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(54) **LOW STEAM CONSUMPTION HIGH SMOKELESS CAPACITY WASTE GAS FLARE**

ABGASFACKEL MIT HOHER RAUCHFREIER KAPAZITÄT UND NIEDRIGEM DAMPFVERBRAUCH

TORCHE À GAZ RÉSIDUAIRE À HAUTE CAPACITÉ DE FONCTIONNEMENT SANS FUMÉE ET À FAIBLE CONSOMMATION DE VAPEUR

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(56) References cited:

EP-A2- 2 256 409 CN-B- 102 901 098

DE-A1- 2 248 465 RU-C1- 2 203 450

US-A- 5 865 613 US-A1- 2007 224 564

US-A1- 2014 329 185 US-A1- 2016 138 805

US-B2- 7 967 600

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an improved flare apparatus and more specifically to an efficient steam-assisted flare apparatus.

[0002] Steam assisted flares are used in refinery and petrochemical plants for the combustion of high volume releases of waste gases during interruptions of normal plant operation. The "smokeless" capacity is an extremely important operating parameter. High quantities of high pressure steam is used to entrain atmospheric air and force the mixing of the air with the waste gases. The greater the quantity of air mixed per pound of steam injected with the waste gases the higher the achievable smokeless capacity.

[0003] Flare apparatus for burning and disposing of combustible gases are well known. Flare apparatus are commonly mounted on flare stacks and are located at production, refining, processing plants and the like for disposing of flammable waste gases or other flammable gas streams which are diverted for any reason including but not limited to venting, shut-downs, upsets and/or emergencies. Flare apparatus are extremely important in the event of plant emergencies such as fire or power failure and a properly operating flare system is a critical component to prevent plant disruption in any of the above-mentioned or other circumstances.

[0004] In one example of an illustration of "traditional" prior art high capacity steam assisted flare design, the waste gas flow enters at the bottom of the flare tip through a 152 cm (60 inch) diameter waste gas connection (conduit). The flare tip is 2.74 to 3.05 meters (9 to 10 feet) in diameter. There are numerous 20 cm (8 inch) diameter nozzles that extend through the wall of the flare tip near the base then vertically to the discharge end of the tip. Attached to the inlet of the nozzle is a "venturi mixer". Steam injection nozzles are located at the inlet end of the venturi mixer. The high pressure steam injection entrains atmospheric air that travels through the nozzle and is injected into the waste gas that travels from the waste gas inlet at the bottom of the tip through the space around air nozzles to the discharge the end of the tip. Only a small portion of the required combustion air flows through the nozzles. The remainder of the required combustion air flows up around the outside of the flare tip. At the discharge end of the flare tip there is the second set of steam nozzles that are used to force the air into the waste gas stream.

[0005] There are several shortcomings for this design. First, the relatively small 20 cm (8 inch) diameter nozzles severely limit the quantity of the air that can be entrained by the steam. Secondly, the steam flow and waste gas flow are essentially parallel which reduces the mixing efficiency. And finally, the waste gas has a tendency to flow up through the center of the tip instead of spreading uniformly across the tip diameter. This causes higher con-

centrations of waste gas in the center of the tip resulting in incomplete combustion that produces smoke.

[0006] It is generally desirable that the flammable gas be burned without producing smoke and typically such smokeless or substantially smokeless burning is mandatory. One method for accomplishing smokeless burning is by supplying combustion air with a steam jet pump, which is sometimes referred to as an eductor. Combustion air insures the flammable gas is fully oxidized to prevent the production of smoke. Thus, steam is commonly used as a motive force to move air in a flare apparatus. When a sufficient amount of combustion air is supplied, and the supplied air mixes well with combustible gas, the steam/air mixture and flammable gas can be smokelessly burned. In a typical flare apparatus, only a fraction of the required combustion air is supplied using motive force such as blower, a jet pump using steam, compressed air or other gas. Most of the required combustion air is obtained from the ambient atmosphere along the length of the flame.

[0007] One type of known steam-assisted flare apparatus comprises a generally cylindrical gas tube into which flammable gas is communicated. Lower steam is communicated through a plurality of steam tubes at an inlet and is forced to negotiate a bend in the steam tube, which causes a pressure drop. At the bend, the steam tubes are redirected so that they are parallel with the outer cylinder. Center steam is injected into the center of the gas tube so that flammable gas and steam pass upwardly through the outer tube and is mixed with steam that exits the lower steam tubes. At the upper end or exit of the gas tube, steam injectors direct steam radially inwardly to control the periphery of the mixture exiting the gas tube, and the steam/air and gas mixture is ignited. The center steam is provided to ensure burning does not occur internally in the gas tube. Internal burning is typically seen at low gas flow rates such as purge rates, and is aggravated by cross wind, capping effects caused by the upper steam, and if the purge gas has a lower molecular weight than air. A purge rate is typically the minimum gas flow rate continuously flowing to the flare to prevent explosion in the flare stack.

