Fig. 3


Declarations under Rule 4.17:
- of inventorship (Rule 4.17(iv))
- with international search report (Art. 21(3))
GAS DEDUSTING FILTER APPARATUS AND PROCESS

FIELD OF THE INVENTION

The present invention relates to the dedusting of gas, e.g. coming from industrial processes and/or industrial systems, such as coal boilers, incinerators, cement works and the like. In particular, the present invention relates to a filter apparatus having improved dedusting efficiency. The filter apparatus according to the present invention makes it possible to improve the dedusting efficiency of traditional electrostatic filters.

In particular, the filter apparatus according to the present invention makes it possible to obtain filtering efficiencies either equal to or better than those of bag filters or ceramic candle filters with much smaller overall size and, consequently, lower installation costs.

Last but not least, the apparatus according to the present invention requires fewer maintenance operations than traditional bag filters or ceramic candle filters, which translates into a further cost abatement.

The present invention further relates to a dedusting process implemented by means of said filter apparatus.

The dedusting process according to the present invention makes it possible to obtain filtering efficiencies either equal to or higher than those of bag filters or ceramic candle filters.

SCOPE OF THE INVENTION

Electrostatic separators or precipitators are also known in the gas dedusting sector, in particular for treating gas coming from industrial processes and/or industrial systems, such as coal boilers, incinerators, cement works and the like. Electrostatic precipitators make it possible to separate the solid polluting particles from the input gas flow.

Indeed, electrostatic precipitators, by means of a difference of potential induced between the emitting and collecting electrodes, achieve the separation of the contaminated particles from the carrier gas which is made to flow between the electrodes. An air flow free from contaminating particles is thus obtained in output.
The dust removal efficiencies of such electrostatic separators or electro-precipitators often do not allow them to achieve the limits required by the most stringent standards in the sector, particularly if the gases to be treated are at high temperatures.

5 DESCRIPTION OF THE PRIOR ART

The particulate material, in general, consists of ashes and/or dust dragged by the gas flow.

The systems mainly used for capturing particulate consist of:

- Electrostatic filters (electrostatic precipitators) for low and high temperature;
- Bag filters for low temperature applications (lower than 250° C);
- Ceramic candle filters for high temperature applications (higher than 250° C).

Electrostatic filters are generally considered relatively high efficiency systems for abating fume particulate (abatement based on inducing electrostatic charges on the fume dust and capturing the dust on a deposit electrode). However, the result is heavily conditioned by the resistivity of the dust, i.e. by the capacity to assume the electrostatic charges induced by the ionizing electrode.

With very low resistivities ($10^3$, $10^5 \text{ ohm}\times\text{cm}$), the particles can easily lose the charge that took them to the capturing electrode and return into the gaseous flow once the cohesion force is overcome.

Problems also occur with particles having excessively high resistivity $10^{10} \text{ ohm}\times\text{cm}$ for their difficulty to neutralize a charge once in contact with the capturing electrode. In such case, an excessive accumulation, which makes filter cleaning operations, in particular of the electrodes, necessary is determined. The periodical cleaning of the electrodes is in all cases needed also in presence of regular operation. The cleaning operations are performed with mechanical percussions. Electrostatic precipitators have good efficiencies also for submicronic particles, low operating costs and relatively simple management.

