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(54) **COKING SYSTEM WITH NON-PERPENDICULAR CONNECTIONS BETWEEN COKE OVEN UPTAKES AND A HOT COMMON TUNNEL AND METHOD FOR REDUCING DRAFT LOSSES**

VERKOKUNGSSYSTEM MIT NICHT SENKRECHTEN VERBINDUNGEN ZWISCHEN KOKSOFFENZUGKANÄLEN UND EINEM GEMEINSAMEN HEISSEN TUNNEL UND VERFAHREN ZUR MINDERUNG DER ZUGLUFTVERLUSTE

SYSTÈME DE COKÉFACTION AVEC RACCORDS NON PERPENDICULAIRES ENTRE DES MONTÉES DE GAZ DE FOUR À COKE ET UN TUNNEL CHAUD COMMUN, ET PROCÉDÉ DE RÉDUCTION DES PERTES DE TIRAGE

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Description

TECHNICAL FIELD

[0001] The present technology is generally directed to non-perpendicular connections between coke oven uptakes and a hot common tunnel, and associated systems and methods.

BACKGROUND

[0002] Coke is a solid carbonaceous fuel that is derived from coal. Coke is a favored energy source in a variety of useful applications. For example, coke is often used to smelt iron ore during the steelmaking process. As a further example, coke may also be used to heat commercial buildings or power industrial boilers.

[0003] In a typical coking process, an amount of coal is baked in a coke oven at temperatures that generally exceed 2,000 degrees Fahrenheit (1093 degrees Celsius). The baking process transforms the relatively impure coal into coke, which contains relatively few impurities. At the end of the baking process, the coke typically emerges from the coke oven as a substantially intact piece. The coke typically is removed from the coke oven, loaded into one or more train cars, and transported to a quench tower in order to cool or "quench" the coke before it is made available for distribution for use as a fuel source.

[0004] The hot exhaust (i.e. flue gas) emitted during baking is extracted from the coke ovens through a network of ducts, intersections, and transitions. The intersections in the flue gas flow path of a coke plant can lead to significant pressure drop losses, poor flow zones (e.g. dead, stagnant, recirculation, separation, etc.), and poor mixing of air and volatile matter. The high pressure drop losses can lead to higher required draft, leaks, and problems with system control. In addition, poor mixing and resulting localized hot spots can lead to earlier structural degradation due to accelerated localized erosion and thermal wear. Erosion includes deterioration due to high velocity flow eating away at material. Hot spots can lead to thermal degradation of material, which can eventually cause thermal/structural failure. The localized erosion and/or hot spots can, in turn, lead to failures at duct intersections.

[0005] Traditional duct intersection designs also result in significant pressure drop losses which may limit the number of coke ovens connected together in a single battery. There are limitations on how much draft a draft fan can pull. Pressure drops in duct intersections can take away from the amount of draft available to exhaust flue gases from the coke ovens. These and other related problems with traditional duct intersection design result in additional capital expenses. Therefore, a need exists to provide improved duct intersection/transitions that can improve mixing, flow distribution, minimize poor flow zones, and reduce pressure drop losses.

[0006] US 4 045 299 A discloses a burner for oil or gas which is controlled by a thermocouple.

[0007] CN 1 255 528 A discloses an integrative cokery.

[0008] A coking system according to the present invention is provided comprising: a plurality of coke ovens; a plurality of uptake ducts in fluid communication with the plurality of coke ovens, each of the plurality of uptake ducts having an uptake flow vector of exhaust gas from one of the plurality of coke ovens; and a common tunnel having a common flow vector of exhaust gas and configured to transfer the exhaust gas to a venting system, the plurality of uptake ducts and common tunnel being fluidly coupled with one another at a plurality of interfaces, at least some of the plurality of interfaces being non-perpendicular, wherein the uptake ducts are disposed at angles with respect to the common tunnel and bias the uptake flow vectors and common flow vector toward a common flow direction, wherein: the plurality of uptake ducts comprises a first uptake duct in fluid communication with a first coke oven of the plurality of coke ovens and having a first uptake flow vector, and wherein the system further comprises a second uptake duct of the plurality of uptake ducts in fluid communication with the first coke oven or a second coke oven of the plurality of coke ovens and having a second uptake flow vector of exhaust gas; and at least a portion of the first uptake duct is non-perpendicular to the common tunnel by a first angle and at least a portion of the second uptake duct is non-perpendicular to the common tunnel by a second angle different from the first angle, whereby minimising a static pressure differential between an upstream portion and a downstream portion of the common tunnel and discouraging a draft loss within the coking system.

[0009] A method of reducing draft losses in a common tunnel in a coking system according to the present invention is provided comprising a plurality of coke ovens and a plurality of uptake ducts in fluid communication with the plurality of coke ovens and the common tunnel, the method comprising: flowing exhaust gas from a first coke oven of the plurality of coke ovens through a first uptake duct of the plurality of uptake ducts with a first uptake flow vector; flowing exhaust gas from the first coke oven, or a second coke oven of the plurality of coke ovens through a second uptake duct of the plurality of uptake ducts with a second uptake flow vector; biasing the exhaust gas exiting the first and second uptake ducts toward a common flow direction in the common tunnel; and merging the exhaust gas exiting the first and second uptake ducts and the common flow at a non-perpendicular interface, wherein: at least a portion of the first uptake duct is disposed at a non-perpendicular first angle with respect to the common tunnel, at least a portion of the second uptake duct is disposed at a non-perpendicular second angle with respect to the common tunnel, the second angle being different from the first angle, whereby aligning an uptake duct mass flow with a common tunnel mass flow in a manner that increases a draft at the uptake duct and decreases a draft loss in the common tunnel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The embodiments shown in the Figures 1-6A and 6C-9 are not according to the presently claimed invention.

Figure 1 is a schematic illustration of a horizontal heat recovery coke plant, configured in accordance with embodiments of the technology.

Figure 2 is an isometric, partial cut-away view of a portion of the horizontal heat recovery coke plant of Figure 1 configured in accordance with examples of the technology.

Figure 3 is a sectional view of a horizontal heat recovery coke oven configured in accordance with examples of the technology.

Figure 4 is a top view of a portion of a horizontal heat recovery coke plant configured in accordance with examples of the technology.

Figure 5A is a cross-sectional top view of a perpendicular interface between an uptake duct and a common tunnel configured in accordance with examples of the technology.

Figure 5B is a cross-sectional top view of a non-perpendicular interface between an uptake duct and a common tunnel configured in accordance with embodiments of the technology.

Figure 5C is a cross-sectional end view of a non-perpendicular interface between an uptake duct and a common tunnel configured in accordance with embodiments of the technology.

Figure 5D is a cross-sectional end view of a non-perpendicular interface between an uptake duct and a common tunnel configured in accordance with embodiments of the technology.

Figure 5E is a cross-sectional end view of a non-perpendicular interface between an uptake duct and a common tunnel configured in accordance with embodiments of the technology.

Figures 6A-6I are top views of various configurations of interfaces between uptake ducts and a common tunnel configured in accordance with examples and embodiments of the technology.

Figure 7A is a cross-sectional top view of a non-perpendicular interface retrofitted between an uptake and a common tunnel configured in accordance with examples of the technology.

Figure 7B is a cross-sectional top view of an interface between an uptake and a common tunnel configured in accordance with examples of the technology.

5 Figure 7C is a cross-sectional top view of a non-perpendicular interface retrofitted between the uptake and common tunnel of Figure 7B configured in accordance with examples of the technology.

10 Figure 8 is a cross-sectional top view of a non-perpendicular interface between an uptake and a common tunnel configured in accordance with examples of the technology.

15 Figure 9 is a plot showing the spatial distribution of gas static pressure along the length of the common tunnel.

DETAILED DESCRIPTION

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[0011] The present technology is generally directed to non-perpendicular connections between coke oven uptakes and a hot common tunnel, and associated systems and methods. In some embodiments, a coking system includes a coke oven and an uptake duct in fluid communication with the coke oven. The uptake duct has an uptake flow vector of exhaust gas from the coke oven. The system also includes a common tunnel in fluid communication with the uptake duct. The common tunnel has a common flow vector and is configured to transfer the exhaust gas to a venting system. The uptake flow vector and common flow vector meet at a non-perpendicular interface to improve mixing between the flow vectors and reduce draft loss in the common tunnel.

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[0012] Specific details of several examples and embodiments of the technology are described below with reference to Figures 1-9 (Fig. 1-6A and 6C-9 are not according to the presently claimed invention). Other details describing well-known structures and systems often associated with coal processing have not been set forth in the following disclosure to avoid unnecessarily obscuring the description of the various embodiments of the technology. Many of the details, dimensions, angles, and other features shown in the Figures are merely illustrative of particular examples and embodiments of the technology.

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[0013] Figure 1 is a schematic illustration of a horizontal heat recovery (HHR) coke plant 100, configured in accordance with embodiments of the technology. The HHR coke plant 100 comprises ovens 105, along with heat recovery steam generators (HRSGs) 120 and an air quality control system 130 (e.g., an exhaust or flue gas desulfurization (FGD) system), both of which are positioned fluidly downstream from the ovens 105 and both of which are fluidly connected to the ovens 105 by suitable ducts. The HHR coke plant 100 also includes one or more common tunnels 110A, 110B (collectively "common tunnel 110") fluidly connecting individual ovens 105

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to the HRSGs 120 via one or more individual uptake ducts 225. In some embodiments, two or more uptake ducts 225 connect each individual oven 105 to the common tunnel 110. A first crossover duct 290 fluidly connects the common tunnel 110A to the HRSGs 120 and a second crossover duct 295 fluidly connects the common tunnel 110B to the HRSGs 120 at respective intersections 245. The common tunnel 110 can further be fluidly connected to one or more bypass exhaust stacks 240. A cooled gas duct 125 transports the cooled gas from the HRSGs to the FGD system 130. Fluidly connected and further downstream are a baghouse 135 for collecting particulates, at least one draft fan 140 for controlling air pressure within the system, and a main gas stack 145 for exhausting cooled, treated exhaust into the environment. Various coke plants 100 can have different proportions of ovens 105, HRSGs 120, uptake ducts 225, common tunnels 110, and other structures. For example, in some coke plants, each oven 105 illustrated in Figure 1 can represent ten actual ovens.

[0014] As will be described in further detail below, in several embodiments the uptake ducts 225 meet the common tunnel 110 at non-perpendicular interfaces. The non-perpendicular interfaces may comprise a fitting within the uptake ducts 225, a fitting within the common tunnel 110, a non-perpendicular uptake duct 225, a non-perpendicular portion of the uptake duct 225, or other feature. The non-perpendicular interfaces can lower the mixing draft loss at the uptake/common tunnel connection by angling the connection in the direction of the common tunnel flow. More specifically, the uptake ducts 225 have an uptake flow having an uptake flow vector (having x, y, and z orthogonal components) and the common tunnel 110 has a common flow having a common flow vector (having x, y, and z orthogonal components). By minimizing the differences between the uptake flow vector and the common flow vector, the lesser the change in the directional momentum of the hot gas and, consequently, the lower the draft losses.

[0015] Furthermore, there are interface angles in which the draft in the common tunnel 110 can increase from the addition of the extra mass flow from the uptake duct 225. More specifically, the interface can act as a vacuum aspirator which uses mass flow to pull a vacuum. By aligning the uptake duct 225 mass flow with the common tunnel 110 mass flow (having a velocity vector in the same major flow direction), a coke plant can achieve more vacuum pull and lower draft loss, which can potentially cause a draft increase. The reduced draft loss can be used to reduce the common tunnel 110 size (e.g., diameter) or lower the required overall system draft.

[0016] Further, various embodiments of the technology are not limited to the interface between uptake ducts and the common tunnel. Rather, any connection where the gas flow undergoes a significant change in direction can be improved to have a lower draft loss by using a non-perpendicular connection. For example, any of the connections in the exhaust flow path (e.g., between the

common tunnel 110 and the bypass exhaust stacks 240) can include ducts meeting head to head; angling these connections can lower draft losses in the manner described above.

[0017] Figures 2 and 3 provide further detail regarding the structure and operation of the coke plant 100. More specifically, Figures 2 and 3 illustrate further details related to the structure and mechanics of exhaust flow from the ovens to the common tunnel. Figures 4 through 9 provide further details regarding various embodiments of non-perpendicular connections between coke oven uptake ducts and the common tunnel.

[0018] Figure 2 is an isometric, partial cut-away view of a portion of the HHR coke plant 100 of Figure 1 configured in accordance with embodiments of the technology. Figure 3 is a sectional view of an HHR coke oven 105 configured in accordance with embodiments of the technology. Referring to Figures 2 and 3 together, each oven 105 can include an open cavity defined by a floor 160, a front door 165 forming substantially the entirety of one side of the oven, a rear door 170 opposite the front door 165 forming substantially the entirety of the side of the oven opposite the front door, two sidewalls 175 extending upwardly from the floor 160 intermediate the front 165 and rear 170 doors, and a crown 180 which forms the top surface of the open cavity of an oven chamber 185. Controlling air flow and pressure inside the oven chamber 185 can be critical to the efficient operation of the coking cycle, and therefore the front door 165 includes one or more primary air inlets 190 that allow primary combustion air into the oven chamber 185. Each primary air inlet 190 includes a primary air damper 195 which can be positioned at any of a number of positions between fully open and fully closed to vary the amount of primary air flow into the oven chamber 185. Alternatively, the one or more primary air inlets 190 are formed through the crown 180.

