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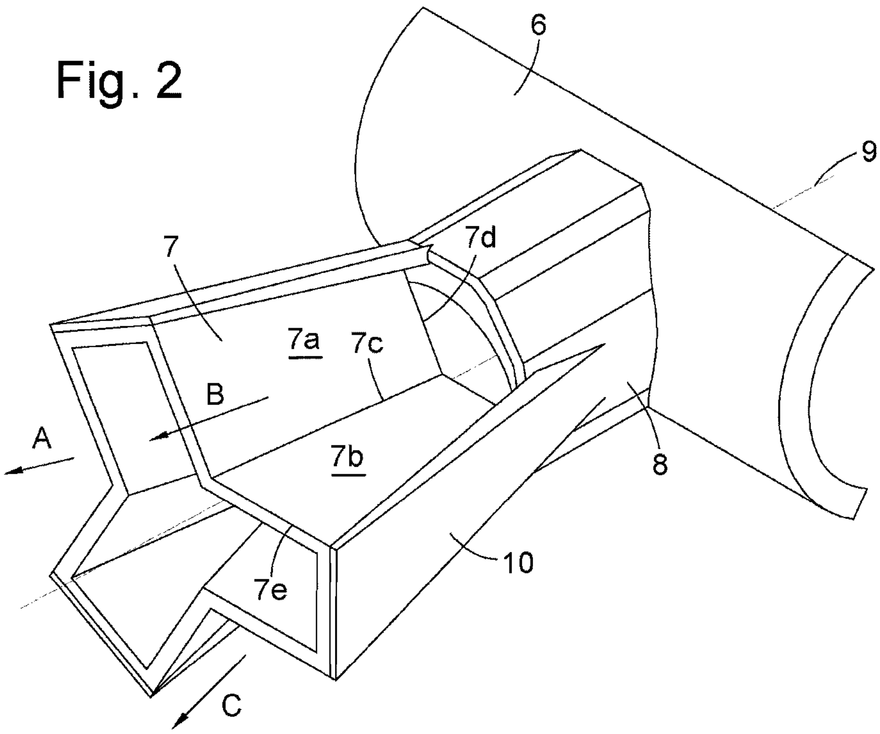
(56) Documents Cited:
US 20180071669 A1 **US 20050120881 A1**

(58) Field of Search:
INT CL **B01D, B05B**
Other: **WPI, EPODOC**

(54) Title of the Invention: **Pulse nozzle for filter cleaning systems**
Abstract Title: **Pulse nozzle for filter cleaning systems**

(57) A nozzle for a filter cleaning system has a stub portion 8 having an inlet opening and an outlet opening, and a splitter portion 7 positioned downstream of the stub portion. The splitter portion has deflector surfaces 7a, 7b arranged to direct the airflow exiting the stub portion outlet in 3 or more different/separate airstreams A, B, C, each of which airstreams are directed inclined axially outwardly from the axial direction 9 of the airflow exiting the stub portion outlet opening. The various parameters of the splitter nozzle portion can be tailored to provide required jet shape and entrainment characteristics. A beneficial feature of the nozzle designs is that jet entrainment and recombination of flows can be specified for different shaped filters.

Fig. 2



This print incorporates corrections made under Section 117(1) of the Patents Act 1977.

