) of the second end section (36) is 4 – 10 % of the filter element length (L_{14}).

5. A method for manufacturing a gas filtering apparatus where the method comprises the steps of arranging several planar filter elements between the substantially gas tight roof section (12") and the bottom section (12') in such a manner that the filter elements are arranged to form wedge-shapedly closing, adjacent spaces (20) to the gas flow inlet side (16), the spaces being defined on the one hand by the roof section and the bottom section and on the other by the filter elements, and in which method the filter elements (14) are simultaneously arranged to form wedge-shapedly opening, adjacent spaces (22) to the gas flow outlet side and in which at least two adjacent filter elements (14) are joined together in the gas flow direction in the first end section (24) extending from the roof section to the bottom section at its first edge (14.1), at least two adjacent filter elements are joined together in the gas flow direction in the second end section (26) extending from the roof section to the bottom section at the latter, second edge, **characterized** in that the filter elements separating breadth (L_{26}) of the second end section (26) is arranged wider than the filter elements separating breadth (L_{24}) separating the filter elements of the first end section (24).

6. The method according to claim 5, **characterized** in that two adjacent filter elements (14) are joined together in the gas flow direction at the latter, second edge (14.1) at a distance of 4 – 10 % of the filter element (L_{14}) length from each other.


12'''
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14.2
18
14.2
26
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16

Fig. 1

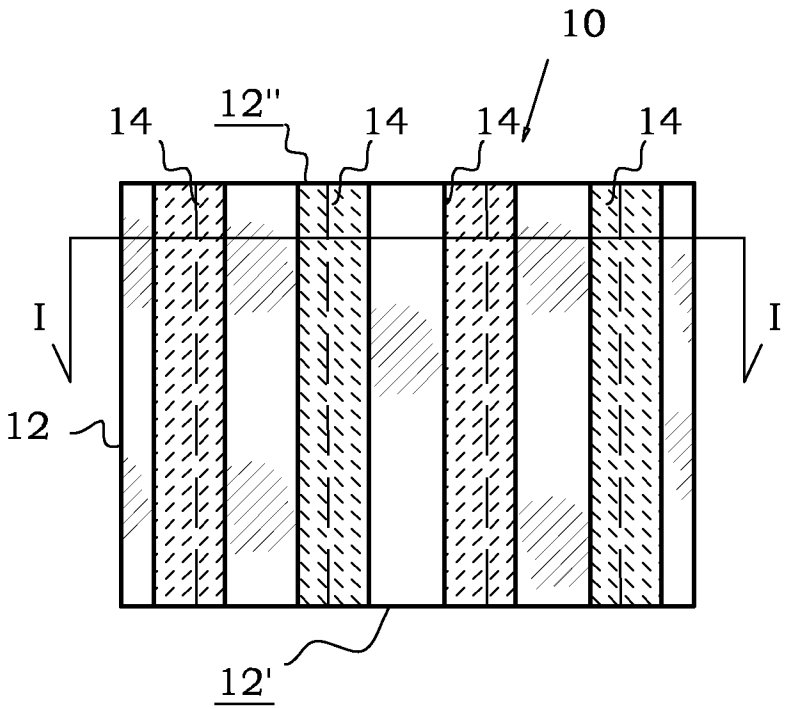

Fig. 2

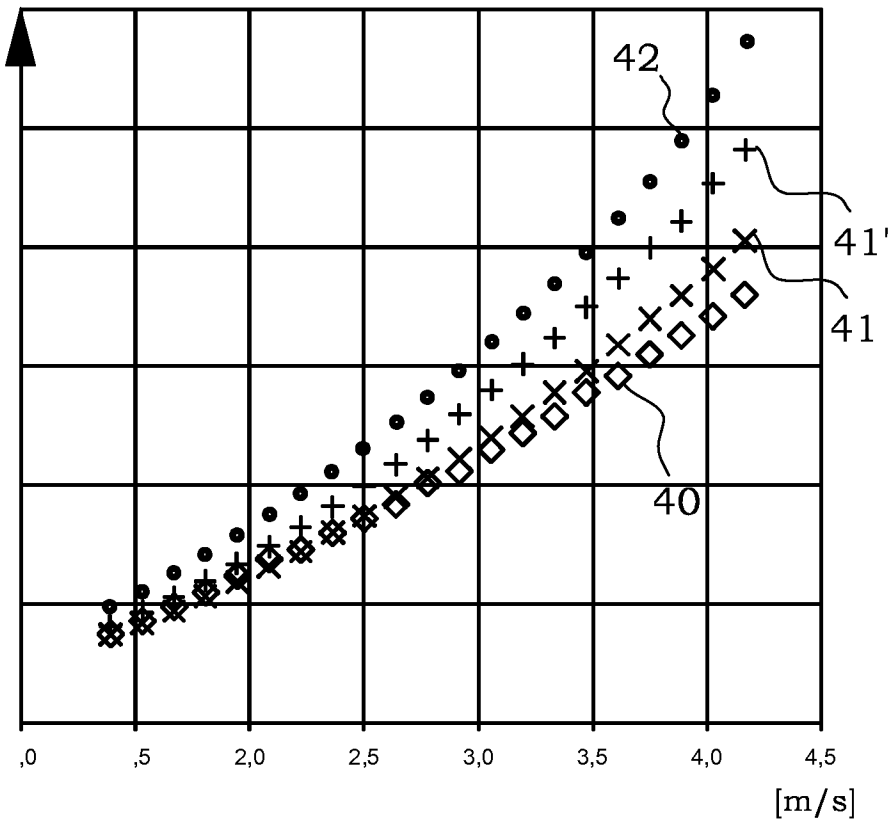

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B01D, F02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9420193 A1 (PALL CORP) 15 September 1994 (15.09.1994) whole document, particularly figure 2	1-6
A	WO 9820961 A1 (MCLEOD RUSSEL HOLDINGS PLC et al.) 22 May 1998 (22.05.1998)	
A	US 3470680 A (AVERA WILLIAM W) 07 October 1969 (07.10.1969)	

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent document cited in search report	Publication date	Patent family members(s)	Publication date
WO 9420193 A1	15/09/1994	AU 6403594 A	26/09/1994
WO 9820961 A1	22/05/1998	EP 0951335 A1	27/10/1999
		DE 69721823T T2	06/05/2004
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US 3470680 A	07/10/1969	None	

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