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Partheepan

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(54) **REDESIGNED BURNER**

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F01K 25/00 (2006.01)

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F23D 14/82 (2006.01)

(Continued)

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CPC **F22B 1/003** (2013.01); **F01K 25/005** (2013.01); **F22G 1/12** (2013.01); **F23D 14/28** (2013.01); **F23D 14/82** (2013.01); **F23K 5/007** (2013.01); **F23K 5/142** (2013.01); **F23K 5/22** (2013.01); **F23L 7/002** (2013.01); **F23L 7/005** (2013.01); **F23L 7/007** (2013.01); **F23N 1/10** (2013.01); **F23D 2214/00** (2013.01); **F23K 2203/002** (2013.01); **F23K 2400/201** (2020.05); **F23N 2239/04** (2020.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,459,953 A 8/1969 Hughes
4,074,708 A 2/1978 Hochmuth
(Continued)

Primary Examiner — Jason Lau

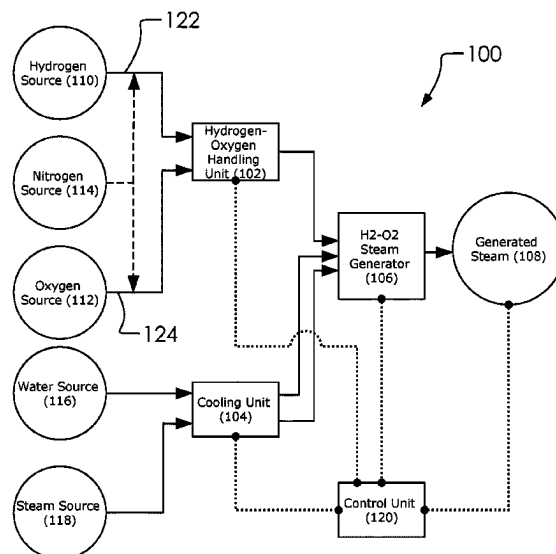
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ABSTRACT

A steam generator system configured to burn hydrogen and oxygen at stoichiometry along with a increased-pressure water and steam. Said steam generator system comprise a hydrogen source, an oxygen source, a nitrogen source, a water source, a steam source, a hydrogen-oxygen handling unit, a cooling unit, a one or more H₂-O₂ steam generators and a control unit. Said steam generator system is configured to provide said hydrogen source to said hydrogen-oxygen handling unit through an oxygen passage, said oxygen source to said hydrogen-oxygen handling unit through a hydrogen passage, and said nitrogen source to selectively purge said oxygen passage and said hydrogen passage. Said water source provide water to said cooling unit. Said cooling unit is configured to receive said water source and said steam source.

32 Claims, 9 Drawing Sheets



(51) **Int. Cl.**

<i>F23K 5/00</i>	(2006.01)
<i>F23K 5/14</i>	(2006.01)
<i>F23K 5/22</i>	(2006.01)
<i>F23L 7/00</i>	(2006.01)
<i>F23N 1/10</i>	(2006.01)

(56)

References Cited

U.S. PATENT DOCUMENTS

4,148,185	A	4/1979	Somers
4,474,140	A	10/1984	Sternfeld
6,206,684	B1	3/2001	Mueggenburg
6,832,622	B2	12/2004	Hassel
2005/0072381	A1	4/2005	Requadt
2008/0083537	A1	4/2008	Klassen et al.

