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(71) Applicant: **Alstom Technology Ltd**
5400 Baden (CH)

(72) Inventors:
- **Hjelmberg, Anders Erik**
  352 44, Växjö (SE)
- **Tabikh, Ali Mustapha**
  352 53, Växjö (SE)

(74) Representative: **Jacobsson, Peter**
Awapatent AB
Östra Storgatan 7
553 21 Jönköping (SE)

(54) **Duct transition arrangement**

(57) The present disclosure provides a duct transition arrangement (1) for use in an exhaust gas cleaning system. The exhaust gas cleaning system comprises an inlet duct (10), an outlet duct (20), and a transition duct (30) connecting the inlet duct to the outlet duct. Once so connected, flue gases flow through the system from the inlet duct through the transition duct and into the outlet duct. The transition duct comprises at least one expanded screen (31) for distribution of gas flow through the transition duct.

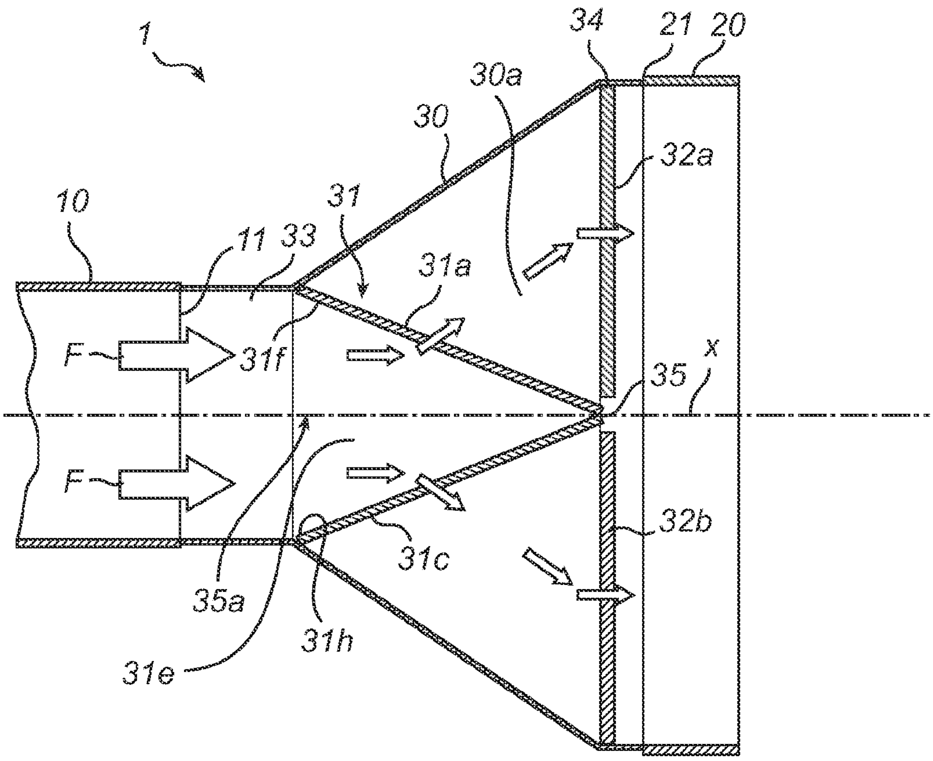

Fig. 4a

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Description

Technical field

[0001] The present disclosure relates to a gas cleaning system, such as a catalytic reduction system or an electrostatic precipitator system, for use in an industrial process plant, such as a fossil-fueled power plant or a waste incineration plant. More particularly, the present disclosure relates to a duct transition arrangement for use in an exhaust gas cleaning system and a method of using the same.

Background

[0002] In the combustion of a fuel, such as coal, oil, peat, waste, etc. in an industrial process plant, such as a fossil-fuelled power plant, a hot process gas is generated, such process gas containing, among other components, dust particles, sometimes referred to as fly ash, and nitrogen oxides. The dust particles are often removed from the process gas by means of a dust removal device, such as an electrostatic precipitator, also called an ESP, or a fabric filter. An ESP system is described in US 4,502,872 incorporated herein in its entirety by reference.

[0003] Between an inlet duct and the ESP processing reactor, a transition duct is arranged. One purpose of the transition duct is to distribute the process gas for flow into the ESP since the inlet duct normally has a smaller cross-sectional area than that of the ESP processing reactor. In existing ESP designs, such as in US 4,207,083 incorporated herein in its entirety by reference, the inlet duct is provided with perforated plates to distribute the process gas to flow over the complete interior area of the ESP. Another solution may be to use guide vanes, such as disclosed in GB346635, to direct and distribute the flow of incoming process gas. Such arrangements with perforated plates and/or guide vanes such as W004067183, need to be tuned after installation and at start up to deliver an even gas distribution. Further, such arrangements consist of many small pieces to be manufactured and assembled. Such arrangements are also expensive due to the special manufacturing requirements of the perforated plates, which plates also add substantial steel weight to the arrangement. During manufacture, the perforated plates are punched and cut such that a significant amount of material goes to waste. The outlet from the ESP, from the reactor casing to a duct, is typically also equipped with similar perforated plates to achieve a good velocity profile downstream of the ESP.

[0004] Consequently, there is a need for another simpler and more cost-effective transition device for efficiently providing an even velocity distribution and/or particle distribution in a duct positioned downstream the transition device.

Summary

[0005] The present disclosure provides a duct transition arrangement that alleviates at least some of the fore mentioned drawbacks associated with present duct transition arrangements.

[0006] Such is achieved by providing a duct transition arrangement for use in a process gas cleaning system. The process gas cleaning system comprises a transition duct fluidly connecting an inlet duct of an inlet duct perimeter to an outlet duct of an outlet duct perimeter that differs from the inlet duct perimeter such that flue gases flow from the inlet duct through the fluidly connected transition duct toward fluidly connected outlet duct. The arrangement is characterized in that the transition duct comprises at least one expanded screen for distribution of flue gas flowing through the transition duct.

[0007] A duct transition arrangement as described above with an expanded screen incorporated therein may effectively distribute and direct flue gas flow. Further, tuning requirements of the duct transition arrangement at start up may be eliminated. The duct transition arrangement as disclosed may reduce manufacturing and installation costs due to fewer parts, less assembly and less construction material consumption. Less material may be used to manufacture an expanded screen than is typically used to manufacture a perforated plate. The subject duct transition arrangement may further increase the robustness of the process gas cleaning system to variations in upstream conditions with regard to the flow of flue gas. Such variations may be differences in the flue gas inlet velocity profile. A stable and even flue gas inlet velocity profile may be achieved downstream the expanded screen. Such may also lend itself to a duct transition arrangement of a more compact design in the exhaust gas cleaning system. A duct transition arrangement of a more compact design may contribute less weight and require less construction material in its manufacture for use in the exhaust gas cleaning system. A duct transition arrangement of a more compact design may further provide a possibility of integrating the arrangement into a duct bend. The transverse cross-sectional areas of the inlet duct and the outlet duct taken at similar points perpendicular to their longitudinal expanses, may differ in size. For instance, the inlet transverse cross-sectional area taken perpendicular to a longitudinal expanse of the inlet duct may be smaller than the outlet transverse cross-sectional area taken perpendicular to a longitudinal expanse of the outlet duct, or vice verse. The differently sized transverse cross-sectional areas of the inlet duct and the outlet duct may also differ in shape. The duct transition arrangement may thereby be designed as a fluidly connected coupling between the inlet duct and the outlet duct. The duct transition arrangement may for instance be connected to an inlet duct with a circular periphery and an outlet duct with a rectangular or square periphery, or vice verse. The inlet duct and outlet duct may also be of any other shape, other than circular, square or rectangular.

