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Partheepan

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(54) **HYDROGEN HYBRID CYCLE SYSTEM**

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F02C 3/22 (2006.01)
F02C 1/00 (2006.01)
F02C 3/24 (2006.01)

(52) **U.S. Cl.**
CPC ***F02C 3/22*** (2013.01); ***F02C 1/00*** (2013.01); ***F02C 3/24*** (2013.01)

(58) **Field of Classification Search**
CPC F02C 3/20; F02C 3/22; F02C 3/24; F02C 3/30; F02C 1/00
See application file for complete search history.

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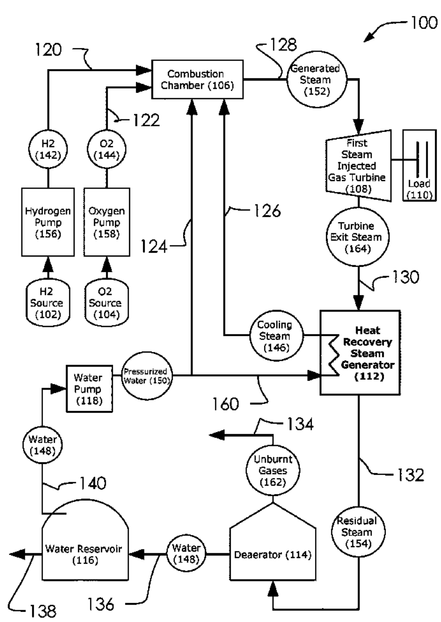
(57) **ABSTRACT**

A hydrogen hybrid cycle system configured to convert heat into mechanical work by burning a H2 and an O2. The hydrogen hybrid cycle system comprises a H2 source, an O2 source, a combustion chamber, a first steam injected gas turbine, a load, a heat recovery steam generator and a water pump. The H2 source provides the H2 to the combustion chamber. The O2 source provides the O2 to the combustion chamber. The combustion chamber burns portions of the H2 and the O2. The hydrogen hybrid cycle system burns the H2 and the O2 at or near stoichiometry in the combustion chamber. The hydrogen hybrid cycle system cools the combustion chamber with at least one of a cooling steam and a water.

19 Claims, 5 Drawing Sheets



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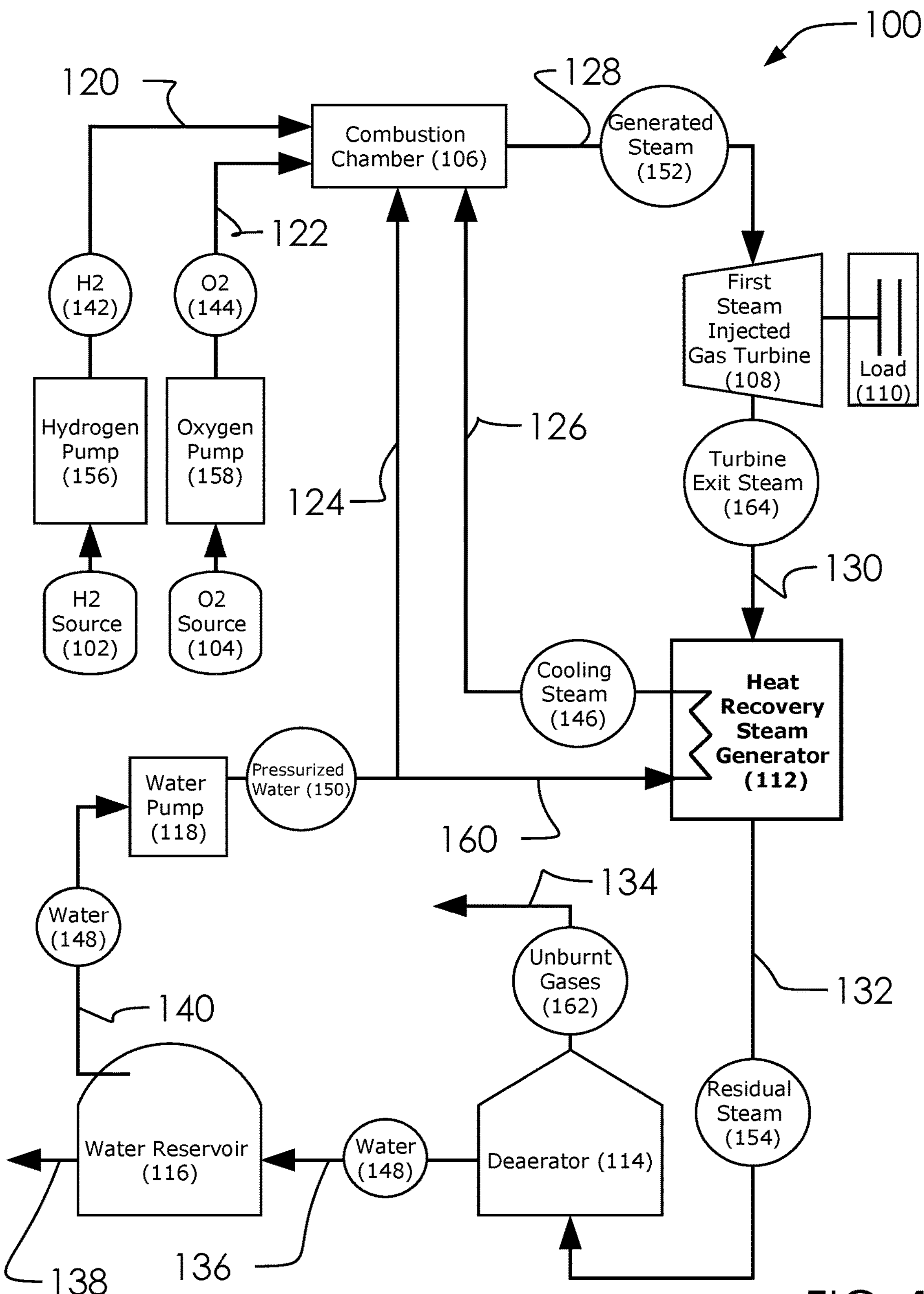
100
120
128
Combustion Chamber (106)
Generated Steam (152)
122
H2 (142)
O2 (144)
First Steam Injected Gas Turbine (108)
Load (110)
Hydrogen Pump (156)
Oxygen Pump (158)
126
124
Turbine Exit Steam (164)
H2 Source (102)
O2 Source (104)
130
Cooling Steam (146)
Heat Recovery Steam Generator (112)
Water Pump (118)
Pressurized Water (150)
160
134
Water (148)
Unburnt Gases (162)
140
132
Residual Steam (154)
Water Reservoir (116)
Water (148)
Deaerator (114)
138
136