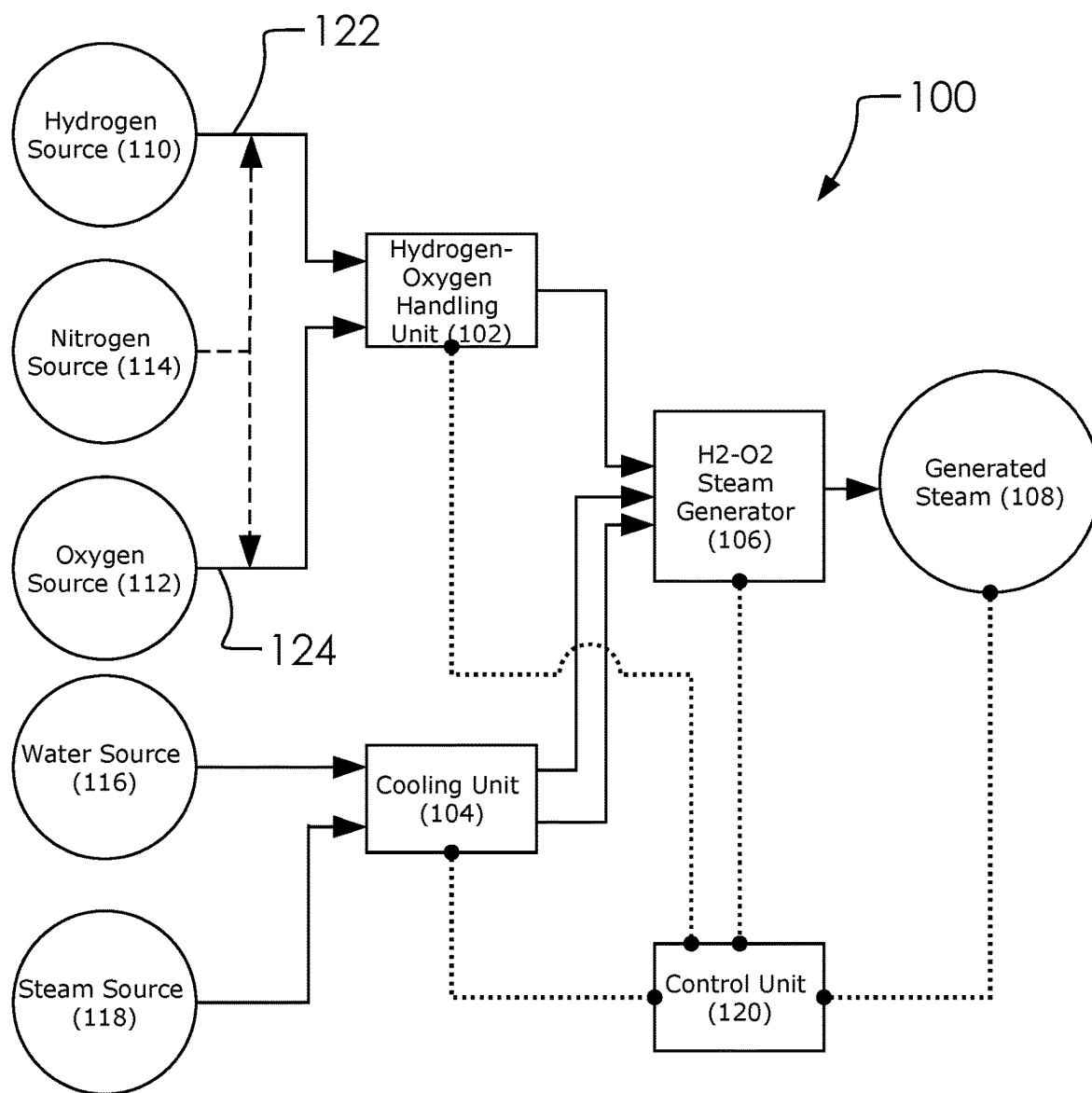


FIG. 1

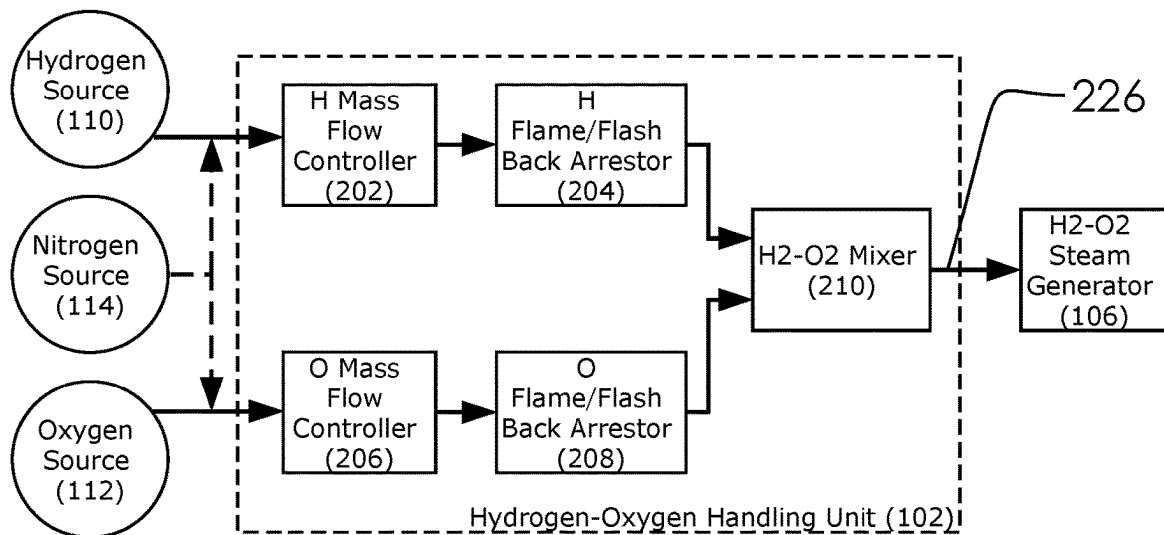


FIG. 2A

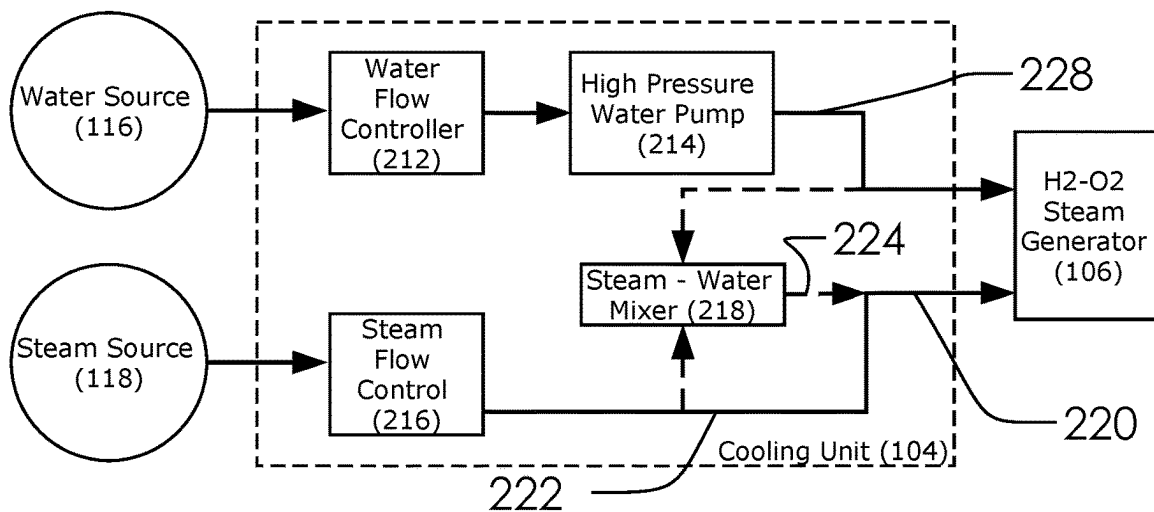


FIG. 2B

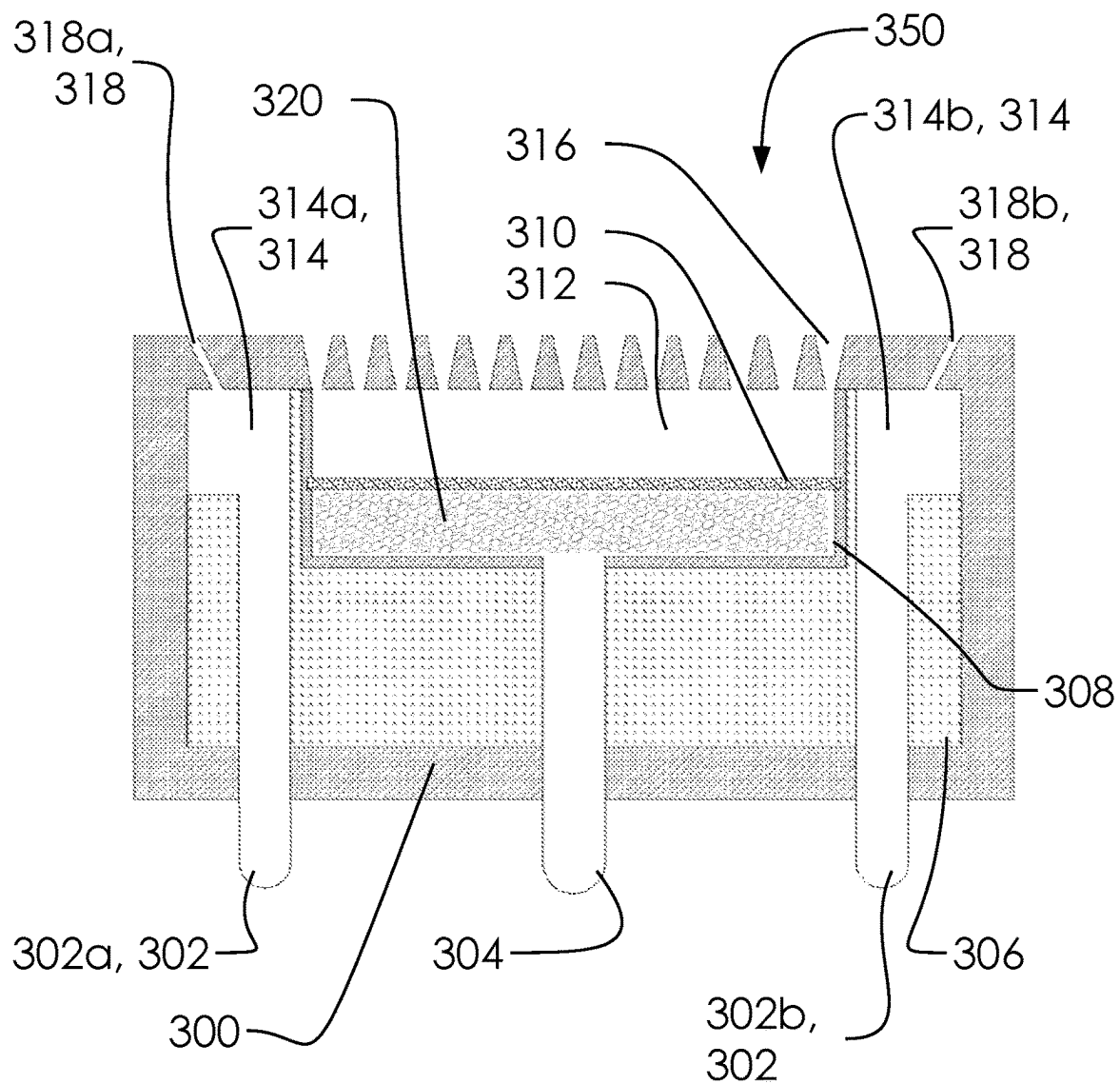


FIG. 3

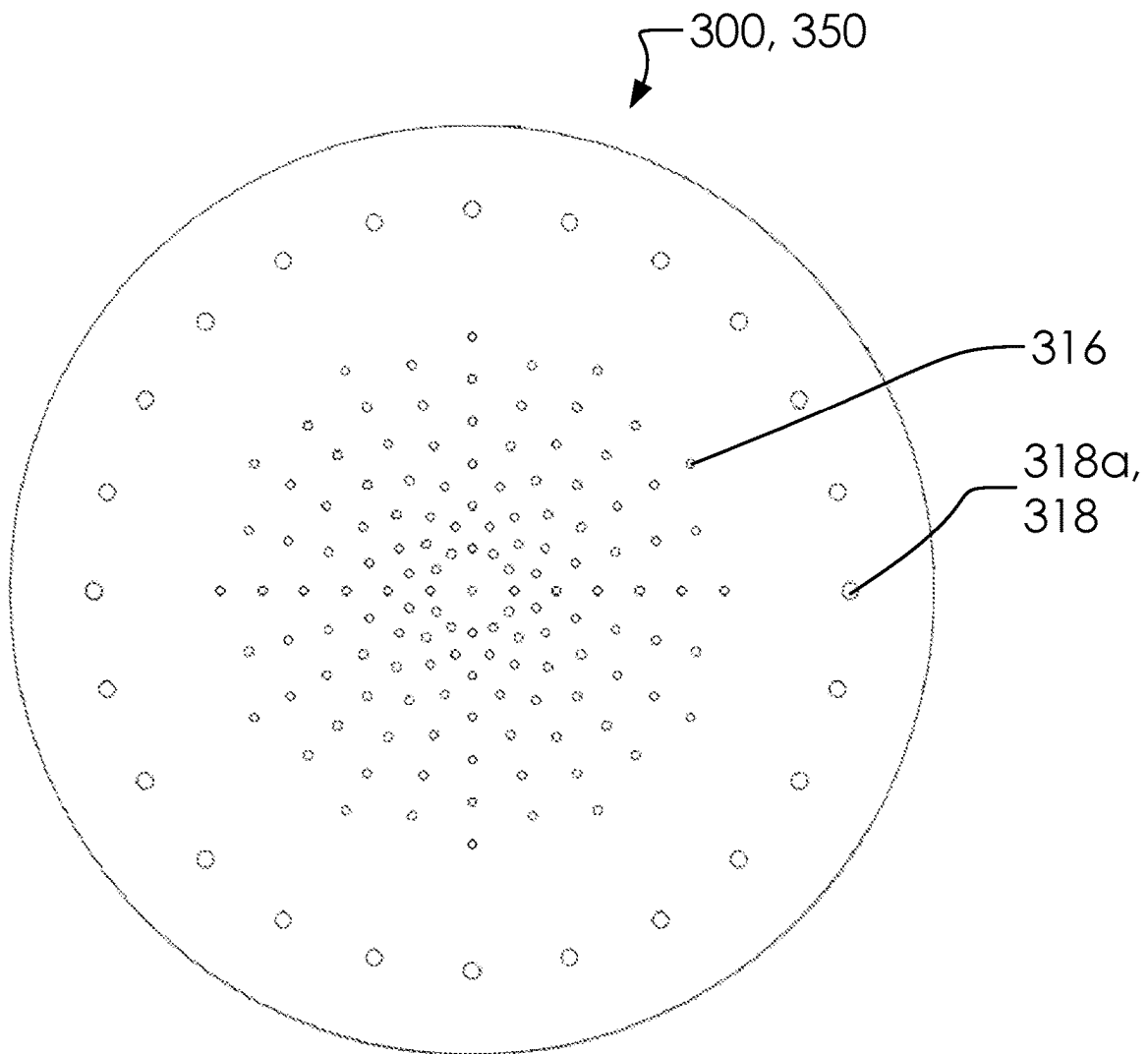


FIG. 4

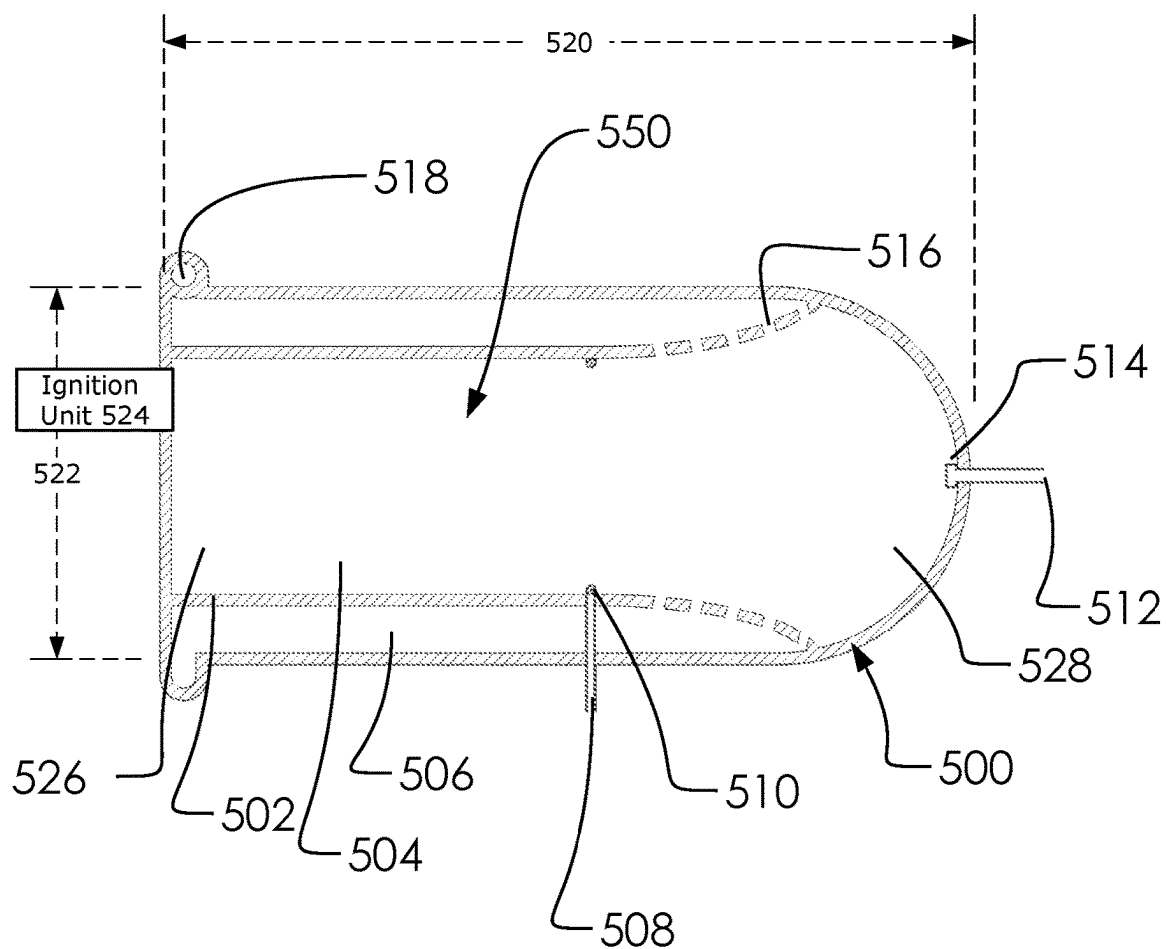


FIG. 5

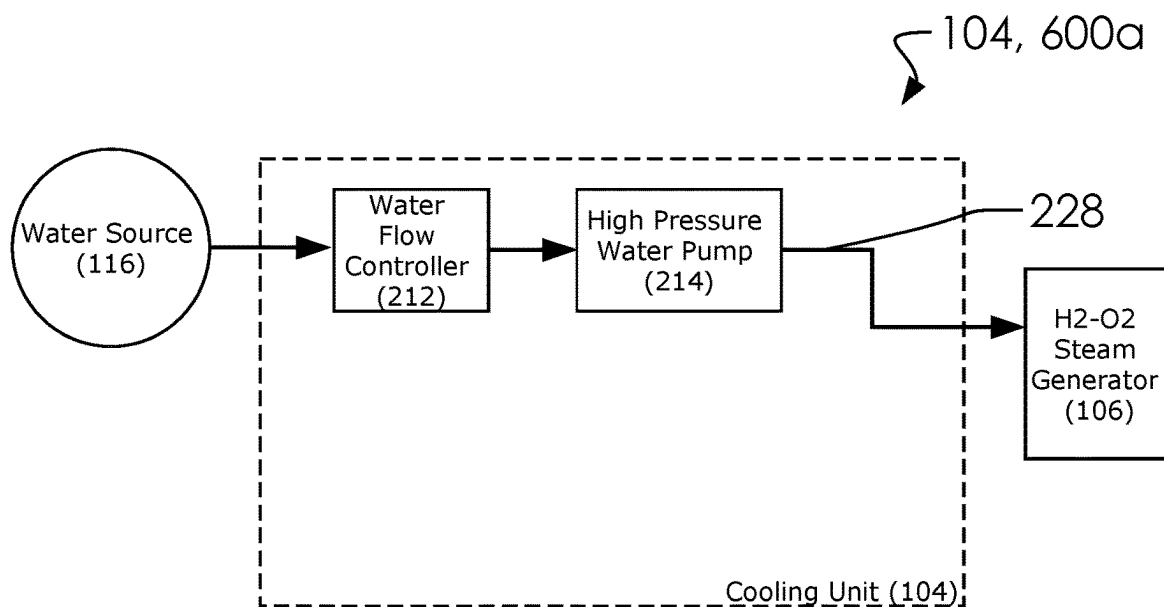


FIG. 6A

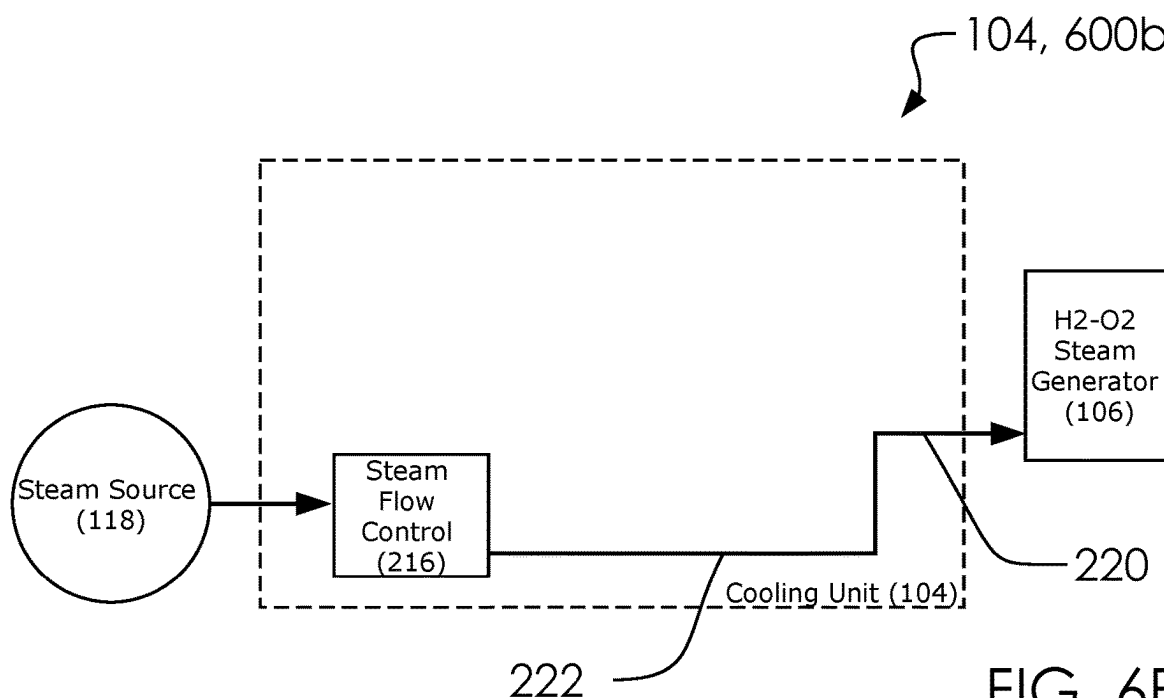


FIG. 6B

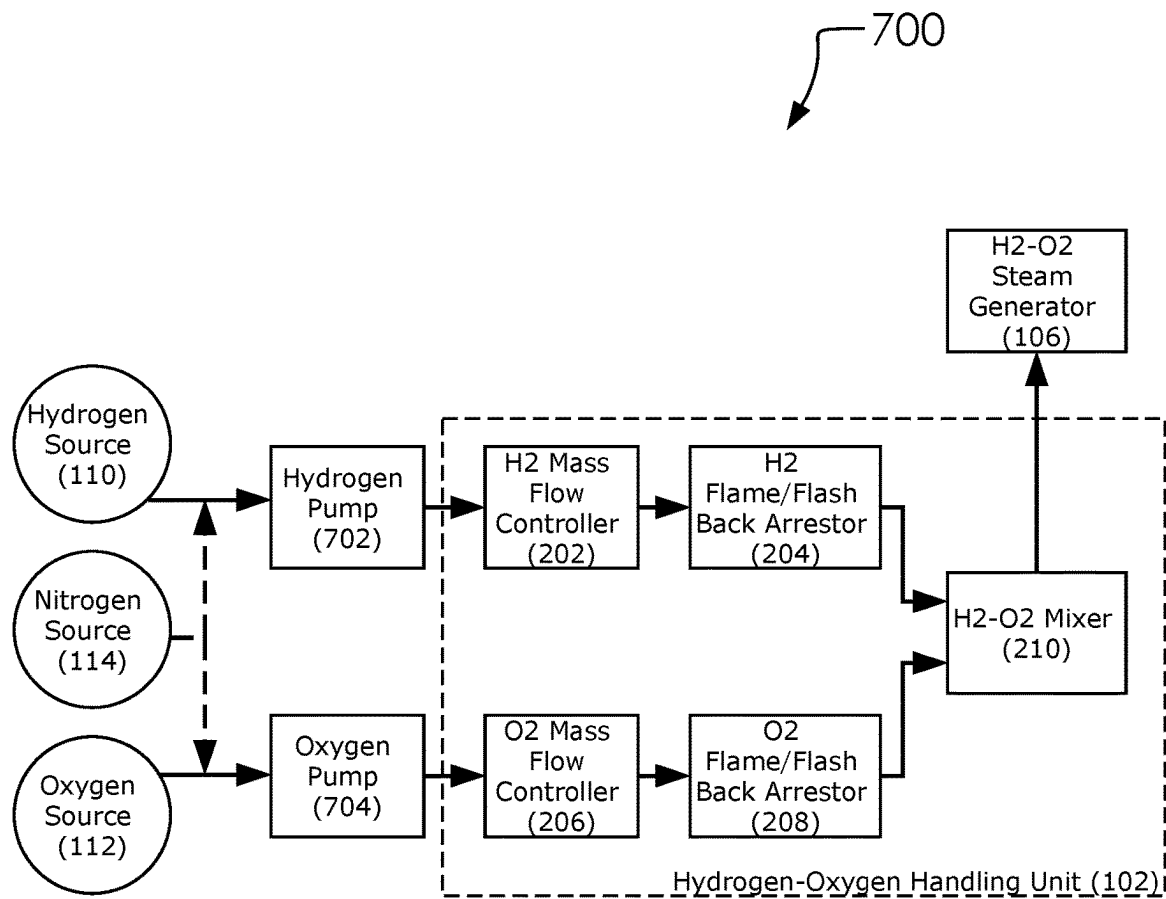


FIG. 7

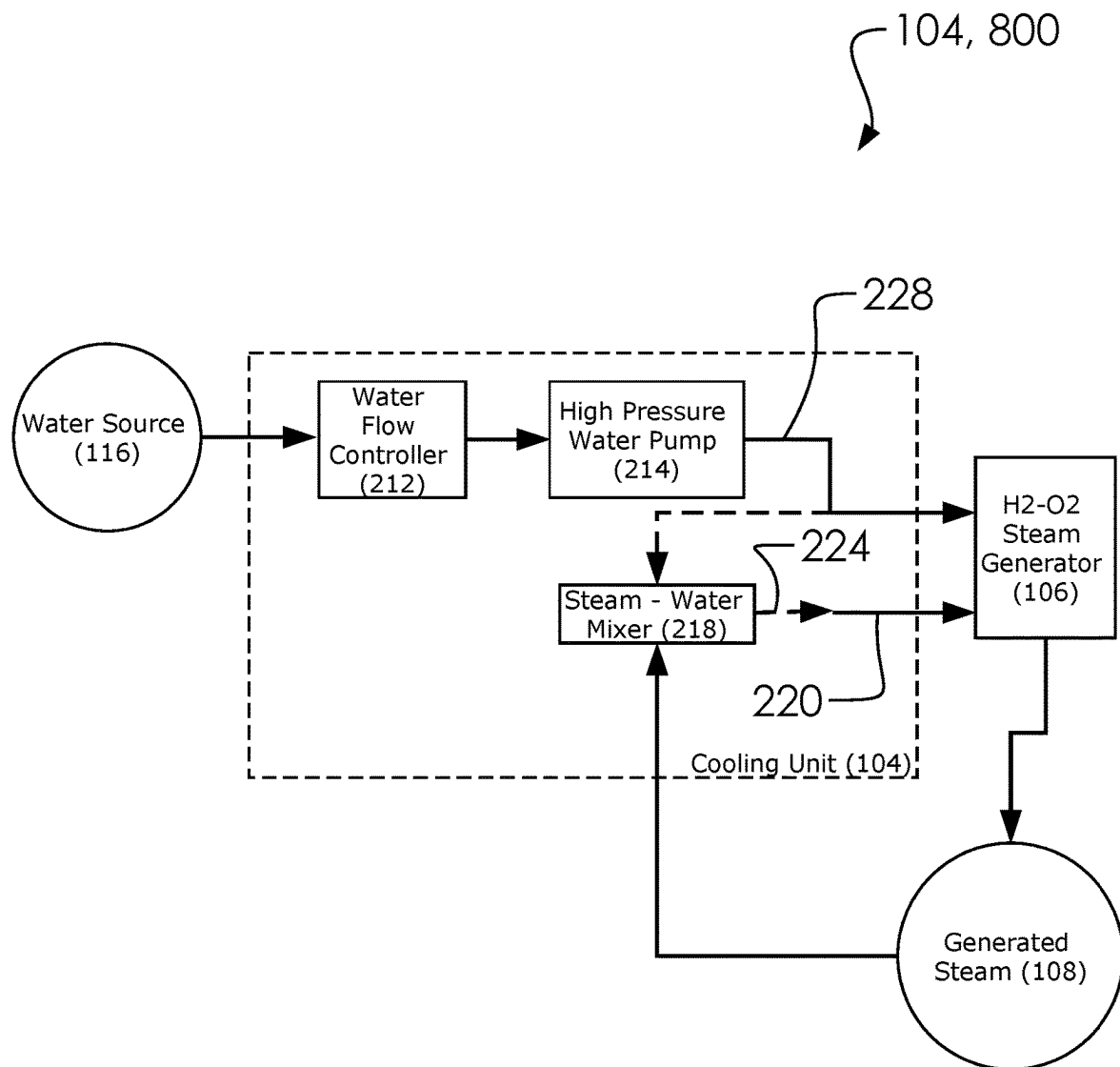


FIG. 8

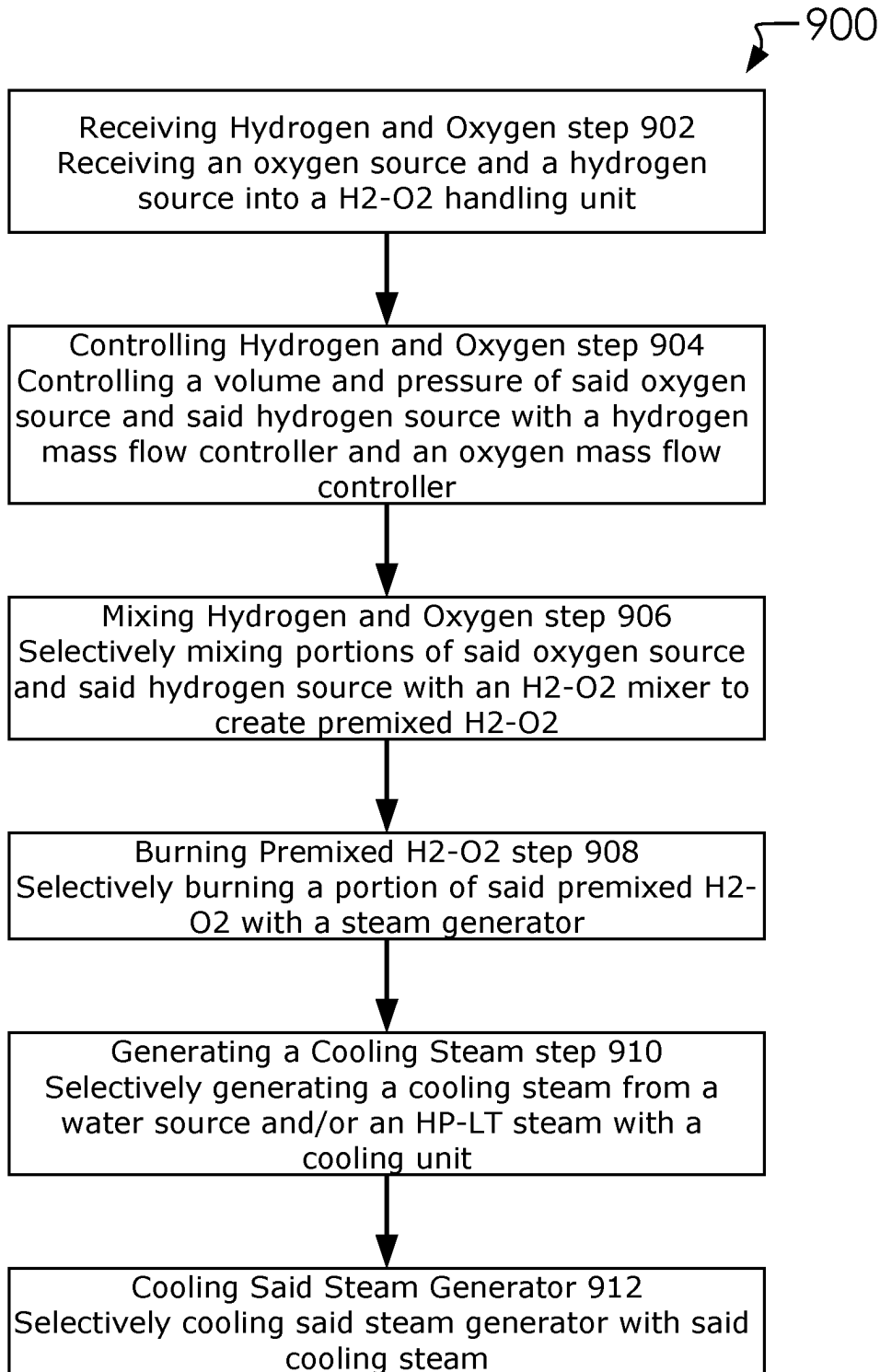


FIG. 9

1

REDESIGNED BURNER**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims benefit to U.S. Patent Application No.(s) 62/540,348 filed on Aug. 2, 2017, U.S. Pat. No. 16,013,880 filed Jun. 20, 2018, U.S. Pat. No. 14,763,467 filed Jul. 24, 2015. It is the national stage filing of PCT application PCT/US18/45065 filed Aug. 2, 2018, which in turn claims U.S. Patent Application No.(s) 62/540,348 filed on Aug. 2, 2017 for priority.

It is noted that the international search report for all 35 claims in this application was returned as 1-35 yes for allowable, 1-35 yes for inventive step, and 1-35 yes for industrial applicability.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT (IF APPLICABLE)

Not applicable.

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISC APPENDIX (IF APPLICABLE)

Not applicable.

BACKGROUND OF THE INVENTION

The premixed H₂-O₂ combustor for steam generation includes an H₂-O₂ handling unit, a cooling unit, and an H₂-O₂ steam generator. The H₂-O₂ handling unit receives the fuel and oxidizer and safely premixes it at the stoichiometry ratio. The cooling unit separately receives the cooling steam and cooling water. Depending on operational requirements, it regulates separate output flows of steam and water or a mixture of steam and water. The part of the system referred to as the "H₂-O₂ steam generator" consists of a burner tip for the premixed H₂-O₂ and the steam generation chamber. The burner tip receives the premixed H₂-O₂ from the H₂-O₂ handling unit and a portion of cooling fluids from the cooling unit and injects them into the steam generation chamber where the mixture is combusted. The combustion resultants are further mixed with the cooling fluids to generate steam at the desired temperature and pressure. The system generates steam with minimal residual from combustion and is free from harmful, polluting greenhouse gases. This steam can be used in power generation, in locomotives for propulsion, and in combined heat and power generation.

The present invention relates to a system for burning hydrogen (H₂) and oxygen (O₂) to provide power or propulsion. In particular, the present invention is directed to a system that can operate in a fully premixed mode at stoichiometry to produce steam. In specific embodiments, the invention allows for operation at high-pressure and different flowrates without flashback problems, with the additional benefit of zero toxic pollutants from combustion sources.

Hydrogen has been known for its combustible nature since 1650, when it was described as "inflammable air." Hydrogen as a fuel is significantly different from all other commonly-used hydrocarbon liquid and gas fuels. Hydrogen is extremely flammable and often described as the most flammable of all known substances.

2