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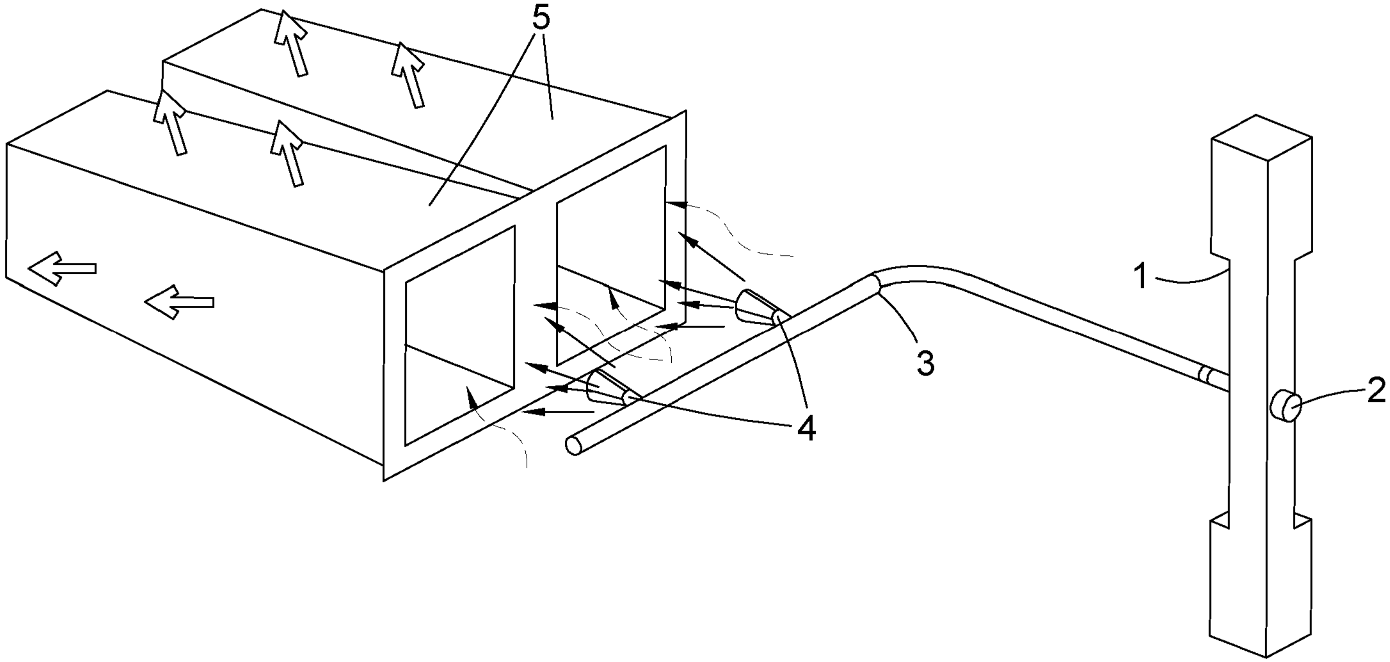