FIG. 1

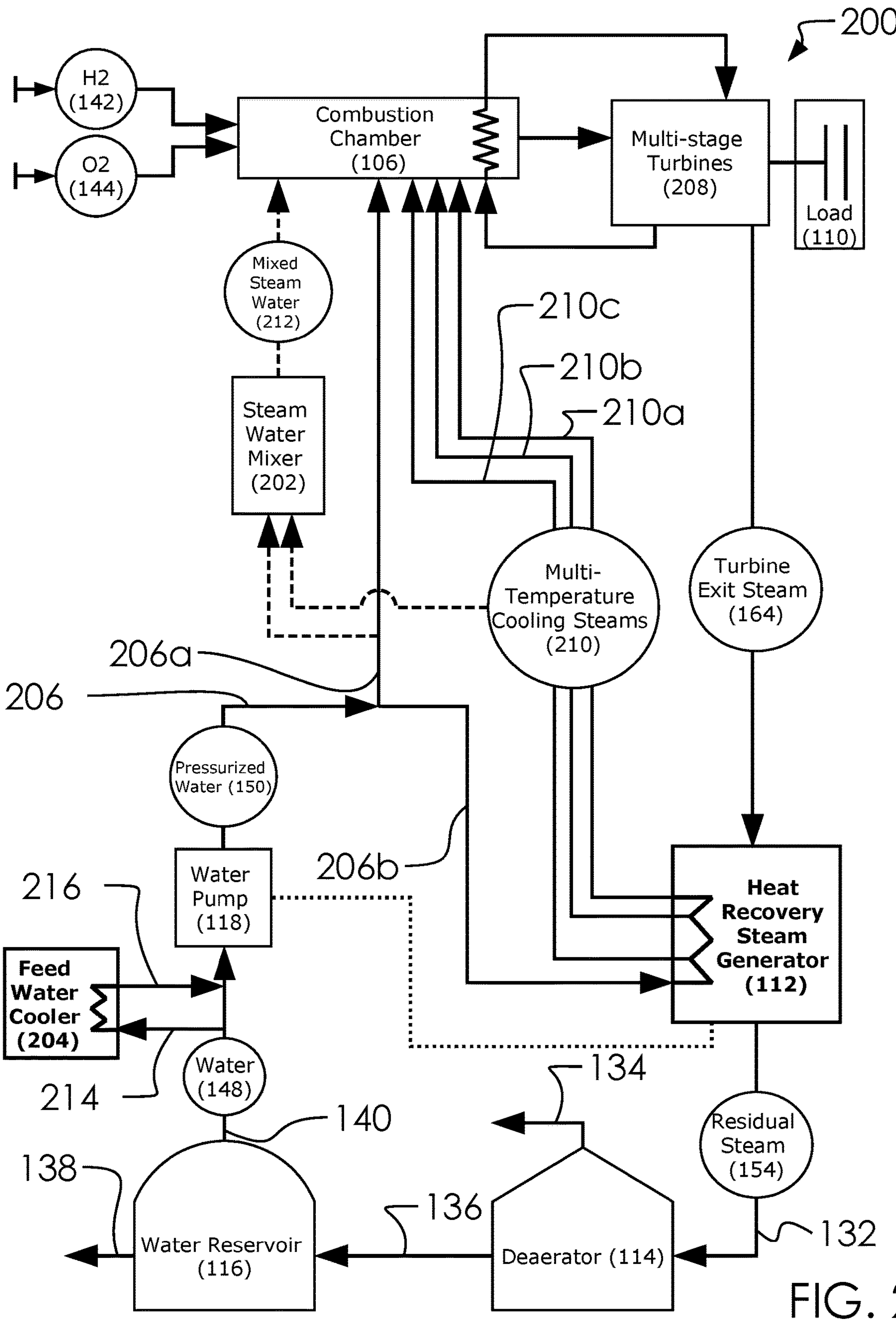
200
H2 (142)
O2 (144)
Combustion Chamber (106)
Multi-stage Turbines (208)
Load (110)
Mixed Steam Water (212)
Steam Water Mixer (202)
210c
210b
210a
Multi-Temperature Cooling Steams (210)
Turbine Exit Steam (164)
206a
206
Pressurized Water (150)
Water Pump (118)
206b
216
Feed Water Cooler (204)
Heat Recovery Steam Generator (112)
214
Water (148)
140
134
138
Residual Steam (154)
136
132
Water Reservoir (116)
Deaerator (114)

FIG. 2

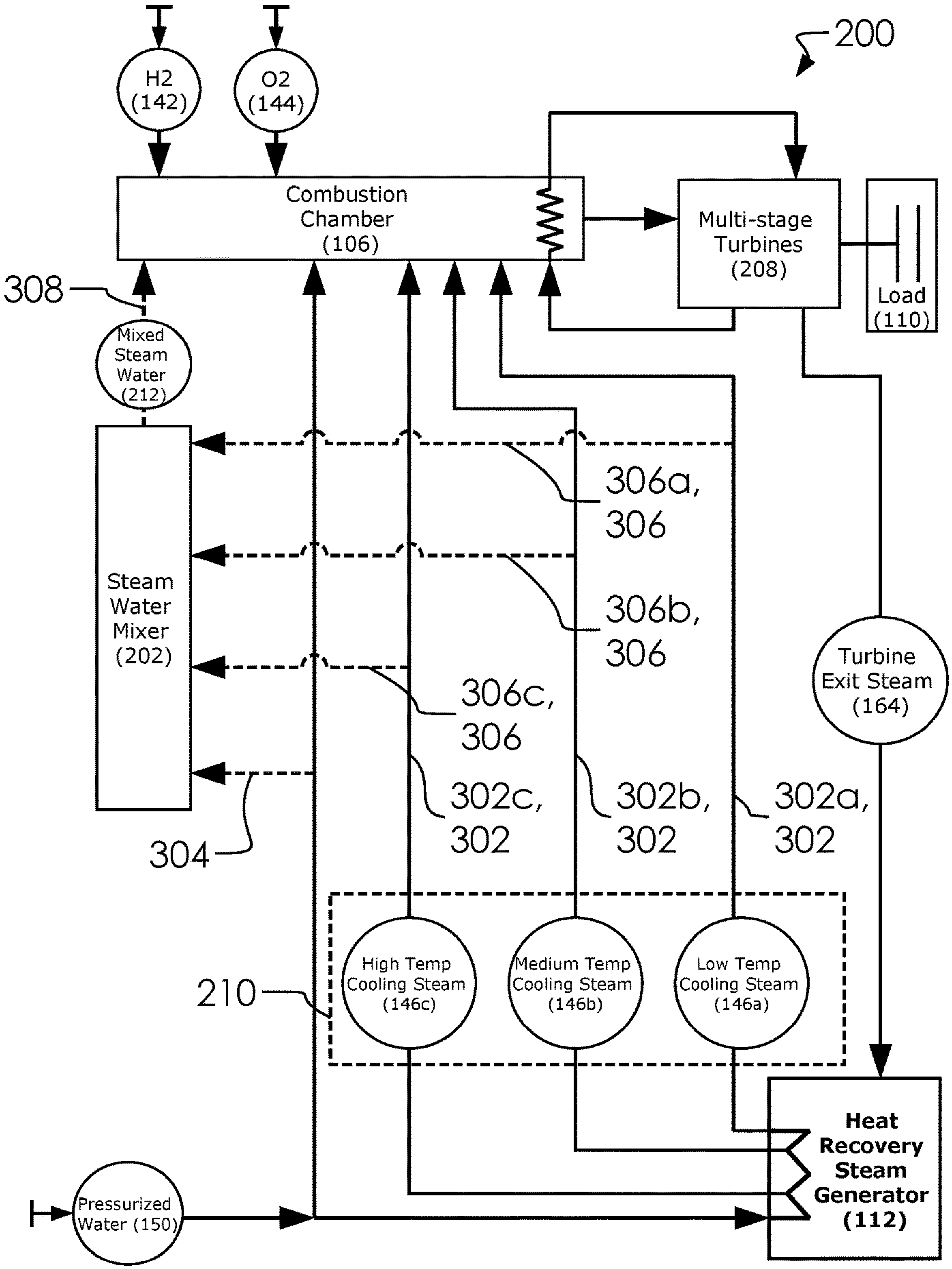
200
H2 (142)
O2 (144)
Combustion Chamber (106)
Multi-stage Turbines (208)
Load (110)
308
Mixed Steam Water (212)
Steam Water Mixer (202)
306a, 306
306b, 306
306c, 306
Turbine Exit Steam (164)
304
302c, 302
302b, 302
302a, 302
210
High Temp Cooling Steam (146c)
Medium Temp Cooling Steam (146b)
Low Temp Cooling Steam (146a)
Pressurized Water (150)
Heat Recovery Steam Generator (112)