In bag filters or ceramic candle filters, the dust is separated from the fumes by means of a proper filtering effect, obtained by making the gaseous current cross through fabric bags (tubular, 150 mm in diameter, 6000-8000 mm long) consisting of microporous felts. The filtering effect is provided, firstly, by the
small size of the pores of the felt which allows the passage of the gas but not of
the dusty particles; the effect determined by the dust layer depositing on the
bags becomes gradually more important as the operation proceeds. Indeed,
when such layer (of accumulation) has reached a thickness such to cause
losses of load deemed excessive on the gas path, the bags themselves must be
cleaned, e.g. by means of counterflow compressed air jets.
The materials used in the bag filters (Teflon or Teflon-coated materials) do not
allow temperature values higher than the range comprised between about 150°
C and 220° C. The materials used in ceramic candle filters are sintered ceramic
fibers or porous ceramic structures.
The operating principle is very simple: in a bag filter cleaned with compressed
air, a steel basket prevents the bag from "collapsing" during the normal filtering,
while in ceramic candle filters the structure is rigid and maintains its shape.
When the fumes pass from the outside through the filtering means, the dust
forms a deposit on the surface of the bag or on the ceramic candle. The filtering
means are generally cleaned by a compressed air pulse in each bag or in each
ceramic candle sent by a nozzle installed immediately over the bag or the
ceramic candle.
These brief air pulses exit from the nozzles and cross the filtering bags of the
creatures. The dust layer is thus destroyed by the shock wave and falls into the
hoppers.
The dust is then removed from the hoppers by means of an evacuation system
for successive extraction or reuse.
The electrostatic filters have good filtering efficiencies but are not sufficient to
comply with the most stringent standards on particulate emissions. It is thus
necessary to define methods which may increase the efficiency of existing
electrostatic filters in order to reduce the emissions thereof under the limits
prescribed by the most modern standards.
Currently, there are various methods.
A currently known apparatus envisages the installation of a plurality of filtering
bags in the end part of an electrostatic precipitator. In all cases, this known
system is not free from drawbacks. A first drawback is in that the installation of
the filtering bags requires considerable changes to the electrostatic precipitator,
with consequent increase of the installation costs due mainly to the high volumes required by the filtering bags. The space for the bags is not sufficient to keep its loss of load down and its reliability acceptable for a long time.

Another method consists in transforming the electrostatic precipitator into a bag filter. In this manner, the greatest drawback is the high cost for supply and assembly. Another drawback is in that the bag filter cannot work in optimal manner at high temperatures, because the material of which the filtering bags are made has a working limit lower than 250°C.

Another method is to enlarge the electrostatic filter so as to increase efficiency.

Also in this case, the drawback is that of having high costs for modification, dismantling, assembly and insulation.

SUMMARY OF THE INVENTION

The present invention thus aims to solve these issues by suggesting a filter apparatus comprising a very compact filtering unit, such to be installed in the outlet hood of an existing electrostatic filter so as to reduce the dustiness in the output flow to extremely low levels, lower than those of an existing bag filter or ceramic candle filter, while keeping the existing electrostatic filter in operation.

According to the present invention, a filter apparatus is suggested comprising an electrostatic filter and at least one filtering unit provided with regeneration means according to the present invention, as well as a filtering process implemented by such apparatus.

According to a consideration underling the present invention, as the gas flow was already deducted by the electrostatic filter to concentrations lower than 100 mg/Nm3, the suggested filtering unit must have a filtering efficiency in the order of 90-99%, which is typical of the efficiency of the wall flow filtering elements described above. In this manner, the gas flow may be taken downstream of said filter apparatus to dustiness levels of 2-3 mg/Nm3 by virtue of the combined action of the electrostatic filter (which works as primary deduster) and of the filter apparatus, which works as finisher.

It is thus an object of the present invention to suggest and/or make available a filter apparatus which combines an electrostatic precipitator and a filtering wall including filtering cells, e.g. of the wall flow type, with a very high overall filtering efficiency, very low installation costs with respect to the conversion of an
electrostatic filter into a bag filter or a ceramic candle filter. The low installation costs mainly derive from the high compactness of the filtering unit which is the object of the present invention and consequently of the filter apparatus which is the object of the invention. The filtering unit implies short assembly times and minimum changes to the structures of the electrostatic precipitator in case of retrofitting of existing electrostatic filters.

It is a further object of the present invention to provide a filter apparatus having improved deducting efficiency which displays an improved reliability with respect to the filtering systems of known type, with consequent reduction of the supplementary maintenance costs. This is possible because the filtering boxes, e.g. of the wall flow, may be made of material which is mechanical and chemically strong (e.g. silicon carbide). Last but not least, it is an object of the present invention to provide a filter apparatus having improved deducting efficiency, capable of operating at high temperatures, i.e. in the order of 600° C, condition of use which cannot be achieved by the bag filters of known type.

It is a further object of the present invention to provide a filter apparatus having improved deducting efficiency which comprises a system for uniforming the gas flow in the electrostatic precipitator itself, regardless of the presence of the perforated plate which is present in the outlet hood of the electrostatic precipitators of known type.

Last but not least, it is the object of the present invention also to provide a deducting process for treating industrial gas. In particular, the deducting process according to the present invention implemented by the filter apparatus having improved deducting efficiency which is also the object of the present invention allows the treatment of gas coming from industrial processes, such as coal boilers, cement works, incinerators and like.