Fig. 1

22 02 21

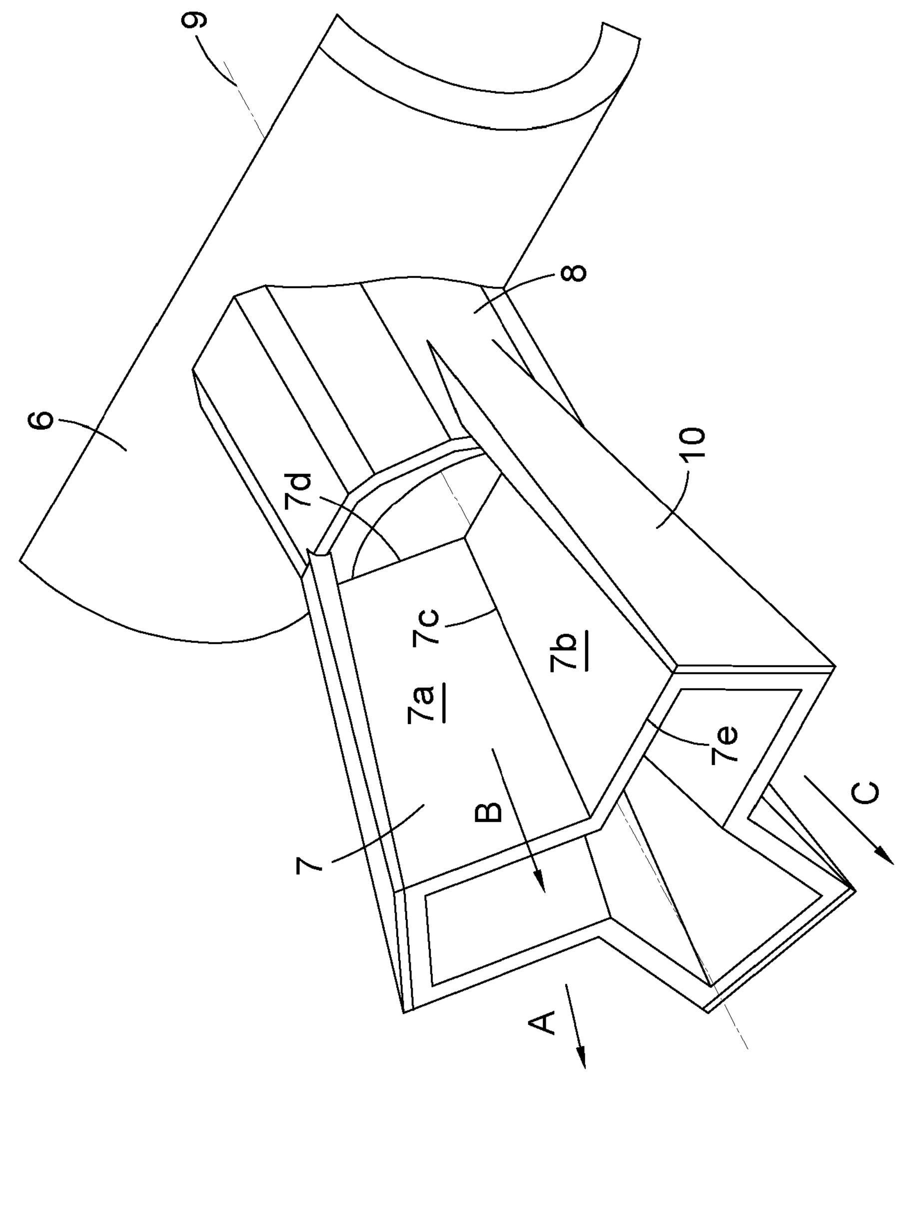

Fig. 2

22 02 21

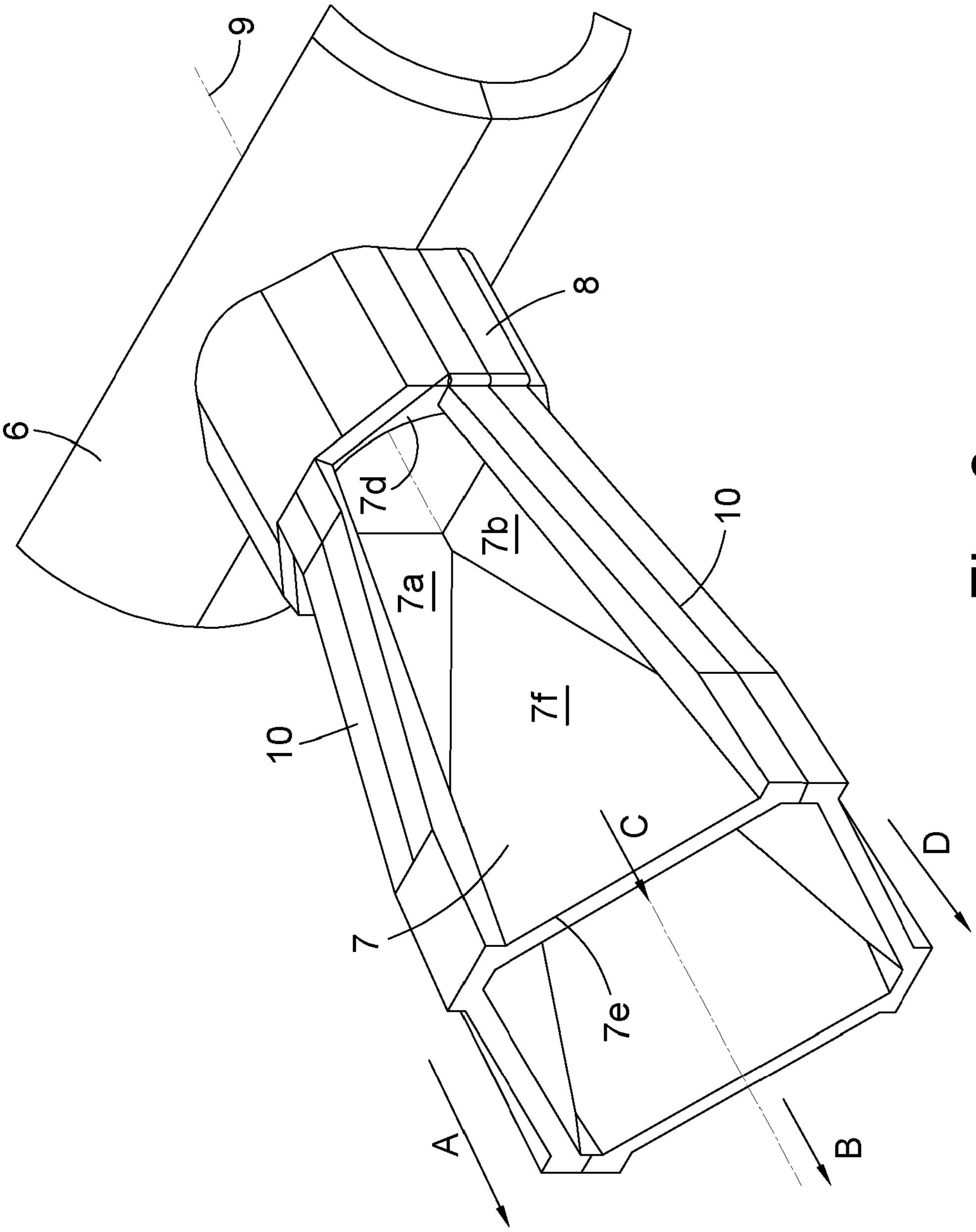

Fig. 3

22 02 21

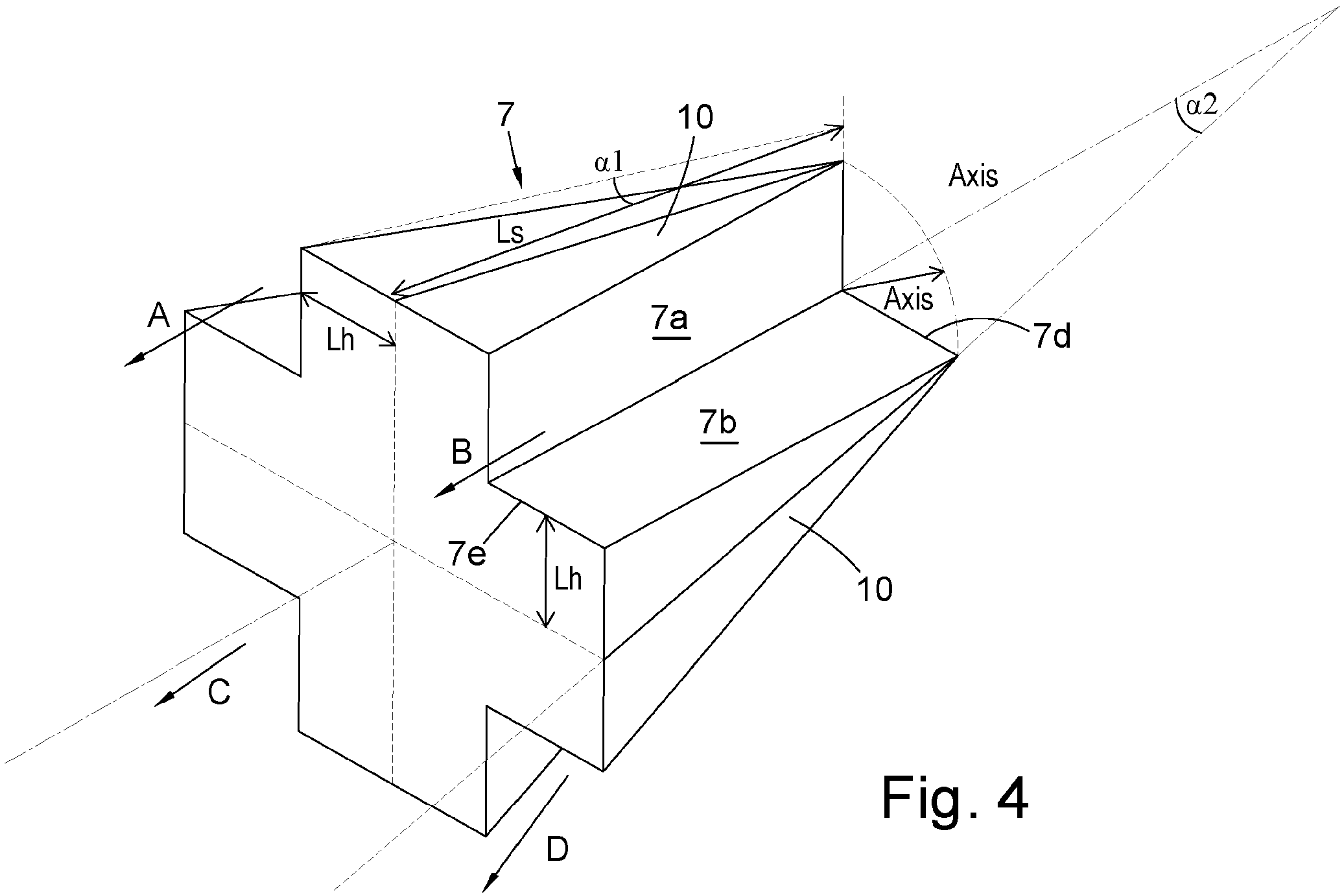

Fig. 4

Pulse nozzle for filter cleaning systems

The present invention relates to a pulse nozzle for filter cleaning systems, and filter cleaning systems using such pulse nozzles.

Pulse-cleaning systems for air filters use short pulses of compressed air to reverse the normal airflow in the filter and remove the dust from the filter media. Such systems are referred to as reverse-flow filter cleaning systems. The air is delivered through a nozzle which may be specially designed to increase the amount of entrainment into the resulting jet and thus the reverse airflow through the filter.

In order to optimise/maximise the cleaning flow for a given filter shape within a defined envelope it is necessary to give consideration to the shape and distribution of the nozzle(s) and the velocity profile of the resulting jet.

For example, pyramid filters such as disclosed in US 8440002 use a 3 or 4-sided configuration may not be cleaned effectively with a round jet or bifurcated jet as typically used for cylindrical or conical filters. Also, increasing the entrainment rate may enable the nozzle(s) to clean effectively while reducing the distance between the nozzle exit plane and the filter and thus the overall size and cost of the filter house.