H₂-O₂ combustion produces a high-temperature flame which results in steam and unburnt gases as the combustion product. Industrial processes predominantly use pure H₂ and O₂ for combustion. These processes are categorized as either "premixed" or "non-premixed (post-mixed)". Premixed H₂-O₂ is used in small-scale applications such as limelight, oxyhydrogen blowpipes, and oxyhydrogen torches for cutting and welding. Non-premixed H₂-O₂ is used in combustion chambers, steam generators, internal-combustion engines, rocket engines, and other industrial and environmental applications.

A device which burns H₂-O₂ at stoichiometry for steam generation, described as an "aphodid burner," was patented in 1967 by Oklahoma State University. Several papers were written about it in the early 1970s. The German Aerospace Center (DLR) and the Institute of Combustion Aerothermics Reactivity and Environment (ICARE) in France collaborated to study several configurations of hydrogen-oxygen combustion-based steam generators for power generation. These used several different configurations of water injection into the steam generators. The DLR and ICARE have also collaborated to design and patent a steam generator for sterilization purposes in the pharmaceutical industry. All of these designs use non-premixed H₂-O₂ combustion.

There are some premixed combustion chamber designs which use "multi-fuel" (either multiple, different fuels, or a combination of different fuels) with pure oxygen at stoichiometric. However, the combustion results in some greenhouse gases which need to be captured and either stored or processed safely.

Several configurations of hydrogen-oxygen combustion-based steam generators for power generation known in the prior art is based on the premixed combustion strategy have been designed and patented. These steam generators were devised to be used in steam turbine cycles for power generation. The prior art steam generators are highly efficient; however, a small proportion of unburnt gases are present in the steam stream. This poses a significant risk when used in steam turbines, as it can cause corrosion and erosion problems. Hydrogen has several unique characteristics related to combustion: wide range of flammability, low ignition energy, small quenching distance, high flame speed and high diffusivity, all of which makes premixed combustion too risky due to the danger of flashbacks and explosions.

The present invention provides premixed hydrogen-oxygen combustion-based steam generators with appropriate gas handling equipment which is capable of reducing the unburnt gases, and eliminating the flashback and explosion problems without thermal meltdown of the combustion chamber. The system can be configured for both conventional steam turbine and steam injected gas turbine operation. Thus, the present invention overcomes the above-mentioned disadvantages and drawbacks of previous designs.

The system consists of an H₂-O₂ handling unit, a cooling unit, and an H₂-O₂ steam generator. Further the H₂-O₂ handling unit can consist of H₂ and O₂ source which delivers H₂ and O₂ respectively, mass flow controllers for H₂ and O₂, flash-back/flame arrestors for H₂ and O₂ and H₂-O₂ mixer. The cooling unit can consist of sources for both water and high-pressure, low-temperature ("HP-LT") steam, flow controllers for water and steam, a high-pressure water pump, and a steam-water mixer. The part of the system referred to as the "H₂-O₂ steam generator" consists of a burner tip for the premixed H₂-O₂ and the steam generation chamber.