This task and other objects which will be more apparent hereinafter from the detailed description of a preferred embodiment of the present invention are achieved by a filter apparatus for gas deducting which comprises one or more electrostatic precipitators, at least one filtering unit comprising, in turn, a plurality of filtering cells of the wall flow type being inserted in each of said electrostatic precipitators.
Preferably, the filtering unit is placed in the outlet hood of the precipitator itself and is configured as a wall so as to form a layer of filtering cells, e.g. of the wall flow type, arranged in parallel.

The wall flow filtering elements are currently used as particulate traps in motor vehicles by virtue of their compactness. They consist of elements containing a high number of small channels crossed by the dusty gas. Since each channel is closed on the bottom, the gas must permeate through the porous side wall of the channel passing in the near channel and then exiting downstream. The filtering and dedusting is thus achieved with very compact dimensions. The volume of a wall flow element is about twenty times smaller than that occupied by bag filters or ceramic candle filters the filtering surface being equal.

For their geometry and compactness, the wall flow elements are currently used only in the automotive sector as particulate traps. However, they are not adapted to operate with high particulate loads or large-size dust, such as those typical of industrial systems, such as cement works and coal electric power stations.

Furthermore, the filtering ceramic wall of the channels themselves is very thin and therefore does not normally guarantee filtering efficiencies higher than 98-99% for fine particles.

The wall flow elements used in the automotive sector are therefore not intrinsically adapted to operate with high loads of particulate and large-size dimensions.

**BRIEF DESCRIPTION OF THE FIGURES**

The present invention will be explained in greater detail below by means of a detailed description of the embodiments shown in the drawings, wherein, in all cases, the present invention is not limited to the embodiments described above and shown on the drawings.

In the accompanying drawings:

- figure 1 shows a diagrammatic side view of the filter apparatus according to an embodiment of the present invention;

- figure 2 shows a diagrammatic perspective view of the filter apparatus according to an embodiment of the present invention in which the counterflow
compressed air pulse washing system used for regenerating the filtering unit is not shown;

figure 3 shows a diagrammatic view of an embodiment of the wall flow filtering cell filtering unit comprising a pneumatic regeneration circuit;

figure 4 shows a diagrammatic overview of the filter apparatus according to an embodiment of the present invention, in which a Venturi tube is associated with the filtering cells of the filtering unit;

figure 5 shows in detail a filtering cell according to an embodiment of the present invention, the cell being provided with a Venturi tube.

DETAILED DESCRIPTION OF THE INVENTION

The filter apparatus 1 according to the embodiment of the present invention shown in figure 1 comprises at least one electrostatic separator or precipitator 100 provided, in turn, with at least one inlet 101 for the gas to be subjected to filtering and at least one outlet 102 for the treated gas.

It is thus possible to identify a gas flow advancement direction in the electrostatic precipitator 100, such advancement direction being indicated in the accompanying figures by the direction of the "IN" arrow at the inlet of the electrostatic precipitator 100 and of the "OUT" arrow at the outlet of the electrostatic precipitator 100.

With respect to such gas advancement direction in the precipitator, said gas inlet 101 in the electrostatic precipitator 100 is arranged upstream of the electrostatic precipitator 100, while said outlet section 102 is arranged downstream of the electrostatic precipitator 100.

With particular reference to Figure 3, the filter apparatus 1 according to the present invention further comprises a plurality of filtering cells, for example but not exclusively of the wall flow type 301, arranged in a matrix and therefore in rows and columns, so as to form a wall-shaped filtering unit 300 positioned in the electrostatic precipitator 100 so as to be invested by the gas to be treated. In particular, according to an embodiment, the inlet portion 101 and/or the outlet or exhaust portion 102 of the electrostatic precipitator 100 are hood-shaped (e.g. with truncated-cone or truncated-pyramid section), the filtering unit being preferably positioned in the outlet hood of the electrostatic precipitator (100).
The filtering unit 300 with cells 301, e.g. of the wall flow type, according to the embodiment of the present invention shown in the drawings, comprises a regeneration system of the dust accumulated on the filtering surface itself of the cells 301.

