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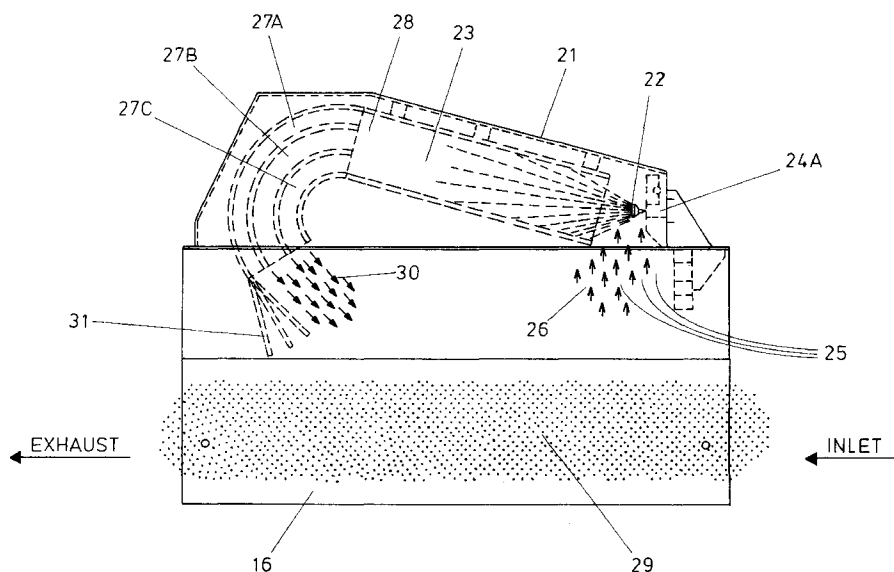
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(54) Particulate matter extraction device

(57) The device is for extracting gas-borne particulate matter from a partly enclosed space through which a mass of bulk material is being conveyed. The device comprises a casing having an entry end and an exit end arranged to allow a conveyor to move through the casing in order to convey a mass of bulk material through the casing. The device includes a duct mounted on the casing and having an inlet which communicates with the casing so as to extract gas-borne particulate matter from

the casing and an outlet communicating with the casing in order to return the particulate matter to the casing. A liquid nozzle is arranged in the duct so as to direct a jet spray of liquid in a direction towards the outlet and thereby induce a flow of gas-borne particulate material into the duct through the inlet thereof and which material is wetted prior to return of the material to the casing via the outlet. The outlet being arranged in use to direct the wetted material downwardly onto a collection surface located in the casing.

**FIG. 3****EP 0 853 985 A2**

Description

The present invention relates to a particulate matter extraction device and particularly, though not exclusively, to a device to control and remove gas borne, particulate matter produced by mechanical devices that break or move solid materials by grinding, milling, crushing or scraping. Particulate matter that is suspended in air, or other gaseous mediums, is captured, moved or otherwise generally controlled by causing the particulate matter to collect on a surface, often a conveyor, or other material removal system.

There is a need, in the process of the removal of the top surface of roads when re-surfacing is required, for a device to minimise the amount of polluting dust that escapes into the atmosphere. Typically the top surface of roads is made from bitumen and local aggregates, such as granite and quartz, so that when the top surface of a road is cut, large amounts of hazardous quartz dust can be generated and discharged into the atmosphere. A commission of five European states has been formed to address the problem of road cutting dust generation, but so far only a 15% decrease in the amount of dust polluting the atmosphere has been achieved.

In accordance with a first aspect of the present invention, there is provided a device (20) for extracting gas-borne particulate matter (25) from a partly enclosed space through which a mass of bulk material is being conveyed, said device comprising:

a casing (17) having an entry end and an exit end, said casing being arranged to allow a conveyor (16) to move through the casing in order to convey a mass of bulk material through the casing;
a duct (21) mounted on the casing (17) and having an inlet which communicates with the casing so as to extract gas-borne particulate matter from the casing, and an outlet communicating with the casing in order to return the particulate matter to the casing; and
a liquid nozzle arranged in the duct so as to direct a jet spray of liquid in a direction towards the outlet and thereby induce a flow of gas-borne particulate matter into the duct through the inlet thereof and which material is wetted prior to return of the material to the casing via the outlet, said outlet being arranged in use to direct the wetted material downwardly onto a collection surface located in the casing.

Preferably the collection surface is the surface (29) of the bulk material which is being transported through the casing.

In a preferred arrangement, the collecting surface is formed by a porous collection surface (32) located under the outlet.