[0008] According to one aspect, the at least one expanded screen may be bent or two or more expanded screens may be combined to form an angle arranged in the inlet duct and/or the outlet duct of a duct transition arrangement. Such an angle is formed when one or a portion of one expanded screen forms a first plane of the angle and a second or a portion of the first expanded screen forms a second plane of the angle. Opposed to the angle point are the free edges of the one or more expanded screens. Using the expanded screen angle, a relatively even flue gas velocity distribution may be achieved with few parts, little assembly and low pressure drop. Such a duct transition arrangement may be placed at an inlet or an outlet of an ESP. Strict requirements regarding even flue gas flow distribution and controlled flue gas direction of flow for the ESP may thus be met. If the duct transition arrangement is placed such that the transverse cross-sectional area of the transition duct taken perpendicular to the longitudinal expanse of the transition duct, increases in the direction of the flue gas flow, the angle point may be placed downstream with respect to the flow of flue gas, from the opposed free edges, i.e., to "point" in the direction of or with the flue gas flow. If the arrangement is placed such that the transverse cross-sectional area of the transition duct taken perpendicular to the longitudinal expanse of the transition duct, decreases in the direction of the flue gas flow, the angle point may be placed upstream with respect to the flow of flue gas, from the opposed free edges, i.e., to "point" in the opposite direction of or against the flue gas flow.

[0009] According to another aspect, the outlet transverse cross-sectional area may be larger than the inlet transverse cross-sectional area taken at similar points, and the angle point of the expanded screen may point in the direction of or with the flue gas flow. The transition duct may thereby be placed at an inlet to an ESP reactor such that the transverse cross-sectional area of the transition duct may increase in the direction of the flue gas flow. The angle point formed by the at least one expanded screen may thereby point in the direction of the flue gas flow and the increasing transverse cross-sectional area of the transition duct. The at least one expanded screen so positioned may provide an effective and even distribution and direction of flue gas flow through an ESP reactor inlet. The outlet transverse cross-sectional area being larger than the inlet transverse cross-sectional area may substantially be realized in that the outlet transverse cross-section differs in shape from the inlet transverse cross-section. For instance, the outlet transverse cross-section may be rectangular in shape and the inlet transverse cross-section may be circular in shape, or vice verse.

[0010] According to yet another aspect, the outlet duct transverse cross-sectional area may be smaller than the inlet transverse cross-sectional area taken at similar points, and the angle point formed by the at least one expanded screen may point in the opposite direction of or against the flue gas flow. The transition duct may thereby be placed at an outlet of an ESP reactor such that the transverse cross-sectional area of the transition duct may decrease in the direction of the flue gas flow. The angle point formed by the at least one expanded screen may thereby point in the opposite direction of the flue gas flow and the decreasing transverse cross-sectional area of the transition duct. The at least one expanded screen so positioned may provide an effective and even distribution and direction of the flue gas flow through an ESP reactor outlet. The outlet transverse cross-sectional area being smaller than the inlet transverse cross-sectional area may substantially be realized in that the outlet cross-section differs in shape from the inlet cross-section. For instance, the outlet cross-section may be rectangular or square in shape and the inlet cross-section may be circular in shape, or vice verse.

[0011] According to a further aspect, the at least one expanded screen may comprise one or more expanded screens folded or combined to form a foursided "pyramid" formation. A rectangular "base" of such an expanded screen pyramid may be formed and sized appropriately, for instance if the inlet duct has a rectangular cross-section. The expanded screen pyramid may provide a distribution and direction of the flue gas flow that is even in all four directions of the rectangular pyramid form. This may provide an even distribution and velocity profile throughout the flowing flue gas affected thereby.

[0012] According to one aspect, the at least one expanded screen may comprise one or more expanded screens in a "cone" formation. If the inlet duct has a circular cross-section, a cone formation may be formed and sized by one or more expanded screens for suitable accommodation of the circular cone "base" within the circular inlet duct. One expanded screen may be bent to form a cone with an open base and a pointed top. The bent expanded screen may be welded, glued or the like to form and maintain the cone shape. The point of the expanded screen cone may point in the direction of or in the opposite direction of the flue gas flow, depending on the placement of the arrangement.

[0013] According to another aspect, the at least one expanded screen may comprise one or more flat screens extending in a plane or planes substantially perpendicular to a longitudinal axis of the duct transition arrangement. Thereby, such duct transition arrangement with at least one expanded screen incorporated therein may effectively distribute and direct flue gas flow. Further, tuning requirements of the duct transition arrangement at start up may be eliminated. The duct transition arrangement as disclosed may reduce manufacturing and installation costs due to fewer parts, less assembly and less construction material consumption. Less construction material may be used to manufacture an expanded screen than is typically used to manufacture a perforated plate. The subject duct transition arrangement may further increase the robustness of the process gas cleaning system to variations in upstream conditions with regard to the flow of flue gas. Such variations may be differences in the flue gas inlet velocity profile. A stable and even flue gas inlet velocity profile may be achieved downstream the expanded screen.

[0014] According to a further aspect, the transition duct arrangement may further comprise an outlet expanded screen positioned in a plane substantially perpendicular to that of a longitudinal axis of the duct transition arrangement. Thereby, the flue gas flow may be evenly distributed by the outlet expanded screen after the flue gas has already been evenly distributed by the at least one expanded screen. As such, the flue gas may flow into and through the outlet duct in a direction substantially parallel to the longitudinal axis of the duct transition arrangement. With the outlet expanded screen arranged in the transition duct, additional flue gas directing effect may be achieved. Further, a skewed velocity profile in the gas flow may be evened out with less pressure drop. It may be advantageous with two expanded screens that each influences the gas flow to a lesser degree with regard to directing the gas flow, evening the velocity profile, and the like. It may further be easier to achieve a robust duct transition arrangement when constructing the duct transition arrangement with the outlet expanded screen positioned in the transition duct arrangement.

[0015] According to another aspect, the outlet expanded screen may be arranged at an end of the transition duct. The outlet expanded screen may be arranged inside the transition duct relatively close to the end of the transition duct that may be fluidly connected to the outlet duct.

[0016] According to yet another aspect, the cross-sectional area or at least a portion of the outlet expanded screen may be substantially similar in shape to that of the transition duct periphery where it is to be positioned. Thereby, the "base" or at least a portion of the outlet expanded screen may abut substantially the entire periphery of the transition duct and occupy substantially the entire transverse cross-section of the transition duct where positioned. As such, substantially all of the flue gas flowing through the transition duct may thereby flow through the outlet expanded screen on route to the outlet duct.

[0017] According to one aspect, the at least one expanded screen may be arranged such that all flue gas that may flow through the inlet duct may pass through the at least one expanded screen. The at least one expanded screen may be arranged such that an opening in the transition duct toward the inlet duct is not completely covered by the at least one expanded screen. However, the at least one expanded screen may be positioned within the transition duct such that all of the flue gas may flow through the at least one expanded screen. Thereby, the distribution and direction of the flue gas flow may be effectively controlled since all of the flue gas passes through the at least one expanded screen.

[0018] According to another aspect, the at least one expanded screen may be made of metal. By using a metal as the construction material for the at least one expanded screen, a robust screen may be achieved with a long working lifetime. Examples of suitable metals for construction of the subject expanded screens are tempered sheet-metal such as sheet iron e.g. Hardox™ (SSAB Svenskt Stal Aktiebolag Corporation, Sweden), or stainless materials, especially for use in corrosive environments. The at least one expanded screen may further be made of many different plastic deformable materials. The plastic deformable material may be a kind of rigid plastic, such as Teflon™ (E.I. Du Pont De Nemours and Company Corporation, USA) or polypropylene (PP). Such material may mainly be used in an environment that demands special material characteristics such as corrosion resistance.

[0019] According to yet another aspect, a reactor duct arrangement for use in an exhaust gas cleaning system is provided, comprising a reactor duct in which a reactor for processing flue gases is positioned, and a reactor inlet transition duct arrangement for distributing the flow of flue gas from a reactor inlet duct to the reactor duct. The reactor inlet transition duct arrangement comprises a first transition duct, wherein an inlet end of the first transition duct has a first transverse cross-sectional area, and an outlet end of the first transition duct has a second transverse cross-sectional area that is larger than the first cross-sectional area. The reactor duct arrangement further comprises a reactor outlet transition duct arrangement for distributing the flow of flue gas from the reactor duct to a reactor outlet duct. The reactor outlet transition duct arrangement comprises a second transition duct, wherein an inlet end of the second transition duct has a third transverse cross-sectional area, and an outlet end of the second transition duct has a fourth transverse cross-sectional area smaller than that of the third transverse cross-sectional area. The first transition duct and the second transition duct each comprise at least one expanded screen for distribution of flue gas flow through the reactor transition duct arrangement.