[0008] Another type of steam-assisted flare uses only center and upper steam injectors, and works in a similar fashion. The steam-assisted flares described herein may accomplish smokeless flaring. However, such flare apparatus may require more steam per waste gas than other steam-assisted flare types, especially at larger sizes; additionally, they may create an excessive amount of noise. The noise from the lower steam can be muffled, while the noise from the upper steam is difficult or impractical to muffle due to its vicinity to the flare flame. A muffler for the lower steam not only adds to the costs, but also increases the wind load of the flare stack, resulting in increased flare stack costs. Due to the high cost of steam and the piping and flare stack structure associated with delivering the steam, it is desirable that less steam be utilized to achieve smokeless burning. Thus,

there is a need for an improved flare apparatus and methods for smokelessly burning combustible gases with air to lessen the noise and to increase the efficiency whereby more fuel may be burned without added steam.

[0009] Under low-flow operating conditions, steam is often added to maintain smokeless combustion, more with higher-wind conditions; however, due to regulatory requirements that the combined steam and waste gas mixture remain above 37.28 kJ/m³ (270 Btu/SCF), extra assist gas, commonly methane, must additionally be added to maintain smokeless combustion. With many steam-assisted flares, the steam and steam/air mixtures are introduced to the waste gas fairly uniformly, whereas the waste gas can exit the flare non-uniformly with higher wind, requiring higher steam and/or assist gas utilities to maintain smokeless combustion. Thus, there is a need for an improved flare apparatus to consume reduced steam and/or assist gas utilities under low-flow conditions, regardless of the wind conditions.

[0010] US 2007/224564 relates to a flare apparatus for burning combustible gases.

[0011] US 2014/329185 relates to an apparatus and method for minimizing smoke formation in a flaring stack.

SUMMARY OF THE INVENTION

[0012] The invention is in accordance with the appended claims. In a first embodiment, the invention provides a steam flare comprising a waste gas cylinder and a plurality of extensions that extend away from a center of said waste gas cylinder, wherein said plurality of extensions are connected to an upper portion of said waste gas cylinder, wherein each of the extensions contain a plurality of flare gas conduits, and a steam tube is located in each of the flare gas conduits. The steam flare may have a ring at a top portion of said flare gas conduit and above a top portion of said steam tube. The steam flare may additionally have a singular or plurality of flow-restricting cones in some section of each of the flare gas conduits below the conduit exit. Each flare gas conduit may be a tube having a cylindrical configuration or other configuration such as a square, rectangular, oval or complex configuration. The steam tube may be a single tube having branches that extend into each of said flare gas conduits. The steam exit may be a singular orifice or plurality of orifices directly vertical or at an angle. The ring may contain perforations or other surface features. The transition from the waste gas cylinder to the waste gas equipment may be completely horizontal, at a certain slope, curved in some direction, or a combination of two or more of these features. The cap of the waste gas cylinder may involve a flat plate, a cone, a smaller concentric cylinder, or a combination of two or more of these features.

[0013] In another embodiment, the invention is a process of operating a steam flare in accordance with the first embodiment of the invention, the process comprising sending a waste gas stream through the waste gas cyl-

inder to the plurality of flare gas conduits while sending a stream of steam through the steam tube wherein said steam tube extends into the corresponding flare gas conduit, mixing said waste gas stream and said steam and then causing a flame to burn as a resulting mixture of said waste gas stream, said steam and oxygen in outside ambient air. There may be a ring at an upper portion on a waste gas tip of the flare gas conduit that comprises perforations or other surface features to direct mixture of said steam and said waste gas. The steam flare may have a singular or plurality of velocity seals or flow-restricting cones in some section of said flare gas conduit below the conduit exit to reduce atmospheric air backflow into the flare gas extensions, additionally reducing the level of assist gas and/or steam required to maintain smokeless combustion under low-flow operating conditions. The steam exit may involve an orifice directly vertical or multiple orifices at an angle to increase mixing of the steam, surrounding atmospheric air, and waste gas and additionally increase the velocity of the waste gas stream while reducing the level of atmospheric air backflow at low flow rates through partial steam-capping of the flare gas conduit, reducing the level of assist gas and/or steam required to maintain smokeless combustion under low-flow operating conditions. The flare gas conduit may have a configuration selected from the group consisting of cylindrical, square, rectangular, oval and complex shapes. The transition from the waste gas cylinder to the waste gas extension may be completely horizontal, at a certain slope, curved in some direction, or a combination of these features to reduce the pressure drop through the tip so as to not require increased nominal tip size with higher structural requirements; in addition, this improves structural integrity of tip by reducing stress from thermal growth due to combustion within tip. The cap of the waste gas cylinder may involve a flat plate, a cone, a smaller concentric cylinder, or a combination of these features, to reduce the stresses from thermal growth, increasing the structural integrity of the apparatus, and result in better flow distribution within the flare apparatus, resulting in acceptable pressure drop. The invention also addresses the situation where atmospheric air ingress into the tip mixes with waste gas and assist gas and combusts within the tip, thereby heating the tip and reducing equipment life; therefore, reducing level of air ingress is important to maximizing equipment life at low-flow operating conditions. In addition, the invention provides advantages in the low amount of steam that is needed with less than 0.091 kg (0.20 lbs) steam used per pound of propane waste gas. All of the steam that is injected internally to the waste gas before exposure to surrounding atmospheric air. The steam imparts mixing and momentum transfer to said waste gas and said surrounding atmospheric air. The invention also provides advantages under low-flow conditions, requiring reduced steam and/or assist gas to maintain smokeless combustion and increase equipment life.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is an isometric perspective of a top portion of a steam flare.

Fig. 2 is a view of the steam flare including a waste gas cylinder and tube for steam.