The wall flow elements of known type used for example in the automotive sector do not comprise any regeneration system because in these applications the particulate is simply burnt since it consists of organic material (soot and drops of liquid hydrocarbons).

The structure of the wall flow type cells is however mechanically very strong and another advantage of such filtering system consists thus in that the filtering unit can operate at temperatures up to 700°C.

By virtue of the installation position downstream of the electrostatic precipitator 100 where the dust levels are low and there are no large-sized particles, and by virtue of the compressed air regeneration system according to the present invention, such wall flow filtering elements may be used to make an extremely compact filtering wall housed in the outlet hood of the electrostatic precipitator capable of filtering the entire flow of effluent gas in the electrostatic precipitator. Furthermore, dedusting efficiency higher than 99% is not needed in this application because the dust pre-separation was already performed by the electrostatic filter itself.

Considering the need (or at least the opportuneness) of periodically and automatically removing the accumulated dust, the filter apparatus according to the embodiment of the present invention is characterized in that it further comprises a counterflow compressed air pulse system of the filtering cells, such as those of said wall flow type.

Said filtering cells (301) are, as shown, arranged side-by-side so as to form a filtering wall arranged upstream of the outlet section of the electrostatic precipitator.

A front inlet surface 301' of the gas to be treated and an rear outlet surface 301" of the outlet surface of the gas to be treated are found on each filtering cell 301, where the orientation of the cell, and thus the words “front” and “rear”, are, as mentioned, referred to the gas flow direction to be treated which strikes the cell itself (figures 1 and 2).
Preferably, said filtering wall 300 is placed inside said electrostatic precipitator 100, preferably immediately upstream of the outlet section 102 (and possibly in the hood-shaped portion). With particular reference to Figures 1 and 2, said filtering wall 300 is arranged substantially transversally to the advancement direction of the gas flow to be treated.

According to a first preferred embodiment of the present invention shown by way of non-limiting example in Figure 3, the filter apparatus 1 according to the present invention further comprises a regeneration system 400 of the flow filtering cells 301 on the wall of said filtering wall 300.

Preferably, said regeneration system 400 comprises, in turn, a feeding line or circuit 410 to feed a fluid, preferably in gaseous state, preferably air, to said cells 301 of said filtering wall 300 in counterflow with respect to the direction with which the gas to be treated which crosses the apparatus strikes it during the gas treatment. So, assuming for the sake of simplicity, the use of a washing gas (see the description below), reference will be made hereinafter to a pneumatic line (or possibly a pneumatic circuit) 410.

Said feeding line or circuit 410 comprises, in turn, a first common stretch 411 of the feeding circuit which branches into a plurality of feeding conduits 412, each adapted to convey the fluid to a nozzle 412a, a dedicated nozzle 412a being preferably provided for each cell 301 of said filtering wall 300.

According to a preferred embodiment shown in Figure 3, being said filtering cells 301 arranged mutually side-by-side to form said rows and/or columns (of a matrix), advantageously said common feeding line 411 branches into a plurality of feeding conduits 412, each feeding conduit 412 being configured to convey the washing fluid to a row of cells 300a.

Naturally, a different configuration of the regeneration circuit may comprise feeding conduits which convey the washing fluid to cells arranged in columns, instead of in rows, as shown here, such variants being comprised in the scope of protection of the present invention in all cases.

Turning back to the embodiment shown in Figure 3, said regeneration system 400 further comprises collecting means 420 (of the washing fluid escaping in counterflow from the cells 301), including, in the embodiment shown in the figure, a collection and conveying 421 line (for example, a pneumatic line)
configured to convey the washing fluid (loaded with the dust removed from the cells 301) after the counterflow washing thereof. In the scope of this invention, pneumatic line (and/or pipe) means a line and/or pipe adapted to convey a gaseous fluid.

At each of said filtering cells 301, in particular at the front surface 301' of said of said filtering cells 301, said washing fluid and dust collecting means 420 comprise dedicated collecting means 422a. In particular, said collection line 421 branches, in turn, similarly to that seen for the feeding line 411, into a plurality of collection ducts 422, one collection duct for each row of cells, e.g. connected, in turn, to said dust collecting means 422a arranged at each single cell.