3

Designs for H₂-O₂ combustion for steam generation and their uses are disclosed in U.S. Pat. Nos. 3,459,953, 4,148, 185, 6,206,684B1 and 4,474,140. However, the current patent application presents a different and unique design.

The international search report cites this prior art, but does not conclude that any render the current claims ineligible for patent protection: U.S. Pat. No. 6,832,622B2, US 2008/0083537A1, U.S. Pat. Nos. 4,148,185A, 4,074,708A, and US2005/0072381A1.

None of the known inventions and patents, taken either singularly or in combination, is seen to describe the instant disclosure as claimed.

BRIEF SUMMARY OF THE INVENTION

A steam generator system configured to burn hydrogen and oxygen at stoichiometry along with a high-pressure water and steam. Said steam generator system comprise a hydrogen source, an oxygen source, a nitrogen source, a water source, a steam source, a hydrogen-oxygen handling unit, a cooling unit, a one or more H₂-O₂ steam generators and a control unit. Said steam generator system is configured to provide said hydrogen source to said hydrogen-oxygen handling unit through an oxygen passage, said oxygen source to said hydrogen-oxygen handling unit through a hydrogen passage, and said nitrogen source to selectively purge said oxygen passage and said hydrogen passage. Said water source provide water to said cooling unit. Said cooling unit is configured to receive said water source and said steam source. Said hydrogen-oxygen handling unit is configured to blend portions of said hydrogen source and said oxygen source into a premixed H₂-O₂, and to selectively send portions of said premixed H₂-O₂ to said one or more H₂-O₂ steam generators. Said cooling unit is configured to receive and process said water source and said steam source into a cooling steam and said high-pressure water, and to selectively send said cooling steam and said high-pressure water to said one or more H₂-O₂ steam generators. Said premixed H₂-O₂ is at stoichiometry. Said one or more H₂-O₂ steam generators is configured to burn said premixed H₂-O₂, and to cool said one or more H₂-O₂ steam generators with said cooling steam and said high-pressure water and thereby to generate a generated steam. Said control unit receives input signals and data from various components of said steam generator system, processes it, and controls various instruments in the system.

A method of burning H₂-O₂ for creating a generated steam comprising the following steps. Receiving a hydrogen from a hydrogen source into a hydrogen-oxygen handling unit having a hydrogen mass flow controller, a H₂ flame/flash back arrestor, an oxygen mass flow controller, an oxygen flame flash back arrestor and a H₂-O₂ mixer. Monitoring said hydrogen from said hydrogen source with said hydrogen mass flow controller for flow rate, temperature and pressure. Controlling desired flow rate of said hydrogen coming from said hydrogen source with said hydrogen mass flow controller of said hydrogen-oxygen handling unit. Further a hydrogen flame flash back arrestor is a safety device, helps in quenches the flame during a flame/flash-back occurrence in the hydrogen passage and preventing it from reaching said hydrogen source. From said H₂ flame/flash back arrestor, said hydrogen is feed into said H₂-O₂ mixer. Receiving an oxygen source into said hydrogen-oxygen handling unit. Monitoring said oxygen from said oxygen source with said oxygen mass flow controller for flow rate, temperature and pressure. Controlling desired flow rate of said oxygen coming from said oxygen source with

4

said oxygen mass flow controller of said hydrogen-oxygen handling unit. Further said oxygen flame flash back arrestor is a safety device, helps in quenches the flame during a flame/flash-back occurrence in the oxygen passage and preventing it from reaching said oxygen source. From said oxygen flame flash back arrestor, said oxygen is feed into said H₂-O₂ mixer. Said H₂-O₂ mixer, receives said hydrogen from said H₂ flame/flash back arrestor and said oxygen from said oxygen flame flash back arrestor and mixes in a stoichiometric ratio and feeds it into a premixed H₂-O₂ inlet of a burner tip. Before and after operation of a steam generator system, nitrogen from a nitrogen source is used to purge said hydrogen passage and said oxygen passage to ensure safe operation and prevent flame/flash back.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 illustrates as a simplified block diagram view of a steam generator system **100**.

FIG. 2A illustrates simplified block diagram view of a hydrogen-oxygen handling unit **102**.

FIG. 2B illustrates simplified block diagram view of a cooling unit **104**.

FIG. 3 illustrates an elevated front side view of a burner tip main body **300** in cross-section.

FIG. 4 illustrates an elevated top side view of a burner tip **350**.

FIG. 5 illustrates an elevated front side view of a burner tip mounting frame **500** in cross-section.

FIG. 6A illustrates block diagram view of a water only configuration **600a**.

FIG. 6B illustrates block diagram view of a steam only configuration **600b**.

FIG. 7 illustrates block diagram view of an alternative configuration **700**.

FIG. 8 illustrates block diagram view of an alternative cooling unit **800**.

FIG. 9 illustrates a flow chart view of a method of burning H₂-O₂ **900**.

DETAILED DESCRIPTION OF THE INVENTION

The following description is presented to enable any person skilled in the art to make and use the invention as claimed and is provided in the context of the particular examples discussed below, variations of which will be readily apparent to those skilled in the art. In the interest of clarity, not all features of an actual implementation are described in this specification. It will be appreciated that in the development of any such actual implementation (as in any development project), design decisions must be made to achieve the designers' specific goals (e.g., compliance with system- and business-related constraints), and that these goals will vary from one implementation to another. It will also be appreciated that such development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the field of the appropriate art having the benefit of this disclosure. Accordingly, the claims appended hereto are not intended to be limited by the disclosed embodiments, but are to be accorded their widest scope consistent with the principles and features disclosed herein.

These parts are illustrated in the figures and discussed below: a steam generator system **100**, a hydrogen-oxygen handling unit **102**, a cooling unit **104**, a one or more H₂-O₂

steam generators **106**, a generated steam **108**, a hydrogen source **110**, an oxygen source **112**, a nitrogen source **114**, a water source **116**, a steam source **118**, a control unit **120**, an oxygen passage **122**, a hydrogen passage **124**, a hydrogen mass flow controller **202**, a hydrogen flame flash back arrestor **204**, an oxygen mass flow controller **206**, an oxygen flame flash back arrestor **208**, a H₂-O₂ mixer **210**, a water flow controller **212**, a high-pressure water pump **214**, a steam flow controller **216**, a steam-water mixer **218**, a cooling steam **220**, a HP-LT steam **222**, a steam-water mist mixture **224**, a premixed H₂-O₂ **226**, a high-pressure water **228**, a burner tip main body **300**, a one or more cooling steam inlets **302**, a first cooling steam inlet **302a**, a second cooling steam inlet **302b**, a premixed H₂-O₂ inlet **304**, an insulating medium **306**, a premixed H₂-O₂ receiving chamber **308**, a sintered plate **310**, a premixed H₂-O₂ upper chamber **312**, a one or more cooling steam chambers **314**, a first cooling steam chamber **314a**, a second cooling steam chamber **314b**, a premixed H₂-O₂ injector array **316**, a one or more steam injectors **318**, a first steam injector **318a**, a second steam injector **318b**, a flow velocity equalizer medium **320**, a burner tip **350**, a burner tip mounting frame **500**, a liner **502**, an inner pass **504**, an outer pass **506**, a cooling steam inlet **508**, a steam injector ring **510**, a cooling water inlet **512**, a water spray nozzle **514**, a liner steam vent **516**, a steam exit vent **518**, a length **520**, a width **522**, an ignition unit **524**, a front end **526**, a rear end **528**, a steam generation chamber **550**, a water only configuration **600a**, a steam only configuration **600b**, an alternative configuration **700**, a hydrogen pump **702**, an oxygen pump **704**, an alternative cooling unit **800**, a method of burning H₂-O₂ **900**, a receiving H₂ and O₂ step **902**, a controlling H₂ and O₂ step **904**, a mixing H₂ and O₂ step **906**, a burning premixed H₂-O₂ step **908**, a generating cooling steam step **910**, and a cooling steam generator step **912**.

FIG. 1 illustrates as a simplified block diagram view of a steam generator system **100**.

In one embodiment, said steam generator system **100** can comprise said hydrogen-oxygen handling unit **102**, said cooling unit **104**, said steam generator **106**, said burner tip **350**, said steam generation chamber **550**, said generated steam **108**, said hydrogen source **110**, said oxygen source **112**, said nitrogen source **114**, said water source **116**, said steam source **118** and said control unit **120**.

In one embodiment, said steam generator **106** can comprise said burner tip **350** and said steam generation chamber **550**.

FIGS. 1-2C represent simplified block diagrams of said steam generator system **100**.

In one embodiment, said steam generator system **100** can comprise said hydrogen source **110**, said nitrogen source **114**, said oxygen source **112**, said water source **116**, said steam source **118**, said hydrogen-oxygen handling unit **102**, said cooling unit **104**, said steam generator **106**, said generated steam **108**, and said control unit **120**. In one embodiment, said hydrogen source **110** can comprise H₂, said nitrogen source **114** can comprise N₂, and said oxygen source **112** can comprise O₂.

Said hydrogen-oxygen handling unit **102** can comprise a hydrogen/oxygen ("H₂-O₂") handling unit. Said steam generator **106** can comprise an H₂-O₂ steam generator. Said water source **116** can be demineralized. Said steam source **118** can comprise steam at "high-pressure, low temperature" as discussed below.

In one embodiment, said hydrogen source **110** can be hydrogen in gaseous phase stored under pressure in gas cylinders, or containers, or hydrogen stored in large scale in

geological storage or hydrogen stored in indirect form for example metal hydrides, or hydrogen from industrial process or hydrogen stored in liquid phase. The hydrogen purity can be of industrial grade; however, some impurities can be accommodated, depending on the final temperature, pressure, and usage of the steam generated by said steam generator system **100**.

In one embodiment, said oxygen source **112** can be oxygen in gaseous phase stored under pressure in gas cylinders, containers, oxygen stored in large scale in geological storage, oxygen from industrial processes, or oxygen stored in liquid phase. The oxygen purity can be of industrial grade; however, some impurities can be accommodated, depending on the final temperature, pressure and usage of the steam generated by said steam generator system **100**.

In one embodiment, said nitrogen source **114** can be nitrogen in gaseous phase stored under pressure in gas cylinders or containers. Said nitrogen source **114** provides nitrogen under pressure to purge the hydrogen and oxygen lines before and after operation of said steam generator system **100**. Said nitrogen source **114** can also be replaced with a variety of inert gases, as is known in the art.

A discussion of monitoring and regulating a pressure of said hydrogen source **110** and said oxygen source **112** with pumps is included below and illustrated in FIG. 7.

In one embodiment, said water source **116** can comprise demineralized water with additives in accordance with industrial standards or requirement for steam generation. In one embodiment, an additive can be used to minimize rust and harm to said steam generator system **100** due to the demineralized water.

In one embodiment, said steam source **118** can comprise steam at "High-Pressure, Low-Temperature" ("HP-LT") characteristics. Wherein, said steam source **118** can provide steam for cooling purposes in said steam generator **106**.

Depending on the application of said steam generator system **100**, availability of resources, and economic factors, said steam generator system **100** can comprise only said water source **116**, only said steam source **118**, or a combination of said water source **116** and said steam source **118**.

In one embodiment, said generated steam **108** can comprise a steam at "high-pressure, high-temperature" ("HP/HT") or "HP-HT"). Said generated steam **108** can be generated by said steam generator **106** at a desired temperature, pressure and mass flow rate. Sensors can be used to measure the temperature, pressure and flow rate of said generated steam **108**.

In one embodiment, said control unit **120** can receive signals from different sensors, measuring devices and instruments used in said steam generator system **100**. In one embodiment, said control unit **120** can process these signals along with external inputs from human or other control units and can send command signals to different instruments and control modules present in said steam generator system **100** to efficiently and accurately carry out the steam generation process. Said control unit **120** can also send and receive signals from said hydrogen-oxygen handling unit **102** and said cooling unit **104** and receive signals from said generated steam **108**.

FIG. 2A illustrates simplified block diagram view of a hydrogen-oxygen handling unit **102**.

FIG. 2B illustrates simplified block diagram view of a cooling unit **104**.

In one embodiment, said steam generator system **100** can comprise said cooling steam **220** and said high-pressure water **228**.

In one embodiment, said hydrogen-oxygen handling unit **102** can comprise said hydrogen mass flow controller **202**, said hydrogen flame flash back arrestor **204**, said oxygen mass flow controller **206**, said oxygen flame flash back arrestor **208**, said H₂-O₂ mixer **210** and said premixed H₂-O₂ **226**.

In one embodiment, said cooling unit **104** can comprise said water flow controller **212**, said high-pressure water pump **214**, said steam flow controller **216**, said steam-water mixer **218**, said HP-LT steam **222**, said steam-mist mixture **224**, said high-pressure water **228** and said high-pressure water **228**.

In one embodiment, said hydrogen-oxygen handling unit **102** can comprise a hydrogen/oxygen (H₂-O₂) handling unit.

In one embodiment, said hydrogen mass flow controller **202** regulates the mass flow of gaseous hydrogen from said hydrogen source **110**. In one embodiment, said hydrogen source **110** can comprise a gaseous hydrogen. In one embodiment, said hydrogen mass flow controller **202** can measure the temperature and pressure of said hydrogen source **110** flowing through it.

In one embodiment, said oxygen mass flow controller **206** regulates the mass flow of gaseous oxygen from said oxygen source **112**. Said oxygen mass flow controller **206** can also measure the temperature and pressure of said oxygen source **112** flowing through it.

In one embodiment, said hydrogen source **110** comprises a liquid hydrogen; wherein, said hydrogen source **110** can be converted into gaseous hydrogen before feeding into said hydrogen mass flow controller **202**. Likewise, said oxygen source **112** can comprise liquid oxygen; wherein, said oxygen source **112** can be converted into gaseous oxygen before feeding into said oxygen mass flow controller **206**.

In one embodiment, said hydrogen flame flash back arrestor **204** helps in arresting the flame or flash back in the hydrogen carrying conduit and prevents the flame/flash back from entering said hydrogen source **110**. Said hydrogen flame flash back arrestor **204** can also act as a reverse flow check valve.