[0019] In operation, volatile gases emitted from the coal positioned inside the oven chamber 185 collect in the crown and are drawn downstream in the overall system into downcomer channels 200 formed in one or both sidewalls 175. The downcomer channels fluidly connect the oven chamber 185 with a sole flue 205 positioned beneath the oven floor 160. The sole flue 205 forms a circuitous path beneath the oven floor 160. Volatile gases emitted from the coal can be combusted in the sole flue 205 thereby generating heat to support the carbonization of coal into coke. The downcomer channels 200 are fluidly connected to chimneys or uptake channels 210 formed in one or both sidewalls 175. A secondary air inlet 215 is provided between the sole flue 205 and the atmosphere; the secondary air inlet 215 includes a secondary air damper 220 that can be positioned at any of a number of positions between fully open and fully closed to vary the amount of secondary air flow into the sole flue 205. The uptake channels 210 are fluidly connected to the common tunnel 110 by the one or more uptake ducts 225. A tertiary air inlet 227 is provided between the uptake

duct 225 and atmosphere. The tertiary air inlet 227 includes a tertiary air damper 229 which can be positioned at any of a number of positions between fully open and fully closed to vary the amount of tertiary air flow into the uptake duct 225.

[0020] In order to provide the ability to control gas flow through the uptake ducts 225 and within the ovens 105, each uptake duct 225 also includes an uptake damper 230. The uptake damper 230 can be positioned at any number of positions between fully open and fully closed to vary the amount of oven draft in the oven 105. The uptake damper 230 can comprise any automatic or manually-controlled flow control or orifice blocking device (e.g., any plate, seal, block, etc.). As used herein, "draft" indicates a negative pressure relative to atmosphere. For example, a draft of 0.1 inches of water indicates a pressure of 0.1 inches of water below atmospheric pressure (24.884 Pascal). Inches of water is a non-SI unit for pressure and is conventionally used to describe the draft at various locations in a coke plant. In some embodiments, the draft ranges from about 0.12 (29.8608 Pascal) to about 0.16 inches of water (39.8144 Pascal) in the oven 105. If a draft is increased or otherwise made larger, the pressure moves further below atmospheric pressure. If a draft is decreased, drops, or is otherwise made smaller or lower, the pressure moves towards atmospheric pressure. By controlling the oven draft with the uptake damper 230, the air flow into the oven 105 from the air inlets 190, 215, 227 as well as air leaks into the oven 105 can be controlled. Typically, as shown in Figure 3, an individual oven 105 includes two uptake ducts 225 and two uptake dampers 230, but the use of two uptake ducts and two uptake dampers is not a necessity; a system can be designed to use just one or more than two uptake ducts and two uptake dampers. All of the ovens 105 are fluidly connected by at least one uptake duct 225 to the common tunnel 110 which is in turn fluidly connected to each HRSG 120 by the crossover ducts 290, 295. The exhaust gases from each oven 105 flow through the common tunnel 110 to the crossover ducts 290, 295.

[0021] In operation, coke is produced in the ovens 105 by first loading coal into the oven chamber 185, heating the coal in an oxygen depleted environment, driving off the volatile fraction of coal, and then oxidizing the VM within the oven 105 to capture and utilize the heat given off. The coal volatiles are oxidized within the ovens over an extended coking cycle, and release heat to regeneratively drive the carbonization of the coal to coke. The coking cycle begins when the front door 165 is opened and coal is charged onto the oven floor 160. The coal on the oven floor 160 is known as the coal bed. Heat from the oven (due to the previous coking cycle) starts the carbonization cycle. As discussed above, in some embodiments, no additional fuel other than that produced by the coking process is used. Roughly half of the total heat transfer to the coal bed is radiated down onto the top surface of the coal bed from the luminous flame of the coal bed and the radiant oven crown 180. The re-

maining half of the heat is transferred to the coal bed by conduction from the oven floor 160 which is convectively heated from the volatilization of gases in the sole flue 205. In this way, a carbonization process "wave" of plastic flow of the coal particles and formation of high strength cohesive coke proceeds from both the top and bottom boundaries of the coal bed.

[0022] Typically, each oven 105 is operated at negative pressure so air is drawn into the oven during the reduction process due to the pressure differential between the oven 105 and atmosphere. Primary air for combustion is added to the oven chamber 185 to partially oxidize the coal volatiles, but the amount of this primary air is controlled so that only a portion of the volatiles released from the coal are combusted in the oven chamber 185, thereby releasing only a fraction of their enthalpy of combustion within the oven chamber 185. The primary air is introduced into the oven chamber 185 above the coal bed through the primary air inlets 190 with the amount of primary air controlled by the primary air dampers 195. The primary air dampers 195 can also be used to maintain the desired operating temperature inside the oven chamber 185. The partially combusted gases pass from the oven chamber 185 through the downcomer channels 200 into the sole flue 205, where secondary air is added to the partially combusted gases. The secondary air is introduced through the secondary air inlet 215. The amount of secondary air that is introduced is controlled by the secondary air damper 220. As the secondary air is introduced, the partially combusted gases are more fully combusted in the sole flue 205, thereby extracting the remaining enthalpy of combustion which is conveyed through the oven floor 160 to add heat to the oven chamber 185. The fully or nearly-fully combusted exhaust gases exit the sole flue 205 through the uptake channels 210 and then flow into the uptake duct 225. Tertiary air is added to the exhaust gases via the tertiary air inlet 227, where the amount of tertiary air introduced is controlled by the tertiary air damper 229 so that any remaining fraction of uncombusted gases in the exhaust gases are oxidized downstream of the tertiary air inlet 227.

[0023] At the end of the coking cycle, the coal has coked out and has carbonized to produce coke. The coke is preferably removed from the oven 105 through the rear door 170 utilizing a mechanical extraction system. Finally, the coke is quenched (e.g., wet or dry quenched) and sized before delivery to a user.

[0024] Figure 4 is a top view of a portion of a horizontal heat recovery coke plant 400 configured in accordance with examples of the technology. The coke plant 400 includes several features generally similar to the coke plant 100 described above with reference to Figure 1. For example, the plant 400 includes numerous uptake ducts 425 in fluid communication with coke ovens (not shown) and the hot common tunnel 110. The uptake ducts 425 can include "corresponding" uptake ducts 425a, 425b opposite one another on opposing lateral sides of the common tunnel 110 and a most-upstream or "end" uptake

duct 425c. The uptake ducts 425 can channel exhaust gas to the common tunnel 110. The exhaust gas in the common tunnel 110 moves from an "upstream" end toward a "downstream" end.

[0025] In the illustrated examples, the uptake ducts 425 meet the common tunnel 110 at a non-perpendicular interface. More specifically, the uptake ducts 425 have an upstream angle θ relative to the common tunnel 110. While the upstream angle θ is shown to be approximately 45° , it can be lesser or greater in other embodiments. Further, as will be discussed in more detail below, in embodiments according to the claimed invention different uptake ducts 425 have different upstream angles θ from one another. The non-perpendicular interfaces between the uptake ducts 425 and the common tunnel 110 can improve flow and reduce draft loss in the manner described above.

[0026] Figure 5A is a cross-sectional top view of a perpendicular interface between an uptake duct 525a and the common tunnel 110 configured in accordance with examples of the technology. An uptake flow of exhaust gas in the uptake duct 525a intersects a common flow of exhaust gas in the common tunnel 110 to form a combined flow. The uptake duct 525a and the common tunnel 110 meet at an interface having an upstream angle α_1 and a downstream angle α_2 which are each approximately 90° . In other words, using a spherical coordinate system, a direction of the uptake flow vector comprises an azimuthal y-component but no azimuthal x-component, while a direction of the common flow vector and combined flow vector comprises an x-component but no y-component.

[0027] Figure 5B is a cross-sectional top view of a non-perpendicular interface between an uptake duct 525b and the common tunnel 110 configured in accordance with embodiments of the technology. The uptake flow from the uptake duct 525b intersects the common flow in the common tunnel 110 to form a combined flow. The uptake duct 525b and the common tunnel 110 meet at an interface having an upstream angle α_1 less than 90° and a downstream angle α_2 greater than 90° . The non-perpendicular interface thus provides an azimuthal commonality between the uptake flow vector and the common flow vector. In other words, the uptake flow vector comprises an x-component having a direction in common with an x-component of the common flow vector, and the exhaust gas accordingly loses less momentum at the uptake duct 525b and common tunnel 110 interface as compared to the arrangement of Figure 5A. The reduced momentum loss can lower the draft loss at the interface or, in some embodiments, can even increase the draft in the common tunnel 110.

[0028] Figure 5C is a cross-sectional end view of a non-perpendicular interface between an uptake duct 525c and a common tunnel 510c configured in accordance with embodiments of the technology. While previous embodiments have shown the common tunnel to have a generally circular cross-sectional shape, in the

embodiment shown in Figure 5C the common tunnel 510c has a generally oval or egg-shaped cross-sectional shape. For example, the common tunnel 510 has a height H between a base B and a top T. In some embodiments, the egg-shaped cross-section can be asymmetrical (i.e., top-heavy), such that the common tunnel 510c has a greater cross-sectional area above a midpoint M between the top T and base B than below the midpoint M. Such a top-heavy design can provide for more room in the upper portion of the common tunnel 510c for combustion to occur, as the buoyancy of hot exhaust gas tends to urge combustion upward. The oblong shape of the illustrated common tunnel 510c can thus minimize flame impingement along the upper surface of the interior of the common tunnel 510c. In further embodiments, the uptake duct 525c can comprise any of the circular or non-circular cross-sectional shapes described above with reference to the common tunnel 510c, and the uptake duct 525c and common tunnel 510c need not have the same cross-sectional shape.

[0029] The uptake flow from the uptake duct 525c intersects the common flow in the common tunnel 510c to form a combined flow. Again referencing a spherical coordinate system, the uptake duct 525c meets the common tunnel 510c at an interface having a negative altitude angle β less than 90° with respect to the horizon (e.g., with respect to the x-y plane). The non-perpendicular interface thus provides an altitudinal difference between the uptake flow vector and the common flow vector. In other words, the uptake flow vector comprises a z-component that differs from a z-component of the common flow vector. In some embodiments, by introducing the uptake flow into the common flow at an altitudinal angle relative to the common flow vector, swirling flow or turbulence is developed inside the common tunnel 510c to enhance mixing and combustion of unburned volatile matter and oxygen. In other embodiments, the altitude angle β is a positive angle, greater than 90° .

[0030] The uptake duct 525c can interface with the common tunnel 510c at any height between the top T and bottom B of the common tunnel 510c. For example, in the illustrated embodiment, the uptake duct 525c intersects with the common tunnel 510c in the lower portion of the common tunnel 510c (i.e., below or substantially below the midpoint M). In further embodiments, the uptake duct 525c intersects with the common tunnel 510c in the upper portion of the common tunnel 510c, at the midpoint M, at a top T or bottom B of the common tunnel 510c, or in multiple locations around the cross-sectional circumference of the common tunnel 510c. For example, in a particular embodiment, one or more uptake ducts 525c may intersect with the common tunnel 510c in the lower portion and one or more other uptake ducts 525c may intersect with the common tunnel 510c in the upper portion.

[0031] Figure 5D is a cross-sectional end view of a non-perpendicular interface between an uptake duct 525d and the common tunnel 510d configured in accord-

ance with embodiments of the technology. In the embodiment shown in Figure 5D the common tunnel 510d has a generally square or rectangular cross-sectional shape. Other embodiments can have other cross-sectional shapes. The uptake flow from the uptake duct 525d intersects the common flow in the common tunnel 510d to form a combined flow. Again referencing a spherical coordinate system, the uptake duct 525d and the common tunnel 510d meet at an interface having a positive altitude angle β less than 90° with respect to the horizon. In other words, the uptake flow vector comprises a z-component that differs from a z-component of the common flow vector. In some embodiments, by introducing the uptake flow into the common flow at an altitudinal angle different from the common flow, mixing draft loss can be reduced and combustion can be encouraged to occur at a height that does not burn the interior surfaces of the common tunnel 510d. For example, the downward altitudinal introduction of flow from the uptake duct 525d can counter the buoyancy of the hot exhaust gas to encourage combustion to occur toward the bottom of the common tunnel 510d so as not to burn the top of the common tunnel 510d.

[0032] Figure 5E is a cross-sectional end view of a non-perpendicular interface between an uptake duct 525e and a common tunnel 510e configured in accordance with embodiments of the technology. The interface has several features generally similar to those discussed above with reference to Figures 5A-5D. However, in the embodiment illustrated in Figure 5E, the common tunnel 510e comprises a symmetrical, elongated oval. More specifically, the common tunnel 510e includes a semi-circular shape at top and bottom positions of the common tunnel 510e, and generally straight, parallel, elongated sides between the top and bottom semi-circles. The elongated shape can provide several of the advantages described above. For example, the design can provide for more room in the midsection of the common tunnel 510e for combustion to occur, as the buoyancy of hot exhaust gas tends to urge combustion upward. Similarly, the downward altitudinal introduction of flow from the uptake duct 525e at angle β can further counter the buoyancy of the hot exhaust gas to encourage combustion to occur toward the bottom of the common tunnel 510e. The oblong shape of the illustrated common tunnel 510e can thus minimize flame impingement along the upper surface of the interior of the common tunnel 510e. In further embodiments, the common tunnel 510e can be symmetrical or asymmetrical and have the same or different shapes.

[0033] While various features of the uptake duct and common tunnel interface have been shown separately for purposes of illustration, any of these features can be combined to achieve reduced draft loss, combustion control, and the most effective mixing of the uptake flow and common flow. More specifically, the azimuthal angle of interface, the altitudinal angle of interface, the height of interface, the shape of the common tunnel and/or uptake duct, or other feature can be selected to achieve the de-

sired thermal and draft conditions at the interface. Various parameters such as common tunnel draft, desired degree of common tunnel combustion, exhaust gas buoyancy conditions, total pressure, etc. can be some of the considerations in selecting the features of the uptake duct and common tunnel interface.