Fig. 3 is a cutaway upper portion of the steam flare.

Fig. 4 shows an isometric view of two flare enclosure conduits.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The present invention delivers smokeless combustion while utilizing less than 0.0907 kg (0.20 lbs) steam per 0.454 kg (1 lb) of propane waste gas stream while requiring no steam for cooling and minimal steam for warming (less than 0.27 g (0.0006 lbs) steam per maximum vent gas flow).

[0016] The invention relies solely on completely internal steam, steam injected completely internally to the flare vent gas ducting with no exposure to surrounding atmospheric air while imparting a significant mixing and momentum transfer effect on the surrounding ambient air environment. Other flares rely on steam that is injected into the air near and immediately surrounding the periphery of the flare tip and aimed so that they drive steam and air near and immediately surrounding the periphery of the flare tip and aimed so that they drive stream and air into the waste gas or effluent stream of the waste gas. Such flares are referred to as "External Steam Flares". There are other flares that may be termed "Internal Steam Flares" that rely on injecting steam through conduits, passageways, or a venturi from a surrounding air atmosphere thereby injecting air and steam through the containing wall or shell of the waste gas stream and into the central core of the waste gas stream.

[0017] In the present invention, as shown in FIG. 1, a waste gas stream passes up through a cylinder 12. Steam 2 is injected into the waste gas stream 1 at one or more locations 4 whereupon the resulting accelerated stream and waste gas mixture, upon exposure to the surrounding air induces the surrounding air into the waste gas (fuel) and steam mixture. There is no mixture of the surrounding air 3 with the waste gas stream 1 before exiting the top of the flare enclosure conduits. The steam and waste gas 5 are partially mixed prior to mixing with the surrounding ambient air 6 but emit from the confines of the flare enclosure or waste gas conduit with sufficient combined velocity and momentum to induce effective mixing of fuel and steam with the surrounding air to affect improved combustion and effectively complete destroying combustible waste gas. Relatively high velocity steam 2 transfers momentum to the relatively low velocity waste gas 1 and induces some mixing of steam and waste gas 5 before exiting into surrounding air 3. The resulting partially mixed steam and waste gas stream then imparts

momentum, drawing in and mixing with, the surrounding ambient air 6 as the steam and waste gas emit from the flare enclosure conduits 7. In Figure 1 are shown four sets of four enclosure conduits 7, conduit steam injection nozzles 8, rings 9, velocity seals 10, and hub steam injection nozzles 16. Also shown are transition plates 11, curved to allow for sufficient flow distribution into cans with minimal wind area and a hub expansion cylinder and plate 13 to mitigate growth from thermal stresses.

[0018] Fig. 2 is a view that includes the lower portion of the flare assembly with the cylinder 12 into which waste gas 1 passes and the pipe in which steam 2 is sent to the upper portion that contains the explained above. Hub steam injection nozzles 16 are shown, which result in steam separating the combusting waste gas stream mixture from the center hub metal.

[0019] Fig. 3 illustrates detail of several flare enclosure conduits. Steam 2 passes into flare conduits 7 and then into surrounding air 3 to be burned effectively. Rings 9 and velocity seals or flow-restricting cones 10 are shown in each enclosure conduit 7.

[0020] Fig. 4 is a view that shows more detail of two individual flare enclosure conduits 7 with steam 8 entering through a tube 14 that extends to near the top of the flare enclosure conduit while waste gas passes up to mix with the outside ambient air to then burn efficiently.

[0021] In other embodiments of the invention, there is a reliance on internally injected steam to keep the steam warm. This steam is injected wholly within the flare tip conduit enclosure and is sufficiently away from, upstream of, the exit to atmosphere opening of the flare tip that this steam completely mixes with the waste gas and imparts a small but largely insignificant momentum component to the waste gas stream and is sufficiently upstream of the flare exit as to impart no significant effect on enabling or enhancing the mixing of the resulting waste gas and steam mixture with the surrounding atmospheric air. This design relies on internal steam as injected through a conduit or venture drawing in surrounding air as described above. External steam is used in drawing in surrounding air from the periphery of the exiting waste gas stream and steam to keep warm is injected wholly within the flare waste stream conduit. The present invention relies on a new, separate and different mixing method of partially mixing steam with waste gas at a location where it can then mix with and impart momentum upon the surrounding atmospheric air.

[0022] The depicted embodiment shows twenty-four waste gas conduits 7, four on each of six transition sections, for a 61 cm (twenty-four inch) riser cylinder 12. In another embodiment, the number and size of waste gas conduits and number and size of transition sections could vary more or less.

[0023] In one embodiment (pictured), the steam injection nozzle is located upstream of the plane at the exit of the waste gas conduit. In another embodiment (not pictured) the steam injection tip extends through and beyond the plane of at the exit of the waste gas conduit

while remaining completely enveloped in the waste gas stream.