FIG. 3

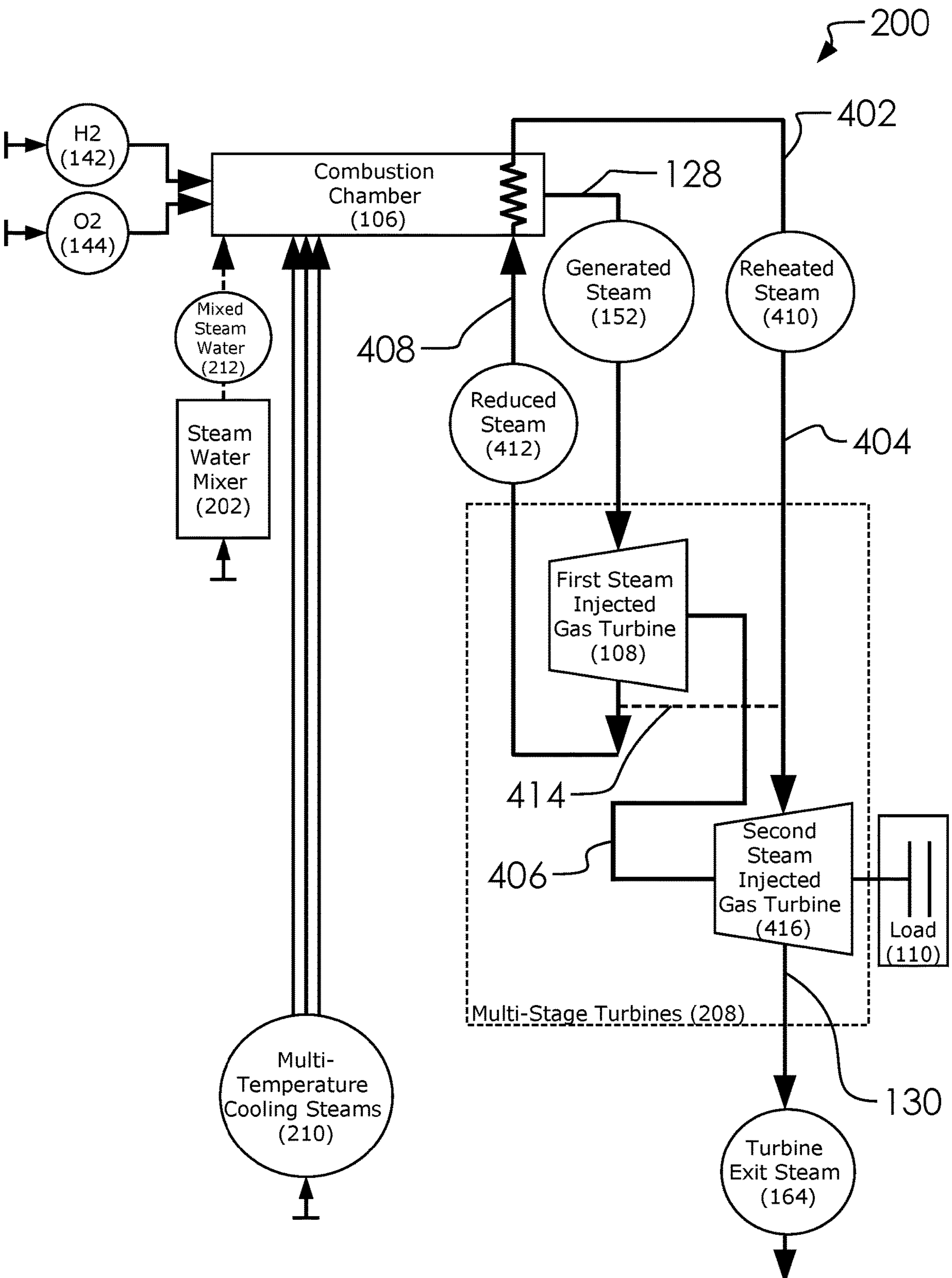
200
402
H2
(142)
O2
(144)
Combustion
Chamber
(106)
128
Generated
Steam
(152)
Reheated
Steam
(410)
Mixed
Steam
Water
(212)
408
Reduced
Steam
(412)
404
Steam
Water
Mixer
(202)
First Steam
Injected
Gas Turbine
(108)
414
406
Second
Steam
Injected
Gas Turbine
(416)
Load
(110)
Multi-Stage Turbines (208)
130
Multi-
Temperature
Cooling Steams
(210)
Turbine
Exit Steam
(164)

FIG. 4

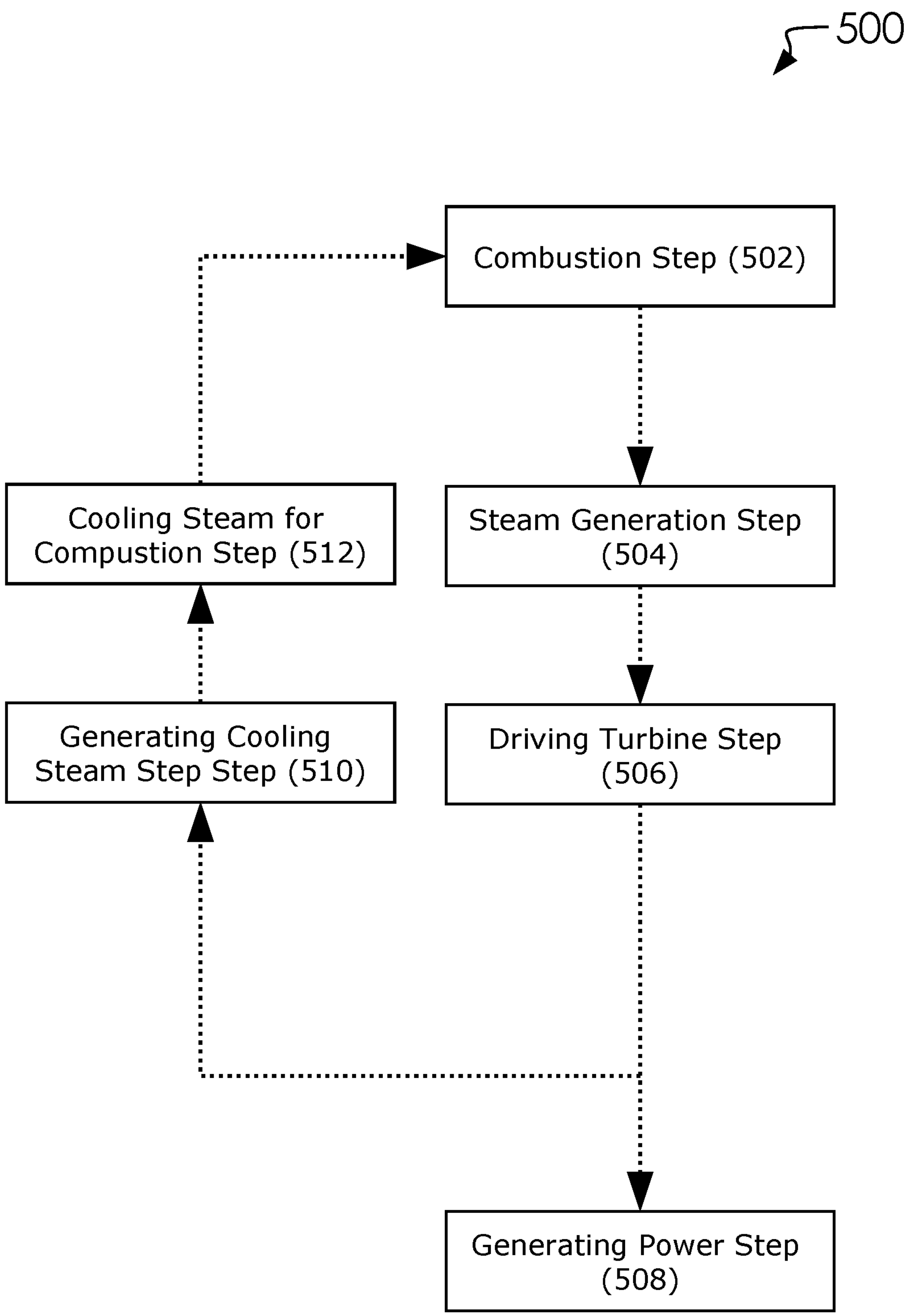
500
Combustion Step (502)
Cooling Steam for Compustion Step (512)
Steam Generation Step (504)
Generating Cooling Steam Step Step (510)
Driving Turbine Step (506)
Generating Power Step (508)

FIG. 5

HYDROGEN HYBRID CYCLE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims benefit to U.S. patent application Ser. No. 14/763,467 filed on 2015 Jul. 24, 62/540,348 filed on 2017 Aug. 2, 62/542,786 filed on Aug. 8 2017, PCT/US18/45881 filed 2018 Aug. 8 and 16787008 filed 2020 Feb. 10. All parent applications are hereby incorporated by reference.