[0020] Thereby, a reactor duct arrangement may be provided that effectively distributes and directs a flow of flue gas into and out from a reactor duct. The expanded screens may eliminate the need for tuning the arrangement at start up, which together with a reduction in construction material consumption provides a more cost-effective solution than that of the prior art. The reactor duct arrangement may also be more robust with regard to variations in upstream conditions in the exhaust gas cleaning system and may cause less of a pressure drop than existing perforated plates.

[0021] According to yet another aspect, a method for controlling gas flow in an exhaust gas cleaning system is provided. The method comprises directing gas flow from an inlet duct of an inlet duct perimeter to an outlet duct of an outlet duct perimeter that differs from the inlet duct perimeter, through a transition duct fluidly connecting the inlet duct to the outlet duct using at least one expanded screen arranged in the transition duct for distribution of gas flow through the transition duct.

Brief description of the drawings

[0022] Referring now to the figures, which are exemplary embodiments of the present system, wherein like elements are numbered alike:

Fig. 1 is a schematic side view of a reactor arrangement according to an embodiment of the present disclosure;
Fig. 2 is a perspective view of a transition duct according to an embodiment of the present disclosure;
Fig. 3 is a perspective view of a transition duct according to another embodiment of the present disclosure;
Fig. 4a is a schematic cross-sectional side view of an inlet duct transition arrangement according to an embodiment of the present disclosure;
Fig. 4b is a schematic cross-sectional side view of an outlet duct transition arrangement according to an embodiment of the present disclosure;
Fig. 5 is a perspective view of an expanded screen according to an embodiment of the present disclosure;
Fig. 6 is a schematic cross-sectional side view of an inlet duct transition arrangement according to an embodiment of the present disclosure; and
Fig. 7 is a schematic cross-sectional side view of an inlet duct transition arrangement according to an embodiment of the present disclosure.

Description of Embodiments

[0023] According to Fig. 1, a reactor duct arrangement 100 is illustrated that comprises a reactor inlet duct transition arrangement 105, a reactor duct 101 and a reactor outlet duct transition arrangement 106. The reactor duct 101 comprises a reactor 102, such as an ESP reactor for processing flue gases entering the reactor duct 101 as a flow of flue gas F.

[0024] Flue gas F enters the reactor duct arrangement 100 through a reactor inlet duct 103. The flue gas F flows into reactor inlet duct 103, through reactor inlet duct transition arrangement 105 and into reactor duct 101 thereby passing through reactor 102. After passing through reactor 102, the flue gas F flows through reactor outlet duct transition arrangement 106 and into reactor outlet duct 104.

[0025] The reactor inlet duct 103 defines a first interior area 103a. The reactor duct 101 defines a second interior area 101 a that is larger in size than that of the first interior area 103a. The reactor outlet duct 104 defines a third interior area 104a that is smaller in size than that of the second interior area 101 a. The third interior area 104a may be about the same in size as that of the first interior area 103a. The reactor inlet duct transition arrangement 105 comprises a first transition duct 30. The first transition duct 30 comprises at least one expanded screen 31 that distributes and directs the flow of flue gas F into reactor duct 101. The first transition duct 30 has a first end 33 fluidly connected to open end 103b of reactor inlet duct 103, and a second end 34 fluidly connected to open end 101 b of reactor duct 101. Thereby, the internal area 30a of first transition duct 30 increases from first end 33 to second end 34. Preferably, interior area 30a increases steadily from first end 33 fluidly connected to reactor inlet duct 103 toward second end 34 fluidly connected to reactor duct 101. At least one expanded screen 31 provides an even distribution of flue gas F as it flows through the increasing interior area 30a of first transition duct 30.

[0026] After the flue gas F has flowed past reactor duct 101, and has been processed by reactor 102, the flue gas F flows into reactor outlet duct transition arrangement 106. The reactor outlet duct transition arrangement 106 comprises a second transition duct 50, which comprises at least one expanded screen 51 that distributes and directs the flue gas F as it flows into reactor outlet duct 104. The second transition duct 50 has a wide end 54 fluidly connected to open end 101 c of reactor duct 101, and an open end 55 fluidly connected to open end 104b of reactor outlet duct 104. Thereby, interior area 50a of second transition duct 50 decreases from wide end 54 to open end 55. Preferably, interior area 50a of second transition duct 50 decreases steadily from wide end 54 fluidly connected to reactor duct 101, to open end 55 fluidly connected to reactor outlet duct 104. At least one expanded screen 51 provides an even distribution of flue gas F as it flows through the decreasing interior area 50a of second transition duct 50. Interior areas 30a, 50a of first transition duct 30 and second transition duct 50 may increase or decrease with an optimized curve profile that is not steady or linear.

[0027] Fig. 2 illustrates a transition duct 30 that comprises first end 33 adapted to be fluidly connected to inlet duct 103 of rectangular cross-section. A second end 34 of the transition duct 30 is adapted to be connected to reactor duct 101. Reactor duct 101 should also have a rectangular cross-section, but larger in size than that of inlet duct 103. Within the first end 33, of transition duct 30, an expanded screen 31 is arranged. Expanded screen 31 comprises four screen sides 31 a-d arranged in a "pyramid" formation having a point or an apex 35. Apex 35 of expanded screen 31 is positioned within interior area 30a so as to "point" in a direction toward second end 34 of the transition duct 30. Opposite apex 35, expanded screen 31 has an open bottom base 35a sized to fit and fixedly attach to the periphery of first end 33 to allow flue gas F to flow into the interior area 31 e of expanded screen 31. Apex 35 of expanded screen 31 thereby "points" in the same direction as or with flue gas F flow through transition duct 30. The free edges 31f-i of expanded screen 31 are of a length L corresponding with length L' of sides 33a-d of rectangularly shaped first end 33 of transition duct 30.

[0028] The transition duct 40 illustrated in Fig. 3 is adapted to be fluidly connected to an inlet duct 103 and a reactor duct 101, each of circular shaped periphery. A first end 42 of transition duct 40 is adapted to be fluidly connected to inlet duct 103. A second end 43 of transition duct 40 is adapted to be fluidly connected to reactor duct 101. Fixedly attached to first end 42, in interior area 40a of transition duct 40, is a cone-shaped expanded screen 41. The base 41 a of expanded screen 41 corresponds in size and shape with that of first end 42 of the transition duct 40. Opposite base 41 a of cone-shaped expanded screen 41 is point or apex 41 b that "points" in a direction toward second end 43 of transition duct 40. The apex 41 b of cone-shaped expanded screen 41 thereby points in the same direction as or with flue gas F flow through transition duct 40. Adjacent to second end 43 of transition duct 40, an outlet expanded screen 44 may be positioned so as to abut the interior periphery (not shown) of second end 43. Outlet expanded screen 44 provides further distribution and direction to flue gas F as it flows through transition duct 40.

[0029] Fig. 4a illustrates a duct transition arrangement 1 at an inlet to an ESP reactor. The duct transition arrangement 1 has a longitudinal expanse along longitudinal axis X. A first end 11 of inlet duct 10 is fluidly connected to a first end 33 of transition duct 30. A flue gas F is adapted to flow from inlet duct 10 into transition duct 30. A second end 34 of transition duct 30 is fluidly connected to a first end 21 of an outlet duct 20. The outlet duct 20 has a larger sized cross-section taken perpendicular to the X axis at first end 21 than that of first end 11 of inlet duct 10, and transition duct 30 functions as a "connector" between the two differently sized ducts 10, 20. The interior area 30a of transition duct 30 preferably increases steadily/linearly from inlet duct 10 to outlet duct 20. Within interior area 30a of transition duct 30, an expanded screen 31 is arranged. Expanded screen 31 is pyramid-shaped comprising four expanded metal screen sides 31 a-31 d culminating in point or apex 35. Expanded screen 31 is positioned so apex 35 "points" in the same direction as or with the direction of flue gas F flow through transition duct 30. Expanded screen 31 has four free edges 31f-i that form open base 35a. Open base 35a corresponds in shape and size with the periphery of first end 33 of the transition duct 30 for attachment thereto. Apex 35 of expanded screen 31 is positioned on longitudinal axis X pointing toward outlet duct 20. Open base 35a allows flue gas F to flow directly into the interior 31 e of expanded screen 31.