[0024] In the depicted embodiment, the waste gas tip has a ring 9 located near, but slightly upstream of the waste gas exit. This ring is not necessary, but can serve to 1) enhance the mixing of waste gas, steam and air, 2) stabilize or create as stable bluff body for flame stabilization and 3) serve as a fine tuning location whereby adjusting the size of the passage(s) in the ring the flow capacity of the flare can be adjusted to specifically meet the flow capacity requirements of a particular flaring application or operation. The benefits of adjusting the capacity of the flare to correctly match the flow and capacity requirements of a particular flaring application or operation include fuller utilization of the available pressure loss in the waste stream system thereby enhancing the mixing of the waste gas, steam and air. Improved or enhance mixing of waste gas, steam and air not only improves the combustion, thereby increasing the smokeless capacity of the flare burner but also further reduces the steam utilization of the flaring system to values of much less than 0.091 kg (0.20 lbs) steam is used per pound of propane waste gas approaching or less than 0.045 kg (0.10 lbs) steam used per pound of propane waste gas. This ring or rings can be located as depicted, upstream of the exit, at the exit or suspended on a structure and held downstream of the exit. These rings may also reside singularly or in plurality on the outside of the waste gas conduit. The depicted waste gas conduit 7 is cylindrical but in practice may be of various shapes including square, rectangular, oval or complex. Given the multiplicity of possible shapes, the "ring(s)" may be of various shapes and dimensions and may contain perforations or other surface features the may disrupt, guide or channel the flow of steam, waste gas or air to affect the mixing of the three component streams.

[0025] In the depicted embodiment, the waste gas tip 9 has three velocity seals or flow-restricting cones 10 per waste stream conduit 7. These cones are not necessary but serve to 1) restrict air from flowing upstream into the flare transition or entry cylinder 12 under low-flow operating conditions, 2) maintain combustion in waste stream conduits 7, and 3) reduce combustion within the waste stream entry cylinder 12. Additionally, these cones can be increased or decreased in count per waste stream conduit or flow diverted from them as required.

[0026] Curved transition plate 11 is shown in the depicted embodiment, but this plate can be flat, sloped, or curved in a direction opposite to that depicted in the figure. The curved shape is utilized to optimize flow distribution while minimizing pressure drop. Hub cylinder and flat plate 13 are not required but as depicted are used to maximize equipment life. Other embodiments not depicted involve cone with flat plate or simple flat plate.

[0027] The entrance of steam 2 into mixing zone with waste gas stream 5 is depicted with nine orifices 15 at a forty degree angle from vertical. Other embodiments include more or less orifices down to a single orifice, rang-

ing from an angle up to fifty degrees from vertical to directly vertical.

[0028] The depicted embodiment displays hub steam injection nozzles which are not required but which lengthen the life of the equipment by separating the center hub metal from the combustion with cooling steam.

Claims

1. A steam flare comprising a waste gas cylinder (12) and a plurality of extensions that extend away from a center of said waste gas cylinder (12), wherein said plurality of extensions are connected to an upper portion of said waste gas cylinder (12), wherein each of said extensions contains a plurality of flare gas conduits (7), and wherein a steam tube (14) is located in each of said flare gas conduits (7).
2. The steam flare of claim 1 wherein each of said flare gas conduits (7) is a tube having a cylindrical, square, rectangular, oval or complex configuration.
3. The steam flare of claim 1 further comprising a multiplicity of flow-reducing cones (10) in each of said flare gas conduits (7) and below a top portion of said steam tube (14).
4. The steam flare of claim 1 with a curved, straight or sloped transition piece from said waste gas cylinder (12) to said flare gas conduits (7).
5. The steam flare of claim 1 with a cone (10) and/or a flat plate capping the waste gas cylinder (12).
6. The steam flare of claim 1 wherein said steam tube (14) has two to twenty orifices (15) pointing at an angle between zero and fifty degrees from vertical.
7. A process of operating a steam flare according to any one of claims 1 to 6, the process comprising sending a waste gas stream through the waste gas cylinder (12) to the plurality of flare gas conduits (7) while sending a stream of steam (8) through the steam tube (14) wherein said steam tube (14) extends into the corresponding flare gas conduit (7), mixing said waste gas stream and said steam (8) and then causing a flame to burn as a resulting mixture of said waste gas stream, said steam (8) and oxygen in outside ambient air.
8. The process of claim 7 wherein a ring (9) at the upper portion of the waste gas tip of said flare gas conduit (7) comprises perforation or other surface features properly sized in proportion to the waste gas stream and thereby values approaching or less than 0.05 kg (0.10 lbs) steam (8) is used per pound of propane waste gas.

9. The process of claim 7 wherein all of said steam (8) is injected internally to said waste gas before exposure to surrounding atmospheric air.
10. The process of claim 7 wherein curved transition pieces between flare gas cylinder and said waste gas conduits (7) improve flow distribution exiting said waste gas conduits (7) and reduce pressure drop through flare gas system.