[0034] Figures 6A-6I are top views of various configurations of interfaces between uptake ducts and a common tunnel configured in accordance with examples and embodiments of the technology. As will be shown, the uptake ducts can comprise various patterns of perpendicular and non-perpendicular interfaces with the common tunnel, or can comprise various non-perpendicular angles relative to the common tunnel. While the examples and embodiments shown and discussed with reference to Figures 6A-6I include numerous features and arrangements, in further examples and embodiments any of these features and/or arrangements can be used independently or in any combination with other features and/or arrangements described herein.

[0035] Referring first to Figure 6A, in some examples each of several uptake ducts 625a meets the common tunnel 110 at a less-than- 90° upstream angle α . The uptake ducts 625a thus reduce mixing loss at the combination of common flow and uptake flow in the manner described above. In some examples, corresponding (i.e., opposing) uptake ducts 625a are laterally offset from one another and are not directly opposing. This is shown in the two most-downstream uptake ducts 625a shown in Figure 6A. In further examples, the spacing between individual uptake ducts 625a (i.e., along the length of the common tunnel 110) can likewise be variable. For example, the distance d between the two most downstream uptake ducts 625a along one side of the common tunnel 110 is greater than the distance between the other uptake ducts 625a. In further examples, the spacing is constant between all uptake ducts 625a.

[0036] Figure 6B illustrates an embodiment according to the presently claimed invention where uptake ducts 625b meet the common tunnel 110 at decreasing upstream angles α . For example, at a most downstream position, the uptake ducts may be perpendicular or nearly-perpendicular to the common tunnel 110. As the uptake tunnels approach an upstream end, the upstream angles α between the uptake ducts 625b and the common tunnel 110 become progressively smaller. In some embodiments, the range of upstream angles α varies from about 15° to about 90° . Since the draft pull is weaker farther upstream, this arrangement can progressively reduce the barrier to entry of the uptake flow into the common flow and thereby reduce draft loss due to mixing or stagnant flow regions. In further embodiments, one or more uptake ducts 625b can be positioned at an upstream angle α that is greater than 90° . In still further embodiments, the trend shown in Figure 6B can be reversed. More specifically, the uptake ducts 625b can meet the common tunnel 110 at increasing upstream angles, wherein the most-upstream angle can be near or

approaching 90°. Such an arrangement can be useful in embodiments where mixing flow losses are potentially greater at downstream positions having higher accumulated common flow.

[0037] Figure 6C illustrates an example having a combination of uptake ducts 625c meeting the common tunnel 110 at non-perpendicular angles α_1 and perpendicular angles α_2 . The illustrated example includes pairs of non-perpendicular ducts 625c along a side of the common tunnel 110 followed by pairs of perpendicular ducts 625c, and so on. In further examples, there can be more or fewer perpendicular or non-perpendicular uptake ducts 625c in a row.

[0038] Figure 6D illustrates an example having a combination of uptake ducts 625d meeting the common tunnel 110 at non-perpendicular angles α_1 and perpendicular angles α_2 . The illustrated example includes alternating non-perpendicular ducts 625d and perpendicular ducts 625d along a side of the common tunnel 110.

[0039] Figure 6E illustrates an example having a combination of uptake ducts 625e meeting the common tunnel 110 at non-perpendicular angles α_1 and perpendicular angles α_2 . The illustrated example includes individual perpendicular uptake ducts 625e alternating with non-perpendicular uptake ducts 625e, followed by pairs of non-perpendicular ducts 625e, followed by pairs of perpendicular ducts 625e, and so on. This pattern or a portion of this pattern can repeat along further sections of the common tunnel 110. In further examples, there can be different combinations of perpendicular and non-perpendicular uptake ducts.

[0040] Figure 6F illustrates an example having a combination of uptake ducts 625f meeting the common tunnel 110 at non-perpendicular angles α_1 and perpendicular angles α_2 . The illustrated example includes a series of non-perpendicular uptake ducts 625f, followed by a perpendicular duct 625f, followed by another series of non-perpendicular ducts 625f, and so on.

[0041] Figure 6G illustrates an example having a combination of uptake ducts 625g meeting the common tunnel 110 at non-perpendicular angles α_1 and perpendicular angles α_2 . The illustrated example includes non-perpendicular uptake ducts 625g on a first lateral side of the common tunnel 110, and perpendicular ducts 625g along a second, opposing, lateral side of the common tunnel 110.

[0042] Figure 6H illustrates an example having a combination of uptake ducts 625h meeting the common tunnel 110 at non-perpendicular angles α_1 and perpendicular angles α_2 . The illustrated example includes alternating non-perpendicular ducts 625h and perpendicular ducts 625h along a side of the common tunnel 110, where the non-perpendicular uptake ducts 625h are opposite perpendicular ducts 625h and vice-versa.

[0043] Figure 6I illustrates an example having uptake ducts 625i along only one lateral side of the common tunnel 110, with no uptake ducts on the opposing lateral side. In some embodiments, two single-sided common

tunnels 110 can be operated in a coke plant in a side-by-side parallel arrangement. The uptake ducts 625i can be angled at non-perpendicular angle α relative to the common tunnel 110 in the manner described above.

[0044] Figure 7A is a cross-sectional top view of a non-perpendicular interface retrofitted between a perpendicular uptake duct 725a and the common tunnel 110 configured in accordance with examples of the technology. The uptake duct 725a and the common tunnel 110 can originally have the same arrangement as the example discussed above with reference to Figure 5A, but can be retrofitted to include one or more non-perpendicular interface features. For example, the interface has been fitted with an internal baffle 726a to alter the flow pattern and create a non-perpendicular interface. More specifically, the baffle 726a is placed in a lumen of the uptake duct 725a and modifies a perpendicular interface into an angled interface that reduces draft loss due to mixing. In the illustrated example, the baffle 726a is triangle-shaped and converges the uptake flow by reducing an inner characteristic dimension of the uptake duct 725a. This converged flow can act as a nozzle and minimize flow energy losses of the uptake flow and/or common flow. In further examples, the baffle 726a can be adjustable (i.e., movable to adjust the flow and interface pattern), can have different shapes and/or sizes, and/or can converge and/or diverge flow to other degrees. Further, the baffle can extend around more or less of the lumen of the uptake duct 725a.

[0045] The common tunnel 110 can further be retrofitted with a flow modifier 703 positioned on an interior surface of the common tunnel 110 and configured to interrupt or otherwise modify flow in the common tunnel 110, or improve the interface (i.e., reduce draft loss) at the junction of the uptake flow and the common flow. The uptake duct 725a has further been modified with a bumped-out diverging flow plate D. The diverging flow plate D modifies the uptake flow vector to have an x-component in common with a common flow vector, thus reducing draft loss between the uptake flow and the common flow. While the diverging flow plate D, the baffle 726a, and the flow modifier 703 are shown in use together, in further examples, any of these features can be used independently or in any combination with any other features described herein.

[0046] While the terms "baffle" 726a and "flow modifier" 703 are used herein, the additions to the uptake duct 726a or common tunnel 110 can comprise any insulation material, refractory material, or other thermally-suitable material. In some examples, the flow modifier 703 and/or baffle 726a may comprise a single or multilayer lining that is built up with a relatively inexpensive material and covered with a skin. In yet another example, refractory or similar material can be shaped via gunning (i.e. spraying). Better control of shaping via gunning may be accomplished by gunning in small increments or layers. In addition, a template or mold may be used to aid the shaping via gunning. A template, mold, or advanced cutting

techniques may be used to shape the refractory (e.g. even in the absence of gunning for the main shape of an internal insert) for insertion into the duct and then attached via gunning to the inner lining of the duct. In yet another example, the flow modifier 703 and/or baffle 726a may be integrally formed along the duct. In other words, the uptake duct 725a wall may be formed or "dent-
 5 ed" to provide a convex surface along the interior surface of the duct. As used herein, the term convex does not require a continuous smooth surface, although a smooth surface may be desirable. For example, the flow modifier 703 and/or baffle 726a may be in the form of a multi-faceted protrusion extending into the flow path. Such a protrusion may be comprised of multiple discontinuous panels and/or surfaces. Furthermore, the flow modifier 703 and/or baffle 726a are not limited to convex surfaces. The contours of the flow modifier 703 and/or baffle 726a may have other complex surfaces, and can be determined by design considerations such as cost, space, operating conditions, etc. In further examples, there can be more than one flow modifier 703 and/or baffle 726a. Further, while the flow modifier 703 is shown in the common tunnel 110, in further examples the flow modifier 703 can be positioned at other locations (e.g., entirely or partially extending into the uptake duct 725a, or around the inner circumference of the common tunnel 110.

[0047] Figure 7B is a cross-sectional top view of an interface between an uptake duct 725b and a common tunnel 110 configured in accordance with examples of the technology. Figure 7C is a cross-sectional top view of a non-perpendicular interface retrofitted between the uptake duct 725b and common tunnel 110 of Figure 7B. Referring to Figures 7B and 7C together, the uptake duct 725b includes a diverging uptake end D that flares at the interface with the common tunnel 110. The uptake duct 725b can be retrofitted with an internal baffle 726c generally similar to the internal baffle 726a described above with reference to Figure 7A. The internal baffle 726c of Figure 7C can eliminate the flare or a portion of the flare at the diverging end D, to create a non-perpendicular interface between the uptake duct 725b and the common tunnel 110 to reduce draft loss. In further examples, the entire internal circumference of the uptake duct 725b can be fitted with the baffle 726c to further narrow or otherwise alter the interface. The baffle 726c can minimize flow energy losses as the uptake flow meets the common flow in the common tunnel 110.

[0048] Figure 8 is a cross-sectional top view of a non-perpendicular interface between an uptake duct 825 and the common tunnel 110 configured in accordance with examples of the technology. The uptake duct 825 includes a converging portion C followed by a diverging portion D. The converging portion C can minimize flow energy losses as the exhaust gas from the uptake duct 825 meets the common flow in the common tunnel 110. The diverging portion provides an interface that modifies the uptake flow vector to have an x-component in common with a common flow vector, thus reducing draft loss

between the pressurized uptake flow and the common flow. In various examples, the diverging and converging portions can have smooth or sharp transitions, and there can be more or fewer converging or diverging nozzles in the uptake duct 825 or common tunnel 110. In another example, the converging portion C is adjacent to the common tunnel 110 and the diverging portion D is upstream in the uptake duct 825. In further examples, the converging portion C can be used independently from the diverging portion D, and vice versa.

[0049] The interface of Figure 8 further includes a jet 803 configured to introduce a pressurized fluid such as air, exhaust gas, water, steam, fuel, oxidizer, inert, or other fluid (or combination of fluids) to the uptake flow or common flow as a way to improve flow and reduce draft loss. The fluid can be gaseous, liquid, or multiphase. The jet 803 can stem from or be supported by any external or internal pressurized source (e.g., a pressurized vessel, a pressurized line, a compressor, a chemical reaction or burning within the coking oven system that supports energy to create pressure, etc.). While the jet 803 is shown as penetrating the common tunnel 110 at a position downstream of the uptake duct 825, in further examples the jet 803 can be positioned in the uptake duct 825, upstream of the uptake duct 825 in the common tunnel 110, in multiple locations (e.g., a ring) around the circumference of the common tunnel 110 or uptake duct 825a, a combination of these positions, or other positions. In a particular example, the jet 803 can be positioned in the uptake duct 825 upstream of the converging portion C. The jet 803 can act as an ejector, and can pull a vacuum draft behind the pressurized fluid. The jet 803 can thus modify flow to create improved draft conditions, energize flow or mixing, or can reduce stagnant air or "dead" zones. In various examples, the jet 803 can pulse the fluid, provide constant fluid, or be run on a timer. Further, the jet 803 can be controlled manually, in response to conditions in the common tunnel 110, uptake duct 825, or other portion of the exhaust system, or as part of an advanced control regime. While the jet 803 is shown in use with the particular uptake duct 825 arrangement illustrated in Figure 8, in further examples, the jet 803 and uptake duct 825 could be employed independently or in any combination with any other features described herein. For example, in a particular example, the jet 803 could be used in combination with the flow modifier 703 shown in Figure 7A, and could be proximate to or protrude through such a flow modifier 703.

[0050] Figure 9 is a plot showing the spatial distribution of the difference in static pressure (in inches-water) along the length of the common tunnel. In other words, the plot illustrates the difference in static pressure at downstream positions in the common tunnel compared to the static pressure at the upstream end. As shown in the plot, the 45 degree uptake has a much lower draft loss over the same length of common tunnel as compared to the perpendicular uptake. This is because the angled uptake has less mixing loss than the perpendicular uptake.

[0051] Traditional heat recovery coke ovens employ an uptake duct connection from the coke oven to the hot common tunnel that is perpendicular to the common tunnel. Due to the perpendicular shape of the interface, the hot flue gas moving toward the common tunnel experiences a 90-degree change in flow direction. This induces considerable flow losses which can lead to a higher pressure drop. Such mixing losses are undesirable. In order to maintain the system under negative pressure, the high draft loss may require that either the common tunnel be made larger or a higher draft be pulled on the whole system to off-set this higher draft loss.