Preferably, the outlet of the duct is arranged to direct the wetted particulate matter in a direction having a com-

ponent which is counter to the conveying direction of the bulk material. The outlet may include a baffle flap, and preferably the baffle flap is adjustable in order to vary the direction of discharge of the wetted material.

More than one jet spray nozzle may be arranged within the duct, near to the inlet thereof. The duct may incorporate arcuate tubes which have downstream ends which are located at the outlet of the duct. The device may be incorporated in a conveyor casing of a road-surface planing machine. The conveyor casing may be substantially sealed to prevent the egress of dust.

In accordance with a further aspect of the present invention, there is provided a method of extracting gas-borne particulate matter from a partly enclosed space through which a mass of bulk material is being conveyed, and passing the extracted material through a duct which is mounted on the casing and applying a wetting treatment to the material prior to returning the material to the casing, said duct having an inlet and an outlet each communicating with the casing, and said method comprising: directing a jet spray of liquid through the duct and in a direction towards the outlet of the duct so as to induce a flow of gas-borne particulate material from the casing and through the inlet, said spray also wetting the particulate material before it issues from the outlet; and guiding the issuing flow of wetted material from the duct and in a direction towards a collection surface in the casing so as to accrete to the collection surface.

The nature of the invention and the manner in which it may be performed will be better understood from the following detailed description of one specific embodiment thereof, by way of illustration only, and with reference to the accompanying drawings, wherein:

Figure 1 is a schematic diagram showing a conventional system for collecting solid matter generated by a cutting machine;

Figure 2 is a perspective view of an embodiment of the device for extracting particulate matter according to the present invention;

Figure 3 is a side elevation of the device shown in Figure 2;

Figure 4 is a plan view of the device; and

Figure 5 is a side elevation of a modified device including a porous collection surface.

Identical articles in the different Figures share common reference numerals. With reference to Figure 1, there is shown a conventional system for collecting solid matter generated by a cutting machine, generally designated by reference numeral 10. A cutting machine 11, such as a road-surface planer, crusher, or other surface material cutter, comprises a cutting means 12 located within a substantially sealed casing 13 which prevents dust 14 produced as a result of the cutting operation from escaping to the atmosphere. Material cut by the cutting means passes to a first conveyor 15 which is par-

tially located in the casing and partially external to the casing. Material from the first conveyor means is transferred to the entry end of a second main conveyor 16 substantially enclosed by a casing 17, forming a partly enclosed space through which a mass of bulk material is conveyed. Typically the second main conveyor may comprise a fully enclosed trough conveyor. The cut material is transported along the second main conveyor and transferred from the exit end to a container 18 which precedes the cutting machine as it travels along the surface it is cutting, from right to left in Figure 1. The transfer rate of material cut from the top surface of a road is up to approximately 24 tons in approximately five minutes. However, during transferring the cut material from the cutting machine to the container, significant amounts of polluting particulate material are lost to the atmosphere when the cut material is transferred from the first conveyor to the main conveyor and from the main conveyor to the container. Of particular concern is the generation of particulate quartz pollution.

A preferred embodiment of the device according to the invention will now be described with reference to Figures 2 to 4. The device is designated generally by reference numeral 20, and is intended to extract gas-borne particulate matter. By way of example only, the device 20 will be described in respect of the extraction of gas-borne particulate matter which has been generated by the system shown in Figure 1.

There is provided a duct 21 which is configured such that the device may be fitted as a replacement block into a section of the main conveyor casing 17 with the device mounted on the roof of the main conveyor casing. A jet spray of liquid 22 is directed into and along a main cavity 23 by forcing a liquid at high pressure through a pair 24a, 24b of similar liquid nozzles. The main cavity has typical dimensions of approximately 0.5m wide and 0.1m deep, the liquid is at a typical pressure of 1500psi and the nozzles are such that the jet of liquid generated is virtually a vapour. Within the casing of the conveyor 17 there is a large volume of air with particulate matter 25 suspended therein. By virtue of the Venturi effect, the jet spray of liquid causes the pressure at the inlet to the cavity 26 to be lower than the pressure within the casing, which is approximately ambient, so that the suspension of particulate matter and air is sucked into the main body of the cavity. At the far end of the cavity, there are provided three substantially parallel, arcuate passages 27a, 27b, 27c, each having a depth less than that of the main cavity and each in communication with the main cavity.