[0030] At second end 34 of transition duct 30 is an outlet expanded screen 32. Outlet expanded screen 32 comprises one or more portions, such as for example two parts 32a, 32b, together covering substantially the whole cross-section taken perpendicular to axis X of transition duct 30 at second end 34 and abutting the interior periphery 34a of second end 34.

[0031] The flue gas F flows from inlet duct 10 passes through expanded screen 31 and is thereby deflected from its course along longitudinal axis X. When the flue gas F reaches output expanded screen 32, the flue gas F is again deflected to achieve flow parallel to longitudinal axis X. This deflection of flue gas F provides a relatively even flow distribution over the entire interior area of the outlet duct. Such an even flue gas F distribution enhances the performance of the ESP reactor downstream with regard to flue gas flow of duct transition arrangement 1.

[0032] Fig. 4b illustrates a duct transition arrangement 2 at an outlet of an ESP reactor. The transition duct 50 is arranged between an inlet duct 15 and an outlet duct 25, wherein inlet duct 15 and outlet duct 25, are both configured to have the same shape, e.g., rectangular, circular or the like. A first end 54 of transition duct 50 is fluidly connected to a first end 16 of the inlet duct 15, and a second end 55 of the transition duct 50 is fluidly connected to a first end 26 of the outlet duct 25. First end 16 of inlet duct 15 has a perimeter significantly larger than that of first end 26 of outlet duct 25. Accordingly, the interior area 50a of transition duct 50 decreases steadily/linearly from first end 54 to second end 55 such that each are suitably sized for fluid connections with first end 16 and first end 26. Interior areas 30a, 50a of transition ducts 30, 50 may increase or decrease with an optimized curve profile that is not steady/linear.

[0033] As possible alternatives, first end 16 of inlet duct 15 and first end 26 of outlet duct 25 need not be configured in the same shape. For example, first end 16 may be circular and first end 26 may be rectangular. Likewise, first end 16 may be rectangular and first end 26 may be circular. Regardless of the shape configurations of first end 16 and first end 26, first end 54 and second end 55 are configured for fluid connection thereto. The same is true with regard to first end 33 and second end 34 of transition duct 30. Regardless of the shape configurations of first end 11 and first end 21, first end 33 and second end 34 of transition duct 30 are configured for fluid connection thereto.

[0034] A pyramid-shaped expanded screen 51 is arranged in interior area 50a of transition duct 50 with point or apex 53 positioned closer to first end 54 than second end 55, i.e., "pointing" toward inlet duct 15 or opposite the direction of or against flue gas F flow. Free edges 51f-i form the "base" of expanded screen 51 and are fixedly attached to the interior periphery 55a of second end 55. Flowing flue gas F reaches expanded screen 51 and passes through expanded screen sides 51 a-d, and is thus deflected to interior area 51 e of expanded screen 51. At the connection between second end 55 of transition duct 50 and first end 26 of outlet duct 25, an outlet expanded screen 52 is arranged. The outlet expanded screen 52 is arranged to abut the interior periphery 55a in a plane substantially perpendicular to longitudinal axis X of duct transition arrangement 2. Flue gas F that has passed through expanded screen 51 passes through outlet expanded screen 52 for evenly distributed flow into outlet duct 25. The flow of flue gas F in outlet duct 25 is substantially parallel to longitudinal axis X.

[0035] The described duct transition arrangements 1, 2 would be arranged and function similarly if the at least one expanded screen 31 were to be configured as a cone with an open "base".

[0036] Fig. 5 describes an expanded screen 31 for use in the present disclosure. To create an expanded screen 31, a shearing knife is used to create a pattern of cuts through the sheet material used to construct screen 31 substantially perpendicular to the plane of the sheet material. While creating cuts or after cuts have been created, the sheet material is stretched, thus deforming both cuts made by the knife, and the sheet material. The result is a pattern of angled strands 38 with apertures 39 between the angled strands 38. In other words, the angled strands 38 of the expanded screen are intermittently angled with respect to the plane of the sheet material.

[0037] These angled strands 38 give expanded screen 31 desirable flue gas deflection properties as required for operation as a static mixer. A perforated plate for example would not have desirable gas deflection properties for the subject purpose due to its lack of angled defection with relatively low pressure drop. To the contrary, expanded screen 31 comprises a plurality of elements E for angled deflection with relatively low pressure drop. Each element E is made up of two angled strands 38a and 38b. One angled strand 38a is angled upwardly from the plane of the sheet material and the other angled strand 38b is angled downwardly from the plane of the sheet material. Together, angled strands 38a and 38b turn element E into somewhat of a loop with aperture 39 surrounded by angled strands 38a and 38b.

[0038] A pyramid-shaped expanded screen 31 may be manufactured from one expanded screen that is bent to form the four sides 31 a-d of the pyramid shape. Alternatively, pyramid-shaped expanded screen 31 may be manufactured by cutting expanded screen into four appropriately shaped parts and combining them to form the four sides 31 a-d. The four sides 31 a-d may be attached together by means of welding, gluing or the like. The four parts may also be attached to each other by means of a bracing, wherein each part is attached to the bracing as a frame to form pyramid-shaped expanded screen 31.

[0039] Figure 6 illustrates an alternative duct transition arrangement 60 according to the invention. In vertical duct transition arrangement 60, vertical inlet duct 61 defines an interior area 61 a, and has an axis Y of longitudinal expanse that differs from axis Z of longitudinal expanse of outlet duct 62. According to Fig. 6, axis Y of longitudinal expanse of vertical inlet duct 61 is perpendicular to axis Z of longitudinal expanse of outlet duct 62. Vertical inlet duct 61 has a smaller cross-sectional area taken perpendicular to axis Y than that of outlet duct 62 taken perpendicular to axis Z at a similar point. Optionally, the cross-sectional area of vertical inlet duct 61 could instead be larger than cross-sectional area of outlet duct 62. In fluidal connection with vertical inlet duct 61 and outlet duct 62, transition duct 63 is arranged to direct or channel flue gas F flow from vertical inlet duct 61 into outlet duct 62. Transition duct 63 thereby deflects the flow of flue gas F from a vertical direction of flow through vertical inlet duct 61 to a horizontal direction of flow through outlet duct 62. Transition duct 63 comprises expanded screen 64 in order to effectively deflect and distribute the flowing flue gas F into and across the complete interior area 62a of outlet duct 62. Expanded screen 64 is made of metal. Expanded screen 64 is arranged at an angle α with respect to a plane Q extending through transition duct 63 perpendicular to axis Z. Hence, plane Q is parallel with the vertical extension direction of vertical inlet duct 61 along axis Y. The angle α is between 0-45 degrees when the vertical inlet duct 61 has a transverse cross-sectional area smaller than that of outlet duct 62 taken at a similar point. With a transverse cross-sectional area of vertical inlet duct 61 more similarly sized to that of outlet duct 62, an angle α closer to 45 degrees is preferable. With a vertical inlet duct 61 having an axis Y perpendicular axis Z of outlet duct 62, only one expanded screen 64 is needed in transition duct 63, although, two or more expanded screens could also be used in transition duct 63 if desired.