Patentansprüche

1. Dampffackel, umfassend einen Abgaszylinder (12) und eine Vielzahl von Verlängerungen, die sich von einer Mitte des Abgaszylinders (12) weg erstrecken, wobei die Vielzahl von Verlängerungen mit einem oberen Abschnitt des Abgaszylinders (12) verbunden ist, wobei jede der Verlängerungen eine Vielzahl von Fackelgasleitungen (7) enthält und wobei ein Dampfrohr (14) in jeder der Fackelgasleitungen (7) angeordnet ist.
2. Dampffackel nach Anspruch 1, wobei jede der Fackelgasleitungen (7) ein Rohr mit einer zylindrischen, quadratischen, rechteckigen, ovalen oder komplexen Konfiguration ist.
3. Dampffackel nach Anspruch 1, ferner umfassend eine Vielzahl von strömungsmindernden Kegeln (10) in jeder der Fackelgasleitungen (7) und unter einem oberen Abschnitt des Dampfrohrs (14).
4. Dampffackel nach Anspruch 1 mit einem gekrümmten, geraden oder abgeschrägten Übergangsstück vom Abgaszylinder (12) zu den Fackelgasleitungen (7).
5. Dampffackel nach Anspruch 1 mit einem Kegel (10) und/oder einer flachen Platte, die den Abgaszylinder (12) abdeckt.
6. Dampffackel nach Anspruch 1, wobei das Dampfrohr (14) zwei bis zwanzig Öffnungen (15) aufweist, die in einem Winkel von null bis fünfzig Grad zur Vertikalen zeigen.
7. Verfahren zum Betreiben einer Dampffackel nach einem der Ansprüche 1 bis 6, wobei das Verfahren das Leiten eines Abgasstroms durch den Abgaszylinder (12) zur Vielzahl der Fackelgasleitungen (7) umfasst, während ein Dampfstrom (8) durch das Dampfrohr (14) geleitet wird, wobei sich das Dampfrohr (14) in die entsprechende Fackelgasleitung (7) erstreckt, den Abgasstrom und den Dampf (8) mischt und wobei dann aus dem erhaltenen Gemisch des Abgasstroms mit dem Dampf (8) und Sauerstoff der Außen-Umgebungsluft eine Flamme entzündet

wird.

8. Verfahren nach Anspruch 7, wobei ein Ring (9) am oberen Abschnitt der Abgasspitze der Fackelgasleitung (7) eine Perforation oder andere Oberflächenmerkmale aufweist, die im Verhältnis zum Abgasstrom richtig bemessen sind, womit Werte nah an oder kleiner als 0,05 kg (0,10 lbs) Dampf (8) pro Pfund Propangas verwendet werden.
9. Verfahren nach Anspruch 7, wobei der gesamte Dampf (8) intern in das Abgas eingespritzt wird, bevor es der umgebenden atmosphärischen Luft ausgesetzt wird.
10. Verfahren nach Anspruch 7, wobei gekrümmte Übergangsstücke zwischen dem Fackelgaszylinder und den Abgasleitungen (7) die Strömungsverteilung beim Verlassen der Abgasleitungen (7) verbessern und den Druckabfall durch das Fackelgassystem verringern.

Revendications

1. Torche à vapeur comprenant une bouteille de gaz résiduaire (12) et une pluralité d'extensions qui s'étendent à partir d'un centre de ladite bouteille de gaz résiduaire (12), ladite pluralité d'extensions étant reliées à une partie supérieure de ladite bouteille de gaz résiduaire (12), chacune desdites extensions contenant une pluralité de conduits de gaz de torche (7) et un tube à vapeur (14) étant situé dans chacun desdits conduits de gaz de torche (7).
2. Torche à vapeur selon la revendication 1, dans laquelle chacun desdits conduits de gaz de torche (7) est un tube de conception cylindrique, carrée, rectangulaire, ovale ou complexe.
3. Torche à vapeur selon la revendication 1, comprenant en outre une multiplicité de cônes réducteurs de débit (10) dans chacun desdits conduits de gaz de torche (7) et au-dessous d'une partie supérieure dudit tube à vapeur (14).
4. Torche à vapeur selon la revendication 1, comportant une pièce de transition incurvée, droite ou inclinée entre ladite bouteille de gaz résiduaire (12) et lesdits conduits de gaz de torche (7).
5. Torche à vapeur selon la revendication 1, comportant un cône (10) et/ou une plaque plate coiffant la bouteille de gaz résiduaire (12).
6. Torche à vapeur selon la revendication 1, dans laquelle ledit tube à vapeur (14) comporte entre deux et vingt orifices (15) pointant selon un angle compris

entre zéro et cinquante degrés par rapport à la verticale.

7. Processus de fonctionnement d'une torche à vapeur selon l'une quelconque des revendications 1 à 6, le processus comprenant l'envoi d'un courant de gaz résiduaire à travers la bouteille de gaz résiduaire (12) vers la pluralité de conduits de gaz de torche (7), tout en envoyant un courant de vapeur (8) à travers le tube à vapeur (14), ledit tube à vapeur (14) s'étendant dans le conduit de gaz de torche (7) correspondant, en mélangeant ledit courant de gaz résiduaire et ladite vapeur (8), puis en faisant brûler une flamme sous la forme d'un mélange résultant composé dudit courant de gaz résiduaire, de ladite vapeur (8) et de l'oxygène présent dans l'air ambiant extérieur.
8. Processus selon la revendication 7, dans lequel un anneau (9), au niveau de la partie supérieure de la pointe de gaz résiduaire dudit conduit de gaz de torche (7), comprend une perforation ou d'autres caractéristiques de surface correctement dimensionnées, proportionnellement au courant de gaz résiduaire, et ainsi des valeurs approchant 0,05 kg (0,10 lb) de vapeur (8) ou moins sont utilisées pour chaque livre de gaz résiduaire de propane.
9. Processus selon la revendication 7, dans lequel la totalité de ladite vapeur (8) est injectée à l'intérieur dudit gaz résiduaire avant exposition à l'air atmosphérique environnant.
10. Processus selon la revendication 7, dans lequel des pièces de transition incurvées entre la bouteille de gaz de torche et lesdits conduits de gaz résiduaire (7) améliorent la distribution d'écoulement sortant desdits conduits de gaz résiduaire (7) et réduisent la chute de pression à travers le système de gaz de torche.