[0052] The non-perpendicular interfaces disclosed herein can lower the mixing draft loss at the uptake/common tunnel connection by angling the connection in the direction of the common tunnel flow. The smaller the upstream angle between the uptake duct and the common tunnel, the lesser the change in the directional momentum of the hot gas and, consequently, the lower the draft losses. By using non-perpendicular interfaces and aligning the uptake duct flow in the direction of the common tunnel flow, the draft loss can be lowered, which then can be used to reduce the common tunnel size or lower the required draft. For example, in some embodiments, the technology described herein can reduce the common tunnel insider diameter to 7-9 feet (2.13-2.74 metres). The technology could similarly allow a longer common tunnel that would traditionally have been prohibitive due to draft losses. For example, in some embodiments, the common tunnel can be long enough to support 30, 45, 60, or more ovens per side.

Claims

1. A coking system (100), comprising:

a plurality of coke ovens (105);
 a plurality of uptake ducts (225) in fluid communication with the plurality of coke ovens (105), each of the plurality of uptake ducts (225) having an uptake flow vector of exhaust gas from one of the plurality of coke ovens (105); and
 a common tunnel (110) having a common flow vector of exhaust gas and configured to transfer the exhaust gas to a venting system,

the plurality of uptake ducts (225) and common tunnel (110) being fluidly coupled with one another at a plurality of interfaces, at least some of the plurality of interfaces being non-perpendicular, wherein the uptake ducts (225) are disposed at angles with respect to the common tunnel (110) and bias the uptake flow vectors and common flow vector toward a common flow direction,
 wherein:

the plurality of uptake ducts (225) comprises a

first uptake duct in fluid communication with a first coke oven of the plurality of coke ovens (105) and having a first uptake flow vector, and wherein the system further comprises a second uptake duct of the plurality of uptake ducts (225) in fluid communication with the first coke oven or a second coke oven of the plurality of coke ovens (105) and having a second uptake flow vector of exhaust gas; and
 at least a portion of the first uptake duct is non-perpendicular to the common tunnel (110) by a first angle and at least a portion of the second uptake duct is non-perpendicular to the common tunnel (110) by a second angle different from the first angle,

whereby minimising a static pressure differential between an upstream portion and a downstream portion of the common tunnel (110) and discouraging a draft loss within the coking system (100).

2. The coking system (100) of claim 1 wherein the uptake flow vector of each of the plurality of uptake ducts (225) includes an x-component, a y-component and a z-component, and the common flow vector includes an x-component, a y-component and a z-component; the y-components of the uptake flow vector and the common flow vector disposed in different directions; the z-components of the uptake flow vector and the common flow vector disposed in different directions.
3. The coking system (100) of claim 1 wherein the common tunnel (110) has a common tunnel height, an upper portion above a midpoint of the common tunnel height, and a lower portion below the midpoint of the common tunnel height, and wherein at least some of the uptake ducts (225) interface with the common tunnel (110) at the upper portion or the lower portion, but not both simultaneously.
4. The coking system (100) of claim 1 wherein at least one non-perpendicular interface comprises at least one of a baffle, gunned surface, contoured duct liner, or convex flow modifier inside at least one of the uptake ducts (225) or common tunnel (110) and configured to alter at least one of the uptake flow vector or common flow vector.
5. The coking system (100) of claim 4 wherein the baffle, gunned surface, contoured duct liner, or convex flow modifier is integral to at least one of the uptake ducts (225) or common tunnel (110) or is retrofitted onto the uptake duct (225) or common tunnel (110).
6. The coking system (100) of claim 1 wherein at least one of the plurality of uptake ducts (225) comprises a portion, which converges in a direction of the up-

- take flow vector in a manner that minimised flow energy losses, and a diverging portion, which defines an interface that modifies the uptake flow vector to have an x-component in common with the common flow vector and reduces draft loss between the pressurized uptake flow and the common flow.
- 5
7. The coking system (100) of claim 1 wherein the first uptake flow vector and common flow vector meet at a non-perpendicular interface, and the second uptake flow vector and common flow vector meet at a perpendicular or non-perpendicular interface.
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8. The coking system (100) of claim 1 wherein:
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- the system (100) further comprises a third uptake duct of the plurality of uptake ducts (225) in fluid communication with the first coke oven, the second coke oven, or a third coke oven of the plurality of coke ovens (105) and having a third uptake flow vector of exhaust gas;
- 20
- the first uptake duct, second uptake duct, and third uptake duct are positioned along a lateral side of the common tunnel (110); and
- 25
- there is a first distance between the first uptake duct and second uptake duct and a second distance different from the first distance between the second uptake duct and the third uptake duct.
- 30
9. The coking system (100) of claim 1 wherein the first uptake duct is positioned on a first lateral side of the common tunnel (110) and the second uptake duct is positioned on a second lateral side of the common tunnel (110) opposite the first lateral side, and wherein the first uptake duct and second uptake duct are laterally offset from one another.
- 35
10. The coking system (100) of claim 1 wherein the first uptake duct and second uptake duct are positioned on a common lateral side of the common tunnel (110), and wherein there are no uptake ducts on an opposing lateral side of the common tunnel (110).
- 40
11. The coking system (100) of claim 1 wherein the common tunnel (110) has one of a circular, non-circular, oval, elongated oval, asymmetrical oval, or rectangular cross-sectional shape.
- 45
12. A method of reducing draft losses in a common tunnel (110) in a coking system (100) comprising a plurality of coke ovens (105) and a plurality of uptake ducts (225) in fluid communication with the plurality of coke ovens (105) and the common tunnel (110), the method comprising:
- 50
- flowing exhaust gas from a first coke oven of the plurality of coke ovens (105) through a first uptake duct of the plurality of uptake ducts (225) with a first uptake flow vector;
- 55
- flowing exhaust gas from the first coke oven, or a second coke oven of the plurality of coke ovens (105) through a second uptake duct of the plurality of uptake ducts (225) with a second uptake flow vector;
- biasing the exhaust gas exiting the first and second uptake ducts (225) toward a common flow direction in the common tunnel (110); and
- merging the exhaust gas exiting the first and second uptake ducts (225) and the common flow at a non-perpendicular interface,
- wherein:
- at least a portion of the first uptake duct (225) is disposed at a non-perpendicular first angle with respect to the common tunnel (110),
- at least a portion of the second uptake duct (225) is disposed at a non-perpendicular second angle with respect to the common tunnel (110), the second angle being different from the first angle,
- whereby aligning an uptake duct mass flow with a common tunnel mass flow in a manner that increases a draft at the uptake duct (225) and decreases a draft loss in the common tunnel (110).
13. The method of claim 12, further comprising at least one of converging or diverging the exhaust gas in or upon exiting one or more of the plurality of uptake ducts (225).
14. The method of claim 12 wherein biasing the exhaust gas comprises biasing the exhaust gas with a baffle in one or more of the plurality of uptake ducts (225).
15. The method of claim 12, further comprising introducing a pressurized fluid via a jet into at least one of the plurality of uptake ducts (225) or the common tunnel (110).
- Patentansprüche**
1. Verkokungssystem (100), umfassend:
- eine Mehrzahl von Koksöfen (105);
- eine Mehrzahl von Aufnahmekanälen (225), die in Fluidverbindung mit der Mehrzahl von Koksöfen (105) stehen, wobei jeder der Mehrzahl von Aufnahmekanälen (225) einen Aufnahme-Strömungsvektor von Abgas von einem der Mehrzahl von Koksöfen (105) aufweist; und
- einen gemeinsamen Tunnel (110), der einen gemeinsamen Strömungsvektor des Abgases aufweist und so konfiguriert ist, dass er das Abgas

zu einem Entlüftungssystem leitet,

wobei die Mehrzahl von Aufnahmekanälen (225) und der gemeinsame Tunnel (110) an mehreren Schnittstellen fluidisch miteinander gekoppelt sind, wobei zumindest einige der mehreren Schnittstellen nicht senkrecht sind, wobei die Aufnahmekanäle (225) unter Winkeln in Bezug auf den gemeinsamen Tunnel (110) angeordnet sind und die Aufnahme-Strömungsvektoren und den gemeinsamen Strömungsvektor in eine gemeinsame Strömungsrichtung lenken, wobei:

die Mehrzahl von Aufnahmekanälen (225) einen ersten Aufnahmekanal umfasst, der in Fluidverbindung mit einem ersten Koksofen der Mehrzahl von Koksöfen (105) steht und einen ersten Aufnahme-Strömungsvektor aufweist, und wobei das System ferner einen zweiten Aufnahmekanal der Mehrzahl von Aufnahmekanälen (225) umfasst, der in Fluidverbindung mit dem ersten Koksofen oder einem zweiten Koksofen der Mehrzahl von Koksöfen (105) steht und einen zweiten Aufnahme-Strömungsvektor von Abgas aufweist; und mindestens ein Abschnitt des ersten Aufnahmekanals um einen ersten Winkel nicht senkrecht zu dem gemeinsamen Tunnel (110) ist und mindestens ein Abschnitt des zweiten Aufnahmekanals um einen zweiten Winkel nicht senkrecht zu dem gemeinsamen Tunnel (110) ist, der sich von dem ersten Winkel unterscheidet, wodurch eine statische Druckdifferenz zwischen einem stromaufwärts gelegenen Abschnitt und einem stromabwärts gelegenen Abschnitt des gemeinsamen Tunnels (110) minimiert wird und ein Zugverlust innerhalb des Verkokungssystems (100) verhindert wird.

2. Verkokungssystem (100) nach Anspruch 1, wobei der Aufnahme-Strömungsvektor jedes der Mehrzahl von Aufnahmekanälen (225) eine x-Komponente, eine y-Komponente und eine z-Komponente aufweist und der gemeinsame Strömungsvektor eine x-Komponente, eine y-Komponente und eine z-Komponente aufweist; wobei die y-Komponenten des Aufnahme-Strömungsvektors und des gemeinsamen Strömungsvektors in unterschiedlichen Richtungen angeordnet sind; wobei die z-Komponenten des Aufnahme-Strömungsvektors und des gemeinsamen Strömungsvektors in unterschiedlichen Richtungen angeordnet sind.
3. Verkokungssystem (100) nach Anspruch 1, wobei der gemeinsame Tunnel (110) eine gemeinsame Tunnelhöhe, einen oberen Abschnitt oberhalb eines Mittelpunkts der gemeinsamen Tunnelhöhe und ei-

nen unteren Abschnitt unterhalb des Mittelpunkts der gemeinsamen Tunnelhöhe aufweist, und wobei mindestens einige der Aufnahmekanäle (225) mit dem gemeinsamen Tunnel (110) an dem oberen Abschnitt oder dem unteren Abschnitt, jedoch nicht gleichzeitig, eine Schnittstelle bilden.

4. Verkokungssystem (100) nach Anspruch 1, wobei mindestens eine nicht senkrechte Schnittstelle mindestens eines der folgenden Elemente umfasst: ein Ablenkblech, eine beschossene Oberfläche, eine konturierte Kanalauskleidung oder einen konvexen Strömungsmodifikator innerhalb mindestens eines der Aufnahmekanäle (225) oder des gemeinsamen Tunnels (110), der so konfiguriert ist, dass den Aufnahme-Strömungsvektor oder/und gemeinsamen Strömungsvektor ändert.
5. Verkokungssystem (100) nach Anspruch 4, bei dem das Ablenkblech, die beschossene Oberfläche, die konturierte Kanalauskleidung oder der konvexe Strömungsmodifikator integraler Bestandteil mindestens eines der Aufnahmekanäle (225) oder des gemeinsamen Tunnels (110) ist oder nachträglich auf dem Aufnahmekanal (225) oder dem gemeinsamen Tunnel (110) aufgebracht ist.
6. Verkokungssystem (100) nach Anspruch 1, wobei mindestens einer der Mehrzahl von Aufnahmekanälen (225) einen Abschnitt umfasst, der in einer Richtung des Aufnahme-Strömungsvektors in einer Weise konvergiert, die Strömungsenergieverluste minimiert, und einen divergierenden Abschnitt, der eine Schnittstelle definiert, die den Aufnahme-Strömungsvektor so modifiziert, dass er eine x-Komponente mit dem gemeinsamen Strömungsvektor gemeinsam hat, und Zugverlust zwischen der unter Druck stehenden Aufnahmeströmung und der gemeinsamen Strömung reduziert.
7. Verkokungssystem (100) nach Anspruch 1, bei dem sich der erste Aufnahme-Strömungsvektor und der gemeinsame Strömungsvektor an einer nicht senkrechten Schnittstelle treffen und der zweite Aufnahme-Strömungsvektor und der gemeinsame Strömungsvektor an einer senkrechten oder nicht senkrechten Schnittstelle treffen.
8. Verkokungssystem (100) nach Anspruch 1, wobei:

das System (100) ferner einen dritten Aufnahmekanal der Mehrzahl von Aufnahmekanälen (225) umfasst, der in Fluidverbindung mit dem ersten Koksofen, dem zweiten Koksofen oder einem dritten Koksofen der Mehrzahl von Koksöfen (105) steht und einen dritten Aufnahme-Strömungsvektor von Abgas aufweist; der erste Aufnahmekanal, der zweite Aufnah-

mekanal und der dritte Aufnahmekanal entlang einer lateralen Seite des gemeinsamen Tunnels (110) angeordnet sind; und es einen ersten Abstand zwischen dem ersten Aufnahmekanal und dem zweiten Aufnahmekanal und einen zweiten Abstand, der sich von dem ersten Abstand unterscheidet, zwischen dem zweiten Aufnahmekanal und dem dritten Aufnahmekanal gibt.