Likewise, said oxygen flame flash back arrestor **208** helps in arresting the flame or flash back in the oxygen-carrying conduit and prevents the flame/flash back from entering said oxygen source **112**. Said oxygen flame flash back arrestor **208** can also act as a reverse-flow check valve.

In one embodiment, said H₂-O₂ mixer **210** can receive hydrogen and oxygen and mix them uniformly to form a stoichiometric ratio of hydrogen and oxygen. Said stoichiometric ratio can comprise 1 Kg of H₂ to 8 Kg of O₂. Said hydrogen mass flow controller **202** and said oxygen mass flow controller **206** precisely control the mass flow of hydrogen and oxygen entering said H₂-O₂ mixer **210** to form a premixed H₂-O₂ **226**, where said premixed H₂-O₂ **226** is at stoichiometric ratio.

In one embodiment, said water flow controller **212** regulates the flow of fluid from said water source **116**. Said water flow controller **212** can also measure the temperature of said water source **116** flowing through it.

In one embodiment, said steam flow controller **216** regulates the flow of said steam source **118**. Said steam flow controller **216** can also measure the temperature and pressure of said steam source **118** flowing through it.

In one embodiment, said high-pressure water pump **214** pumps said water source **116** to an increased-pressure water **228**. In one embodiment, said increased-pressure water **228** can comprise approximately 2000 psi. In one embodiment,

said increased-pressure water **228** can be directed to said steam generator **106** and/or to said steam-water mixer **218**.

As discussed and illustrated a FIGS. 6A-6B, said steam generator system **100** can comprise either said water source **116** or said steam source **118** as inputs. However, as discussed here, said steam generator system **100** can comprise both said water source **116** and said steam source **118**. In such case, both said increased-pressure water **228** and steam source **118** can be used in said steam generator **106** for temperature regulating purposes.

In one embodiment, a portion of said increased-pressure water **228** and a portion of said steam source **118** can enter said steam-water mixer **218**, said steam-water mixer **218** can direct said increased-pressure water **228** to be sprayed into said cooling steam **220** as said steam-mist mixture **224** by using a high-pressure spray nozzle (or nozzles); wherein, said steam-mist mixture **224** can be carried by said cooling steam **220** into said steam generator **106**.

FIG. 3 illustrates an elevated front side view of a burner tip main body **300** in cross-section.

In one embodiment, said burner tip main body **300** can comprise said one or more cooling steam inlets **302**, said premixed H₂-O₂ inlet **304**, said insulating medium **306**, said premixed H₂-O₂ receiving chamber **308**, said sintered plate **310**, said premixed H₂-O₂ upper chamber **312**, said one or more cooling steam chambers **314**, said premixed H₂-O₂ injector array **316** and said one or more steam injectors **318**.

In one embodiment, said one or more cooling steam chambers **314** can comprise said first cooling steam chamber **314a** and said second cooling steam chamber **314b**.

In one embodiment, said one or more steam injectors **318** can comprise said first steam injector **318a** and said second steam injector **318b**.

In one embodiment, said one or more cooling steam inlets **302** can comprise said first cooling steam inlet **302a** and said second cooling steam inlet **302b**.

In one embodiment, said premixed H₂-O₂ receiving chamber **308** can comprise said flow velocity equalizer medium **320**.

In one embodiment, said steam generator system **100** can comprise said burner tip main body **300**.

In one embodiment, said burner tip **350** can comprise said burner tip main body **300**, said one or more cooling steam inlets **302**, said first cooling steam inlet **302a**, said second cooling steam inlet **302b**, said premixed H₂-O₂ inlet **304**, said insulating medium **306**, said premixed H₂-O₂ receiving chamber **308**, said sintered plate **310**, said premixed H₂-O₂ upper chamber **312**, said one or more cooling steam chambers **314**, said first cooling steam chamber **314a**, said second cooling steam chamber **314b**, said premixed H₂-O₂ injector array **316**, said one or more steam injectors **318**, said first steam injector **318a**, said second steam injector **318b** and said flow velocity equalizer medium **320**.

In one embodiment, said steam generator **106** can comprise two sections, namely, said burner tip **350** and said steam generation chamber **550**.

In one embodiment, said burner tip main body **300** can comprise a cylindrical structure. Said burner tip main body **300** can be made of material capable of handling high-pressure and temperature. Said burner tip main body **300** can help in collectively holding the sections of said burner tip **350** together.

In one embodiment, said one or more cooling steam inlets **302** can receive said cooling steam **220** from said cooling unit **104**. The cooling steam **220** can be either HP-LT steam **222** from said steam flow controller **216** or a steam-mist mixture **224** from said steam-water mixer **218**. Said one or

more cooling steam inlets **302** can comprise an inline reverse-flow check valve which prevents reverse flow of any exhaust or explosive mixture from said steam generator **106** to said cooling unit **104**.

In one embodiment, said premixed H₂-O₂ inlet **304** can receive a premixed H₂-O₂ **226** from said hydrogen-oxygen handling unit **102**. Said premixed H₂-O₂ inlet **304** can comprise an inline, reverse-flow check valve, which prevents reverse flow of any exhaust or explosive mixture from said steam generator **106** to said hydrogen-oxygen handling unit **102**.

In one embodiment, said premixed H₂-O₂ **226** from said hydrogen-oxygen handling unit **102** enters said burner tip **350** through said premixed H₂-O₂ inlet **304** and reaches said premixed H₂-O₂ receiving chamber **308**.

In one embodiment, said premixed H₂-O₂ receiving chamber **308** can contain a flow velocity equalizer medium **320**. Said flow velocity equalizer medium **320** can be included or omitted depending on a desired settings for an inlet pressure and velocity of said premixed H₂-O₂ **226** to attain a favorable velocity and pressure for combustion process. In one embodiment, said flow velocity equalizer medium **320** can comprise small spherical balls or glass wool.

In one embodiment, said sintered plate **310** separates said premixed H₂-O₂ receiving chamber **308** from said premixed H₂-O₂ upper chamber **312**. Said sintered plate **310** helps in quenching the flashback and backfire in case of occurrence and prevents it from entering said hydrogen-oxygen handling unit **102**. In one embodiment, said sintered plate **310** can also be replaced with multiple sintered disks or sintered cylinders or a combination of both depending on the pressure of incoming said premixed H₂-O₂ **226** and pressure loss at the sintered disk or cylinder.

In one embodiment, said premixed H₂-O₂ **226** can pass through said sintered plate **310** and reach said premixed H₂-O₂ upper chamber **312**. Said premixed H₂-O₂ upper chamber **312** can be more beneficial for combustion, especially during load cycling, by acting as a small reservoir to help stabilize the pressure of said premixed H₂-O₂ **226** before injecting it into said steam generation chamber **550** for combustion.

In one embodiment, said one or more cooling steam chambers **314** receives cooling steam **220** from said one or more cooling steam inlets **302**. Said one or more cooling steam chambers **314** acts as a small reservoir for cooling steam **220** to help stabilize the pressure, especially during load cycling.

In one embodiment, said premixed H₂-O₂ **226** in said premixed H₂-O₂ upper chamber **312** exits through said premixed H₂-O₂ injector array **316** into said steam generation chamber **550**. The number of said premixed H₂-O₂ injector array **316**, the size of injectors and angle of inclination in said premixed H₂-O₂ injector array **316** can be optimized for a flow rate, velocity and pressure of said premixed H₂-O₂ **226** as it exits through said premixed H₂-O₂ injector array **316** to enhance combustion without flash backs at various loading conditions.

FIG. 4 illustrates an elevated top side view of a burner tip **350**.

The number of said one or more steam injectors **318** and angle of inclination can be optimized for the flow rate, velocity and pressure of the cooling steam **220** exiting through said one or more steam injectors **318**.

Discussed below in the description of FIG. 8 is an embodiment of said steam generator system **100** with said

generated steam **108** used as an input to said steam-water mixer **218** for generation of said cooling steam **220**.

FIG. 5 illustrates an elevated front side view of a burner tip mounting frame **500** in cross-section.

In one embodiment, said burner tip mounting frame **500** can comprise said liner **502**, said inner pass **504**, said outer pass **506**, said cooling steam inlet **508**, said steam injector ring **510**, said cooling water inlet **512**, said water spray nozzle **514**, said liner steam vent **516**, said steam exit vent **518**, said length **520** and said width **522**.

In one embodiment, said inner pass **504** can comprise said front end **526** and said rear end **528**.

In one embodiment, said steam generator **106** can comprise said ignition unit **524**. Said ignition unit **524** can be a spark ignitor, pilot ignitor, gas ignitor and it is adopted as according to the steam generation capacity, operating pressure and temperature of the said steam generator **106**.

In one embodiment, said steam generation chamber **550** can comprise said burner tip mounting frame **500**, said liner **502**, said inner pass **504**, said outer pass **506**, said cooling steam inlet **508**, said steam injector ring **510**, said cooling water inlet **512**, said water spray nozzle **514**, said liner steam vent **516** and said steam exit vent **518**.

In one embodiment, the cooling steam **220** from said one or more cooling steam chambers **314** exits through said one or more steam injectors **318** into said steam generation chamber **550**. Said one or more steam injectors **318** can be inclined in such a way that it provides a steam film (not illustrated) along a side of said inner pass **504** of said liner **502** within said steam generation chamber **550**; wherein, said cooling steam **220** acts as a coolant to prevent thermal meltdown or other damages due to thermal stress during a combustion of said premixed H₂-O₂ **226**.

In one embodiment, said water spray nozzle **514** can comprise increased-pressure water.

In one embodiment, said steam generation chamber **550** can be a solid structure capable of handling high-pressure and temperature. Said length **520** and said width **522** can be altered to achieve variations in the temperature, flow rate, and pressure of said generated steam **108**.

In one embodiment, said burner tip mounting frame **500** has the required opening, sealants and brackets to accommodate said burner tip **350** and an ignition unit being appropriate for the use of said steam generator system **100**. Said burner tip mounting frame **500** can be at the front end of said steam generation chamber **550**.

In one embodiment, said steam generation chamber **550** can comprise a two-pass design which can comprise said inner pass **504** and said outer pass **506**. In said inner pass **504**, combustion of H₂-O₂ occurs in the front end of the chamber and injection of water and/or steam occurs at the middle and rear end of said inner pass **504**. Complete mixing of coolant and combustion resultant occurs at said outer pass **506**.

In one embodiment, said liner **502** can be a wall separating said inner pass **504** and said outer pass **506**. It can be made of a good heat conductor to evenly distribute the temperature to avoid hot spots and undergo less thermal stress. Copper can be the choice for said liner **502**.

In one embodiment, said outer pass **506** can have fins or other appropriate structure attached to said liner **502** to enhance the heat transfer between streams in said inner pass **504** and said outer pass **506**.

In one embodiment, said cooling steam inlet **508** receives said cooling steam **220** from said cooling unit **104** and passes it to said steam injector ring **510**. Said cooling steam **220** can be either HP-LT steam from said steam flow

11

controller **216** or a mixture of HP-LT steam and water mist from said steam-water mixer **218**. Said cooling steam inlet **508** can comprise an inline reverse-flow check valve, which can be configured to prevent reverse flow of any exhaust or explosive mixture from said steam generation chamber **550** to said cooling unit **104**. The number of said cooling water inlet **512** and the size of the cooling water inlet **512** are optimized for the flow rate and pressure of cooling steam **220** from said cooling unit **104**.

In one embodiment, said steam injector ring **510** receives cooling steam **220** through said cooling steam inlet **508** and injects it into said inner pass **504** using a series of ports in a ring structure attached to said liner **502** of said inner pass **504**. The number of ring structures and ports in each ring structure are optimized for the flow rate and pressure of cooling steam **220** from said cooling unit **104**.

In one embodiment, said cooling water inlet **512** receives cooling water from said cooling unit **104** and passes it to said water spray nozzle **514**.

In one embodiment, said water spray nozzle **514** receives said cooling steam **220** through said cooling water inlet **512** and can there after injects it into said inner pass **504**. Said inner pass **504** can be at the rear end of said steam generator **106**. The size of the cooling water inlet **512** and the number of said water spray nozzle **514** are optimized for the flow rate and pressure of said cooling steam **220**.

In one embodiment, the position of said steam injector ring **510** and said water spray nozzle **514** depends on the flame length and required flow rate, temperature and pressure of said generated steam **108** being generated in said steam generation chamber **550**. Optimum placement of said steam injector ring **510** and said water spray nozzle **514** helps to generate said generated steam **108** at required temperatures and pressures with minimal temperature deviation and hot spots.

In one embodiment, said liner steam vent **516** are configured to allow the coolant and combustion resultant to reach said outer pass **506** from said inner pass **504**. The size and number of holes represented by said liner steam vent **516** can be determined by the flow rate of hydrogen, oxygen and coolant, as well as the rated operating pressure inside said steam generation chamber **550**.

In one embodiment, said cooling steam inlet **508** can also be placed in the middle or front end of the separator wall for optimum efficiency. This can depend on the cooling steam **220** and cooling water mass flow rate and rated maximum operating temperature and pressure of said generated steam **108**.

In one embodiment, said generated steam **108** exits said steam generation chamber **550** through said steam exit vent **518**. The optimum position of said steam exit vent **518** depends on the flow rate of said generated steam **108**, positioning of said liner steam vent **516** and flow rate of cooling steam **220** and cooling water.

FIG. 6A illustrates block diagram view of a water only configuration **600a**.

FIG. 6B illustrates block diagram view of a steam only configuration **600b**.

In one embodiment, said cooling unit **104** can comprise said water only configuration **600a** and said steam only configuration **600b**.

In one alternative embodiment, said water source **116** or said steam source **118** can be optional.

As illustrated in said water only configuration **600a**, in one embodiment, said steam generator system **100** can comprise only of said water source **116** and not said steam

12

source **118**; wherein, said increased-pressure water **228** can be directed into said steam generator **106** for cooling without said cooling steam **220**.

As illustrated in said steam only configuration **600b**, in one embodiment, said steam source **118** can be preferred over said water source **116**, provided that said steam source **118** is readily available. Thus, in one embodiment said steam source **118** can be injected into said steam generator **106** for temperature regulating purposes.

In one embodiment, when said increased-pressure water **228** comprises the only coolant, said cooling steam inlet **508**, said steam injector ring **510**, said one or more cooling steam inlet **302**, said one or more cooling steam chamber **314** and said one or more steam injector **318** can be modified to inject water. When cooling steam **220** comprises the only coolant, said cooling water inlet **512** and said water spray nozzle **514** can be modified to accommodate steam. Depending on the generated steam temperature, pressure and quantity, one or more of said cooling steam inlet **508**, said steam injector ring **510**, said one or more cooling steam inlet **302**, said one or more cooling steam chamber **314** and said one or more steam injector **318** can be modified to inject water and one or more of said cooling water inlet **512** and said water spray nozzle **514** can be modified to accommodate steam to optimize the performance and improve the steam quality.