US7195659 discloses at figure 11 onwards various configurations of pulse nozzles that the present invention seeks to improve upon.

Previous work has been conducted on improving nozzle design for round cartridge filters and a range of different designs is in use. An exemplary design is shown in for example US7585343.

In US2007/0137151, the nozzle configuration uses multiple outlets directing pulsed air across thin wedges to attempt a similar effect for a large V-type filter.

An improved arrangement has now been devised.

The improved nozzle comprises:

i) a stub portion having an inlet opening and an outlet opening; and,

ii) a splitter portion positioned downstream of the stub portion; wherein the splitter portion has deflector surfaces arranged to direct the airflow exiting the stub portion outlet in 3 or more different/separate airstreams each of which airstreams are directed inclined axially outward from the axial direction of the airflow exiting the stub portion outlet.

It is preferred that the deflector surfaces directing each airstream are substantially planar.

It is preferred that, for each airstream, two or more inclined deflector surfaces are provided, meeting at one or more intersections.

It is preferred that the intersections are linear and preferably are inclined axially outwardly from the axial direction of the stub portion.

It is preferred that the stub portion has a single/common outlet opening, which single/common outlet directs the airflow onto each of the deflector surfaces.

It is preferred that the outlet opening of the stub portion comprises a circular aperture.

It is preferred that the splitter portion is formed to have spacer sections (such as bridges, walls or webs) to separate the different/separate airstreams.

It is preferred that the spacer sections are present extending between adjacent deflector surfaces of the different/separate airstreams.

It is preferred that the spacer sections run longitudinally along the length of the splitter portion and are inclined axially outwardly from stub axis.

It is preferred that the spacer sections are each inclined axially at the same angle of inclination.

It is preferred that the spacer sections extend from the stub portion.

It is preferred that the deflector surfaces for each airstream define an airstream channel.

It is preferred that each airstream channel is of the same shape and configuration as the other separate airstream channels of the nozzle.

It is preferred that the splitter portion has a deflector surface leading edge configuration in which the airflow exiting the stub outlet is split into the different/separate airstreams at a common point along the longitudinal axis of the nozzle.