9. Verkokungssystem (100) nach Anspruch 1, wobei der erste Aufnahmekanal an einer ersten lateralen Seite des gemeinsamen Tunnels (110) positioniert ist und der zweite Aufnahmekanal an einer zweiten lateralen Seite des gemeinsamen Tunnels (110) gegenüber der ersten lateralen Seite positioniert ist, und wobei der erste Aufnahmekanal und der zweite Aufnahmekanal seitlich zueinander versetzt sind.
10. Verkokungssystem (100) nach Anspruch 1, wobei der erste Aufnahmekanal und der zweite Aufnahmekanal auf einer gemeinsamen lateralen Seite des gemeinsamen Tunnels (110) positioniert sind, und wobei es auf einer gegenüberliegenden lateralen Seite des gemeinsamen Tunnels (110) keine Aufnahmekanäle gibt.
11. Verkokungssystem (100) nach Anspruch 1, wobei der gemeinsame Tunnel (110) eine kreisförmige, nicht kreisförmige, ovale, länglich-ovale, asymmetrisch-ovale oder rechteckige Querschnittsform aufweist.
12. Verfahren zum Reduzieren von Zugverlusten in einem gemeinsamen Tunnel (110) in einem Verkokungssystem (100), das eine Mehrzahl von Koksöfen (105) und eine Mehrzahl von Aufnahmekanälen (225) in Fluidverbindung mit der Mehrzahl von Koksöfen (105) und dem gemeinsamen Tunnel (110) umfasst, wobei das Verfahren umfasst:

Strömenlassen von Abgas aus einem ersten Koksofen der Mehrzahl von Koksöfen (105) durch einen ersten Aufnahmekanal der Mehrzahl von Aufnahmekanälen (225) mit einem ersten Aufnahme-Strömungsvektor;

Strömenlassen von Abgas aus dem ersten Koksofen oder einem zweiten Koksofen der Mehrzahl von Koksöfen (105) durch einen zweiten Aufnahmekanal der Mehrzahl von Aufnahmekanälen (225) mit einem zweiten Aufnahme-Strömungsvektor;

Lenken des aus dem ersten und zweiten Aufnahmekanal (225) austretenden Abgases in Richtung einer gemeinsamen Strömungsrichtung in dem gemeinsamen Tunnel (110); und

Zusammenführen des aus den ersten und zweiten Aufnahmekanälen (225) austretenden Ab-

gases und der gemeinsamen Strömung an einer nicht senkrechten Schnittstelle,

wobei:

- 5 mindestens ein Abschnitt des ersten Aufnahmekanals (225) in einem nicht senkrechten ersten Winkel in Bezug auf den gemeinsamen Tunnel (110) angeordnet ist,
- 10 mindestens ein Abschnitt des zweiten Aufnahmekanals (225) in einem nicht senkrechten zweiten Winkel in Bezug auf den gemeinsamen Tunnel (110) angeordnet ist, wobei der zweite Winkel sich von dem ersten Winkel unterscheidet,
- 15 wodurch ein Massenstrom des Aufnahmekanals mit einem Massenstrom des gemeinsamen Tunnels in einer Weise ausgerichtet wird, die einen Zug am Aufnahmekanal (225) erhöht und einen Zugverlust im gemeinsamen Tunnel (110) verringert.
13. Verfahren nach Anspruch 12, ferner umfassend mindestens eines von:
- 25 Konvergieren oder Divergieren des Abgases im oder beim Austritt aus einem oder mehreren der Mehrzahl von Aufnahmekanälen (225).
14. Verfahren nach Anspruch 12, wobei das Lenken des Abgases das Lenken des Abgases mit einem Ablenkblech in einem oder mehreren der Mehrzahl von Aufnahmekanälen (225) umfasst.
- 30 15. Verfahren nach Anspruch 12, ferner umfassend das Einleiten eines unter Druck stehenden Fluids über einen Strahl in mindestens einen der Mehrzahl von Aufnahmekanälen (225) oder den gemeinsamen Tunnel (110).
- 35
- 40

Revendications

1. Système de cokéfaction (100), comprenant :

45 une pluralité de fours à coke (105) ;
 une pluralité de conduits de montée de gaz (225) en communication fluide avec la pluralité de fours à coke (105), chacun de la pluralité de conduits de montée de gaz (225) ayant un vecteur de flux de montée de gaz des gaz d'échappement de l'un de la pluralité de fours à coke (105) ;
 et
 un tunnel commun (110) ayant un vecteur de flux commun de gaz d'échappement et étant configuré pour transférer les gaz d'échappement vers un système de ventilation,
 50 la pluralité de conduits de montée de gaz (225) et le tunnel commun (110) étant couplés de ma-

nière fluïdique les uns aux autres à une pluralité d'interfaces, au moins certaines de la pluralité d'interfaces étant non perpendiculaires, où les conduits de montée de gaz (225) sont disposés selon des angles par rapport au tunnel commun (110) et sollicitent les vecteurs de flux de montée de gaz et le vecteur de flux commun vers une direction de flux commun, dans lequel :

la pluralité de conduits de montée de gaz (225) comprend un premier conduit de montée de gaz en communication fluïdique avec un premier four à coke de la pluralité de fours à coke (105) et ayant un premier vecteur de flux de montée de gaz, et où le système comprend en outre un deuxième conduit de montée de gaz de la pluralité de conduits de montée de gaz (225) en communication fluïdique avec le premier four à coke ou un deuxième four à coke de la pluralité de fours à coke (105) et ayant un deuxième vecteur de flux de montée de gaz des gaz d'échappement ; et

au moins une partie du premier conduit de montée de gaz est non perpendiculaire au tunnel commun (110) d'un premier angle et au moins une partie du deuxième conduit de montée de gaz est non perpendiculaire au tunnel commun (110) d'un deuxième angle différent du premier angle, ce qui minimise une pression différentielle statique entre une partie amont et une partie aval du tunnel commun (110) et prévient une perte de tirage dans le système de cokéfaction (100).

2. Système de cokéfaction (100) de la revendication 1, dans lequel le vecteur de flux de montée de gaz de chacun de la pluralité de conduits de montée de gaz (225) comporte une composante x, une composante y et une composante z, et le vecteur de flux commun comporte une composante x, une composante y et une composante z ; les composantes y du vecteur de flux de montée de gaz et du vecteur de flux commun étant disposées dans des directions différentes ; les composantes z du vecteur de flux de montée de gaz et du vecteur de flux commun étant disposées dans des directions différentes.
3. Système de cokéfaction (100) de la revendication 1, dans lequel le tunnel commun (110) a une hauteur de tunnel commun, une partie supérieure au-dessus d'un point médian de la hauteur de tunnel commun, et une partie inférieure en dessous du point médian de la hauteur de tunnel commun, et dans lequel au moins certains des conduits de montée de gaz (225) forment une interface avec le tunnel commun (110)

au niveau de la partie supérieure ou de la partie inférieure, mais pas les deux en même temps.

4. Système de cokéfaction (100) de la revendication 1, dans lequel au moins une interface non perpendiculaire comprend au moins l'un d'un déflecteur, d'une surface à projection, d'un revêtement de conduit profilé et d'un modificateur de flux convexe dans au moins l'un des conduits de montée de gaz (225) ou le tunnel commun (110) et étant configurée pour modifier au moins l'un du vecteur de flux de montée de gaz et du vecteur de flux commun.
5. Système de cokéfaction (100) de la revendication 4, dans lequel le déflecteur, la surface à projection, le revêtement de conduit profilé ou le modificateur de flux convexe est solidaire d'au moins l'un des conduits de montée de gaz (225) ou du tunnel commun (110) ou est adapté sur le conduit de montée de gaz (225) ou le tunnel commun (110) .
6. Système de cokéfaction (100) de la revendication 1, dans lequel au moins l'un de la pluralité de conduits de montée de gaz (225) comprend une partie, qui converge dans une direction du vecteur de flux de montée de gaz de manière à minimiser les pertes d'énergie de flux, et une partie divergente, qui définit une interface qui modifie le vecteur de flux de montée de gaz pour avoir une composante x en commun avec le vecteur de flux commun et réduit la perte de tirage entre le flux de montée de gaz sous pression et le flux commun.
7. Système de cokéfaction (100) de la revendication 1, dans lequel le premier vecteur de flux de montée de gaz et le vecteur de flux commun se rencontrent à une interface non perpendiculaire, et le deuxième vecteur de flux de montée de gaz et le vecteur de flux commun se rencontrent à une interface perpendiculaire ou non perpendiculaire.
8. Système de cokéfaction (100) de la revendication 1, où :

le système (100) comprend en outre un troisième conduit de montée de gaz de la pluralité de conduits de montée de gaz (225) en communication fluïdique avec le premier four à coke, le deuxième four à coke ou un troisième four à coke de la pluralité de fours à coke (105) et ayant un troisième vecteur de flux de montée de gaz des gaz d'échappement ; le premier conduit de montée de gaz, le deuxième conduit de montée de gaz et le troisième conduit de montée de gaz sont positionnés le long d'un côté latéral du tunnel commun (110) ; et il y a une première distance entre le premier con-

- duit de montée de gaz et le deuxième conduit de montée de gaz et une deuxième distance différente de la première distance entre le deuxième conduit de montée de gaz et le troisième conduit de montée de gaz.
- 5
9. Système de cokéfaction (100) de la revendication 1, dans lequel le premier conduit de montée de gaz est positionné sur un premier côté latéral du tunnel commun (110) et le deuxième conduit de montée de gaz est positionné sur un deuxième côté latéral du tunnel commun (110) opposé au premier côté latéral, et dans lequel le premier conduit de montée de gaz et le deuxième conduit de montée de gaz sont décalés latéralement l'un par rapport à l'autre.
- 10
10. Système de cokéfaction (100) de la revendication 1, dans lequel le premier conduit de montée de gaz et le deuxième conduit de montée de gaz sont positionnés sur un côté latéral commun du tunnel commun (110), et dans lequel il n'y a pas de conduits de montée de gaz sur un côté latéral opposé du tunnel commun (110).
- 15
11. Système de cokéfaction (100) de la revendication 1, dans lequel le tunnel commun (110) a l'une d'une forme de section transversale circulaire, non circulaire, ovale, ovale allongée, ovale asymétrique et rectangulaire.
- 20
12. Procédé de réduction des pertes de tirage dans un tunnel commun (110) dans un système de cokéfaction (100) comprenant une pluralité de fours à coke (105) et une pluralité de conduits de montée de gaz (225) en communication fluïdique avec la pluralité de fours à coke (105) et le tunnel commun (110), le procédé comprenant les étapes consistant à :
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- amener des gaz d'échappement à s'écouler d'un premier four à coke de la pluralité de fours à coke (105) à travers un premier conduit de montée de gaz de la pluralité de conduits de montée de gaz (225) avec un premier vecteur de flux de montée de gaz ;
- 30
- amener les gaz d'échappement à s'écouler du premier four à coke, ou d'un deuxième four à coke de la pluralité de fours à coke (105) à travers un deuxième conduit de montée de gaz de la pluralité de conduits de montée de gaz (225) avec un deuxième vecteur de flux de montée de gaz ;
- 35
- solliciter les gaz d'échappement sortant des premier et deuxième conduits de montée de gaz (225) vers une direction de flux commun dans le tunnel commun (110) ; et
- 40
- fusionner les gaz d'échappement sortant des premier et deuxième conduits de montée de gaz (225) et le flux commun à une interface non per-
- 45
- pendiculaire, dans lequel :
- 50
- au moins une partie du premier conduit de montée de gaz (225) est disposée selon un premier angle non perpendiculaire par rapport au tunnel commun (110), au moins une partie du deuxième conduit de montée de gaz (225) est disposée selon un deuxième angle non perpendiculaire par rapport au tunnel commun (110), le deuxième angle étant différent du premier angle, ce qui permet d'aligner un flux massique de conduit de montée de gaz avec un flux massique de tunnel commun de manière à augmenter un tirage au niveau du conduit de montée de gaz (225) et à diminuer une perte de tirage dans le tunnel commun (110).
- 55
13. Procédé de la revendication 12, comprenant en outre au moins l'une des étapes consistant à converger et à diverger les gaz d'échappement dans ou à la sortie d'un ou plusieurs de la pluralité de conduits de montée de gaz (225) .
14. Procédé de la revendication 12, dans lequel la sollicitation des gaz d'échappement comprend la sollicitation des gaz d'échappement avec un déflecteur dans un ou plusieurs de la pluralité de conduits de montée de gaz (225).
15. Procédé de la revendication 12, comprenant en outre l'étape consistant à introduire un fluide sous pression par l'intermédiaire d'un jet dans au moins l'un de la pluralité de conduits de montée de gaz (225) ou le tunnel commun (110).