The particulate matter and air suspension intermingle with the droplets of the jet of liquid as they pass along the main cavity towards the entrances of the arcuate passages 28. After passing into the arcuate passages, the particulate matter and air suspension and liquid droplets are compressed and caused to further intermingle by virtue of the arcuate passages having a lesser depth and hence lesser relative volume than compared

with the main cavity. The arcuate passages are arranged to direct the material that passes through them toward a collection surface 29, which may be constituted by the upper surface of a mass of bulk cut material which is laying on, and being transported past the device by, the main conveyor 16. The action of the wetted particulate matter exiting from the downstream ends of the arcuate passages at the outlet 30 of the duct and impacting on the collection surface 29 (in a direction having a component which is counter to the conveying direction of the main mass of conveyed bulk material), causes the wetted particulate matter to accrete to the collection surface and be carried away by the mass of bulk cut material, thereby removing particulate matter from the air volume within the main conveyor casing. That particulate matter which does not accrete to the impact surface travels back to the inlet 26 to the main cavity and recirculates through the device together with any further particulate matter newly arrived at the main cavity inlet.

There is also provided an adjustable baffle flap 31 located at the outlet of the duct, which can be positioned to vary the constriction of the downstream ends of the arcuate passages and the direction of discharge of the wetted material, thereby controlling the speed at which material is sucked into the inlet and exhausted from the outlet of the device so as to control the circulation rate through the device. The adjustment of the baffle flap 31 may be varied according to conditions, including (i) speed of the conveyor, (ii) the nature of the material being handled and (iii) the speed and pressure of the water jets. The process of particulate matter removal is circulatory so that any particulate matter that is not removed by impacting with the collection surface is recirculated through the device by the action of the liquid jet.

The device may be modified and provided with a porous collection surface instead of or in addition to the collection surface provided by the conveyed bulk material. A porous collection surface provides a means of impacting the wetted particulate matter to remove it from suspension while allowing the liquid to pass through the collection surface. Hence the collection surface may be constituted by any material having sufficient surface area to act as an impact surface to remove particulate matter by accretion as well as having pores passing through the material to allow the liquid to pass through the collection surface without collecting on it.

As shown in Figure 5, the porous collection surface 32 is provided between the outlet of the duct 30 and above the surface of the conveyed bulk material at a position so that the exhausted wetted particulate matter 30 is caused to impact on the porous collection surface. The porous collection surface may have the form of a rigid plate providing an impact surface 33 to which wetted material accretes and passages 34 through the collection surface via which fluid may pass so as not to collect on the porous collection surface.

The provision of a porous collection surface helps to prevent the generation of further particulate pollution

by the action of the wetted matter disturbing particulate matter from the bulk conveyed material. This can occur when a high pressure water jet, and consequently high momentum wetted particulate matter, is required to extract the particulate material. Hence the porous collection surface is positioned to act as a shield to prevent direct high momentum impacts of wetted material on the conveyed bulk material.

The porous collection surface can take many forms. It may be in the form of a folded metal chain held in a container so that the surface of the chain acts as the impact surface and the holes in the chain links and gaps act as the pores providing passages for the liquid to pass through the chain. Sufficient chain is provided that there is no direct route through the chain for wetted material to pass without impacting the chain surface. The liquid from the wetted material can gradually percolate through the gaps in the chain material and drop onto the bulk conveyed material. Any rigid formation with tortuous paths through it to prevent the direct transmittal of wetted material would be suitable as a porous collection surface.

The porosity of the porous collection surface can be chosen so that if it is highly porous both the porous collection surface and the bulk conveyed matter act as collection surfaces; i.e. the porous collection surface does not entirely shield the bulk conveyed material from wetted material impacts so that it also acts to collect wetted matter. Alternatively, the porosity can be low so that there are no direct wetted material impacts on the bulk conveyed material.

It has been found that simply spraying a fine mist of liquid, or foam, downwardly as a curtain onto a gaseous suspension of particulate matter does not achieve satisfactory separation of the particulate matter from the suspension. Rather, the step of impacting the wetted particulate matter with a collection surface such as the main mass of conveyed bulk material, so that the particulate matter accretes thereto, has been found to be necessary in order to successfully separate out the particulate matter. By using the main mass of conveyed bulk material as a collection surface, a further benefit of the device is provided. The wetted particulate matter that accretes to the main mass, produces a coating which acts to seal-in any particulate matter that has not yet been released from the conveyed bulk material, thereby further preventing the generation of particulate matter which may act as a source of pollution as the conveyed bulk material is further transported.