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 present invention is a system for burning hydrogen (H2) and oxygen (O2) to provide power or propulsion. It can comprise a system that operates in a closed loop by combustion hydrogen at stoichiometry or near stoichiometry to produce steam. Steam drives a turbine to convert the heat energy into mechanical energy which can be used for useful work. In specific configurations, the invention allows for operation at various pressures, temperatures and load efficiently, making the system a flexible, economical, and pollution-free power generation source for electric utilities and large-scale locomotives.

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

Hydrogen is not often used in a combustion process for energy conversion, but rather used in fuel cells to produce electrical energy. Hydrogen fuel cells are efficient, but expensive, and sensitive to load fluctuations, operational environment, and fuel impurities. Hydrogen combustion for power generation can be an alternative to fuel cells, but the key challenges with hydrogen combustion for energy conversion are to ensure operational safety of the process and to reduce its complexity and cost.

Combustion of said H2 and said O2 at stoichiometry produces a high-temperature flame which results in steam and unburnt gasses. This unique property of hydrogen oxygen combustion can be used to generate steam by mixing the hot combustion resultant with said water or steam to regulate the resultant steam temperature as desired.

A device which burns H2 and/or 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 said 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.

Several thermodynamic cycle models were proposed after the invention of hydrogen-oxygen combustion-based steam generators. Models of H2 and/or O2 combustion for power generation are disclosed in U.S. Pat. Nos. 3,459,953, 4,148,185, 5,331,806, 5,644,911, 5,687,559, 5,775,091, 5,782,081, 5,809,768, 6,021,569, 6,263,568 B1, 6,282,883 B1, 7,546,732 B2, 8,169,101 B2, 20050223711 A1, 20043435 A1, 20314878 A1, 20175638 A1. However, the current patent application presents a different and unique design.

Further, these references are cited in the examination of the parent application: Uematsu U.S. Pat. No. 5,809,768 in view of Huber U.S. Pat. No. 5,644,911; Knapp 2006/0185347; Pronske 2011/0126549; and Sato U.S. Pat. No. 5,687,559.

Uematsu, ’768, describes a hydrogen hybrid cycle system configured to convert heat into mechanical work by burning a H2 and an O2. The hydrogen hybrid cycle system comprises a H2 source, an O2 source, a combustion chamber, a first steam injected gas turbine, a load, a heat recovery steam generator and a water pump. Sato, ’559, describes about a hydrogen-oxygen combustion turbine plant having an improved thermal efficiency and capable of being designed in a flexible manner. The plant consist of a compressor, a water injection device, a condenser, a gas turbine, a Second turbine, a third turbine and the combustion chamber.

Comparing these references highlights the advancements of the current system. Uematsu does not use a steam compressor whereas Sato uses a steam compressor. Uematsu uses a gas turbine assembly which might have multiple stage and multiple axis, whereas Sato uses a gas turbine which might have multiple stage and multiple axis and additionally uses two more gas turbine. Likewise, Uematsu uses one heat recovery steam generator, which can extract the heat from the gas turbine exhaust and generate cooling steam, whereas Sato refers to multiple heat exchanger catering to different turbine assembly.

Unlike Uematsu and Sato, the current system does not compress fluids between points. Uematsu uses a compressor instead of using steam in the turbine set. Steam compressors are not thermodynamically efficient. As is known in the art, gas systems require air to be compressed. The current system, however, eliminates a compressor and sees up to a 100% jump in efficiency. The claims of this continuation call on this distinction to differentiate itself from the prior art.

For reasons outlined below, these references are not seen whether taken singularly or in combination, to describe the instant disclosure as claimed.

BRIEF SUMMARY OF THE INVENTION

A hydrogen hybrid cycle system configured to convert heat into mechanical work by burning a H2 and an O2. Said hydrogen hybrid cycle system comprises a H2 source, an O2 source, a combustion chamber, a first steam injected gas turbine, a load, a heat recovery steam generator and a water pump. Said H2 source provides said H2 to said combustion chamber. Said O2 source provides said O2 to said combustion chamber. Said combustion chamber burns portions of said H2 and said O2. Said hydrogen hybrid cycle system burns said H2 and said O2 at or near stoichiometry in said combustion chamber. Said hydrogen hybrid cycle system cools said combustion chamber with at least one of a cooling steam and a water. Said combustion chamber creates a generated steam. Said generated steam turns said first steam injected gas turbine. Said first steam injected gas turbine is coupled said load.

A power generation method for producing useful work through said hydrogen hybrid cycle system includes following stages, or components: a combustion step, a steam generation step, a driving turbine step, a generating power step, a generating cooling steam step and a cooling stream for combustion step. Said combustion step comprises receiving said H2 in said combustion chamber, receiving said O2 in said combustion chamber, and burning portions of said H2 and said O2 in said combustion chamber. Said steam generation step comprises cooling said combustion chamber with said cooling steam and said water, and generating said generated steam. Said driving turbine step comprises driving said first steam injected gas turbine with said generated steam. Said generating power step comprises generating said cooling steam with said heat recovery steam generator, and delivering said cooling steam from said heat recovery steam generator to said combustion chamber through one or more cooling steam passages. Said generating cooling steam step comprises cooling said combustion chamber with said cooling steam. Said hydrogen hybrid cycle system comprises said H2 source, said O2 source, said combustion chamber, said first steam injected gas turbine, said heat recovery steam generator, said water pump, and said load. Said H2 source provides said H2 to said combustion chamber. Said O2 source provides said O2 to said combustion chamber. Said combustion chamber burns portions of said H2 and said O2. Said hydrogen hybrid cycle system burns said H2 and said O2 at or near stoichiometry in said combustion chamber. Said hydrogen hybrid cycle system cools said combustion chamber with said cooling steam and said water. Said combustion chamber creates said generated steam. Said first steam injected gas turbine is coupled with said load. Said combustion chamber receives said H2 from said H2 source through a H2 passage, said O2 from said O2 source through an O2 passage, said water from a water reservoir through a water reservoir passage, and said cooling steam from said heat recovery steam generator through a steam passage.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. **1** illustrates block diagram view of a hydrogen hybrid cycle system **100**.

FIG. **2** illustrates block diagram view of a hydrogen hybrid cycle system **100**.

FIG. **3** illustrates block diagram view of a hydrogen hybrid cycle system **100**.

FIG. **4** illustrates block diagram view of a detailed cycle system **200**.

FIG. **5** illustrates a flow chart view of a power generation method **500**.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** illustrates block diagram view of a hydrogen hybrid cycle system **100**.

In one embodiment, said hydrogen hybrid cycle system **100** can comprise a H2 source **102**, an O2 source **104**, a combustion chamber **106**, a first steam injected gas turbine **108**, a load **110**, a heat recovery steam generator **112**, a deaerator **114**, a water reservoir **116**, a water pump **118**, a steam passage **126**, a generated steam passage **128**, a turbine exit steam passage **130**, a residual steam passage **132**, an unburnt gas vent passage **134**, a water reservoir passage **136**, a bleed water passage **138**, a second water passage **140**, a H2 **142**, an O2 **144**, a cooling steam **146**, a water **148**, a pressurized water **150**, a generated steam **152**, a residual steam **154**, a hydrogen pump **156**, an oxygen pump **158**, a water to heat recovery steam generator passage **160**, an unburnt gas **162** and a turbine exit steam **164**.