[0040] Figure 7 illustrates a duct transition arrangement 3 at an inlet to an ESP reactor. The duct transition arrangement 3 has a longitudinal expanse along longitudinal axis X. A first end 71 of inlet duct 70 is fluidly connected to a first end 63 of transition duct 60. A flue gas F is adapted to flow from inlet duct 70 into transition duct 60. A second end 64 of transition duct 60 is fluidly connected to a first end 81 of an outlet duct 80. The outlet duct 80 has a larger sized periphery or cross-section taken perpendicular to axis X at first end 81 than that of inlet duct 70 at first end 71, and transition duct 60 functions as a "connector" between the two differently sized ducts 70, 80. Within the transition duct 60, an expanded screen 61 is arranged. Expanded screen 60 is relatively planar. Expanded screen 60 comprises two parts 61 a, 61 b. The relatively planar expanded screen 60 is arranged substantially perpendicular to the longitudinal axis X. The two parts 61 a, 61 b have differently directed angled strands 38 (Fig. 5) to direct the flow of flue gas F in the transition duct 60. Expanded screen 61 corresponds in size and shape with the interior periphery of first end 63 of the transition duct 60 for attachment thereto.

[0041] At second end 64 of transition duct 60 is an outlet expanded screen 62. The outlet expanded screen 62 is substantially planar. Outlet expanded screen 62 is arranged substantially perpendicular to the longitudinal axis X. Outlet expanded screen 62 comprises one or more portions, such as for example two parts 62a, 62b, together occupying substantially the whole cross-section taken perpendicular to axis X of transition duct 60 at second end 64. The two parts 62a, 62b have differently directed angled strands 38 (Fig. 5) to direct the flow of flue gas F in the transition duct 60. Outlet expanded screen 62 corresponds in size and shape with the interior periphery 64a of second end 64 of the transition duct 60 for attachment thereto.

[0042] The flue gas F flows from inlet duct 70 through expanded screen 61 1 and is thereby deflected from its course along longitudinal axis X. Deflection occurs due to angled strands 38 of expanded screen 61. When the flue gas F reaches outlet expanded screen 62, the flue gas F is again deflected to achieve flow parallel to longitudinal axis X. Deflection occurs due to angled strands 38 of outlet expanded screen 62. This deflection of flue gas F provides a relatively even flow distribution over the entire interior area of the outlet duct 80. Such an even flue gas F distribution enhances the performance of the ESP reactor downstream with regard to flue gas flow, of duct transition arrangement 3.

[0043] A duct transition arrangement 3 at an inlet to an ESP reactor as shown in Figure 7 may similarly be arranged at an outlet of an ESP reactor.

[0044] According to one embodiment, a method is provided for controlling gas flow in an exhaust gas cleaning system by directing gas flow from an inlet duct 10, 15 of an inlet duct perimeter to an outlet duct 20, 25 of an outlet duct perimeter that differs from the inlet duct perimeter through a transition duct 30, 40, 50 fluidly connecting the inlet duct 10, 15 to the outlet duct 20, 25 using at least one expanded screen 31, 41, 51, arranged in the transition duct 30, 40, 50 for distribution of gas flow through the transition duct 30, 40, 50.

[0045] According to a further embodiment, the method provides that the at least one expanded screen 31, 41, 51 used for directing gas flow from the inlet duct 10, 15, through the transition duct 30, 40, 50 to the outlet duct 20, 25 includes an apex 35 arranged to point in the direction of the larger perimetered inlet duct 10, 15 or outlet duct 20, 25.

[0046] According to another embodiment, the method provides that the outlet duct perimeter is larger than the inlet duct perimeter, and apex 35, of the at least one expanded screen 31, 41, 51 directing flue gas F flow, points in the same direction as that of the flue gas F flow.

[0047] According to yet another embodiment, the method provides that the outlet duct perimeter is smaller than the inlet duct perimeter, and apex 35, of the at least one expanded screen 31, 41, 51 directing flue gas F flow, points in a direction opposite the direction of flue gas F flow.

[0048] According to a further embodiment, the method comprises a further direction of flue gas F flow by an outlet expanded screen 32, 44, 52, 62 provided in transition duct 30, 40, 50, 60, and which outlet expanded screen 32, 44, 52, 62 extends in a plane substantially perpendicular to a longitudinal axis X of the transition duct 30, 40, 50, 60.

[0049] While the invention has been described with reference to various exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for features thereof without departing from the spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A duct transition arrangement (1; 2) for use in an exhaust gas cleaning system, comprising:

    a transition duct (30; 40; 50) fluidly connecting an inlet duct (10; 15) of an inlet duct perimeter to an outlet duct (20; 25) of an outlet duct perimeter that differs from the inlet duct perimeter such that flue gases flow from the inlet duct (10; 15) through the transition duct (30; 40; 50) and into the outlet duct (20; 25),
    characterized in that the transition duct (30; 40; 50) comprises at least one expanded screen (31; 41; 51) for distribution of gas flow through the transition duct (30; 40; 50).

2. Duct transition arrangement (1; 2) according to claim 1, wherein the at least one expanded screen (31; 41; 51) includes an apex (35) arranged to point in the direction of the larger perimetered inlet duct (10; 15) or outlet duct (20; 25).

3. Duct transition arrangement (1) according to claim 2, wherein the outlet duct perimeter is larger than the inlet duct perimeter and apex (35) points in the same direction as that of flue gas (F) flow.

4. Duct transition arrangement (2) according to claim 2, wherein the outlet duct perimeter is smaller than the inlet duct perimeter, and apex (53) points in a direction opposite the direction of flue gas (F) flow.

5. Duct transition arrangement (1; 2) according to any of the preceding claims, wherein the at least one expanded screen (31; 51) comprises four expanded screen sides (31 a-31 d) in a pyramid shape.

6. Duct transition arrangement according to any of the claims 1-4, wherein the at least one expanded screen (41) comprises one or more expanded screens in a cone shape.

7. Duct transition arrangement (3) according to claim 1, wherein the at least one expanded screen (61) comprises one or more flat screens extending in a plane substantially perpendicular to a longitudinal axis (X) of duct transition arrangement (3).

8. Duct transition arrangement (1; 2) according to any

of the claims 1-7, wherein the transition duct (30; 40; 50; 60) further comprises an outlet expanded screen (32; 44; 52; 62) extending in a plane substantially perpendicular to a longitudinal axis (X) of duct transition arrangement (1; 2; 3).

9. Duct transition arrangement (1; 2) according to claim 8, wherein the outlet expanded screen (32; 44; 52; 62) is arranged at an end (34; 43; 55; 64) of the transition duct (30; 40; 50; 60) fluidly connected to outlet duct (20; 25; 80).

10. Duct transition arrangement (1; 2; 3) according to claim 8 or 9, wherein the outlet expanded screen (32; 44; 52; 62) substantially covers the outlet duct (20; 25; 80).