FIG. 7 illustrates block diagram view of an alternative configuration **700**.

In one embodiment, said hydrogen-oxygen handling unit **102** can comprise said alternative configuration **700**, said hydrogen pump **702** and said oxygen pump **704**.

In one embodiment, said oxygen source **112** can supply oxygen under pressure to said hydrogen-oxygen handling unit **102**. In one embodiment, where said oxygen source **112** comprises pressure below a minimum threshold, said oxygen pump **704** can be used to attain necessary pressure of oxygen for operation within said hydrogen-oxygen handling unit **102**. Likewise, where said hydrogen source **110** is below a desired pressure, said hydrogen pump **702** can be used to attain necessary pressure of hydrogen for operation before entering said hydrogen-oxygen handling unit **102**.

In one embodiment, said hydrogen pump **702** and said oxygen pump **704** can be built into said hydrogen-oxygen handling unit **102** or, as illustrated, said hydrogen pump **702** and said oxygen pump **704** can be outside of said hydrogen-oxygen handling unit **102**.

FIG. 8 illustrates block diagram view of an alternative cooling unit **800**.

In one embodiment, said cooling unit **104** can comprise said alternative cooling unit **800**.

In one embodiment, if said steam source **118** is absent in said steam generator system **100**, then a portion of said generated steam **108** can be reused. In such case, a portion of said generated steam **108** can be directed to said steam-water mixer **218** where it can be mixed with increased-pressure water **228** to form said cooling steam **220** and then feed into said one or more cooling steam inlets **302** of said burner tip **350** for temperature regulation purposes.

In one embodiment, depending on the operation temperature and pressure of said generated steam **108** and coolant phase (steam or water), the steam cooling setup in burner tip (said one or more cooling steam inlets **302**, said one or more cooling steam chambers **314** and said one or more steam injectors **318**) can be removed without posing any significant risk to said steam generation chamber **550** and said burner tip **350**.

13

In one embodiment, if said steam source **118** is absent from the system, a portion of said generated steam **108** can be reused. In such case a portion of said generated steam **108** can be directed to said steam-water mixer **218** where it can be mixed with increased-pressure water **228** mist to form said cooling steam **220** and then fed into said cooling steam inlet **508** of said steam generation chamber **550** for cooling purposes.

In one embodiment, said steam generator system **100** can be useful for power generation, in locomotives for propulsion, and in combined heat and power generation.

In one embodiment, said steam generator system **100** can work alongside or completely replace the conventional burners in steam- or gas-turbine power plants to generate power at reduced or zero pollution, provided that the hydrogen is generated from or using renewable energy sources.

In one embodiment, said steam generator system **100** can work along with a steam engine, steam-turbine, gas-turbine, or electric hybrid engine. It can completely replace gasoline, diesel, oil or gas engines in trucks, trains, submarines, ships, tanks etc. to increase efficiency at reduced or zero pollution, provided that the hydrogen is generated from or using renewable energy sources.

In one embodiment, said steam generator system **100** can be useful for both power generation and heat energy utilization. One such example, but not limited to this, is cane sugar production, in which said steam generator system **100** can produce high-pressure high-temperature steam which passes through a steam turbine or steam-injected gas turbine to generate electric power. The exhaust steam from the turbine can be used in industrial processing of cane sugar.

FIG. 9 illustrates a flow chart view of a method of burning H2-O2 **900**.

In one embodiment, said method of burning H2-O2 **900** can comprise said receiving H2 and O2 step **902**, said controlling H2 and O2 step **904**, said mixing H2 and O2 step **906**, said burning premixed H2-O2 step **908**, said generating cooling steam step **910** and said cooling steam generator step **912**.

In one embodiment, said method of burning H2-O2 **900** can comprise a method of using steam generator system **100**.

receiving H2 and O2 step **902** can comprise receiving hydrogen source **110** and oxygen source **112** into hydrogen-oxygen handling unit **102**. controlling H2 and O2 step **904** can comprise using portions of hydrogen-oxygen handling unit **102** to control intake of hydrogen source **110** and oxygen source **112**. mixing H2 and O2 step **906** can comprise creating premixed H2-O2 **226** with hydrogen-oxygen handling unit **102**. burning premixed H2-O2 step **908** and generating cooling steam step **910** can comprise burning premixed H2-O2 **226** with steam generator **106** to create generated steam **108**. cooling steam generator step **912** can comprise receiving water source **116** and steam source **118** into cooling unit **104** to generate increased-pressure water **228** and cooling steam **220** for cooling steam generator **106**.

The following sentences are included for completeness of this disclosure with reference to the claims.

A steam generator system **100** configured to burn hydrogen and oxygen at stoichiometry along with a increased-pressure water **228** and steam. Said steam generator system **100** comprise a hydrogen source **110**, an oxygen source **112**, a nitrogen source **114**, a water source **116**, a steam source **118**, a hydrogen-oxygen handling unit **102**, a cooling unit **104**, a one or more H2-O2 steam generators **106** and a control unit **120**. Said steam generator system **100** is configured to provide said hydrogen source **110** to said hydrogen-oxygen handling unit **102** through an oxygen passage

14

122, said oxygen source **112** to said hydrogen-oxygen handling unit **102** through a hydrogen passage **124**, and said nitrogen source **114** to selectively purge said oxygen passage **122** and said hydrogen passage **124**. Said water source **116** provide water to said cooling unit **104**. Said cooling unit **104** is configured to receive said water source **116** and said steam source **118**. Said hydrogen-oxygen handling unit **102** is configured to blend portions of said hydrogen source **110** and said oxygen source **112** into a premixed H2-O2 **226**, and to selectively send portions of said premixed H2-O2 **226** to said one or more H2-O2 steam generators **106**. Said cooling unit **104** is configured to receive and process said water source **116** and said steam source **118** into a cooling steam **220** and said increased-pressure water **228**, and to selectively send said cooling steam **220** and said increased-pressure water **228** to said one or more H2-O2 steam generators **106**. Said premixed H2-O2 **226** is at stoichiometry. Said one or more H2-O2 steam generators **106** is configured to burn said premixed H2-O2 **226**, and to cool said one or more H2-O2 steam generators **106** with said cooling steam **220** and said increased-pressure water **228** and thereby to generate a generated steam **108**. Said control unit **120** receives input signals and data from various components of said steam generator system **100**, processes it, and controls various instruments in the system.

Said hydrogen source **110** comprising hydrogen in liquid phase or gaseous phase stored in a one or more containers selected among: gas cylinders, geological storage, and metal hydrides. Where said hydrogen source **110** consists of liquid or low-pressure hydrogen, said steam generator system **100** further comprises a hydrogen vaporizer and a hydrogen pump **702** respectively used to produce gaseous hydrogen at the necessary pressure for operation before it enters said hydrogen-oxygen handling unit **102**. Said hydrogen source **110** comprises an industrial grade, with some impurities are accommodated depending on the final temperature, pressure, quality and usage of the steam generated by said steam generator system **100**.

Said oxygen source **112** having oxygen in gaseous phase or liquid phase stored under pressure in one or more containers selected among: a gas cylinders, geological storage, from an industrial process, or in liquid phase. Where said oxygen source **112** consists of liquid or low-pressure oxygen, said steam generator system **100** further comprises an oxygen vaporizer and an oxygen pump **704** respectively, wherein. Said oxygen vaporizer and said oxygen pump **704** are used to produce gaseous oxygen at the necessary pressure for operation before it enters said hydrogen-oxygen handling unit **102**. A purity of said oxygen are of industrial grade with some impurities depending on the final temperature, pressure, quality and usage of the steam generated by said steam generator system **100**.

Said nitrogen source **114** having nitrogen in gaseous phase stored under pressure in gas cylinders, or other containers. Said nitrogen source **114** provides nitrogen under pressure to purge the hydrogen and oxygen conduit before and after operation of said steam generator system **100**.

Said nitrogen source **114** is replaced with an inert gas.

Said water source **116** is de-mineralized water comprising added chemicals to prevent rusting in said steam generator system **100**.

Said steam source **118** is a high-pressure low temperature steam.

Said hydrogen-oxygen handling unit **102** comprise a hydrogen mass flow controller **202**, a hydrogen flame flash back arrestor **204**, an oxygen mass flow controller **206**, an oxygen flame flash back arrestor **208**, a H2-O2 mixer **210**.

15

Said hydrogen mass flow controller **202** is configured to receive said hydrogen source **110** and regulating its flow. Said hydrogen flame flash back arrestor **204** is configured to quench a flame during a flame/flash-back occurrence and preventing it from reaching said hydrogen source **110**. Said oxygen mass flow controller **206** receives said oxygen source **112** and regulating its flow. Said oxygen flame flash back arrestor **208** is configured to quench a flame during a flame/flash-back occurrence and preventing it from reaching said oxygen source **112**. Said H₂-O₂ mixer **210** is configured to receive said hydrogen source **110** from said hydrogen mass flow controller **202** and said oxygen source **112** from said oxygen mass flow controller **206**, uniformly mix said hydrogen source **110** and said oxygen source **112** at stoichiometry into said premixed H₂-O₂ **226**, and send said premixed H₂-O₂ **226** to said one or more H₂-O₂ steam generators **106**.

Said one or more H₂-O₂ steam generators **106** comprise a burner tip **350** and a steam generation chamber **550**. Said burner tip **350** is configured to receive said premixed H₂-O₂ **226** from said hydrogen-oxygen handling unit **102**, said increased-pressure water **228** from said cooling unit **104**, and said cooling steam **220** from said cooling unit **104**. Said steam generation chamber **550** is configured to combust said premixed H₂-O₂ **226** and mix said cooling steam **220** and/or said increased-pressure water **228** to create said generated steam **108** at a desired temperature and pressure.

Said steam generation chamber **550** comprising a burner tip mounting frame **500**, a liner **502**, an inner pass **504**, an outer pass **506**, a cooling steam inlet **508**, a steam injector ring **510**, a cooling water inlet **512**, a water spray nozzle **514**, a liner steam vent **516**, a steam exit vent **518**, and an ignition unit **524**. Said burner tip mounting frame **500** is configured for mounting said burner tip **350** and said ignition unit **524** into said steam generation chamber **550**. Said liner **502** which divides the hollow interior of said steam generation chamber **550** into two passes. Said inner pass **504** at which the combustion of said premixed H₂-O₂ **226** occurs and said increased-pressure water **228** and/or a steam-water mist mixture **224** are injected. Said outer pass **506** at which the combustion product of said premixed H₂-O₂ **226** combustion and the coolant (water or steam or both) mix to form said generated steam **108** at desired temperature. Said cooling steam inlet **508** is configured for receiving said cooling steam **220** from said cooling unit **104**. Said steam injector ring **510** is configured for injecting said cooling steam **220**. Said cooling water inlet **512** is configured for receiving said increased-pressure water **228** from said cooling unit **104**. Said water spray nozzle **514** is configured for injecting said increased-pressure water **228**. Said liner steam vent **516** is configured to allow a mixture of steam to pass from said inner pass **504** to said outer pass **506**. Said steam exit vent **518** is configured to selectively vent said generated steam **108** out of said steam generation chamber **550**. Said ignition unit **524** configured to ignite said premixed H₂-O₂ **226** at said inner pass **504**.

Said steam generator system **100** is configured with a size and number of a liner steam vent **516** to optimize a flowrate of hydrogen, oxygen and coolant, as well as the rated operating pressure inside said steam generation chamber **550**.

A steam injector ring **510** is configured to inject said cooling steam **220** into an inner pass **504** using a series of ports in a ring structure attached to a liner **502** of said inner pass **504**. The number of ring structures and ports in the ring structures are optimized for the flow rate and pressure of said cooling steam **220** from said cooling unit **104**.

16

Placement of a cooling steam inlet **508**, a steam injector ring **510**, a cooling water inlet **512**, a water spray nozzle **514**, a liner steam vent **516**, and a steam exit vent **518** to get maximum thermal efficiency with reduced pressure losses and hot spots depends on the flowrate of said premixed H₂-O₂ **226**, said cooling steam **220**, and said cooling steam **220**, and the rated maximum operating temperature and pressure of said generated steam **108**.

An outer pass **506** comprises fins attached to a liner **502** to enhance the heat transfer between the stream in an inner pass **504** and said outer pass **506** and allow proper mixing of the coolant and combustion resultant of said premixed H₂-O₂ **226**.

A liner **502** comprises a heat conductor configured to distribute the heat over its surface area to avoid hot spots during the combustion process.

Said burner tip **350** comprising a burner tip main body **300**, a cooling steam inlet **508**, a premixed H₂-O₂ inlet **304**, an insulating medium **306**, a premixed H₂-O₂ receiving chamber **308**, a sintered plate **310**, a premixed H₂-O₂ upper chamber **312**, a one or more cooling steam chambers **314**, a premixed H₂-O₂ injector array **316** and a one or more steam injectors **318**. Said burner tip main body **300** is configured to hold the parts of said burner tip **350** in place for safe and sustained operation. Said cooling steam inlet **508** is configured for receiving said cooling steam **220** from said cooling unit **104**. Said premixed H₂-O₂ inlet **304** is configured for receiving said premixed H₂-O₂ **226** from said hydrogen-oxygen handling unit **102**. Said insulating medium **306** configured for preventing heat loss of said cooling steam **220** and heat transfer between said cooling steam **220** and said premixed H₂-O₂ **226**. Said premixed H₂-O₂ receiving chamber **308** configured for receiving said premixed H₂-O₂ **226** from said premixed H₂-O₂ inlet **304**. Said sintered plate **310** is configured to act as a flame/flash-back arrestor to prevent damage to said burner tip **350** during flame/flash-back occurrence. Said premixed H₂-O₂ upper chamber **312** is configured for receiving said premixed H₂-O₂ **226** from said premixed H₂-O₂ receiving chamber **308**, after passing through said sintered plate **310** and stabilizing said premixed H₂-O₂ **226** gas pressure, and before being injected into said steam generation chamber **550**. Said one or more cooling steam chambers **314** is configured for receiving said cooling steam **220** from said cooling steam inlet **508**, and stabilizing a steam pressure of said cooling steam **220** before being injected into said steam generation chamber **550**. Said premixed H₂-O₂ injector array **316** is configured for injecting said premixed H₂-O₂ **226** into said steam generation chamber **550** for combustion. Said one or more steam injectors **318** is configured for injecting said cooling steam **220** into said steam generation chamber **550** for cooling a liner **502** on an inner pass **504**.