Preferably the casing 17 surrounding the conveying means 16 is substantially sealed along the length of the conveyor. This helps to prevent the egress of polluting particulate matter from the casing 17 which can be caused if the wetted particulate matter 30 disturbs further particulate matter from the bulk conveyed material 29 as the wetted particulate matter impacts the conveyed bulk material.

Typically the liquid used in the device is water and

by reason of the jet arrangement, can be consumed at a modest rate of approximately 4.5 litres per minute.

It is envisaged that the device of this invention may also be applied to extract particulate matter suspended in gas in a volume enclosing other types of transported material, whenever the transported material is such that combining the material with a liquid does not damage the transported material, e.g. waste materials that produce particulate matter and any particulate materials that can be combined with a liquid without having a deleterious effect on the transported materials. In particular, a device according to this invention may be used in waste handling vehicles which use a vacuum, or some other method, to collect particulate matter and filter the particulate matter from an exhaust gas, to replace or complement the filtering stage. Further a device according to this invention may be used to control dust generated when conveying quarried materials, or material coming from crushing machines.

Claims

1. A device (20) for extracting gas-borne particulate matter (25) from a partly enclosed space through which a mass of bulk material is being conveyed, said device comprising:

a casing (17) having an entry end and an exit end, said casing being arranged to allow a conveyor (16) to move through the casing in order to convey a mass of bulk material through the casing;

a duct (21) mounted on the casing (17) and having an inlet which communicates with the casing so as to extract gas-borne particulate matter from the casing, and an outlet communicating with the casing in order to return the particulate matter to the casing; and

a liquid nozzle arranged in the duct so as to direct a jet spray of liquid in a direction towards the outlet and thereby induce a flow of gas-borne particulate material into the duct through the inlet thereof and which material is wetted prior to return of the material to the casing via the outlet, said outlet being arranged in use to direct the wetted material downwardly onto a collection surface located in the casing.

2. A device according to claim 1 in which said collection surface is formed by the surface (29) of the bulk material which is being conveyed through the casing.
3. A device according to claim 1, in which the device has a porous collection surface (32) located under the outlet and acting as said collection surface.

4. A device according to claim 1, in which the outlet of the duct is arranged to direct the wetted particulate material in a direction having a component which is counter to the conveying direction of the bulk material. 5
5. A device according to claim 4, in which the outlet includes a baffle flap.
6. A device according to claim 5, in which the baffle flap is adjustable in order to vary the direction of discharge of the wetted material. 10
7. A device according to anyone of claims 1 to 6, in which more than one jet spray nozzle is arranged within the duct, near to the inlet thereof. 15
8. A device according to any one of claims 1 to 7, in which the duct incorporates arcuate tubes (27a,b, c) which have downstream ends which are located at the outlet of the duct. 20
9. A device according to any one of claims 1 to 8, and incorporated in a conveyor casing of a road-surface planing machine. 25
10. A method of extracting gas-borne particulate matter (25) from a partly enclosed space through which a mass of bulk material is being conveyed, and passing the extracted material through a duct which is mounted on the casing and applying a wetting treatment to the material prior to returning the material to the casing, said duct having an inlet and an outlet each communicating with the casing, and said method comprising: 30
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directing a jet spray of liquid through the duct and in a direction towards the outlet of the duct so as to induce a flow of gas-borne particulate material from the casing and through the inlet, said spray also wetting the particulate material before it issues from the outlet; and 40
guiding the issuing flow of wetted material from the duct and in a direction towards a collection surface in the casing so as to accrete to the collection surface. 45