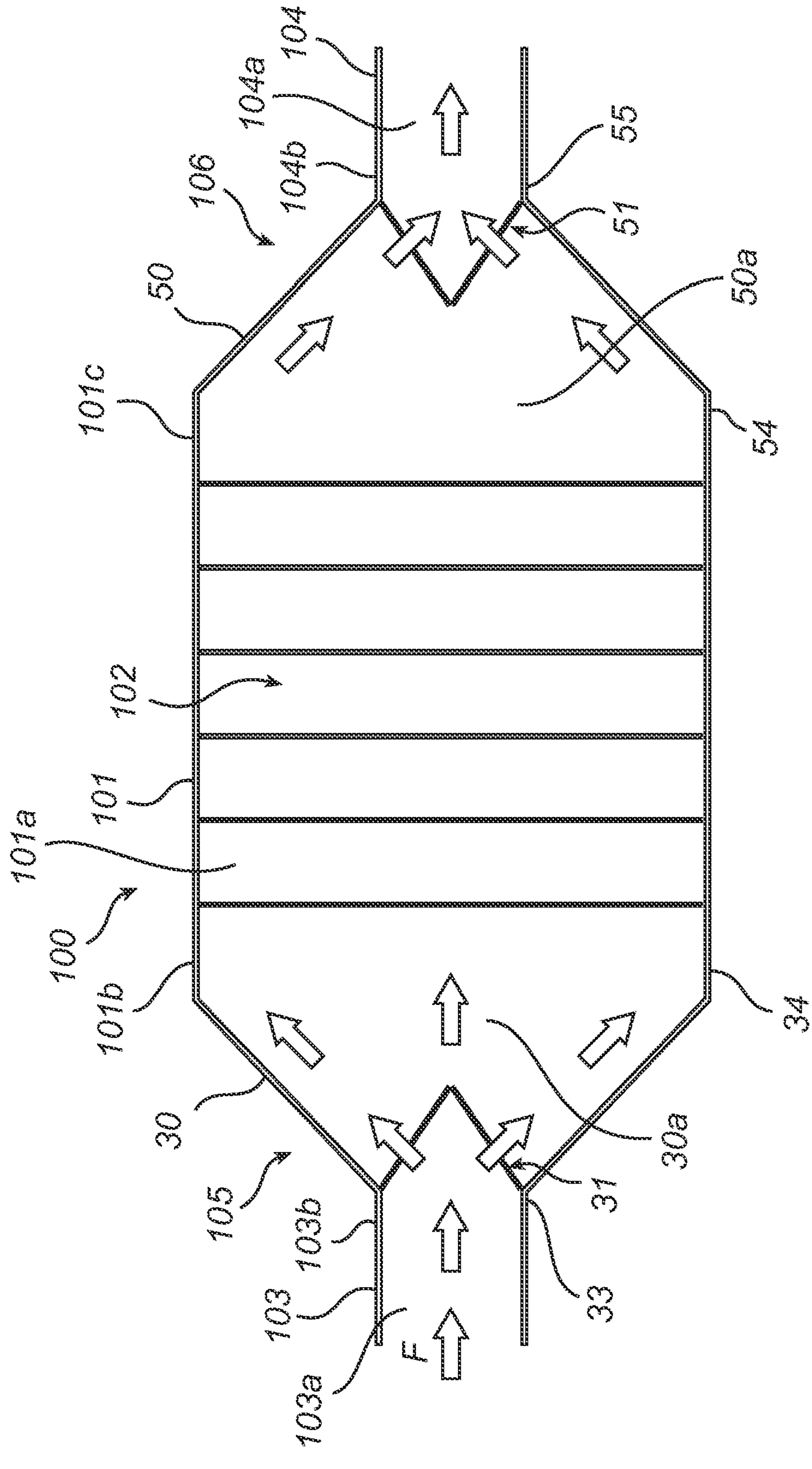
11. Duct transition arrangement (1; 2; 3) according to any of the preceding claims, wherein the at least one expanded screen (31; 41; 51; 61) is arranged such that substantially all flue gas (F) flowing through inlet duct (10; 15; 70) may pass through at least one expanded screen (31; 41; 51; 61).

12. Duct transition arrangement (1; 2; 3) according to any of the preceding claims, wherein the at least one expanded screen (31; 41; 51; 61) is made of metal.

13. A reactor duct arrangement (100) for use in an exhaust gas cleaning system, comprising
a reactor duct (101) in which a reactor (102) for processing gases is positioned,
a reactor inlet transition duct arrangement (105) for distributing gas flow from a reactor inlet duct (103) of an inlet duct perimeter to the reactor duct (101) of a reactor duct perimeter that is larger than the inlet duct perimeter, the reactor inlet transition duct arrangement (105) comprising a first transition duct (30) in fluid connection with the reactor inlet duct and the reactor duct, and
a reactor outlet transition duct arrangement (106) for distributing the gas flow from the reactor duct to a reactor outlet duct (104) of an outlet duct perimeter that is smaller than the reactor duct perimeter, the reactor outlet transition duct arrangement (106) comprising a second transition duct (50),
characterized in that the first transition duct (30) and the second transition (50) duct each comprises at least one expanded screen (107; 108) for distribution of gas flow (F) through the reactor duct arrangement.

14. Method for controlling gas flow in an exhaust gas cleaning system by directing gas flow from an inlet duct (10; 15) of an inlet duct perimeter to an outlet duct (20; 25) of an outlet duct perimeter that differs from the inlet duct perimeter through a transition duct (30; 40; 50) fluidly connecting the inlet duct (10; 15) to the outlet duct (20; 25) using at least one expanded screen (31; 41; 51) arranged in the transition duct (30; 40; 50) for distribution of gas flow through the transition duct.

15. Method according to claim 14, wherein the at least one expanded screen (31; 41; 51) used for directing gas flow from the inlet duct (10; 15), through the transition duct (30; 40; 50) to the outlet duct (20; 25) includes an apex (35) arranged to point in the direction of the larger perimetered inlet duct or outlet duct.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F
103a

Fig. 1

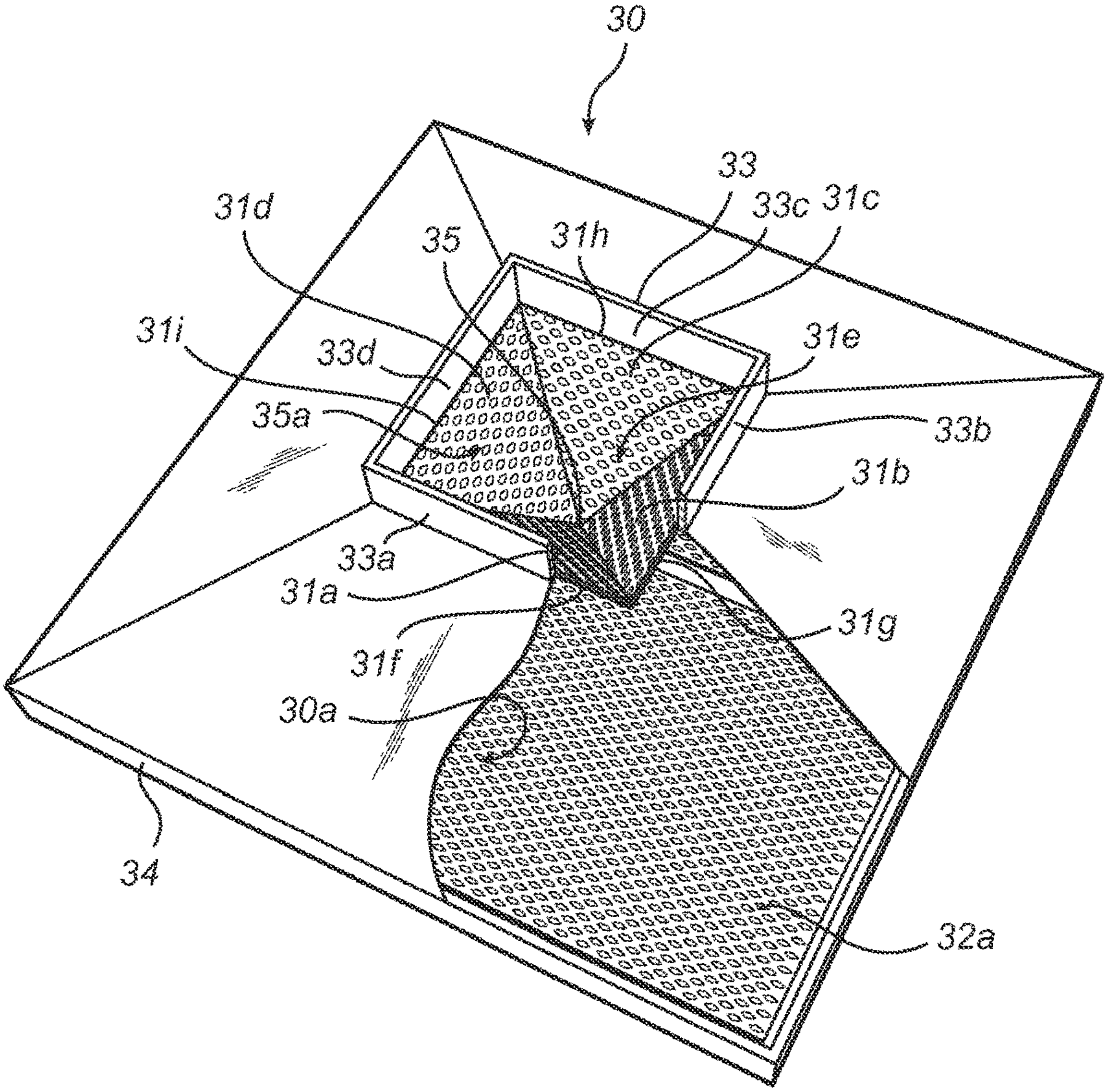
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Fig. 2