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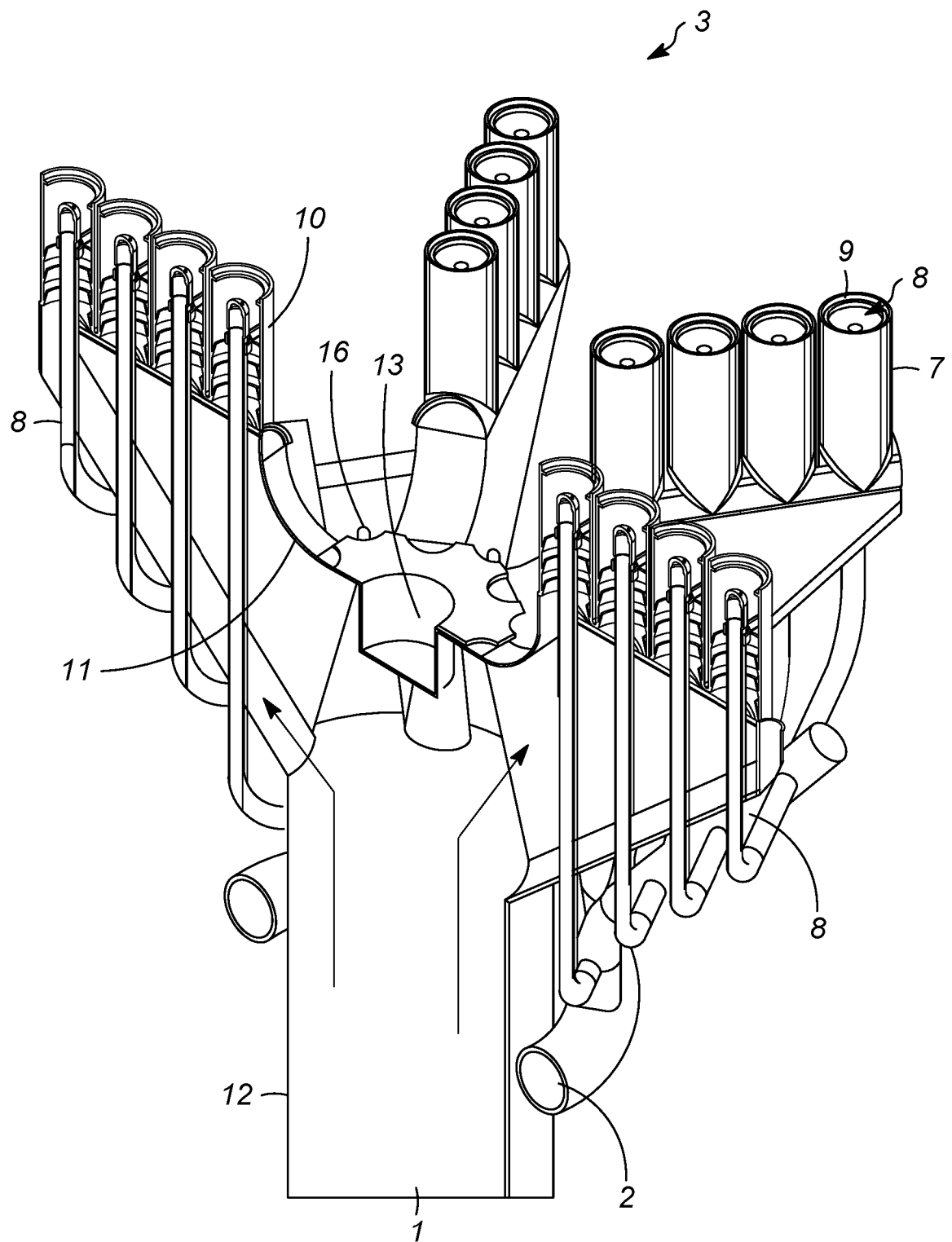