In one embodiment, said cooling steam **146** can comprise a low temp cooling steam **146*a***, a medium temp cooling steam **146*b*** and a high temp cooling steam **146*c***.

Note that the simplified block diagram represents a minimalistic version of said hydrogen hybrid cycle system **100**. Many of the elements illustrated in FIG. **1** are described and illustrated in more detail below.

In one embodiment, said hydrogen hybrid cycle system **100** can comprise said H2 source **102**, said O2 source **104**, said combustion chamber **106**, said first steam injected gas turbine **108**, said heat recovery steam generator **112**, said deaerator **114**, said water reservoir **116** and said water pump **118**.

In one embodiment, said H2 source **102** can be hydrogen in gaseous phase stored under pressure in gas cylinders, or containers. Said H2 source **102** can comprise hydrogen stored in large scale in geological storage. Said H2 source **102** can comprise hydrogen stored in indirect form, i.e., metal hydrides. Said H2 source **102** can comprise hydrogen from industrial processes. Said H2 source **102** can comprise hydrogen stored in liquid phase.

In one embodiment, said H2 source **102** can comprise a hydrogen comprising an impurity ratio. Said impurity ratio comprises an industrial standard of ninety-nine-point nine percent pure hydrogen; wherein, said hydrogen hybrid cycle system can be configured to accommodate said impurity ratio being below said industrial standard depending on a final temperature, a pressure, a quality and a usage of a generated steam by a combustion chamber. In another embodiment, said hydrogen hybrid cycle system **100** can accommodate some impurities in said H2 source **102**, depending on the final temperature and pressure of said generated steam **152** and the tolerance of said first steam injected gas turbine **108** towards impurities.

In one embodiment, said H2 source **102** can supply said H2 **142** under pressure to said combustion chamber **106**. Where said H2 source **102** comprises a low-pressure, said hydrogen pump **156** can be used to attain necessary pressure of said H2 **142** for operation before entering said combustion chamber **106**.

Said H2 source **102** is fed into said combustion chamber **106** through a H2 passage **120**.

In one embodiment, said O2 source **104** can be said O2 **144** in gaseous phase stored under pressure in gas cylinders, or containers. Said O2 source **104** can comprise oxygen stored in large scale in geological storage. Said O2 source **104** can comprise oxygen from industrial processes. Said O2 source **104** can comprise oxygen stored in liquid phase. Said O2 source **104** can comprise an oxygen purity which can comprise an industrial grade. In one embodiment, said hydrogen hybrid cycle system **100** can accommodate some impurities depending on the final temperature and pressure of said generated steam **152** and the tolerance of said first steam injected gas turbine **108** towards impurities.

In one embodiment, said O2 source **104** will supply said O2 **144** under pressure to said combustion chamber **106**. If said O2 source **104** comprises low-pressure oxygen, said oxygen pump **158** can be used to attain the necessary pressure of oxygen for operation before entering said combustion chamber **106**.

In one embodiment, said O2 **144** can be fed into said combustion chamber **106** through an O2 passage **122**.

In one embodiment, said water reservoir **116** contains said water **148** being demineralized with additives in accordance with industrial standards or requirements for said first steam injected gas turbine **108** and/or said heat recovery steam generator **112**.

In one embodiment, said water **148** is pumped into said combustion chamber **106** through said second water passage **140** and a first water passage **124**, as illustrated.

In one embodiment, said heat recovery steam generator **112** creates said cooling steam **146**. In one embodiment, said cooling steam **146** is delivered to said combustion chamber **106** through said steam passage **126**.

In one embodiment, said combustion chamber **106** receives said H2 **142**, said O2 **144**, said cooling steam **146**, said pressurized water **150** and said generated steam **152**.

In one embodiment, said combustion chamber **106** is configured to: (**1**) burn said H2 **142** and said O2 **144** at or near stoichiometry, (**2**) include said cooling steam **146** and said pressurized water **150** and/or a mixture of both as a coolant. In one embodiment, inclusion of said pressurized water **150** and/or said cooling steam **146** can be selected depending on a configuration of said combustion chamber **106** and availability of said pressurized water **150** or said cooling steam **146**.

The temperature of said generated steam **152**, created by said combustion chamber **106**, depends on a flow and temperature of said pressurized water **150** and said cooling steam **146** entering said combustion chamber **106**.

Said combustion chamber **106** can utilize any suitable type of combustion strategy, depending on the application and operational circumstances.

In one embodiment, said first steam injected gas turbine **108** receives said generated steam **152** through said generated steam passage **128**.

In one embodiment, said generated steam **152** can selectively turn one or more turbines in said first steam injected gas turbine **108**, and consequently produces useful outputs, such as electricity, as is known in the art.

In one embodiment, said turbine exit steam **164** reaches said heat recovery steam generator **112** through said turbine exit steam passage **130**.

In one embodiment, said turbine exit steam **164** can be low in pressure, but high in temperature; wherein, energy which is found in said turbine exit steam **164** can be harnessed in said heat recovery steam generator **112** and used to convert said pressurized water **150** into said cooling steam **146**. In one embodiment, said cooling steam **146** can be high-pressure. In one embodiment, said cooling steam **146** and said residual steam **154** do not commingle with each other.

In one embodiment, said residual steam **154** can comprise condensate from said heat recovery steam generator **112**. Said condensate can reach said deaerator **114** through said residual steam passage **132**. Said unburnt gas **162** are separated in said deaerator **114** and safely released into the atmosphere through said unburnt gas vent passage **134**. Said water **148** can then be collected and stored in said water reservoir **116**.

In one embodiment, said water **148** from said deaerator **114** can reach said water reservoir **116** through said water reservoir passage **136**.

In one embodiment, said water reservoir **116** can be configured to store said water **148** for reuse in said hydrogen hybrid cycle system **100**. Depending on the needs of an installation of said hydrogen hybrid cycle system **100**, portions of said water **148** can exit said water reservoir **116** through said bleed water passage **138** and be used for additional purposes, including drinking, agriculture, or industrial processes.

In one embodiment, said water pump **118** can pump said water **148** from said water reservoir **116**. Said pressurized water **150** can be divided and then fed into said heat recovery steam generator **112** and said combustion chamber **106** through said water to heat recovery steam generator passage **160** and said first water passage **124**, respectively.

In one embodiment, pressure loss (in said combustion chamber **106**, said first steam injected gas turbine **108** and said heat recovery steam generator **112**), along with the maximum working pressure of steam in said hydrogen hybrid cycle system **100** can be used to determine a pressure of said pressurized water **150** to be delivered from said water pump **118**.

In one embodiment, pressure loss in said heat recovery steam generator **112**, said first water passage **124**, said steam passage **126** and said water to heat recovery steam generator passage **160**, along with the maximum working pressure of steam in said hydrogen hybrid cycle system **100** can be used to determine a pressure of said pressurized water **150** to be delivered from said water pump **118**.

In one embodiment, said water **148** that enters said heat recovery steam generator **112** can be converted into said cooling steam **146** (which can comprise high-pressure) by transferring heat from said turbine exit steam **164** (which can comprise low-pressure, high temperature). In one embodiment, said cooling steam **146** from said heat recovery steam generator **112** can be fed into said combustion chamber **106** through said steam passage **126**.

FIG. **2** illustrates block diagram view of said hydrogen hybrid cycle system **100**.

In one embodiment, a pressurized water streams **206** can comprise a first pressurized water stream **206***a* and a second pressurized water stream **206***b*.