Advantageously, a shut-off valve 413 is envisaged on the supply line 410, and in particular on each single feeding conduit 412 upstream of said nozzles 412a. In this manner, it is possible to advantageously proceed with selective regeneration (selective washing) of a group of cells 301, e.g. of a row 300a or of two or more rows 300a, without involving all the cells of the filtering wall 300 in the washing process. In this manner, the filter apparatus can continue its gas dedusting operation without the filtering wall cell regeneration operations invalidating the filter functionality.

Similarly to that shown on the feeding line 410, also for the collecting means 420, in particular on the washing fluid and dust collection line 421, shut-off valves 423 for collecting the washing fluid and dust escaping from the cells 301 are envisaged so as to proceed with the selective washing of one or more groups of cells in this manner, as mentioned.

Turning back to the overview in Figure 3, said regeneration system 400 preferably comprises, as mentioned, said at least one pneumatic collection line 421 of the washing liquid (dust load) which escapes from the cells 301 following the washing with pressurized gas, preferable counterflow compressed air pulses, as mentioned.

With reference to Figure 1, said regeneration system, and in particular the dust collecting means 422a arranged at the front inlet surface 301' of the gas to be treated in each single cell, preferably form a dust-catching grid, generically indicated in Figures 1 and 2 by reference number 500, which is arranged
upstream of said filtering wall 300, with respect to the flow direction of the gas to be treated. For example, said grid 500 may comprise perforated tubular stretches each arranged at a cell 301.

Again with reference to Figure 1, said regeneration system may advantageously comprise the dust-catching pneumatic line 421 connected to said dust-catching grid, as shown above, for carrying the dust, configured to convey the dust extracted from the cells 301.

According to a possible embodiment, shown in Figure 1, said collection line 421 may advantageously convey the dust directly into one of the collection hoppers 600 provided under said electrostatic precipitator 100.

According to an alternative embodiment of the present invention, not shown in the accompanying figures, the collecting means 420, in particular by means of the collection line 421, may advantageously convey the dust to a dedicated filter, external to the electrostatic precipitator 100 to which they are connected (e.g. by means of line 421, if present) in fluid connection.

According to a further alternative embodiment of the present invention, not shown in the accompanying figures, said collecting means 420 may advantageously convey the dust upstream of the electrostatic precipitator 100 itself, or in any point of the electrostatic precipitator, thus achieving in fact a recirculation line, on said recirculation line.

According to a preferred embodiment of the present invention, said dust-catching grid 500 comprises intake means, preferably comprising a circular or rectangular section tube, provided with suction holes.

Said suction means of said grid 500 comprise one or more fans, the intake flange of which is connected to the dust-catching grid, generates a vacuum capable of preferably conveying the dust into the collection grid, thus moving it away from the filtering wall 300.

According to a further embodiment of the present invention, shown in the Figure 4 and 5, a Venturi tube 310 is arranged upstream of each of said filtering cells 301 and directly connected thereto. The reference is in particular to Figure 5.

According to this embodiment, the washing fluid and dust collecting means 420 including the dust collection line 421, and possibly the grid 500 and the suction means, and/or of the recirculation circuit to a point of the electrostatic
precipitator could be possibly omitted. Indeed, by virtue of the Venturi tubes 310, the compressed air emitted by the nozzles 412a crosses the cell 301 and escaping from the cell, loaded with dust, is expanded and accelerated in the Venturi tube, which thus impresses a speed to the compressed air flow sufficient to reach a zone of the electrostatic precipitator sufficiently upstream, and thus near the inlet zone 101, to be filtered again by the precipitator and fall into the collection hoppers 600.

According to the present invention, an embodiment is provided in which the washing fluid and dust collecting means 420 including the dust collection line 421, and possibly the grid 500 and the suction means, and/or the dust recirculation circuit to a point of the electrostatic precipitator are provided and positioned and/or arranged so as to collect (intercept and/or capture) the washing fluid (loaded with dust) escaping from the Venturi tubes 310.

It is further object of the invention a dedusting process comprising the following steps:

- a first step of filtering by means of an electrostatic precipitator 100;
- a second step of filtering by means of said filtering unit 300 comprising said plurality of wall flow filtering cells 301.

According to an embodiment, the dedusting process further comprises a step of regenerating of said filtering unit 300.

Said step of regenerating preferably comprises at least one step of washing of said wall flow cells 301 by means of counterflow compressed air pulses.