Said insulating medium **306** is liquid, solid or in gaseous phase, depending on the temperature of said cooling steam **220**.

Said premixed H₂-O₂ receiving chamber **308** contains a flow velocity equalizer medium **320** to attain a favorable velocity and pressure for the combustion process depending on the inlet pressure and velocity of said premixed H₂-O₂ **226** entering said premixed H₂-O₂ receiving chamber **308**.

Said sintered plate **310** is replaced with multiple sintered disks or sintered cylinders, or a combination of both, depending on the pressure of said premixed H₂-O₂ **226** and acceptable pressure loss at the sintered disk or cylinder.

Said premixed H₂-O₂ injector array **316** with injector size, arrangement and angle of inclination are optimized for the flowrate, velocity and pressure of said premixed H₂-O₂

226 at exit of said premixed H₂-O₂ injector array 316 to enhance combustion without flashbacks at various loading conditions.

Said one or more steam injectors 318 is inclined in such a way that it provides a steam film along said inner pass 504 side of said liner 502 of said steam generation chamber 550 which acts as a coolant to prevent thermal meltdown or other damages due to thermal stress during said premixed H₂-O₂ 226 combustion. The number of said one or more steam injectors 318 and angle of inclination is optimized for the flowrate, velocity and pressure of said cooling steam 220 exiting through the injectors. Provided adequate a HP-LT steam 222 is not available or more cooling is required for the inner surface of said liner 502, said cooling steam inlet 508 and said one or more steam injectors 318 of said burner tip 350 are configured to handle said increased-pressure water 228.

Said steam generator system 100 is configured to operate without said water source 116 which feeds said increased-pressure water 228 into said cooling unit 104. Said cooling unit 104 operates without a water flow controller 212, a high-pressure water pump 214 and a steam-water mixer 218. A cooling water inlet 512 and a water spray nozzle 514 in a steam generation chamber 550 are modified to accommodate a HP-LT steam 222.

Said steam generator system 100 is configured to operate without said steam source 118 which feeds said cooling steam 220 into said cooling unit 104. Said cooling unit 104 operates without a steam flow controller 216 and a steam-water mixer 218. A cooling steam inlet 508, a one or more cooling steam chambers 314 and a one or more steam injectors 318 at a burner tip 350 are configured to be modified to inject said increased-pressure water 228. Said cooling steam inlet 508, a steam injector ring 510, at a steam generation chamber 550 are configured to be modified to inject said increased-pressure water 228.

Said one or more H₂-O₂ steam generators 106 are configured to create said generated steam 108. Said steam generator system 100 is configured to increase efficiency, provided an absence of said steam source 118 in said steam generator system 100, to direct a portion of said generated steam 108 to said steam-water mixer 218 in said cooling unit 104 for reuse, said portion of said generated steam 108 is mixed with said increased-pressure water 228 to form a steam-water mist mixture 224, said steam-water mist mixture 224 is fed into said cooling steam inlet 508 of said burner tip 350 and said steam generation chamber 550 for cooling purposes.

Said steam source 118 comprises a high-pressure, low-temperature (HP-LT) steam created in a method selected among: an industrial process, a bleed steam from a steam or gas turbine cycle, or a steam generated by waste heat recovery. A portion of said steam source 118 is injecting into a steam-water mixer 218, where said increased-pressure water 228 is misted into a HP-LT steam 222 and then injected into said one or more H₂-O₂ steam generators 106. A method of burning H₂-O₂ 900 for creating a generated steam 108 comprising the following steps.

Receiving a hydrogen from a hydrogen source 110 into a hydrogen-oxygen handling unit 102 having a hydrogen mass flow controller 202, a H₂ flame/flash back arrestor, an oxygen mass flow controller 206, an oxygen flame flash back arrestor 208 and a H₂-O₂ mixer 210. Monitoring said hydrogen from said hydrogen source 110 with said hydrogen mass flow controller 202 for flow rate, temperature and pressure. Controlling desired flow rate of said hydrogen coming from said hydrogen source 110 with said hydrogen

mass flow controller 202 of said hydrogen-oxygen handling unit 102. Further a hydrogen flame flash back arrestor 204 is a safety device, helps in quenches the flame during a flame/flash-back occurrence in the hydrogen passage and preventing it from reaching said hydrogen source 110. From said H₂ flame/flash back arrestor, said hydrogen is feed into said H₂-O₂ mixer 210. Receiving an oxygen source 112 into said hydrogen-oxygen handling unit 102. Monitoring said oxygen from said oxygen source 112 with said oxygen mass flow controller 206 for flow rate, temperature and pressure. Controlling desired flow rate of said oxygen coming from said oxygen source 112 with said oxygen mass flow controller 206 of said hydrogen-oxygen handling unit 102. Further said oxygen flame flash back arrestor 208 is a safety device, helps in quenches the flame during a flame/flash-back occurrence in the oxygen passage and preventing it from reaching said oxygen source 112. From said oxygen flame flash back arrestor 208, said oxygen is feed into said H₂-O₂ mixer 210. Said H₂-O₂ mixer 210, receives said hydrogen from said H₂ flame/flash back arrestor and said oxygen from said oxygen flame flash back arrestor 208 and mixes in a stoichiometric ratio and feeds it into a premixed H₂-O₂ inlet 304 of a burner tip 350. Before and after operation of a steam generator system 100, nitrogen from a nitrogen source 114 is used to purge said hydrogen passage and said oxygen passage to ensure safe operation and prevent flame/flash back.

Delivering a premixed H₂-O₂ 226 into said premixed H₂-O₂ inlet 304 of said burner tip 350, wherein a steam generator comprises said burner tip 350, a steam generation chamber 550 and an ignition unit 524, and said burner tip 350 comprises said premixed H₂-O₂ inlet 304, an insulating medium 306, a premixed H₂-O₂ receiving chamber 308, a sintered plate 310 and a premixed H₂-O₂ upper chamber 312. Said premixed H₂-O₂ 226 passes into said premixed H₂-O₂ receiving chamber 308, and further pass through said sintered plate 310 into said premixed H₂-O₂ upper chamber 312. From which said premixed H₂-O₂ 226 is injected in to said steam generation chamber 550 through a premixed H₂-O₂ injector array 316.

Creating said increased-pressure water 228 and/or a cooling steam 220 with a cooling unit 104. Receiving a water from a water source 116 into a water flow controller 212 of said cooling unit 104. Receiving a steam from a steam source 118 into a steam flow controller 216 of said cooling unit 104. Regulating a flow rate of said water from said water source 116 with said water flow controller 212. Regulating a flow rate of said steam from said steam source 118 with said steam flow controller 216. Pressurizing said water from said water source 116 with said high-pressure water pump 214. Delivering a portion of said increased-pressure water 228 into said steam generator from said high-pressure water pump 214. Delivering a portion of said steam from said steam source 118 to said steam generator as a HP-LT steam 222. A portion of said increased-pressure water 228 and a portion of said steam from said steam source 118 enter a steam-water mixer 218, where it is mixed and send to said steam generator as said HP-LT steam 222.

Said HP-LT steam 222 and said increased-pressure water 228 received at a cooling steam inlet 508 and a cooling water inlet 512 respectively of said steam generation chamber 550 is injected into an inner pass 504 of said steam generation chamber 550 by optimally placing a steam injector ring 510 and a water spray nozzle 514 in such a way that the coolant is sprayed/injected uniformly in to the combustion resultant stream.

19

The sprayed/injected coolant and the combustion resultant stream exits said inner pass **504** through optimally placed a liner steam vent **516** into an outer pass **506** where it is mixes well and forms a uniformly mixed said HP-LT steam **222** and exits said steam generator system **100** through a steam exit vent **518**.

Injecting a portion of said cooling steam **220** into a one or more cooling steam inlets **302** of said burner tip **350**. Spraying a portion of said cooling steam **220** out of a one or more steam injectors **318** of said burner tip **350**. Configuring said one or more steam injectors **318** at an angle in such a way that it forms a steam film along the inner surface of a liner **502** of said steam generation chamber **550**. Cooling a portion of said steam generation chamber **550** with said steam film and/or said cooling steam **220** as a cooling medium for said liner **502**. A cooling steam inlet **508** and steam injector of said burner tip **350** are configured to handle said increased-pressure water **228** if adequate said HP-LT steam **222** is not available or more cooling is required for the inner surface of said liner **502**.

Igniting said premixed H₂-O₂ **226** with ignited located on a front end **526** of an inner pass **504** of said steam generation chamber **550**.

Mixing said oxygen with said hydrogen in said H₂-O₂ mixer **210** at stoichiometry ratio. A premixed H₂-O₂ injector array **316** with injector size, arrangement and angle of inclination are optimized for the flowrate, velocity and pressure of a premixed H₂-O₂ **226** at exit of said premixed H₂-O₂ injector array **316** to enhance combustion without flashbacks at various loading conditions. A sintered plate **310** being replaced with multiple sintered disks or sintered cylinders, or a combination of both, depending on the pressure of incoming said premixed H₂-O₂ **226** and acceptable pressure loss at the sintered disk or cylinder. A premixed H₂-O₂ receiving chamber **308** can contain a flow velocity equalizer medium **320** configured to adjust an inlet pressure and velocity of said premixed H₂-O₂ **226** entering said premixed H₂-O₂ receiving chamber **308** to attain a favorable velocity and pressure for the combustion process. Said flow velocity equalizer medium **320** being selected from among small spherical balls or glass wool. An insulating medium **306** are liquid, solid or in gaseous phase, depending on the temperature of a cooling steam **220**. A premixed H₂-O₂ upper chamber **312** receiving said premixed H₂-O₂ **226** from said premixed H₂-O₂ receiving chamber **308** after passing through said sintered plate **310** and stabilizing said premixed H₂-O₂ **226** gas pressure before being injected into a steam generation chamber **550**. A one or more cooling steam chambers **314** configured for receiving a HP-LT steam **222** from a cooling steam inlet **508** and stabilizing the steam pressure before being injected into said steam generation chamber **550**.

A control unit **120** receives input signals and data from various components of the system, processes it, and controls various instruments in the system.

Said generated steam **108** has minimal residual from combustion and is free from harmful, polluting greenhouse gases and are used in power generation, in locomotive for propulsion and in combined heat and power generation.

Various changes in the details of the illustrated operational methods are possible without departing from the scope of the following claims. Some embodiments may combine the activities described herein as being separate steps. Similarly, one or more of the described steps may be omitted, depending upon the specific operational environment the method is being implemented in. It is to be understood that the above description is intended to be

20

illustrative, and not restrictive. For example, the above-described embodiments may be used in combination with each other. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms “including” and “in which” are used as the plain-English equivalents of the respective terms “comprising” and “wherein.”

The invention claimed is:

1. A steam generator system configured to burn hydrogen and oxygen at stoichiometry along with an increased-pressure water and a steam, wherein:

said steam generator system comprise a hydrogen source, an oxygen source, a nitrogen source, a water source, a steam source, a hydrogen-oxygen handling unit, a cooling unit, a one or more H₂-O₂ steam generators and a control unit;

said steam generator system is configured to provide said hydrogen source to said hydrogen-oxygen handling unit through an oxygen passage, said oxygen source to said hydrogen-oxygen handling unit through a hydrogen passage, and said nitrogen source to selectively purge said oxygen passage and said hydrogen passage; said water source provide water to said cooling unit; said cooling unit is configured to receive said water source and said steam source;

said hydrogen-oxygen handling unit is configured to blend portions of said hydrogen source and said oxygen source into a premixed H₂-O₂, and to selectively send portions of said premixed H₂-O₂ to said one or more H₂-O₂ steam generators; said cooling unit is configured to receive and process said water source and said steam source into a cooling steam and said increased-pressure water, and to selectively send said cooling steam and said increased-pressure water to said one or more H₂-O₂ steam generators;

said premixed H₂-O₂ is at stoichiometry;

said one or more H₂-O₂ steam generators is configured to burn said premixed H₂-O₂, and to cool said one or more H₂-O₂ steam generators with said cooling steam and said increased-pressure water and thereby to generate a generated steam; and said control unit receives input signals and data from various components of said steam generator system, processes it, and controls various instruments in the system.

2. The steam generator system from claim 1, wherein: said hydrogen source comprising hydrogen in liquid phase or gaseous phase stored in a one or more containers selected among: gas cylinders, and metal hydrides;

where said hydrogen source comprises liquid or low-pressure hydrogen, said steam generator system further comprises a hydrogen vaporizer and a hydrogen pump respectively used to produce gaseous hydrogen at the necessary pressure for operation before it enters said hydrogen-oxygen handling unit;

said hydrogen source comprises an industrial grade, with some impurities are accommodated depending on the final temperature, pressure, quality and usage of the steam generated by said steam generator system.

21

3. The steam generator system from claim 1, wherein:
 said oxygen source having oxygen in gaseous phase or
 liquid phase stored under pressure in one or more
 containers such as a gas cylinders;
 where said oxygen source comprises of liquid or gaseous
 oxygen, said steam generator system further comprises
 an oxygen vaporizer and an oxygen pump respectively,
 wherein;
 said oxygen vaporizer and said oxygen pump are used to
 produce gaseous oxygen at the necessary pressure for
 operation before it enters said hydrogen-oxygen han-
 dling unit; and
 a purity of said oxygen are of industrial grade with some
 impurities depending on the final temperature, pres-
 sure, quality and usage of the steam generated by said
 steam generator system.

4. The steam generator system from claim 1, wherein:
 said nitrogen source having nitrogen in gaseous phase
 stored under pressure in gas cylinders, or other con-
 tainers; and
 said nitrogen source provides nitrogen under pressure to
 purge the hydrogen and oxygen conduit before and
 after operation of said steam generator system.

5. The steam generator system from claim 4, wherein:
 said nitrogen source is replaced with an inert gas.

6. The steam generator system from claim 1, wherein:
 said water source is de-mineralized water comprising
 added chemicals to prevent rusting in said steam gen-
 erator system.