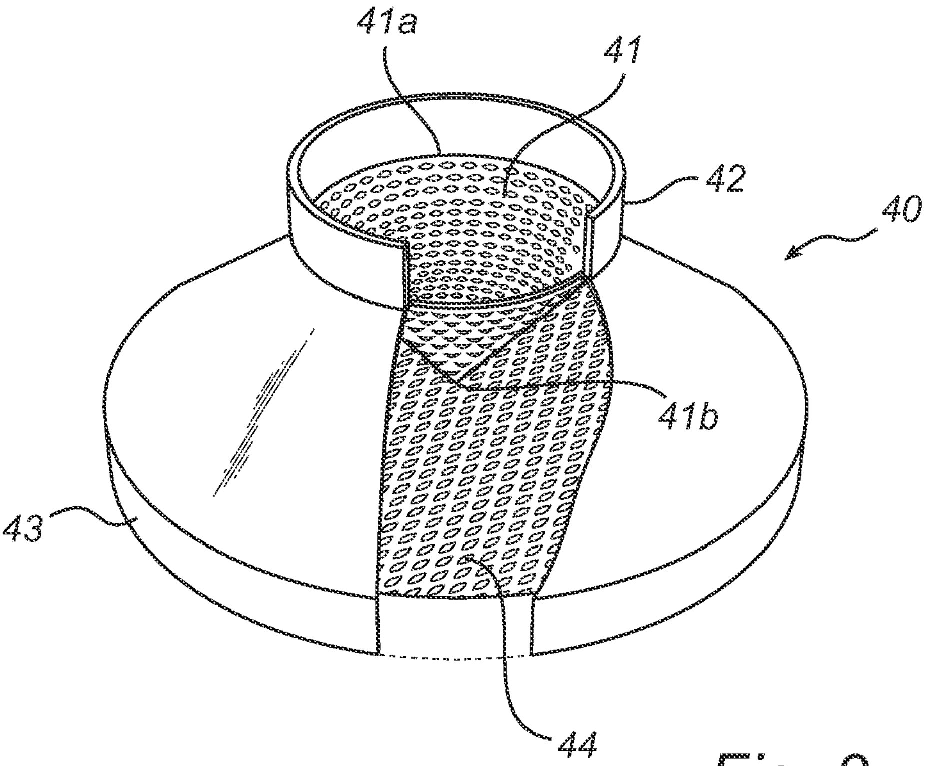

Fig. 3

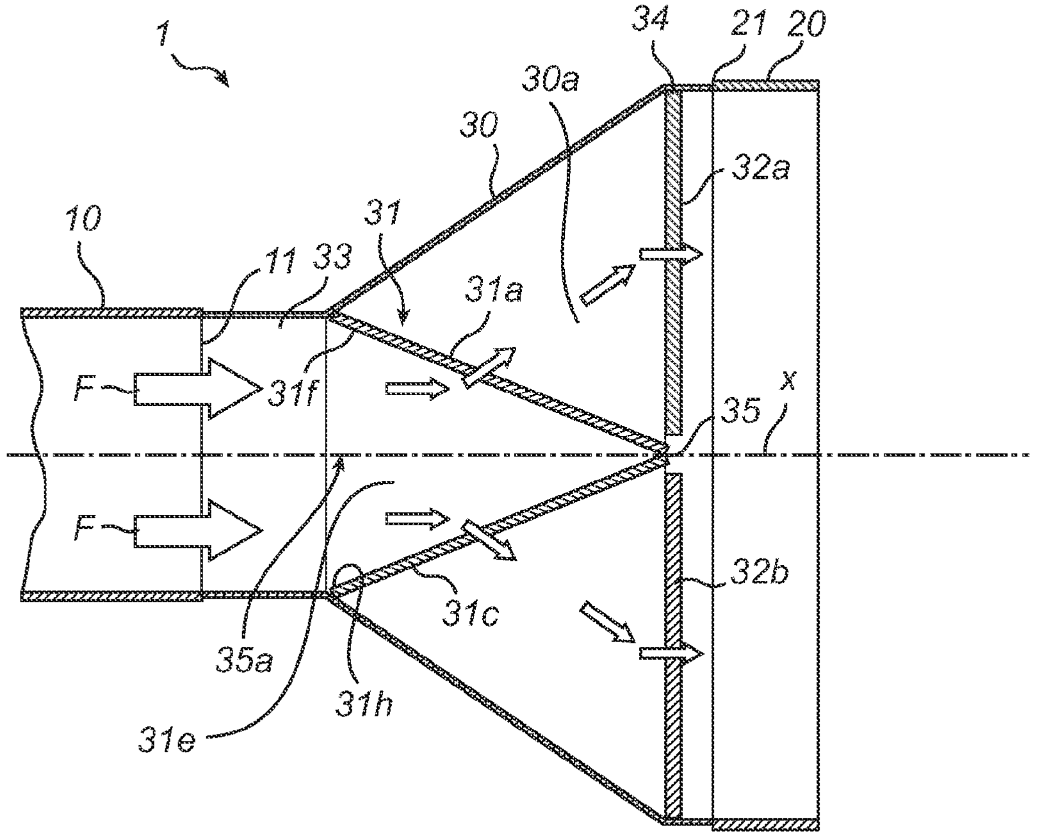
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Fig. 4a

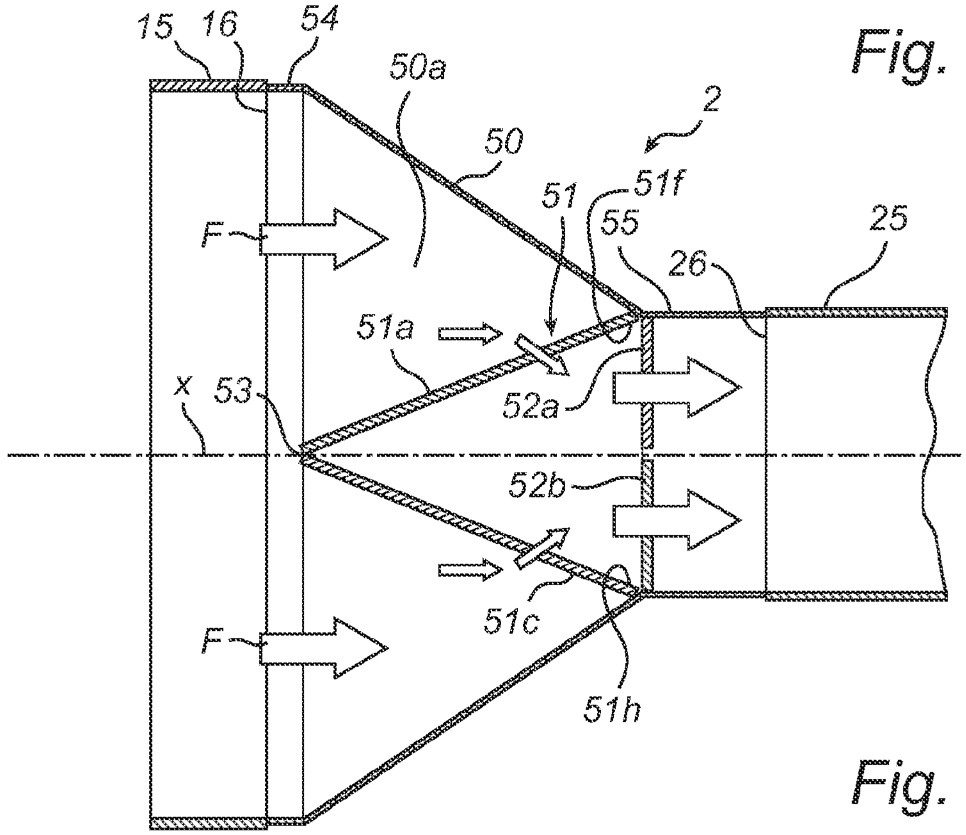
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Fig. 4b