The dedusting process according to an embodiment of the present invention preferably comprises a further step of collecting and/or conveying the dust escaping from said filtering cells 301 following the counterflow washing to an external filter.

Alternatively, the dedusting process according to an embodiment of the present invention preferably comprises a step of recirculating the dust escaping from said filtering cells 301 after the counterflow washing in any point of the electrostatic precipitator 100, e.g. by means of a pneumatic collecting and conveying line 421.

Alternatively, the dedusting process according to the present invention preferably comprises a step of accelerating of the washing fluid and of the dust
escaping from the cells 301, e.g. by means of Venturi tubes 310, and possibly a step consisting in sending the dust escaping from said Venturi tubes 310 into the electrostatic precipitator.
The filter apparatus thus devised and described, like the dedusting process which is the object of the present invention, thus achieve the set task and objects.
Many changes can be made by a person skilled in the art without departing from the scope of protection of the present invention, determined by the scope of the claims, which are an integral part of the present text and are thus entirely quoted herein.
The scope of protection of the claims, therefore, must not be limited to the illustration or preferred embodiments described by way of example, but rather the claims must include all the features of patentable novelty inferable from the present invention, including all the features that would be treated as equivalent by a person skilled in the art.
CLAIMS

1. A filter apparatus (1) for deducting gas coming from industrial processes and/or plants, comprising at least one electrostatic precipitator (100) and further comprising at least one filtering unit (300) housed in said at least one electrostatic precipitator (100), the filtering unit comprising a plurality of filtering cells (301) arranged so as to form a wall adapted to be struck by the flow of said gas inside said electrostatic precipitator (100), said filtering unit (300) comprising, in turn, a regeneration system (400) of said cells (301), said regeneration system comprising, in turn, means (410) for conveying or delivering a washing fluid, preferably gaseous, to said cells (301) in counterflow with respect to the flow of said gas in said electrostatic precipitator (100), characterized in that said regeneration system (400) comprises collecting and/or conveying means (420) for collecting and/or conveying the dust escaping from the cells (301) following the washing by means of said washing fluid.

2. A filter apparatus (1) according to claim 1, characterized in that said collecting and/or conveying means (420) comprise a Venturi tube (310) positioned at each of said filtering cells (301) and adapted to increase the speed of the washing fluid escaping from said cells (301).

3. A filter apparatus (1) according to the preceding claim 1 or 2, characterized in that said collecting and/or conveying means comprise at least one pneumatic collection line (421) of the dust which escapes from said Venturi tubes following the washing of said cells (300) by means of said washing fluid.

4. A filter apparatus (1) according to the preceding claim 3, characterized in that said collecting means (420) comprise a dust-catching grid (500).

5. A filter apparatus (1) according to the preceding claim 4, characterized in that said collecting grid (500) comprises a plurality of tubular components, each provided with suction holes and positioned either at a Venturi tube (310) or directly at a cell (301).

6. A filter apparatus (1) according to any one of the preceding claims from 4 to 5, characterized in that said collecting and/or conveying means comprise suction means adapted to generate a vacuum adapted to convey the dust into said grid (500) upstream of said filtering units (301).
7. A filter apparatus (1) according to the preceding claim 6, characterized in that said suction means further comprise one or more fans adapted to generate a vacuum capable of conveying the dust either preferably out from said Venturi tubes (310) or directly from said cells (301) into said collection grid (500).

8. A filter apparatus (1) according to any one of the preceding claims from 3 to 7, characterized in that said collection line (421) is in fluid connection with a dedicated external filter, external to the electrostatic precipitator (100).

9. A filter apparatus (1) according to any one of claims from 3 to 7, characterized in that said collection line (421) is configured to recirculate the dust upstream of said electrostatic precipitator (100) or in any point of said electrostatic precipitator (100) upstream of said filtering unit (300).

10. A filter apparatus (1) according to any one of the preceding claims from 1 to 9, characterized in that each of said filtering cells (301) is configured as a wall flow cell.

11. A filter apparatus (1) according to any one of the preceding claims from 1 to 10, characterized in that said means (410) for conveying said washing fluid, preferably gaseous, to said cells (301) in counterflow with respect to the flow of said gas in said electrostatic precipitator (100) comprise a pneumatic supply line (410) for feeding said washing fluid, preferably in gaseous stage, under pressure, to said cells (301).