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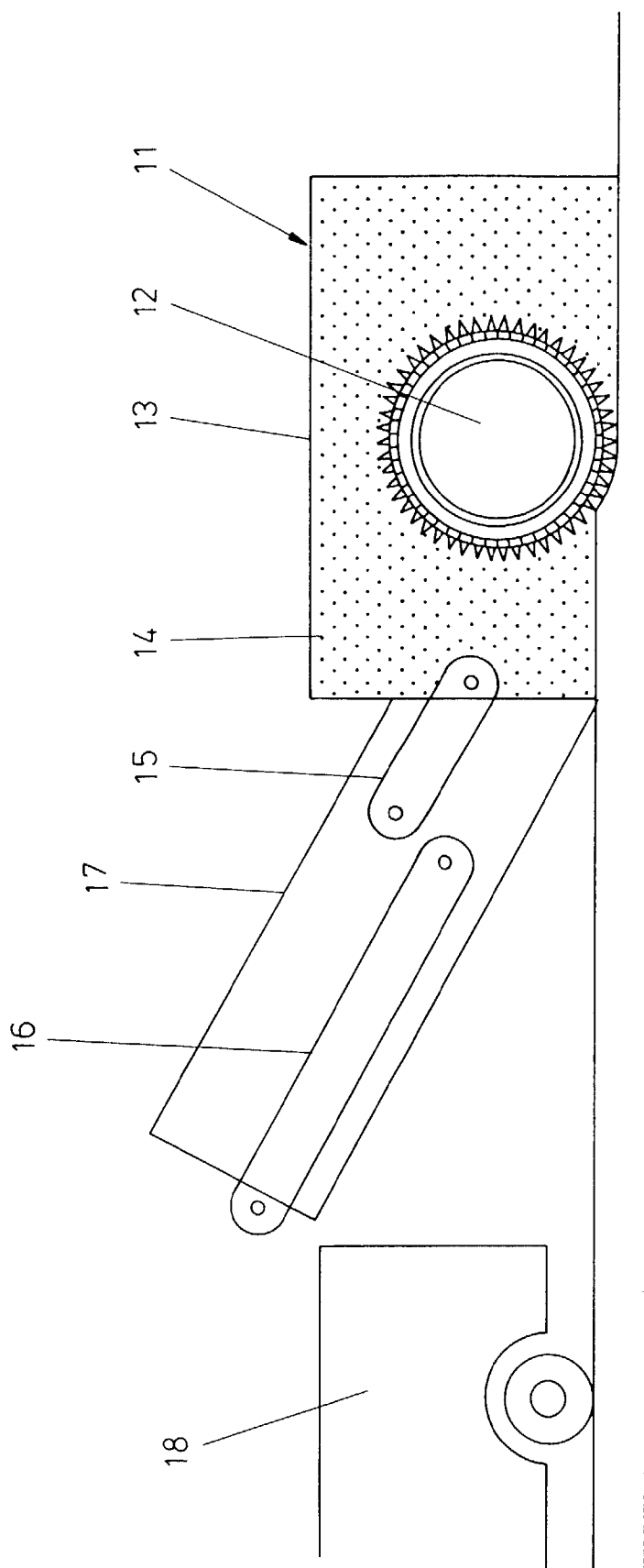