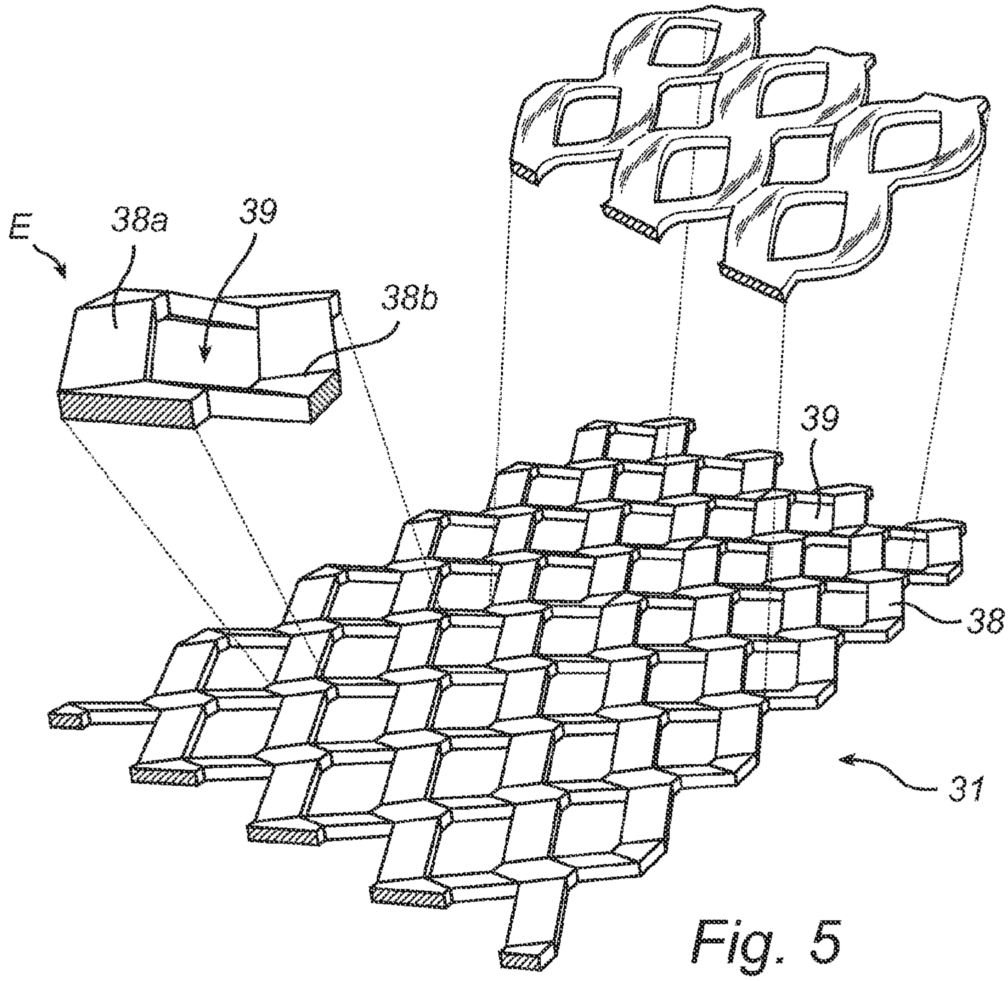

Fig. 5

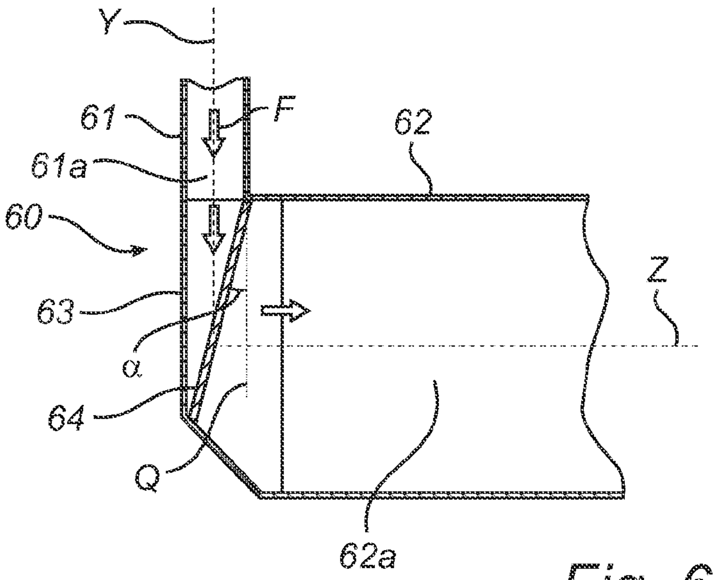

Fig. 6

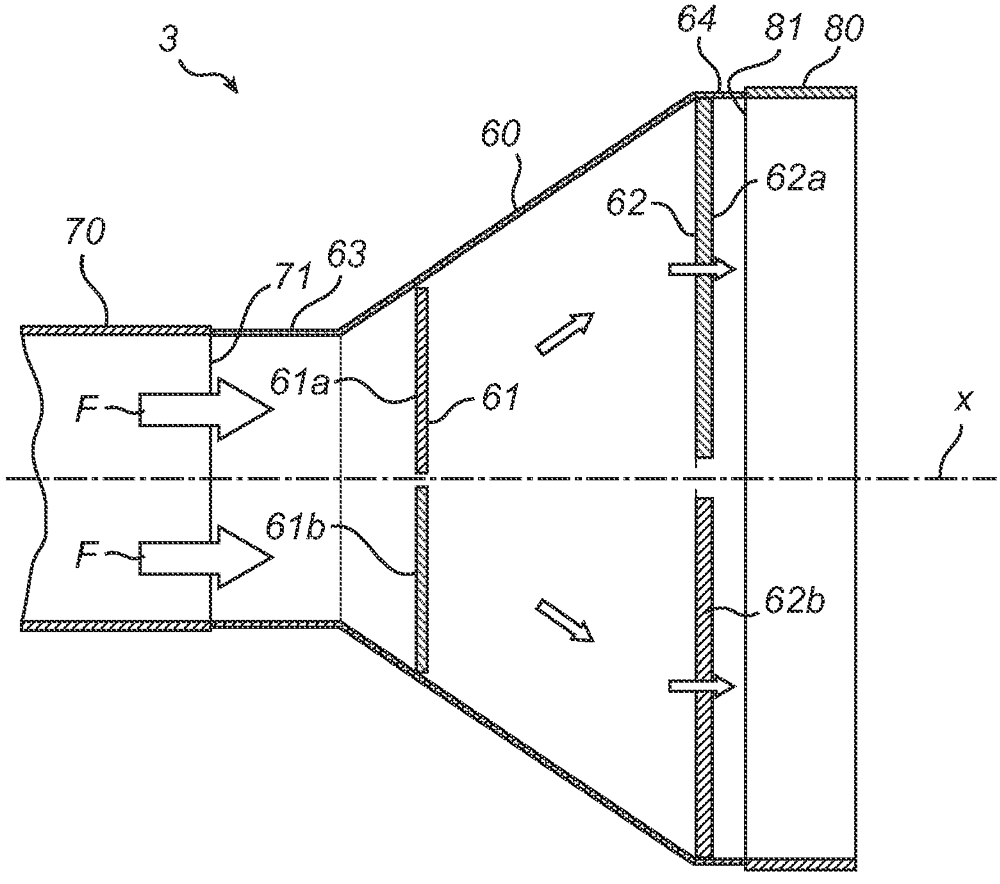

Fig. 7

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Place of search	Date of completion of the search	Examiner
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