It is preferred that the splitter portion has a deflector surface leading edge configuration in which the airflow exiting the stub outlet is split into the different/separate airstreams, the leading edge being positioned contiguous with (or close to) the outlet opening of the stub portion. By ‘close to’ it is to be understood a distance of substantially 15mm or less.

It is preferred that the splitter portion has a deflector surface leading edge configuration in which the airflow exiting the stub outlet is split into the different/separate airstreams, the deflector surface leading edge configuration extending transversely across the entirety of the outlet opening of the stub portion.

It is preferred that the nozzle further comprises a source of compressed air and means for delivering the compressed air to the nozzle.

It is preferred that the system includes a pulsation system for pulsing the air delivered to the nozzle.

The invention will now be further described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a filter cleaning system in accordance with the invention;

Figure 2 is a perspective view of an embodiment of a nozzle according to the invention;

Figure 3 is a perspective view of a second embodiment of a nozzle in accordance with the invention;

Figure 4 is a diagram of the nozzle geometry of an alternative configuration of nozzle in accordance with the invention;

A reverse-flow pulsed filter cleaning system is shown in figure 1. The system is suitable for use in relation to generally known industrial applications such as that described in US7195659 for cleaning, for example filter arrangements provided for a gas intake system for a gas turbine system. The reverse-flow pulsed filter cleaning system shown in figure 1 comprises a compressed air header (1) with a number of pulse valves (2) each connected to a blowpipe (3). The blowpipe (3) delivers a short pulse of compressed air to one or more nozzles (4). Each nozzle directs the resulting pulse jet in such a way as to reverse the air flow through a single filter (5). The nozzle may be attached to the side of the blowpipe via a saddle (as shown - 6) or mated directly to the open end of the blowpipe.

In the present invention the nozzle utilizes a splitter nozzle portion (7) with a stellate or pyramidal wedge – typically, but not exclusively, 3 or 4 pointed/sided. The splitter nozzle portion (7) is placed flow-wise downstream of a single converging or convergent-divergent (typically) round stub nozzle (8). The leading edge of the splitter may be coincident with the nozzle exit plane or a few (e.g.. 5-15) millimetres downstream. The splitter deflects and divides the flow issuing from a single nozzle into multiple (3 or more) streams angled away from the nozzle axis (9) thus allowing increased entrainment due to the increased surface area of the shear layer. Side plate spacers (10) may be used to attach the splitter to the stub nozzle. In some configurations these also aid the jet/airstream separation.

The angle at which the jets/airstreams diverge, whether and where they subsequently re-combine to form a single jet with a non-circular cross-section, is controlled by splitter angles, length, position, cross-section shape and (optionally) side plates spacers (10). CFD simulation and experimental testing can be used to determine the effect of these parameters on entrainment ratio and jet cross-section. In this way a nozzle with specific values of these parameters can be used provide the optimum cleaning flow for a given filter size and/or shape.

The various parameters of the splitter nozzle portion (7), the spacing from the stub nozzle portion (8) and the geometry of the stub nozzle portion (8) can be tailored to provide the required jet shape and entrainment characteristics. A beneficial feature of the nozzle designs is that jet entrainment and recombination of flows can be specified for different shaped filters.

Referring now to the specific nozzle configuration of figure 2, the arrangement has a saddle (6) for mounting to the blowpipe (3) with the axis (9) in line coaligned with the axis of an outlet aperture in the blowpipe (3). The splitter portion (7) is mounted to the stub nozzle portion by means of side plate spacers (10) and the splitter portion (7) has deflector surfaces (7a,7b) inclined axially outward from the axial direction of the airflow exiting the stub nozzle portion (8). In the arrangement shown in figure 2, the deflector surfaces of the splitter portion (7) direct substantially all the air exiting the stub nozzle portion (8) into 3 separate streams (A B C) each of which airstreams is directed inclined axially outward from the axial direction of the airflow exiting the stub nozzle (8). Separate pairs of deflector surfaces (7a 7b) effectively define separate airstream channels for each of the airstreams (A B C). Substantially all the axially flowing air exiting the stub nozzle (8) is therefore deflected (in a separate respective airstream channel) axially outwardly at a uniform airstream direction for each of the 3 airflows (A B C). The deflector surfaces (7a,7b) inclined axially outward intersect at a longitudinally extending intersection line (7c) which is also inclined axially outwardly from the axial direction of the airflow exiting the stub nozzle portion (8). In this embodiment the separate airstreams are separated at a common leading edge (7d) of the splitter portion (7) which is contiguous with the single outlet opening of the stub nozzle portion (8). To an extent this is enhanced by the spacer side plates (10) separating the airflow into the separate airstreams (A B C) at that common leading edge (7d). The deflector surfaces (7a 7b) for each of the airstreams (A B C) are inclined to a common angle of inclination as are the intersection lines (7c) and the side plate spacers (10). The width of the side plate spacers (8) inclination of the surfaces (7a 7b) and/ or the side plate spacers (10) can be tailored to modify the entrainment characteristics and downstream airstream recombination characteristics for the nozzle at given flow rates. The splitter nozzle portion (7) has a trailing edge (7e), and the initial jet/airstream trajectory is established by the deflector surfaces (7a 7b) before the airstream passes over the trailing edge (7e).