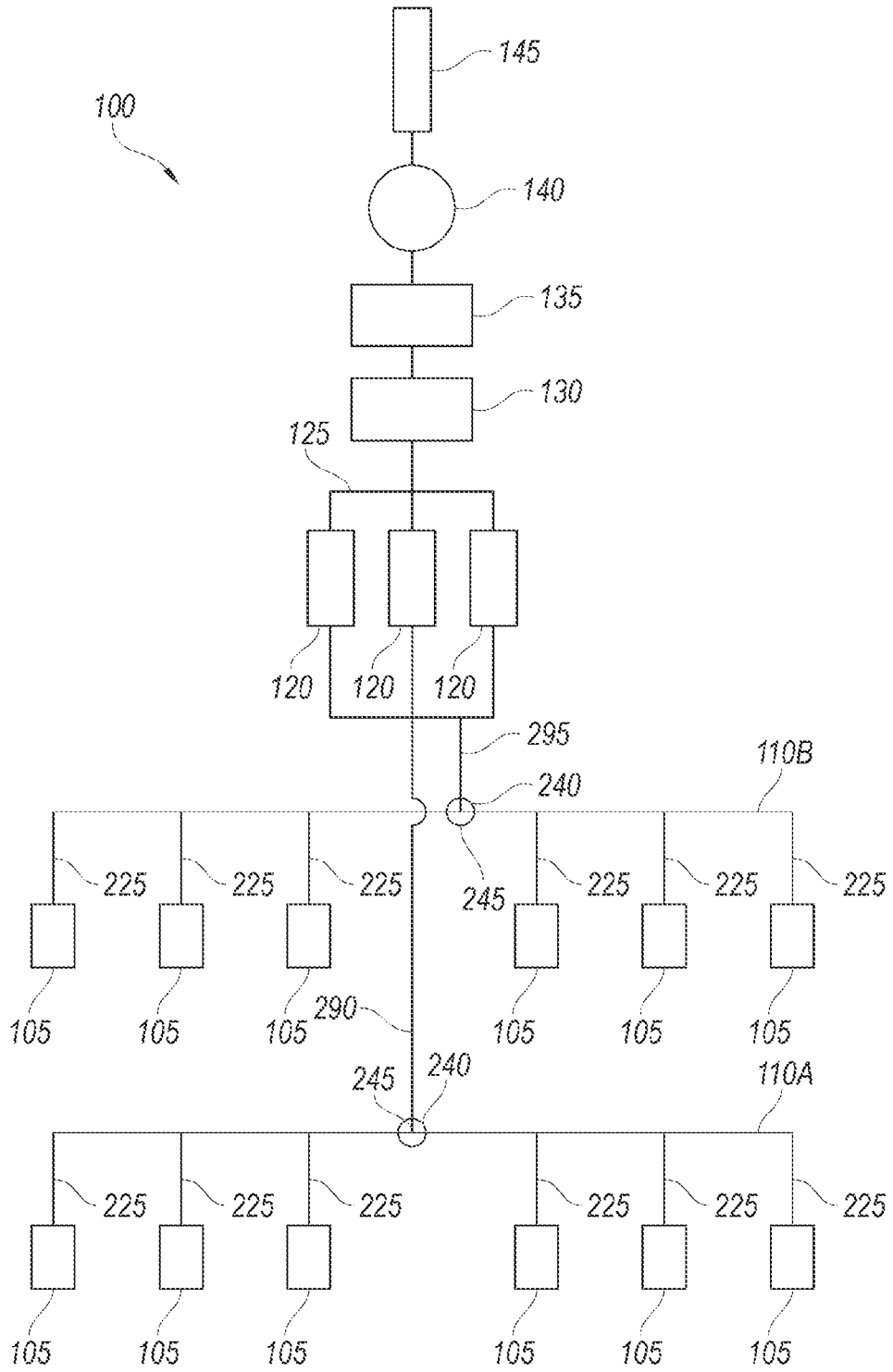


Fig. 1

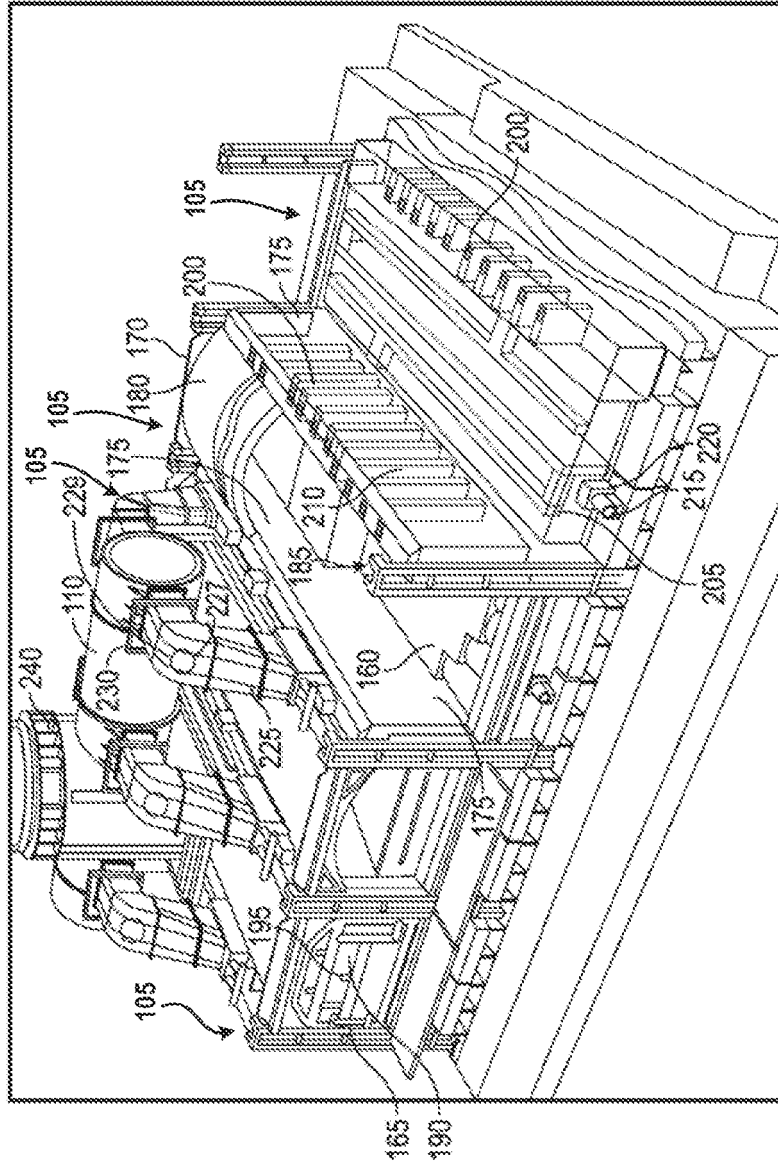


Fig. 2

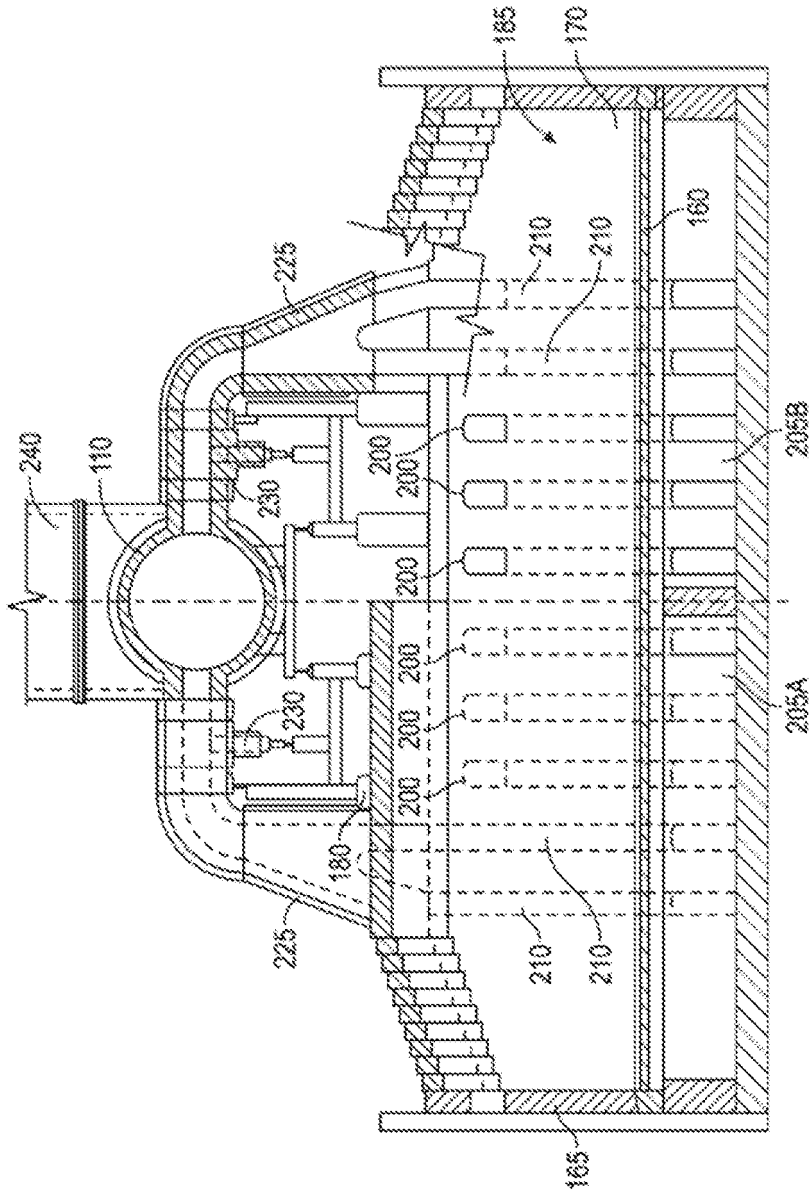


Fig. 3

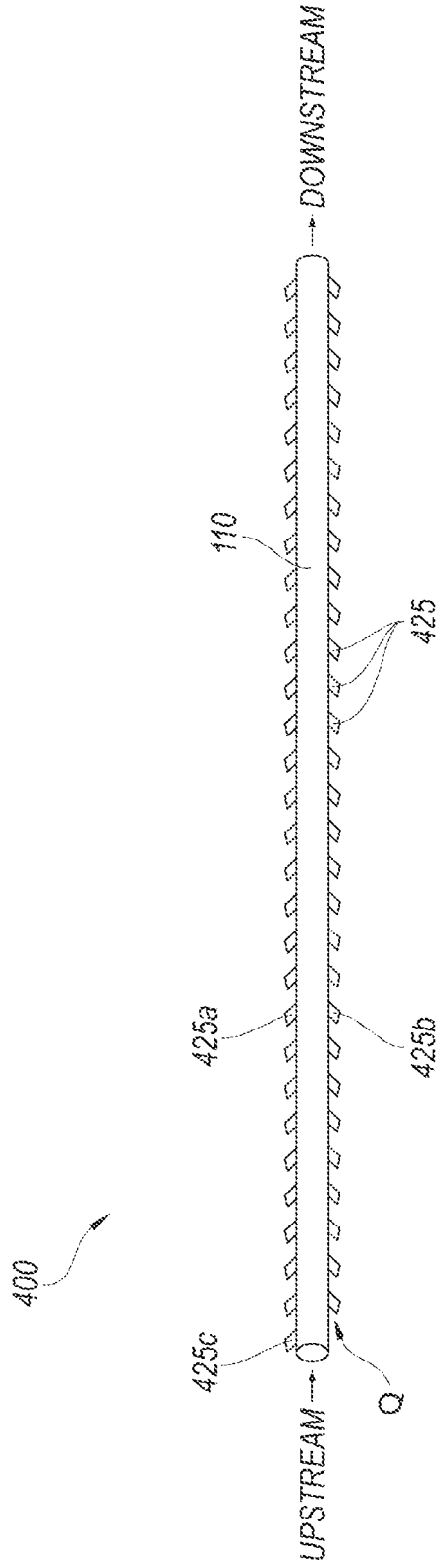


Fig. 4

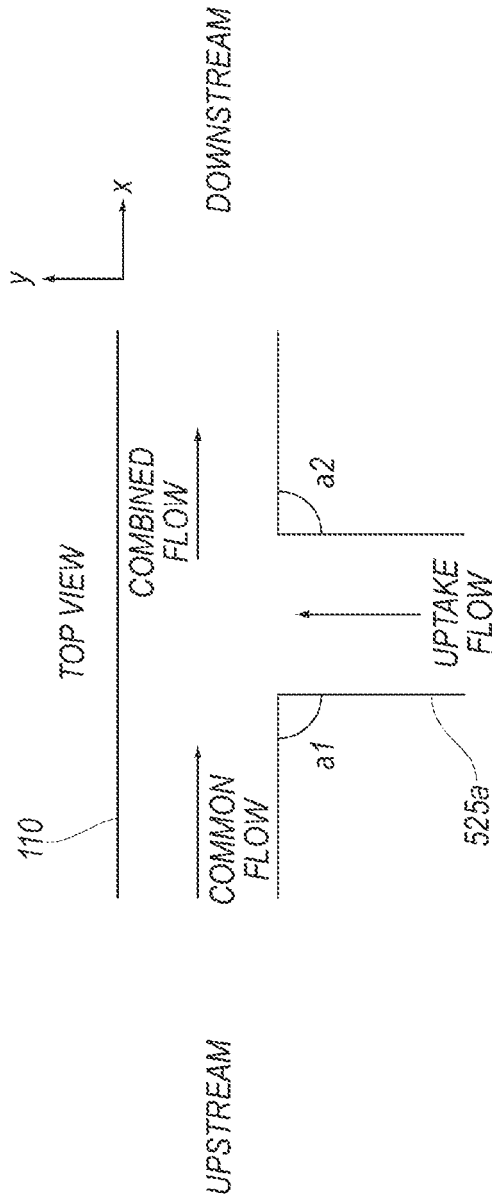


Fig. 5A

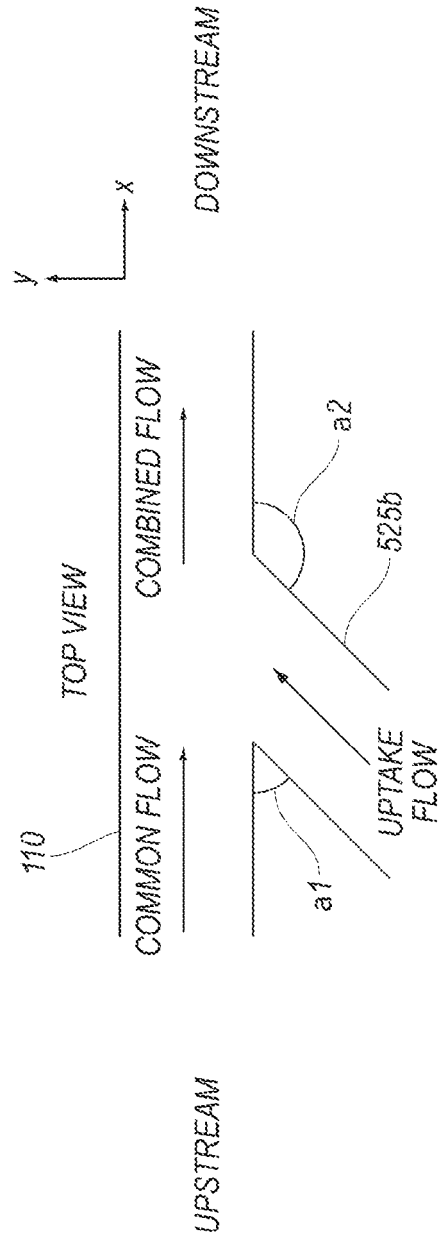


Fig. 5B

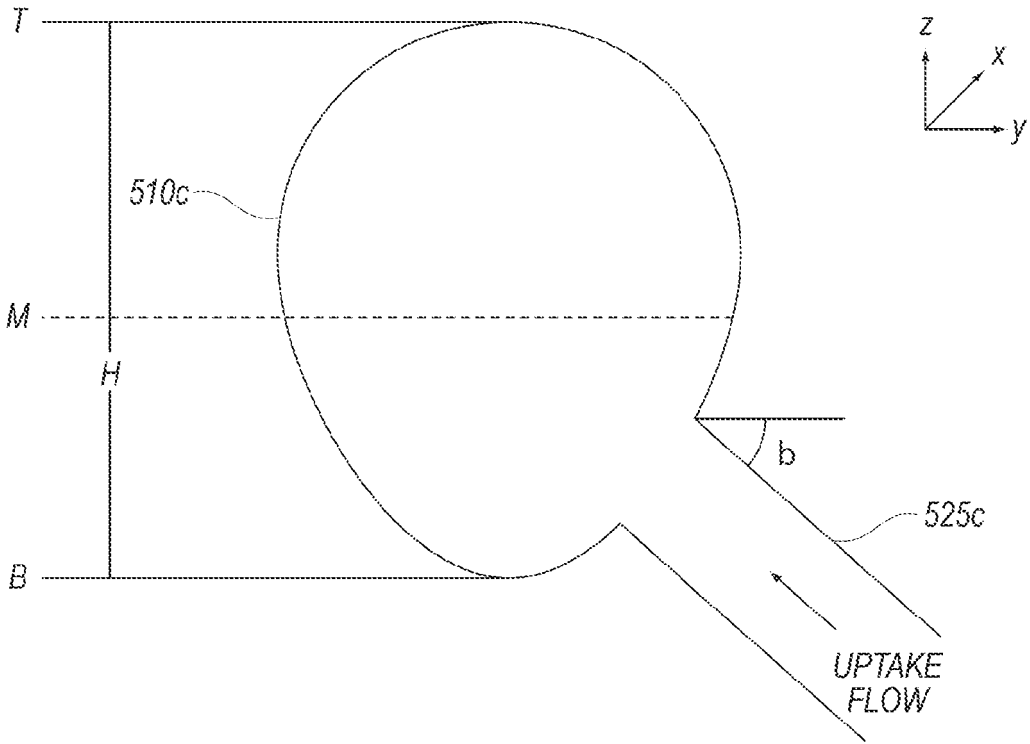


Fig. 5C

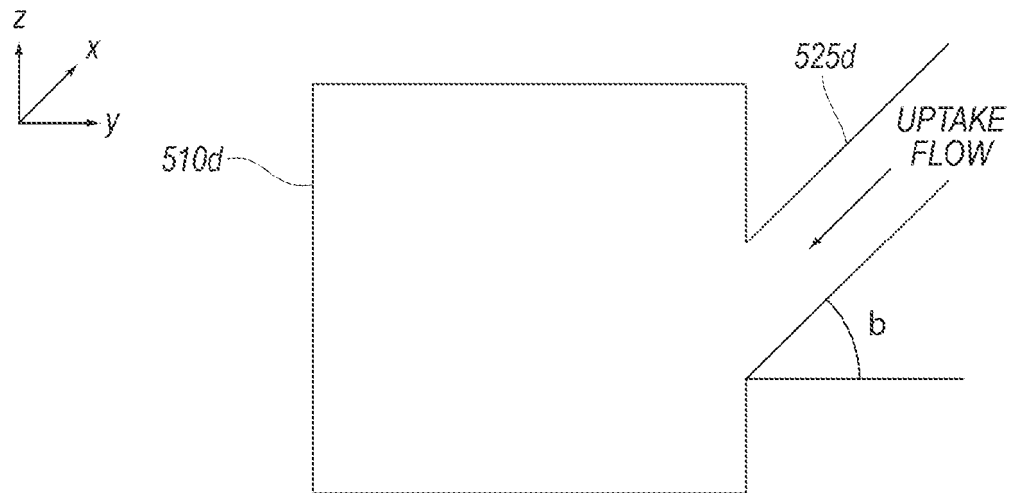


Fig. 5D