FIG. 1

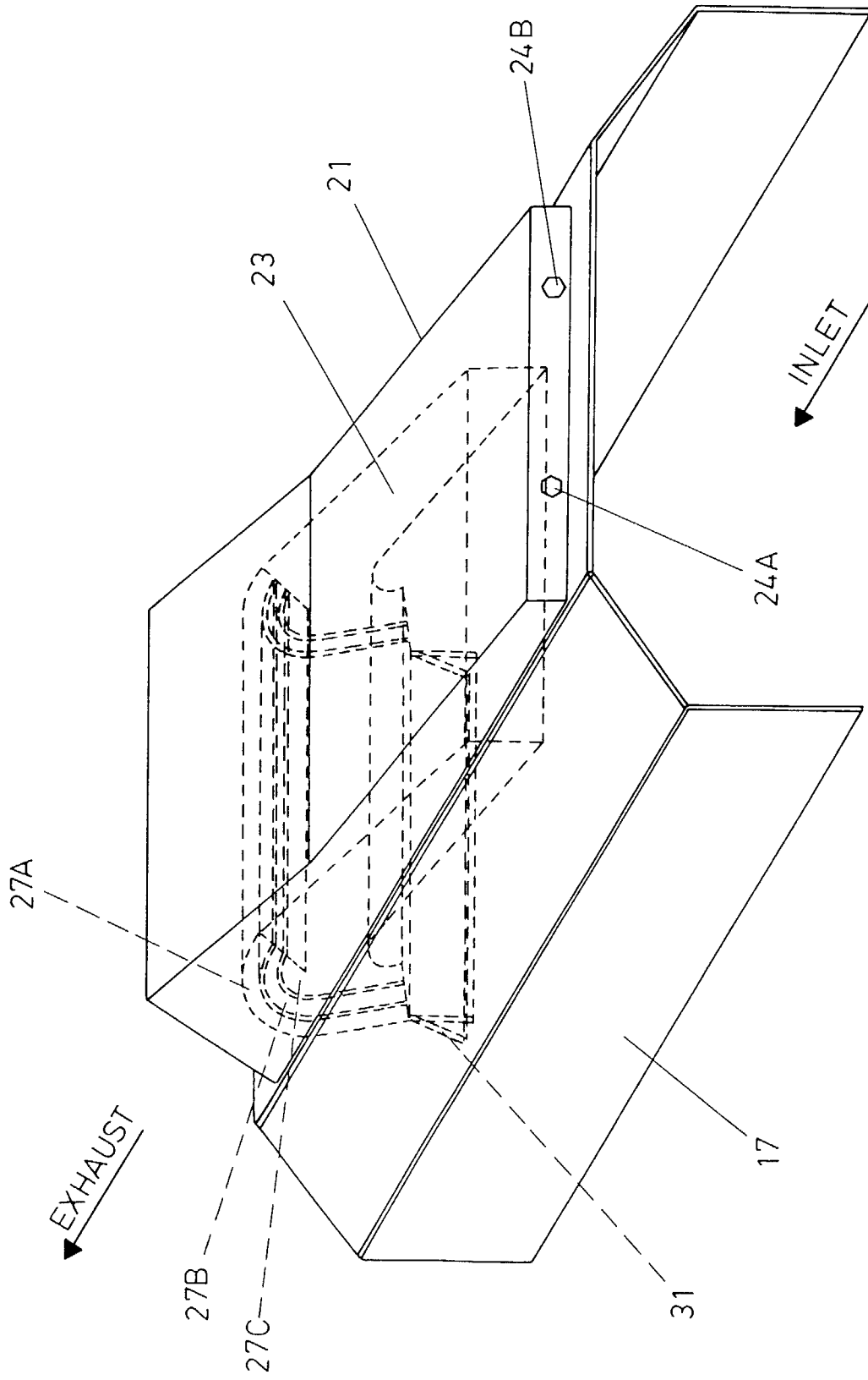


FIG. 2