FIG. 1

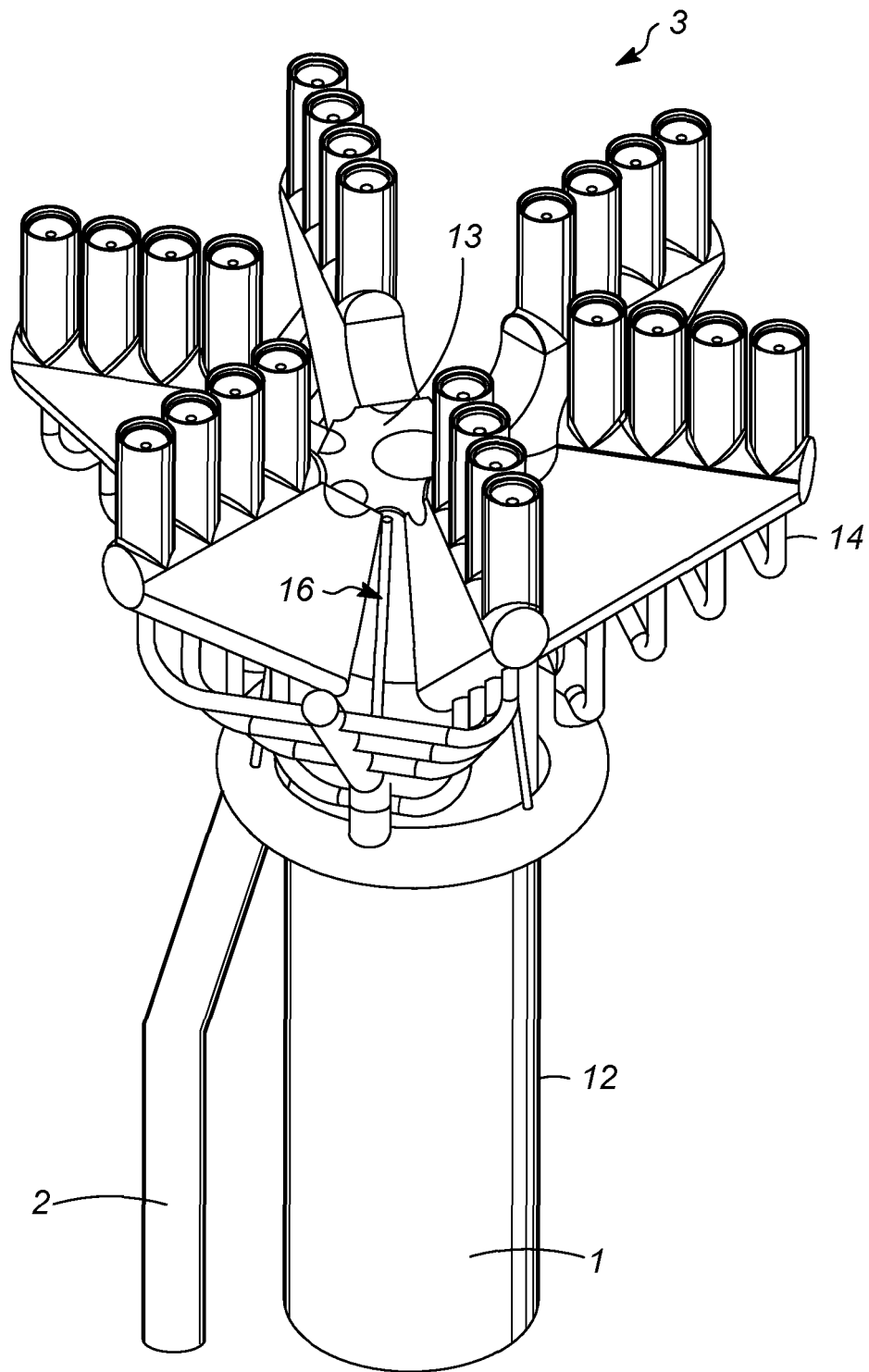


FIG. 2

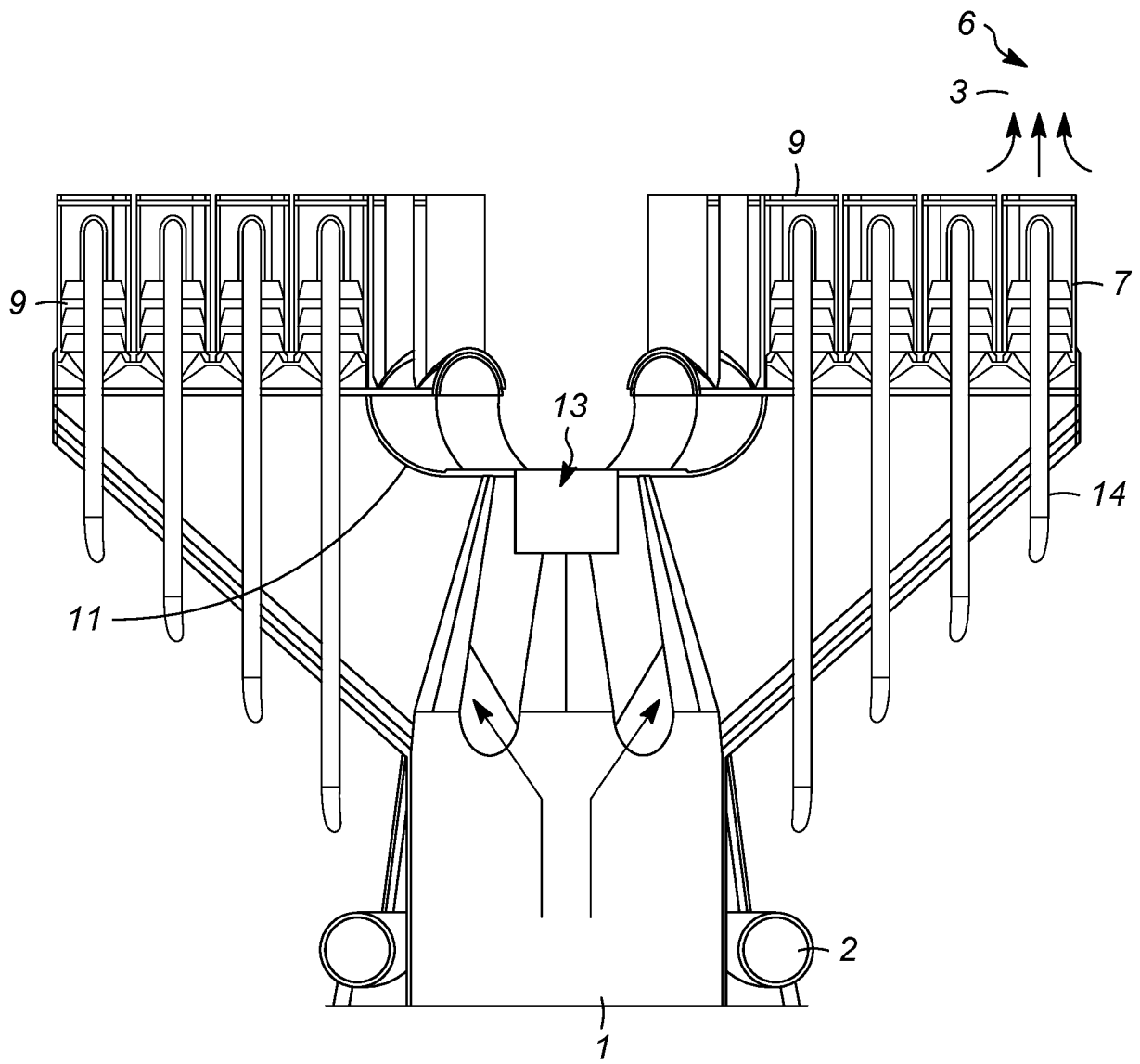


FIG. 3