7. The steam generator system from claim 1, wherein:
 said steam source comprises a steam for use in said
 cooling unit.

8. The steam generator system from claim 1, wherein:
 said hydrogen-oxygen handling unit comprise a hydrogen
 mass flow controller, a hydrogen flame flash back
 arrestor, an oxygen mass flow controller, an oxygen
 flame flash back arrestor, a H₂-O₂ mixer;
 said hydrogen mass flow controller is configured to
 receive said hydrogen source and regulating its flow;
 said hydrogen flame flash back arrestor is configured to
 quench a flame during a flame/flash-back occurrence
 and preventing it from reaching said hydrogen source;
 said oxygen mass flow controller receives said oxygen
 source and regulating its flow;
 said oxygen flame flash back arrestor is configured to
 quench a flame during a flame/flash-back occurrence
 and preventing it from reaching said oxygen source;
 and
 said H₂-O₂ mixer is configured to
 receive said hydrogen source from said hydrogen mass
 flow controller and said oxygen source from said
 oxygen mass flow controller,
 uniformly mix said hydrogen source and said oxygen
 source at stoichiometry into said premixed H₂-O₂,
 and
 send said premixed H₂-O₂ to said one or more H₂-O₂
 steam generators.

9. The steam generator system from claim 1, wherein:
 said one or more H₂-O₂ steam generators comprise a
 burner tip and a steam generation chamber;
 said burner tip is configured to receive
 said premixed H₂-O₂ from said hydrogen-oxygen han-
 dling unit,
 said increased-pressure water from said cooling unit,
 and
 said cooling steam from said cooling unit; and

22

said steam generation chamber is configured to combust
 said premixed H₂-O₂ and mix said cooling steam
 and/or said increased-pressure water to create said
 generated steam at a desired temperature and pressure.

10. The steam generator system from claim 9, wherein:
 said steam generation chamber comprising a burner tip
 mounting frame, a liner, an inner pass, an outer pass, a
 cooling steam inlet, a steam injector ring, a cooling
 water inlet, a water spray nozzle, a liner steam vent, a
 steam exit vent, and an ignition unit;
 said burner tip mounting frame is configured for mounting
 said burner tip and said ignition unit into said steam
 generation chamber;
 said liner which divides the hollow interior of said steam
 generation chamber into two passes;
 said inner pass at which the combustion of said premixed
 H₂-O₂ occurs and said increased-pressure water and/or
 a steam-water mist mixture are injected;
 said outer pass at which the combustion product of said
 premixed H₂-O₂ combustion and the coolant (water or
 steam or both) mix to form said generated steam at
 desired temperature;
 said cooling steam inlet is configured for receiving said
 cooling steam from said cooling unit;
 said steam injector ring is configured for injecting said
 cooling steam;
 said cooling water inlet is configured for receiving said
 increased-pressure water from said cooling unit;
 said water spray nozzle is configured for injecting said
 increased-pressure water;
 said liner steam vent is configured to allow a mixture of
 steam to pass from said inner pass to said outer pass;
 said steam exit vent is configured to selectively vent said
 generated steam out of said steam generation chamber;
 and
 said ignition unit configured to ignite said premixed
 H₂-O₂ at said inner pass.

11. The steam generator system from claim 9, wherein:
 said steam generator system is configured with a size and
 number of a liner steam vent to optimize a flowrate of
 hydrogen, oxygen and coolant, as well as the rated
 operating pressure inside said steam generation cham-
 ber.

12. The steam generator system from claim 9, wherein:
 a steam injector ring is configured to inject said cooling
 steam into an inner pass using a series of ports in a ring
 structure attached to a liner of said inner pass; and
 the number of ring structures and ports in the ring
 structures are optimized for the flow rate and pressure
 of said cooling steam from said cooling unit.

13. The steam generator system from claim 9, wherein:
 placement of a cooling steam inlet, a steam injector ring,
 a cooling water inlet, a water spray nozzle, a liner steam
 vent, and a steam exit vent to get maximum thermal
 efficiency with reduced pressure losses and hot spots
 depends on
 the flowrate of said premixed H₂-O₂, said cooling steam,
 and said cooling steam, and
 the rated maximum operating temperature and pressure of
 said generated steam.

14. The steam generator system from claim 9, wherein:
 a liner comprises a heat conductor configured to distribute
 the heat over its surface area to avoid hot spots during
 the combustion process.

15. The steam generator system from claim 9, wherein:
 said burner tip comprising a burner tip main body, a
 cooling steam inlet, a premixed H₂-O₂ inlet, an insu-

23

lating medium, a premixed H₂-O₂ receiving chamber, a sintered plate, a premixed H₂-O₂ upper chamber, a one or more cooling steam chambers, a premixed H₂-O₂ injector array and a one or more steam injectors; said burner tip main body is configured to hold the parts of said burner tip in place for safe and sustained operation; said cooling steam inlet is configured for receiving said cooling steam from said cooling unit; said premixed H₂-O₂ inlet is configured for receiving said premixed H₂-O₂ from said hydrogen-oxygen handling unit; said insulating medium configured for preventing heat loss of said cooling steam and heat transfer between said cooling steam and said premixed H₂-O₂; said premixed H₂-O₂ receiving chamber configured for receiving said premixed H₂-O₂ from said premixed H₂-O₂ inlet; said sintered plate is configured to act as a flame/flash-back arrestor to prevent damage to said burner tip during flame/flash-back occurrence; said premixed H₂-O₂ upper chamber is configured for receiving said premixed H₂-O₂ from said premixed H₂-O₂ receiving chamber, after passing through said sintered plate and stabilizing said premixed H₂-O₂ gas pressure, and before being injected into said steam generation chamber; said one or more cooling steam chambers is configured for receiving said cooling steam from said cooling steam inlet, and stabilizing a steam pressure of said cooling steam before being injected into said steam generation chamber; said premixed H₂-O₂ injector array is configured for injecting said premixed H₂-O₂ into said steam generation chamber for combustion; and said one or more steam injectors is configured for injecting said cooling steam into said steam generation chamber for cooling a liner on an inner pass.

16. The steam generator system from claim 15, wherein: said insulating medium is liquid, solid or in gaseous phase, depending on the temperature of said cooling steam.

17. The steam generator system from claim 15, wherein: said premixed H₂-O₂ receiving chamber contains a flow velocity equalizer medium to attain a favorable velocity and pressure for the combustion process depending on the inlet pressure and velocity of said premixed H₂-O₂ entering said premixed H₂-O₂ receiving chamber.

18. The steam generator system from claim 15, wherein: said premixed H₂-O₂ injector array with injector size, arrangement and angle of inclination are optimized for the flowrate, velocity and pressure of said premixed H₂-O₂ at exit of said premixed H₂-O₂ injector array to enhance combustion without flashbacks at various loading conditions.

19. The steam generator system from claim 15, wherein: said one or more steam injectors is inclined in such a way that it provides a steam film along said inner pass side of said liner of said steam generation chamber which acts as a coolant to prevent thermal meltdown or other damages due to thermal stress during said premixed H₂-O₂ combustion;

24

the number of said one or more steam injectors and angle of inclination is optimized for the flowrate, velocity and pressure of said cooling steam exiting through the injectors; and provided adequate amounts of said steam is not available or more cooling is required for the inner surface of said liner, said cooling steam inlet and said one or more steam injectors of said burner tip are configured to handle said increased-pressure water.

20. The steam generator system from claim 1, wherein: said steam generator system is configured to operate without said water source which feeds said increased-pressure water into said cooling unit; said cooling unit operates without a water flow controller, a high-pressure water pump and a steam-water mixer; and a cooling water inlet and a water spray nozzle in a steam generation chamber are modified to accommodate said steam.

21. The steam generator system from claim 1, wherein: said steam generator system is configured to operate without said steam source which feeds said cooling steam into said cooling unit; said cooling unit operates without a steam flow controller and a steam-water mixer; a cooling steam inlet, a one or more cooling steam chambers and a one or more steam injectors at a burner tip are configured to be modified to inject said increased-pressure water; and said cooling steam inlet, a steam injector ring, at a steam generation chamber are configured to be modified to inject said increased-pressure water.

22. The steam generator system from claim 21, wherein: said one or more H₂-O₂ steam generators are configured to create said generated steam; and said steam generator system is configured to increase efficiency, provided an absence of said steam source in said steam generator system, to direct a portion of said generated steam to said steam-water mixer in said cooling unit for reuse, said portion of said generated steam is mixed with said increased-pressure water to form a steam-water mist mixture, said steam-water mist mixture is fed into said cooling steam inlet of said burner tip and said steam generation chamber for cooling purposes.

23. The steam generator system from claim 1, wherein: said steam source supplies a steam created in a method selected among: an industrial process, a bleed steam from a steam or gas turbine cycle, or a steam generated by waste heat recovery; and a portion of said steam source is injecting into a steam-water mixer, where said high increased-pressure water is misted into said steam and then injected into said one or more H₂-O₂ steam generators.

24. A method of burning H₂-O₂ for creating a generated steam comprising the following steps: receiving a hydrogen from a hydrogen source into a hydrogen-oxygen handling unit having a hydrogen mass flow controller, a H₂ flame/flash back arrestor, an oxygen mass flow controller, an oxygen flame flash back arrestor and a H₂-O₂ mixer; monitoring said hydrogen from said hydrogen source with said hydrogen mass flow controller for flow rate, temperature and pressure;

25

controlling desired flow rate of said hydrogen coming from said hydrogen source with said hydrogen mass flow controller of said hydrogen-oxygen handling unit; further a hydrogen flame flash back arrestor is a safety device, helps in quenches the flame during a flame/flash-back occurrence in the hydrogen passage and preventing it from reaching said hydrogen source; from said H2 flame/flash back arrestor, said hydrogen is feed into said H2-O2 mixer; receiving an oxygen source into said hydrogen-oxygen handling unit; monitoring said oxygen from said oxygen source with said oxygen mass flow controller for flow rate, temperature and pressure; controlling desired flow rate of said oxygen coming from said oxygen source with said oxygen mass flow controller of said hydrogen-oxygen handling unit; further said oxygen flame flash back arrestor is a safety device, helps in quenches the flame during a flame/flash-back occurrence in the oxygen passage and preventing it from reaching said oxygen source; from said oxygen flame flash back arrestor, said oxygen is feed into said H2-O2 mixer; said H2-O2 mixer, receives said hydrogen from said H2 flame/flash back arrestor and said oxygen from said oxygen flame flash back arrestor and mixes in a stoichiometric ratio and feeds it into a premixed H2-O2 inlet of a burner tip; and before and after operation of a steam generator system, nitrogen from a nitrogen source is used to purge said hydrogen passage and said oxygen passage to ensure safe operation and prevent flame/flash back.

25. The method of burning H2-O2 from claim **24**, wherein:

delivering a premixed H2-O2 into said premixed H2-O2 inlet of said burner tip, wherein

a steam generator comprises said burner tip, a steam generation chamber and an ignition unit, and said burner tip comprises said premixed H2-O2 inlet, an insulating medium, a premixed H2-O2 receiving chamber, a sintered plate and a premixed H2-O2 upper chamber;

said premixed H2-O2 passes into said premixed H2-O2 receiving chamber, and further pass through said sintered plate into said premixed H2-O2 upper chamber; and from which said premixed H2-O2 is injected in to said steam generation chamber through a premixed H2-O2 injector array.

26. The method of burning H2-O2 from claim **25**, wherein:

providing a water and/or a steam from a cooling unit, wherein:

receiving a water from a water source into a water flow controller of said cooling unit;

receiving a steam from a steam source into a steam flow controller of said cooling unit;

regulating a flow rate of said water from said water source with said water flow controller;

regulating a flow rate of said steam from said steam source with said steam flow controller;

pressurizing said water into an increased-pressure water from said water source with a high-pressure water pump;

delivering a portion of said increased-pressure water into said steam generator from said high-pressure water pump;

26

delivering a portion of said steam from said steam source to said steam generator; and

a portion of said increased-pressure water and a portion of said steam from said steam source enter a steam-water mixer, where they are mixed and sent to said steam generator as said steam.

27. The method of burning H2-O2 from claim **26**, wherein:

said steam and said increased-pressure water are received at a cooling steam inlet and a cooling water inlet respectively of said steam generation chamber and are injected into an inner pass of said steam generation chamber by optimally placing a steam injector ring and a water spray nozzle in such a way that said steam and increased-pressure water are injected uniformly in to the combustion resultant stream.

28. The method of burning H2-O2 from claim **27**, wherein:

the sprayed/injected coolant and the combustion resultant stream exits said inner pass through optimally placed a liner steam vent into an outer pass where it is mixes well and forms a uniformly mixed said steam and exits said steam generator system through a steam exit vent.

29. The method of burning H2-O2 from claim **26**, wherein:

injecting a portion of said cooling steam into a one or more cooling steam inlets of said burner tip;

spraying a portion of said cooling steam out of a one or more steam injectors of said burner tip;

configuring said one or more steam injectors at an angle in such a way that it forms a steam film along the inner surface of a liner of said steam generation chamber;

cooling a portion of said steam generation chamber with said steam film and/or said cooling steam as a cooling medium for said liner; and

a cooling steam inlet and steam injector of said burner tip are configured to handle said increased-pressure water and said steam if cooling is required for the inner surface of said liner.

30. The method of burning H2-O2 from claim **25**, wherein:

igniting said premixed H2-O2 with ignited located on a front end of an inner pass of said steam generation chamber.

31. The method of burning H2-O2 from claim **24**, wherein:

mixing said oxygen with said hydrogen in said H2-O2 mixer at stoichiometry ratio;

a premixed H2-O2 injector array with injector size, arrangement and angle of inclination are optimized for the flowrate, velocity and pressure of a premixed H2-O2 at exit of said premixed H2-O2 injector array to enhance combustion without flashbacks at various loading conditions;

a premixed H2-O2 receiving chamber can contain a flow velocity equalizer medium configured to adjust an inlet pressure and velocity of said premixed H2-O2 entering said premixed H2-O2 receiving chamber to attain a favorable velocity and pressure for the combustion process;

said flow velocity equalizer medium being selected from among small spherical balls or glass wool;

an insulating medium are liquid, solid or in gaseous phase, depending on the temperature of a cooling steam;

a premixed H2-O2 upper chamber receiving said premixed H2-O2 from said premixed H2-O2 receiving

27

chamber after passing through said sintered plate and
stabilizing said premixed H₂-O₂ gas pressure before
being injected into a steam generation chamber; and
a one or more cooling steam chambers configured for
receiving a steam from a cooling steam inlet and 5
stabilizing the steam pressure before being injected into
said steam generation chamber.

32. The method of burning H₂-O₂ from claim **31**,
wherein:

a control unit receives input signals and data from various 10
components of the system, processes it, and controls
various instruments in the system.

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28