This embodiment is particularly adapted for use in a system designed to clean triangular cross-sectional tapering filters. However, the embodiment is also suitable for use with cylindrical or conical filters.

The embodiment shown in figure 3 is particularly adapted to clean square cross-sectional filters such as pyramid geometry filters and shares many characteristics with the nozzle embodiment of figure 2. The arrangement is arranged to have a splitter portion (7) which has splitter surfaces (7a 7b) which direct the airflow to lead into a planar deflector surface (7f) which is inclined axially outward to a trailing edge (7e). In the arrangement shown in figure 3, the deflector surfaces of the splitter portion (7) direct substantially all the air exiting the stub nozzle portion (8) into 4 separate streams (A B C D) each of which airstreams is directed inclined axially outward from the axial direction of the airflow exiting the stub nozzle (8). Separate groups of splitter and deflector surfaces (7a 7b 7f) effectively define separate airstream channels for each of the airstreams (A B C D). Substantially all the axially flowing air exiting the stub nozzle (8) is therefore deflected (in a separate respective airstream channel) axially outwardly at a uniform airstream direction for each of the 4 airflows (A B C D). In this embodiment the separate airstreams are separated at a leading edge (7d) of the splitter portion (7) which is contiguous with the single outlet opening of the stub nozzle portion (8). This is enhanced/maintained by the spacer side plates (10) separating the airflow into the separate airstreams (A B C D) at the leading edge (7d). The deflector surfaces (7f) for each of the airstreams (A B C D) are inclined to a common angle of inclination as are the side plate spacers (10). The width of the side plate spacers (10) inclination of the surfaces (7f) and/ or the side plate spacers (10) can all be tailored to modify the entrainment characteristics and downstream airstream recombination characteristics for the nozzle at given flow rates. The splitter nozzle portion (7) has a trailing edge (7e), and the initial jet/airstream trajectory is established by the deflector surfaces before the airstream passes over the trailing edge (7e).

Figure 4 shows schematically the geometry of an alternative nozzle splitter portion (7) that can be used to split the airflow into 4 separate airstreams (A B C D). The arrangement is arranged to have a splitter portion (7) which has deflector surfaces (7a 7b) inclined axially outwardly from the axial direction of the airflow exiting the stub nozzle portion (8). In the arrangement shown in figure 4, the deflector surfaces of the splitter portion (7) direct substantially all the air exiting the stub nozzle portion (8) into 4 separate streams (A B C D) each of which airstreams is directed inclined axially outward from the axial direction of the airflow exiting the stub nozzle (8). Separate pairs of deflector surfaces (7a 7b) effectively define separate respective airstream channels for each of the airstreams (A B C D). Substantially all the axially flowing air exiting the stub nozzle (8) is therefore deflected (in a separate respective airstream channel) axially outward at a uniform airstream direction for each of the 4 airflows (A B C D). In this embodiment the separate airstreams are separated at a leading edge (7d) of the splitter portion (7) which is contiguous with the single outlet opening of the stub nozzle portion (8). This is achieved by the spacer side plates (10) separating the airflow into the separate airstreams (A B C D) at the leading edge (7d). The deflector surfaces (7a 7b) for each of the airstreams (A B C D) are inclined to a common angle of inclination as are the side plate spacers (10). The width of the side plate spacers (10) inclination of the surfaces (7a 7b) and/ or the side plate spacers (10) can all be tailored to modify the entrainment characteristics and downstream airstream recombination characteristics for the nozzle at given flow rates. The splitter nozzle portion (7) has a trailing edge (7e), and the initial jet/airstream trajectory is established by the deflector surfaces before the airstream passes over the trailing edge (7e). In this embodiment the side plate spacers (10) taper from a relatively narrower portion near the stub portion (8) to a relatively wider portion towards the trailing edge (7e) in a similar manner to the embodiment of figure 2.