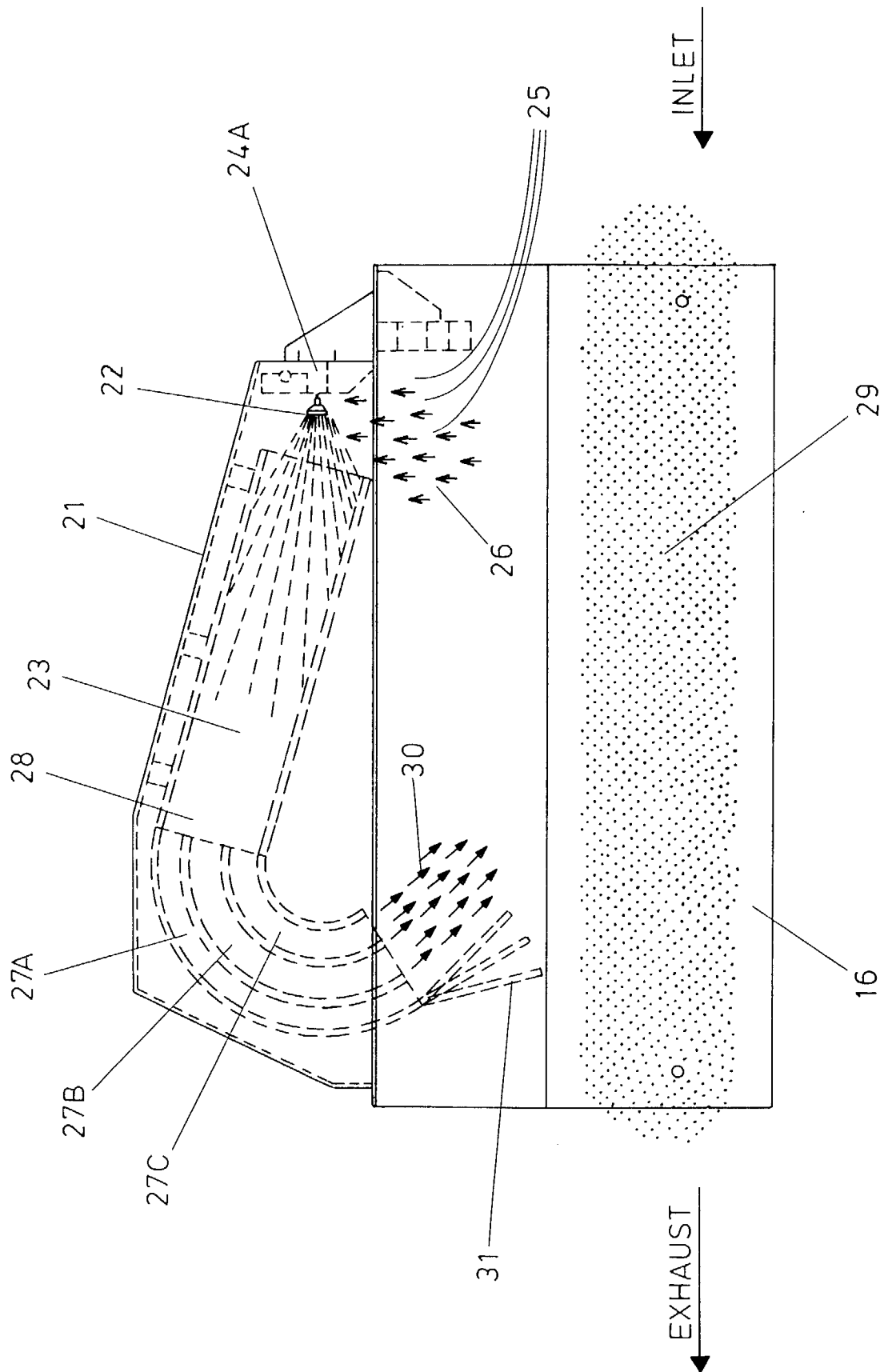


FIG. 3

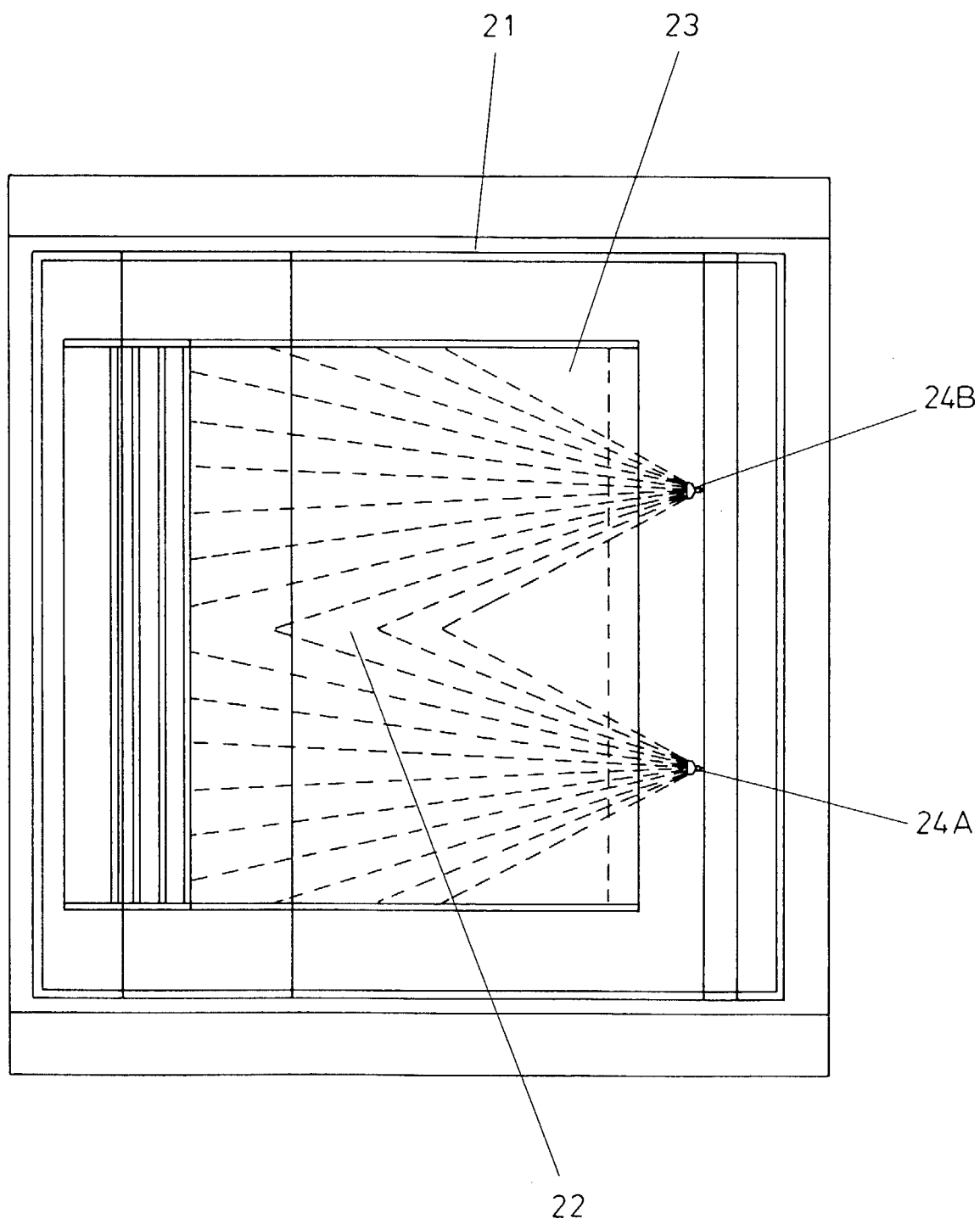