In one embodiment, a feed water cooler **204** can comprise feed said water **148** to a feed water to feed water cooler input passage **214** and a feed water to feed water cooler output passage **216**.

In one embodiment, a multi-temperature cooling steams **210** can comprise a first temperature cooling steam **210***a*, a second temperature cooling steam **210***b* and a third temperature cooling steam **210***c*.

In one embodiment, said hydrogen hybrid cycle system **100** can comprise said feed water cooler **204** and a multi-stage turbines **208**.

In one embodiment, said cooling steam **146** can comprise said multi-temperature cooling steams **210** and a mixed steam water **212**.

In one embodiment, said water **148** can comprise a steam water mixer **202** and said pressurized water streams **206**.

a Detailed cycle system **200** can comprise a more detailed version of said hydrogen hybrid cycle system **100**.

In one embodiment, said detailed cycle system **200** can comprise said heat recovery steam generator **112**, said steam water mixer **202**, said feed water cooler **204** and said multi-stage turbines **208**. Said heat recovery steam generator **112** in said detailed cycle system **200** can comprise a multi-temperature, elevated pressure configuration.

In one embodiment, said heat recovery steam generator **112** can deliver said multi-temperature cooling steams **210** which can comprise said cooling steam **146** at two or more different temperatures. In one embodiment, said multi-temperature cooling steams **210** can be configured to maximize heat recovery from said turbine exit steam **164**. In one embodiment, said turbine exit steam **164** can comprise low-pressure, high-temperature steam.

In one embodiment, said heat recovery steam generator **112** can also produce variable-pressure, variable-temperature steam, if it is required by said combustion chamber **106** to increase performance and flexibility of said hydrogen hybrid cycle system **100** to integrate different tasks. In one embodiment, a plurality of said water pump **118** can be added to said hydrogen hybrid cycle system **100** to regulate different pressures in said multi-temperature cooling steams **210**.

In one embodiment, said feed water cooler **204** can be optional. In one embodiment, said feed water cooler **204** can be installed to cool said water **148** before being pumped by said water pump **118** to operate said hydrogen hybrid cycle system **100** at optimum efficiency.

Said water **148** from said water reservoir **116** can enter said feed water cooler **204** using said feed water to feed water cooler input passage **214** and can exit using said feed water to feed water cooler output passage **216**. Said feed water to feed water cooler input passage **214** can capture a portion of said water **148** flowing through said second water passage **140**. Said feed water to feed water cooler output passage **216** can return a portion of said water **148** back to said second water passage **140** after passing through said feed water cooler **204**.

In one embodiment, said feed water cooler **204** can be air-cooled, water-cooled, hydrogen cooled, oxygen cooled, or a combination of different coolants depending on the location, availability of resources and temperature difference of said feed water to feed water cooler input passage **214** and said feed water to feed water cooler output passage **216**.

In one embodiment, said H2 **142** and said O2 **144** enter said combustion chamber **106**. A flowrate of said H2 **142** and said O2 **144** are measured and regulated to attain a stoichiometry or near-stoichiometry ratio. Said H2 **142** and said O2 **144** can be injected into said combustion chamber **106** and safely ignited. A flame resulting from burning said H2 **142** and said O2 **144** can result in a steam and an energy released in the form of very high temperature heat.

In one embodiment, cooling said generated steam **152**, said hydrogen hybrid cycle system **100** is provided with said pressurized water **150**, said multi-temperature cooling steams **210** and said mixed steam water **212** which can be injected into said combustion chamber **106**.

In one embodiment, a flame resulting from burning said H2 **142** and said O2 **144** at stoichiometry or near-stoichiometry ratio can result in a steam and an energy released in the form of very high temperature heat, in order to reduce very high temperature heat generated cooling arrangements are available. Said hydrogen hybrid cycle system **100** cooling system is provided with said pressurized water **150**, said multi-temperature cooling steams **210** and said mixed steam water **212** which can be injected into said combustion chamber **106** to generate said generated steam **152**.

In one embodiment, a temperature of said generated steam **152** can depend on a flow rate, temperature and pressure of the inputs of said combustion chamber **106** (such as said H2 **142**, said O2 **144**, said pressurized water **150**, said multi-temperature cooling steams **210** and said mixed steam water **212**). said hydrogen hybrid cycle system **100** can comprise a controller and a plurality of sensors for measuring such inputs.

In one embodiment, said combustion chamber **106** can be configured to minimize hot spots in said unburnt gas **162** in said residual steam **154**. It can also be designed to handle said multi-temperature cooling steams **210**.

In one embodiment, said turbine exit steam **164** can be very hot; wherein, said heat recovery steam generator **112** can harness waste energy and thereby convert said pressurized water **150** into said cooling steam **146** or said multi-temperature cooling steams **210** depending on the configuration.

Said steam water mixer **202** can be used to mix said cooling steam **146**, said pressurized water **150** and said multi-temperature cooling steams **210** to increase combustion and mixing efficiency at said combustion chamber **106**. Said steam water mixer **202** can be configured to control portions of said cooling steam **146**, said pressurized water **150** and said multi-temperature cooling steams **210** to be included in said mixed steam water **212**. Said steam water mixer **202** can be configured to optimize temperature, pressure and flow rate of said multi-temperature cooling steams **210** from said heat recovery steam generator **112**.

FIG. **3** illustrates block diagram view of said hydrogen hybrid cycle system **100**.

In one embodiment, one or more cooling steam passages **302** can comprise a first cooling steam passage **302***a*, a second cooling steam passage **302***b* and a third cooling steam passage **302***c*.

In one embodiment, one or more steam to steam water mixer passages **306** can comprise a first steam to steam water mixer passage **306***a*, a second steam to steam water mixer passage **306***b* and a third steam to steam water mixer passage **306***c*.

In one embodiment, said detailed cycle system **200** can comprise a water passage **304**, said one or more steam to steam water mixer passages **306** and a mixed steam water passage **308**.

In one embodiment, said cooling steam **146** can comprise said one or more cooling steam passages **302**.

In one embodiment, said multi-temperature cooling steams **210** can comprise said low temp cooling steam **146***a*, said medium temp cooling steam **146***b* and said high temp cooling steam **146***c*.

In one embodiment, said multi-temperature cooling steams **210** can be passed to said combustion chamber **106** using said one or more cooling steam passages **302**; namely, said low temp cooling steam **146***a* using said first cooling steam passage **302***a*, said medium temp cooling steam **146***b* using said second cooling steam passage **302***b*, and said third cooling steam passage **302***c* using said high temp cooling steam **146***c*.

In one embodiment, said low temp cooling steam **146***a* can comprise a low temperature, said medium temp cooling steam **146***b* can comprise an intermediate temperature and said high temp cooling steam **146***c* can comprise a high temperature, as compared with one another.

In one embodiment, said multi-temperature cooling steams **210** can be adjusted, with regard to temperature and flow rate, depending on the optimum design and heat extraction rate of said heat recovery steam generator **112**, and can vary according to conditions of said load **110**.

In one embodiment, to increase the operational performance of said combustion chamber **106**, said multi-temperature cooling steams **210** can be mixed with said pressurized water **150** in said steam water mixer **202** prior to entering said combustion chamber **106**. Said first temperature cooling steam **210***a* can be selectively delivered to said steam water mixer **202** through said one or more steam to steam water mixer passages **306**; namely, said low temp cooling steam **146***a* using said first steam to steam water mixer passage **306***a*, said medium temp cooling steam **146***b* using said second steam to steam water mixer passage **306***b*, and said high temp cooling steam **146***c* using said third steam to steam water mixer passage **306***c*. Likewise, a portion of said pressurized water **150** can be delivered to said steam water mixer **202** through said water passage **304**.