CLAIMS

1. a nozzle for a filter cleaning system, the nozzle comprising:

    i) a stub portion having an inlet opening and an outlet opening; and,

    ii) a splitter portion positioned downstream of the stub portion; wherein the splitter portion has deflector surfaces arranged to direct the airflow exiting the stub portion outlet in 3 or more different/separate airstreams each of which airstreams are directed inclined axially outwardly from the axial direction of the airflow exiting the stub portion outlet.

2. A nozzle according to claim 1, wherein the deflector surfaces directing each airstream are substantially planar.

3. A nozzle according to claim 2, wherein for each airstream, two or more inclined deflector surfaces are provided, meeting at one or more intersections.

4. A nozzle according to claim 3, wherein the intersections are linear and preferably are inclined axially outwardly from the axial direction of the stub portion.

5. A nozzle according to any preceding claim, wherein the stub portion has a single/common outlet opening, which single/comment outlet directs the airflow onto each of the deflector surfaces.

6. A nozzle according to any preceding claim wherein the outlet opening of the stub portion comprises a circular aperture.

7. A nozzle according to any preceding claim, wherein the splitter portion is formed to have spacer sections (such as bridges, walls or webs) to separate the different/separate airstreams.

8. A nozzle according to claim 7, wherein the spacer sections are present extending between adjacent deflector surfaces of the different/separate airstreams.

9. A nozzle according to claim 7 or claim 8, wherein the spacer sections run longitudinally along the length of the splitter portion and are inclined axially outwardly from stub axis.

10. A nozzle according to claim 9, wherein the spacer sections are each inclined axially at the same angle of inclination.

11. A nozzle according to any of claims 7 to 10, wherein the spacer sections extend from the stub portion.

12. A nozzle according to any preceding claim, wherein the deflector surfaces for each airstream define an airstream channel.

13. A nozzle according to claim 12, wherein each airstream channel is of the same shape and configuration as the other separate airstream channels of the nozzle.

14. A nozzle according to any preceding claim, wherein the splitter portion has a deflector surface leading edge configuration in which the airflow exiting the stub outlet is split into the different/separate airstreams at a common point along the longitudinal axis of the nozzle.

15. A nozzle according to any preceding claim, wherein the splitter portion has a deflector surface leading edge configuration in which the airflow exiting the stub outlet is split into the different/separate airstreams, the leading edge being positioned contiguous with the outlet opening of the stub portion.

16. A nozzle according to any preceding claim, wherein the splitter portion has a deflector surface leading edge configuration in which the airflow exiting the stub outlet is split into the different/separate airstreams, the deflector surface leading edge configuration extending transversely across the entirety of the outlet opening of the stub portion.

17. A filter cleaning system including a nozzle according to any preceding claim.

18. A filter cleaning system according to claim 17 and further comprising a source of compressed air and means for delivering the compressed air to the nozzle.

19. A filter cleaning system according to claim 17 or claim 18 and further comprising a pulsation system for pulsing the air delivered to the nozzle.

20. A filtration system comprising a filter mounted in a filter housing adjacent a filter cleaning system in accordance with claim 17.

Intellectual Property Office

Application No:	GB2002551.6	**Examiner:**	Mr Rhys J. Williams
Claims searched:	1-20	**Date of search:**	22 July 2020

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A	-	US 2018/0071669 A1 (JACKSON) See whole document.
A	-	US 2005/0120881 A1 (SPORRE) See whole document.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B01D; B05B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
B05B	0001/26	01/01/2006
B01D	0046/00	01/01/2006
B01D	0046/04	01/01/2006
B05B	0001/02	01/01/2006