FIG. 4

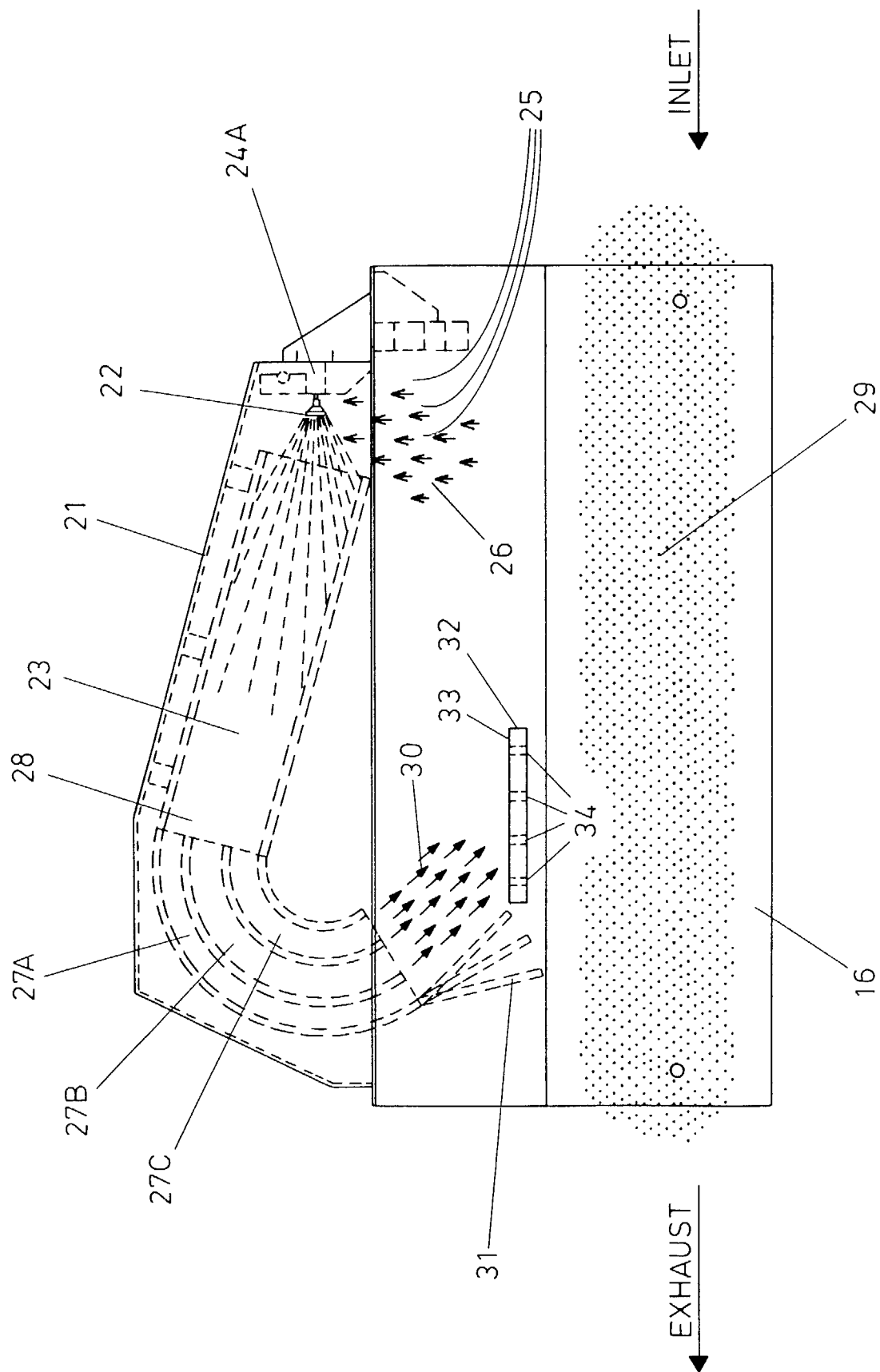


FIG. 5