12. A filter apparatus (1) according to the preceding claim 11, characterized in that said pneumatic supply line (410) comprises, in turn, a first common stretch (411) which branches into a plurality of supply pipes (412) each equipped with a nozzle (412a), a dedicated nozzle (412a) being provided for each of said cells (301).

13. A filter apparatus (1) according to any one of the preceding claims from 1 to 12, characterized in that the exhaust portion of said electrostatic precipitator (100) for exhausting said gas is hood-shaped, said filtering unit (300) being installed in the exhaust hood of said electrostatic precipitator (100).

14. A gas dedusting process performed by means of a filter apparatus according to any one of the claims from 1 to 13, said process comprising the following steps:
- a first step of electrostatic filtering of said gas by means of said electrostatic precipitator (100);
- a second step of filtering of said gas by means of said filtering wall (300) comprising said plurality of wall flow filtering cells (301);

5 characterized by a step of regenerating said filtering cells (301) of said filtering unit (300) by sending a washing fluid, preferably gaseous, to said cells (301) in counterflow with respect to the flow of said gas in said electrostatic precipitator (100),

and in that said process comprises a further step of collecting and/or conveying the dust escaping from the cells (301) following the washing by means of said washing fluid.

15. A dedusting process according to the preceding claim 14, characterized in that said washing flow comprises pulsed compressed air.
16. A dedusting process according to any one of the preceding claims 14 and
15, characterized in that it further comprises a step of collecting said washing fluid escaping from said cells (301).
17. A dedusting process according to the preceding claim 16, characterized in that it further comprises a step consisting of conveying said washing fluid flow escaping from said cells (301) to a dedicated filter external to the electrostatic precipitator.
18. A dedusting process according to claim 16, characterized in that it further comprises a step of reintroducing said washing fluid escaping from said cells (301) in any point of said electrostatic precipitator (100) upstream of said filtering unit (300).
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. B03C3/019  B03C3/155  B03C3/36  B03C3/80

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)

B03C  F01N

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

*EPO-Internal, WPI Data*

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>WO 2011/141827 A1 [SMIDTH AS F L [DK]; PEDERSEN HENRIK VITTRUP [DK]; POULSEN KARSTEN [DK]]</td>
<td>1-18</td>
</tr>
<tr>
<td></td>
<td>17 November 2011 (2011-11-17) figure 1 paragraph [0012] - paragraph [0013]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>figure 1 page 4, line 12 - page 10, line 26</td>
<td></td>
</tr>
</tbody>
</table>
|          | figures 1-4 column 3, line 37 - column 5, line 28 | -/-

[X] Further documents are listed in the continuation of Box C.

[X] 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
  * "E" earlier application or patent but published on or after the international filing date
  * "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another application or other special reason (as specified)
  * "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

"**" 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

"*" 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

"**" 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**

24 May 2017

**Date of mailing of the international search report**

06/06/2017

Name and mailing address of the ISA/Authorized officer

European Patent Office, P.B. 5618 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax. (+31-70) 340-3016

Menck, Anja
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 5 158 580 A (CHANG RAMSAY [US]) 27 October 1992 (1992-10-27) figures 6,7 column 6, line 43 - column 7, line 5</td>
<td>1-18</td>
</tr>
</tbody>
</table>
### INTERNATIONAL SEARCH REPORT

Information on patent family members

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>WO 201141827 A1</td>
<td>17-11-2011</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>WO 2013179266 A1</td>
<td>05-12-2013</td>
<td>CA 2875171 A1</td>
<td>05-12-2013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DK 2855865 T3</td>
<td>08-05-2017</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 2855865 A1</td>
<td>08-04-2015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 2013179266 A1</td>
<td>05-12-2013</td>
</tr>
<tr>
<td>US 5616717 A</td>
<td>01-04-1997</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 12014000396 A1</td>
<td>27-06-2016</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 12014000396 A1</td>
<td>27-06-2016</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2079786 A1</td>
<td>08-08-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69219959 D1</td>
<td>03-07-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 69219959 T2</td>
<td>18-12-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP H05607236 A</td>
<td>21-10-1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 5158580 A</td>
<td>27-10-1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 9213641 A1</td>
<td>20-08-1992</td>
</tr>
</tbody>
</table>