In one embodiment, said pressurized water **150** can be misted and/or vaporized in said steam water mixer **202** to form said mixed steam water **212**. Said mixed steam water **212** can increase a thermal efficiency of a combustion process and reduce hotspots through more uniform mixing of said multi-temperature cooling steams **210** and said pressurized water **150** into said mixed steam water **212** and the combustion product in said combustion chamber **106**.

In one embodiment, said steam water mixer **202** can be configured to uniformly mix said cooling steam **146** and said pressurized water **150**, and thereby reduce cold spots in said mixed steam water **212** entering said combustion chamber **106**. Said mixed steam water **212** can enter said combustion chamber **106** through said mixed steam water passage **308**.

In one embodiment, a portion of said multi-temperature cooling steams **210** can pass directly into said combustion chamber **106** through said one or more cooling steam passages **302**, and a remaining portion of said multi-temperature cooling steams **210** can pass through said one or more steam to steam water mixer passages **306** into said steam water mixer **202**.

In one embodiment, the amount of said pressurized water **150** and said multi-temperature cooling steams **210** entering said steam water mixer **202** depends on the flow rates, temperature and pressure of said pressurized water **150** and said multi-temperature cooling steams **210**.

In one embodiment, the portions of said pressurized water **150** and said multi-temperature cooling steams **210** entering said combustion chamber **106** and said steam water mixer **202** is optimized depending to various operational parameters in said hydrogen hybrid cycle system **100** to meet requirements of said combustion chamber **106** with regards to safe and efficient operation at maximized cycle performance

FIG. **4** illustrates block diagram view of a said detailed cycle system **200**.

In one embodiment, said hydrogen hybrid cycle system **100** can comprise a reheated steam **410**, a reduced steam **412** and a bypass steam passage **414**.

In one embodiment, said multi-stage turbines **208** can comprise said first steam injected gas turbine **108**, a passage **402**, a reheat steam passage **404**, and a reduced steam to combustion chamber passage **408**.

In one embodiment, can comprise said multi-stage turbines **208**.

Said multi-stage turbines **208** can comprise said first steam injected gas turbine **108** and a second steam injected gas turbine **416**.

In one embodiment, said reduced steam **412** can comprise a steam in between stages. Said reduced steam **412** can be bled and reheated in said combustion chamber **106** to said reheated steam **410**, and then reinjected into said multi-stage turbines **208**, to increase output and efficiency of operation of said hydrogen hybrid cycle system **100**.

In one embodiment, said multi-stage turbines **208** can receive said generated steam **152** (which can comprise high-pressure, high-temperature steam) from said combustion chamber **106** through said generated steam passage **128**. Said generated steam **152** can then be reduced to a specified pressure and temperature, and re-fed into said combustion chamber **106** through said reduced steam to combustion chamber passage **408** as said reduced steam **412**. Said reduced steam **412** can be injected back into said combustion chamber **106** for reheating and become said reheated steam **410** which passes through said passage **402** from said combustion chamber **106**. Said reheated steam **410** (intermediate pressure high temperature steam) can be injected into said multi-stage turbines **208** at said second steam injected gas turbine **416** through said reheat steam passage **404**. In one embodiment, for operational flexibility in different configurations and loading conditions, said reduced steam **412** can bypass reheating in said combustion chamber **106** be injected directly into said second steam injected gas turbine **416** through said bypass steam passage **414**.

In summary, said hydrogen hybrid cycle system **100** can form forms a simple closed loop system with higher operating efficiency and lower capital cost than conventional designs. Said hydrogen hybrid cycle system **100** can have the added benefit of zero operational pollution.

In one embodiment, said hydrogen hybrid cycle system **100** can be useful for power generation, in locomotives for propulsion, and in combined heat and power applications.

In one embodiment, said hydrogen hybrid cycle system **100** can work alongside 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 through renewable energy sources. Said hydrogen hybrid cycle system **100** can also be accommodated in a conventional coal or gas turbine or nuclear power plant with minor changes to generate electricity with reduced pollution and increased efficiency.

In one embodiment, said hydrogen hybrid cycle 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 through renewable energy sources.

In one embodiment, said hydrogen hybrid cycle 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 hydrogen hybrid cycle system **100** is used to generate electric power. The exhaust steam from the turbine can be used in industrial processing of cane sugar before or after being used in said heat recovery steam generator **112**.

While the invention has been shown in only one of its forms, it is not thus limited but is flexible to various configurations and modifications without departing from the spirit thereof. In one alternative version, said cooling steam **146** by said combustion chamber **106** can be used in various industrial processes before or after being injected into said heat recovery steam generator **112**. Possible industrial uses include conventional power plants, sugar production, and paper production

FIG. **5** illustrates a flow chart view of a power generation method **500**.

In one embodiment, said power generation method **500** can comprise a combustion step **502**, a steam generation step **504**, a driving turbine step **506**, a generating power step **508**, a generating cooling steam step **510** and a cooling stream for combustion step **512**.

In one embodiment, said power generation method **500** can comprise the steps for implementing said hydrogen hybrid cycle system **100** and said detailed cycle system **200**, as discussed above

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 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.

Parts List:

said hydrogen hybrid cycle system **100**,
Said H2 source **102**,
Said O2 source **104**,
Said combustion chamber **106**,
Said first steam injected gas turbine **108**,
Said load **110**,
Said heat recovery steam generator **112**,
Said deaerator **114**,
Said water reservoir **116**,
Said water pump **118**,
Said steam passage **126**,
Said generated steam passage **128**,
Said turbine exit steam passage **130**,
Said residual steam passage **132**,
Said unburnt gas vent passage **134**,
Said water reservoir passage **136**,
Said bleed water passage **138**,
Said second water passage **140**,
Said H2 **142**,
Said O2 **144**,
Said cooling steam **146**,
Said water **148**,
Said pressurized water **150**,
Said generated steam **152**,
Said residual steam **154**,
Said hydrogen pump **156**,
Said oxygen pump **158**,
Said water to heat recovery steam generator passage **160**,
Said unburnt gas **162**,
Said turbine exit steam **164**,
Said low temp cooling steam **146***a*,
Said medium temp cooling steam **146***b*,
Said high temp cooling steam **146***c*,
Said H2 passage **120**,
Said O2 passage **122**,
Said first water passage **124**,
Said pressurized water streams **206**,
Said first pressurized water stream **206***a*,
Said second pressurized water stream **206***b*,
Said feed water cooler **204**,
Said feed water to feed water cooler input passage **214**,
Said feed water to feed water cooler output passage **216**,
Said multi-temperature cooling steams **210**,
Said first temperature cooling steam **210***a*,
Said second temperature cooling steam **210***b*,
Said third temperature cooling steam **210***c*,
Said multi-stage turbines **208**,
Said mixed steam water **212**,
Said steam water mixer **202**,
Said detailed cycle system **200**,
Said one or more cooling steam passages **302**,
Said first cooling steam passage **302***a*,
Said second cooling steam passage **302***b*,
Said third cooling steam passage **302***c*,
Said one or more steam to steam water mixer passages **306**,
Said first steam to steam water mixer passage **306***a*,
Said second steam to steam water mixer passage **306***b*,
Said third steam to steam water mixer passage **306***c*,
Said water passage **304**,
Said mixed steam water passage **308**,
Said reheated steam **410**,
Said reduced steam **412**,
Said bypass steam passage **414**,
Said passage **402**,
Said reheat steam passage **404**,
Said reduced steam to combustion chamber passage **408**,
Said second steam injected gas turbine **416**,
Said power generation method **500**,
Said combustion step **502**,
Said steam generation step **504**,
Said driving turbine step **506**,
Said generating power step **508**,
Said generating cooling steam step **510**, and
said cooling stream for combustion step **512**.