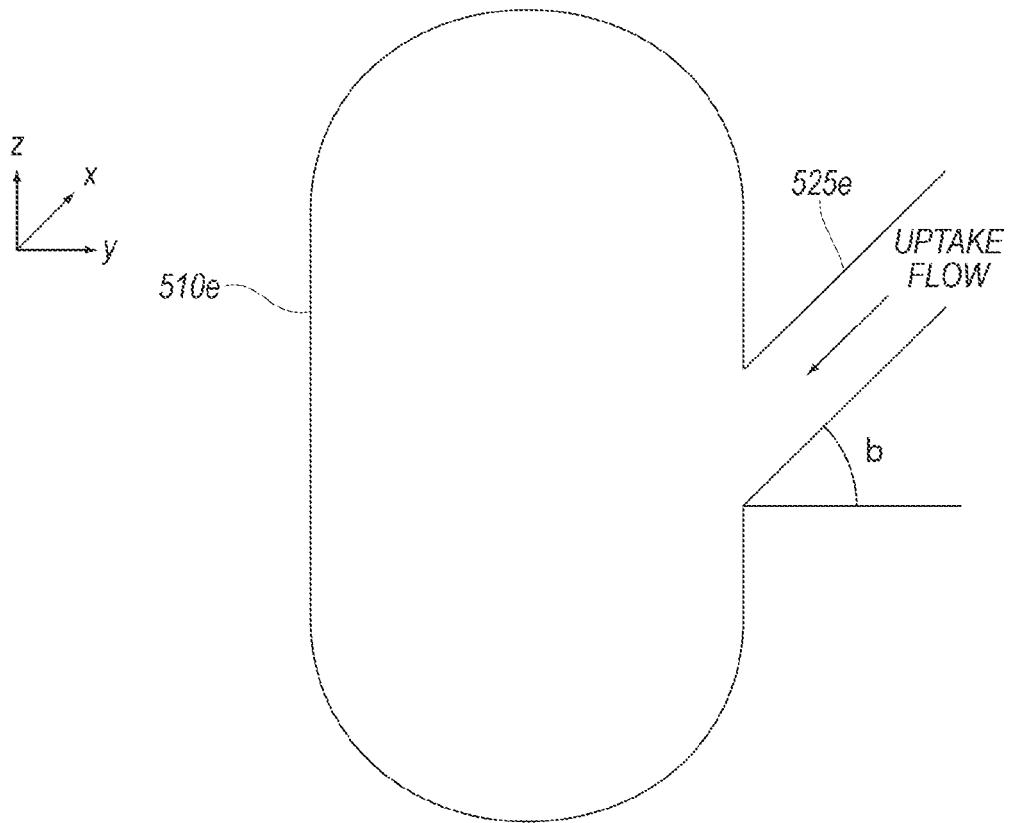


Fig. 5E

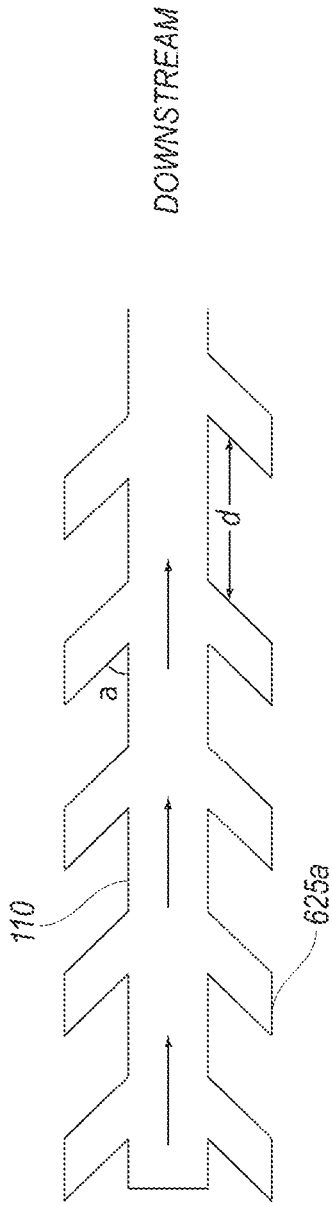


Fig. 6A

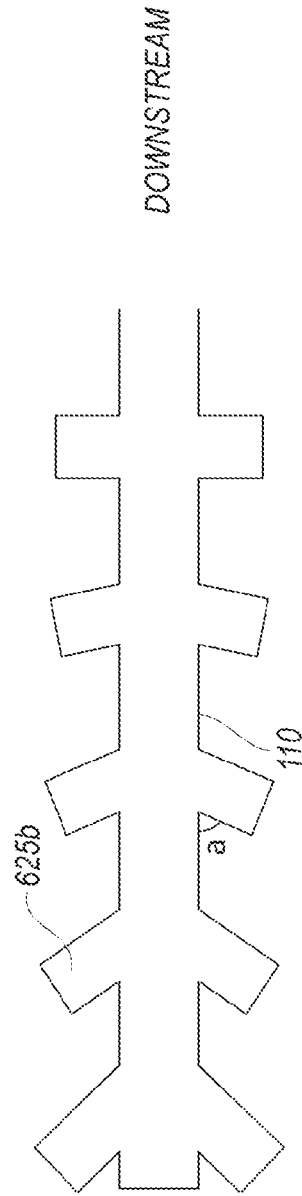


Fig. 6B

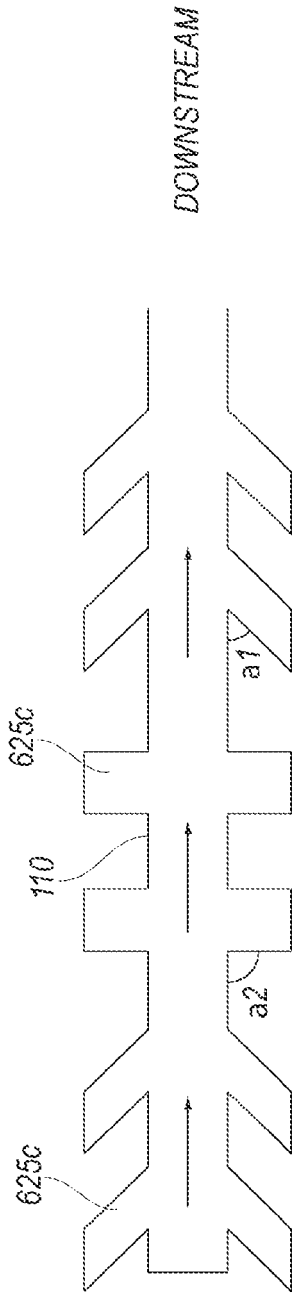


Fig. 6C

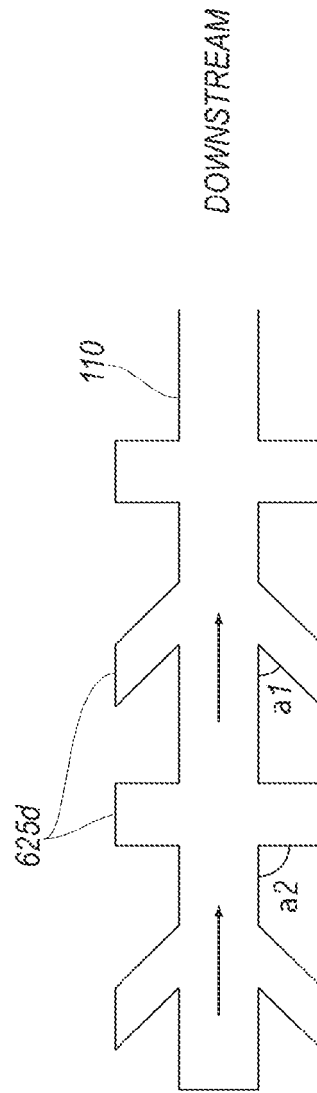


Fig. 6D

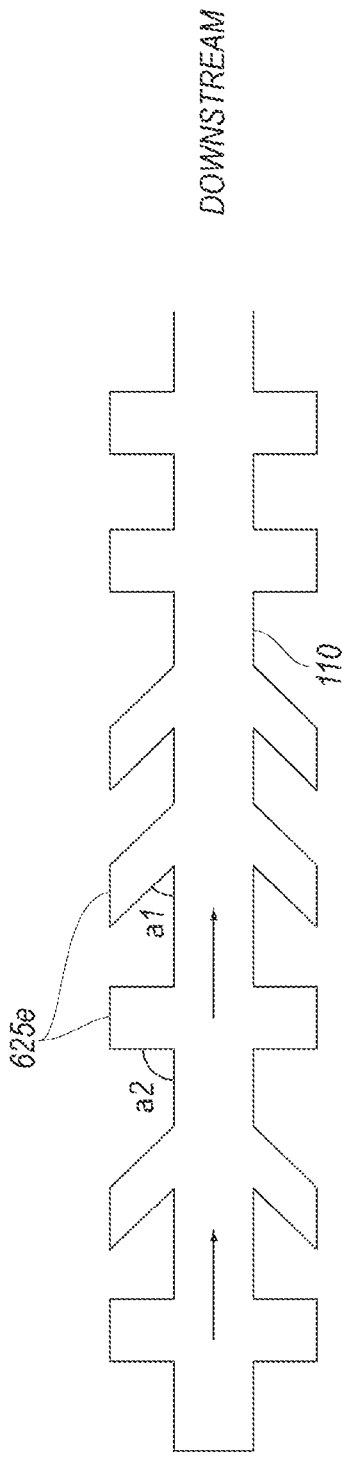


Fig. 6E

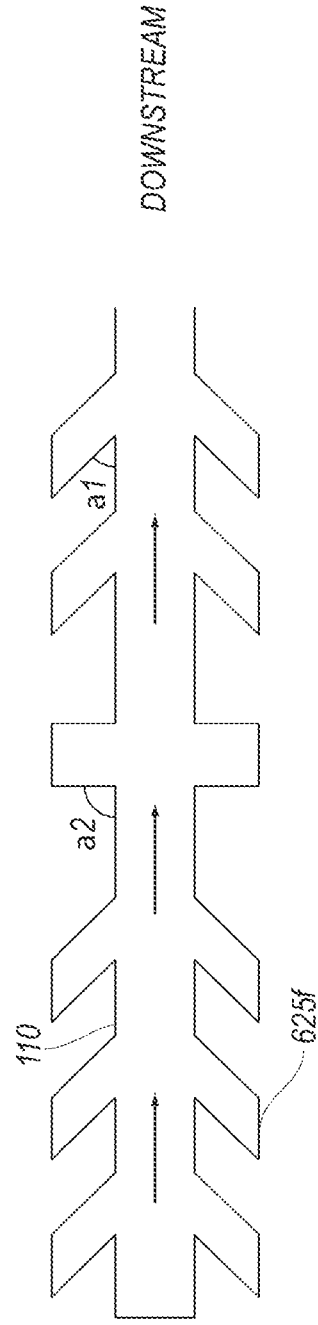


Fig. 6F

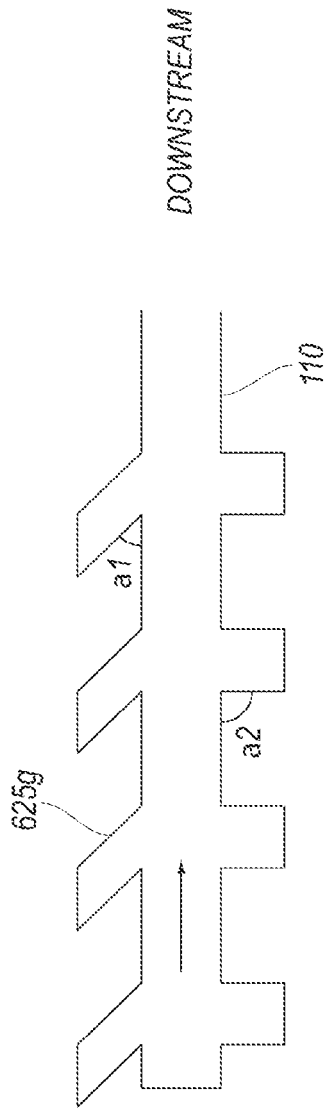


Fig. 6G