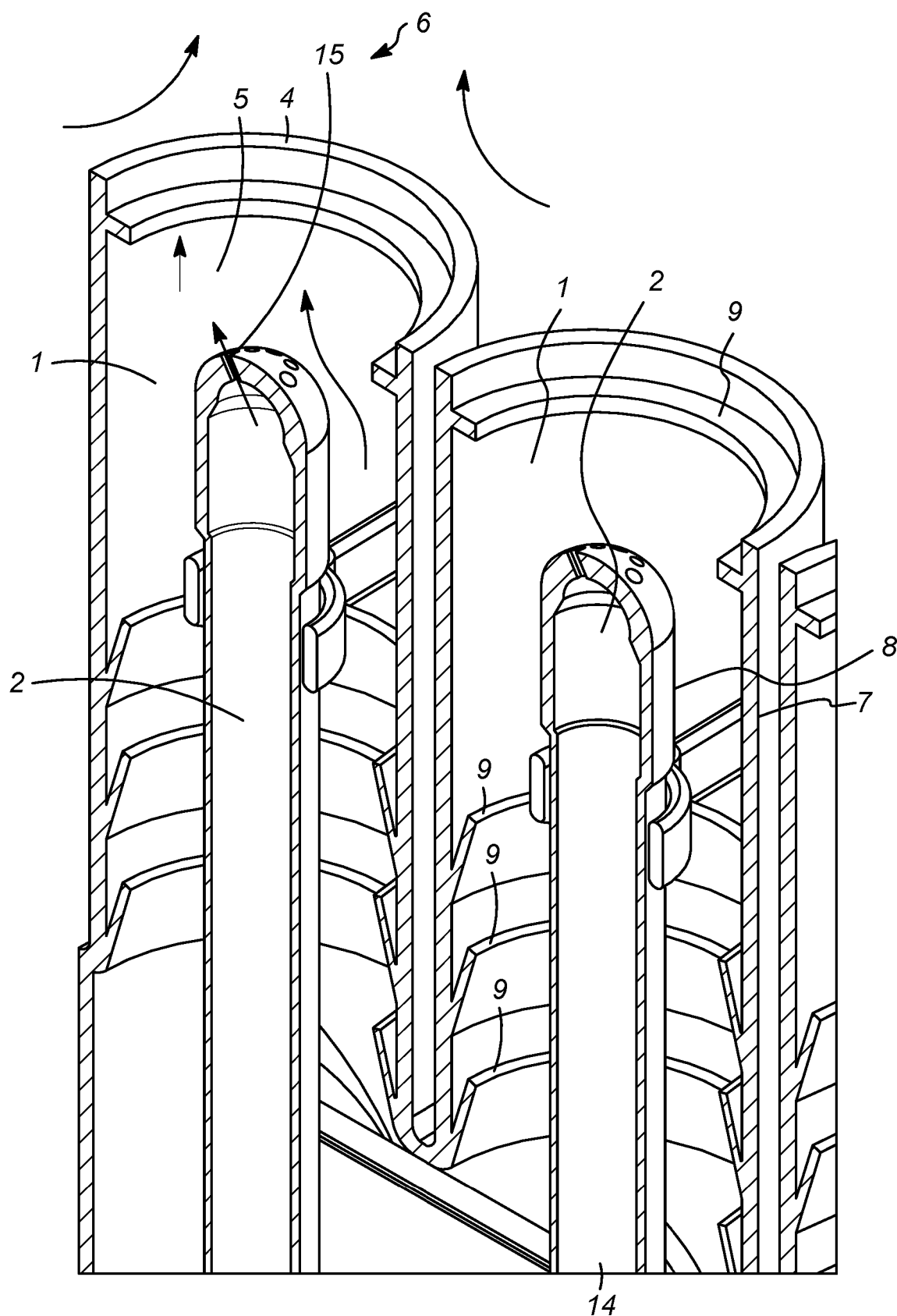


FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2007224564 A [0010]
- US 2014329185 A [0011]