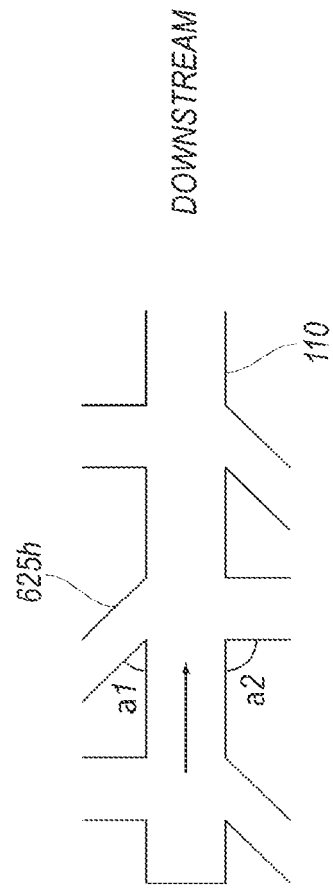


Fig. 6H

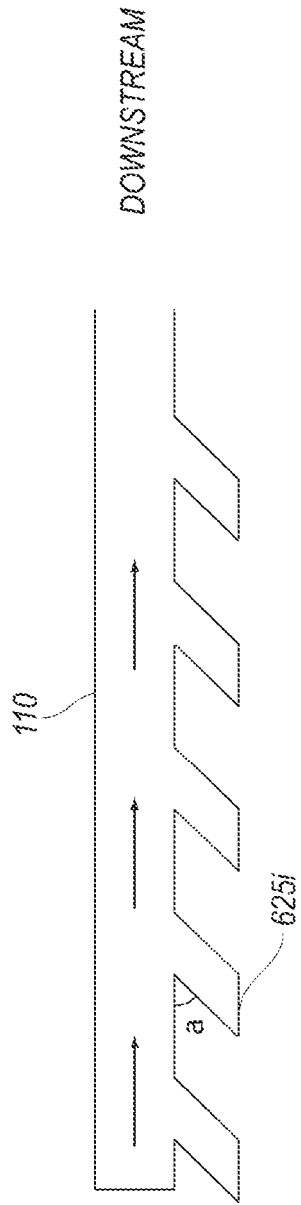


Fig. 6I

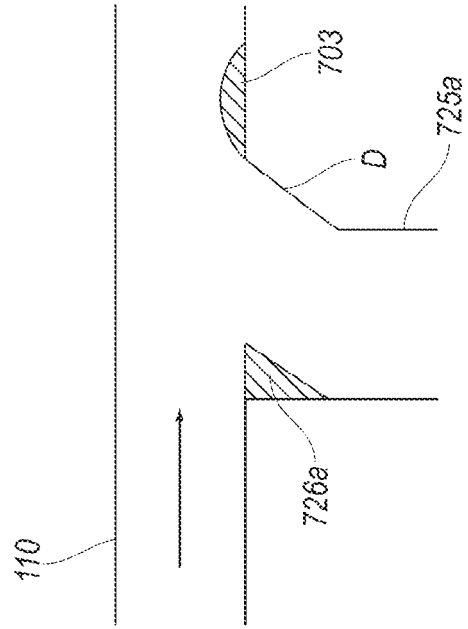


Fig. 7A

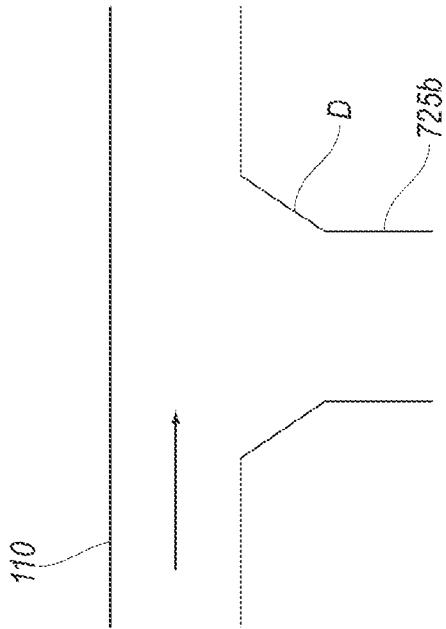


Fig. 7B

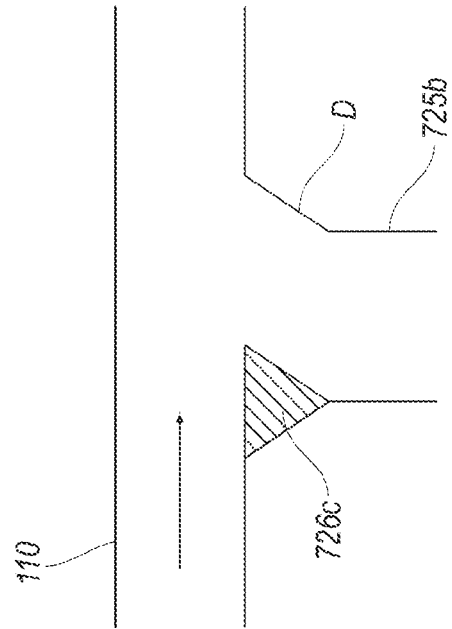


Fig. 7C

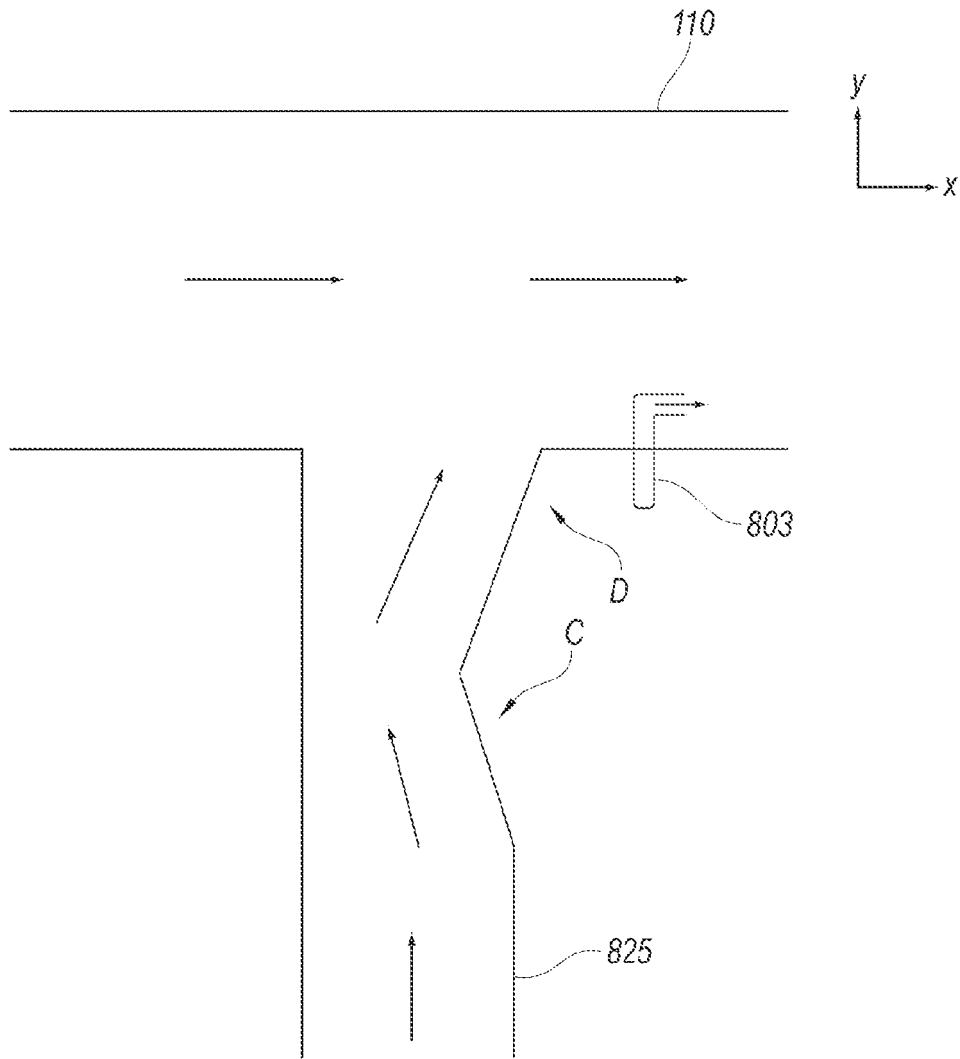


Fig. 8

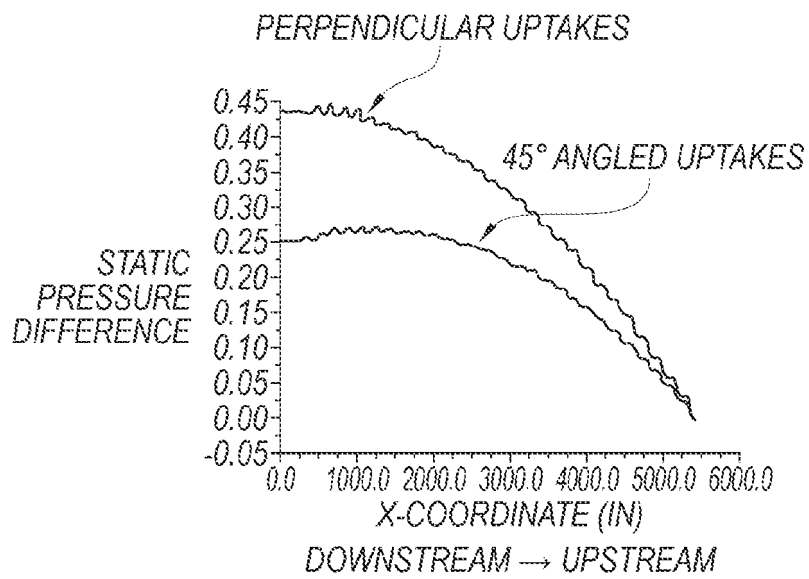


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- CN 1255528 A [0007]