Preferred Embodiment:

A hydrogen hybrid cycle system configured to convert heat into mechanical work by burning a H2 and an O2. Said hydrogen hybrid cycle system comprises a H2 source, an O2 source, a combustion chamber, a first steam injected gas turbine, a load, a heat recovery steam generator and a water pump. Said H2 source provides said H2 to said combustion chamber. Said O2 source provides said O2 to said combustion chamber. Said combustion chamber burns portions of said H2 and said O2.Said hydrogen hybrid cycle system burns said H2 and said O2 at or near stoichiometry in said combustion chamber. Said hydrogen hybrid cycle system cools said combustion chamber with at least one of a cooling steam and a water. Said combustion chamber creates a generated steam. Said generated steam turns said first steam injected gas turbine. Said first steam injected gas turbine can be coupled said load.

A hydrogen hybrid cycle system configured to convert heat into mechanical work by burning a H2 and an O**2**. Said hydrogen hybrid cycle system comprises a H2 source, an O2 source, a combustion chamber, a first steam injected gas turbine, a load, a heat recovery steam generator and a water pump. Said H2 source provides said H2 to said combustion chamber. Said O2 source provides said O2 to said combustion chamber. Said combustion chamber burns portions of said H2 and said O2. Said hydrogen hybrid cycle system burns said H2 and said O2 at or near stoichiometry in said combustion chamber. Said hydrogen hybrid cycle system cools said combustion chamber with at least one of a cooling steam and a water. Said combustion chamber creates a generated steam. Said generated steam turns said first steam injected gas turbine. Said first steam injected gas turbine can be coupled said load.

Said H2 source comprises liquid hydrogen or hydrogen stored in gaseous phase under high pressure or at ambient pressure. Said H2 can be stored in a containment selected among cylinders, geological storage, indirect form, or as a byproduct of industrial process. Said hydrogen hybrid cycle system further comprises a hydrogen pump. Said hydrogen pump can be configured to deliver low pressure H2 as a gaseous phase at the necessary elevated pressure for operation before it enters said combustion chamber. Said hydrogen hybrid cycle system further comprises an hydrogen vaporizer. Said hydrogen pump and said hydrogen vaporizer produce gaseous hydrogen from liquid hydrogen at a necessary pressure for operation before it enters said combustion chamber.

Said H2 comprises an impurity ratio. Said impurity ratio comprises an industrial standard of 99.9% pure hydrogen. Said hydrogen hybrid cycle system can be configured to accommodate said impurity ratio being below said industrial standard depending on a final temperature, a pressure, a quality and a usage of a generated steam by said combustion chamber.

Said O2 source comprises liquid oxygen or oxygen stored in gaseous phase under high pressure or at ambient pressure. Said O2 can be stored in a containment selected among cylinders, geological storage, indirect form, or as a byproduct of industrial process. Said hydrogen hybrid cycle system further comprises an oxygen pump. Said oxygen pump can be configured to deliver low pressure O2 as a gaseous phase at the necessary elevated pressure for operation before it enters said combustion chamber. Said hydrogen hybrid cycle system further comprises an oxygen vaporizer. Said oxygen pump and said oxygen vaporizer produce gaseous oxygen from liquid oxygen at a necessary pressure for operation before it enters said combustion chamber.

Said O2 comprises an impurity ratio. Said impurity ratio comprises an industrial standard of ninety-nine point nine percent pure oxygen. Said impurity ratio comprises an industrial grade. Said hydrogen hybrid cycle system can be configured to accommodate said impurity ratio being below said industrial standard.

A water reservoir stores said water. Said water can be demineralized with chemical additives.

Said hydrogen hybrid cycle system further comprising a feed water cooler. Said feed water cooler comprising a feed water to feed water cooler input passage, and a feed water to feed water cooler output passage. A water reservoir feeds said water to said water pump through a second water passage. Said feed water to feed water cooler input passage pulls a portion of said water out of a second water passage. Said feed water cooler cools a portion of said water. Said feed water to feed water cooler output passage returns a portion of said water back into said second water passage.

Said feed water cooler comprises a cooling equipment selected from among air cooling, and hydrogen cooling. Said feed water cooler can be configured to optimize a temperature of said water to optimize said hydrogen hybrid cycle system.

Said combustion chamber receives: said H2 from said H2 source through a H2 passage, said O2 from said O2 source through an O2 passage, said water from a water reservoir through a second water passage, and said cooling steam from said heat recovery steam generator through a steam passage.

Said combustion chamber can be configured to burn said H2 and said O2 with said pressurized water and said cooling steam.

Said heat recovery steam generator can be configured to generate a multi-temperature cooling steams at multi-temperatures. Said multi-temperature cooling steams can be delivered from said heat recovery steam generator to said combustion chamber through one or more cooling steam passages. Said hydrogen hybrid cycle system further comprises a steam water mixer configured for: receiving a portion of said multi-temperature cooling steams and said pressurized water, mixing said multi-temperature cooling steams and said pressurized water to create a mixed steam water, and delivering said mixed steam water into said combustion chamber through a mixed steam passage.

Said first steam injected gas turbine comprises one among a multi-stage turbines. Said multi-stage turbines comprises said first steam injected gas turbine, a second steam injected gas turbine, and a bypass steam passage. Said multi-stage turbines receives said generated steam from said combustion chamber into said first steam injected gas turbine and generates a reduced steam and powers said load. Said multi-stage turbines receives a reheated steam from said combustion chamber through a passage. Said reheated steam can be fed into said second steam injected gas turbine and can be converted into a turbine exit steam. Said reduced steam can be reheated in said combustion chamber and comes out as said reheated steam. Said reduced steam can be configured to increase a power output of said multi-stage turbines. For operational flexibility in different configurations and loading conditions, said reduced steam can bypass the re-heater in said combustion chamber and be injected directly into said second steam injected gas turbine through said bypass steam passage.

Said multi-stage turbines can be configured to reinject a portion of said reduced steam into said second steam injected gas turbine through said bypass steam passage.

Said heat recovery steam generator receives a turbine exit steam through a turbine exit steam passage. Said turbine exit steam from said multi-stage turbines can be harnessed in said heat recovery steam generator and used to convert said pressurized water into said cooling steam or a multi-temperature cooling steams. Said heat recovery steam generator can be configured to produce a multi-temperature cooling steams. Said multi-temperature cooling steams configured to increase heat recovery rate and cycle efficiency of said hydrogen hybrid cycle system. Said multi-temperature cooling steams comprises a low temp cooling steam, a medium temp cooling steam and a high temp cooling steam, as compared to one another, respectively. A portion of said multi-temperature cooling steams can be delivered to said combustion chamber through said one or more cooling steam passages. A remaining portion of said multi-temperature cooling steams can be delivered to a steam water mixer through one or more steam to steam water mixer passages.

Said heat recovery steam generator receives said pressurized water and a turbine exit steam. Said heat recovery steam generator generates said cooling steam from said pressurized water and heat from said turbine exit steam. Said heat recovery steam generator creates a residual steam from said turbine exit steam. Said turbine exit steam and said pressurized water do not commingle with each other in said heat recovery steam generator.

Said hydrogen hybrid cycle system comprises a deaerator, an unburnt gas vent passage, and a water reservoir passage. Said deaerator receives a residual steam from said heat recovery steam generator through a passage. Said residual steam comprises condensate. An unburnt gas can be released from said deaerator into an atmosphere through said unburnt gas vent passage. Said deaerator delivers a portion of said water to a water reservoir through said water reservoir passage.

Said hydrogen hybrid cycle system comprises said water pump, a first water passage, a second water passage and a water to heat recovery steam generator passage. Said water can be pumped out of a water reservoir through said second water passage and into said water pump. Said water can be converted into a pressurized water in said water pump. Said heat recovery steam generator produces a multi-temperature cooling steams. Said water pump comprises a plurality of pumps configured to pump said water into said heat recovery steam generator at a desired pressure.

A steam water mixer receives said pressurized water from said water pump through a third water passage and a multi-temperature cooling steams from said heat recovery steam generator through one or more steam to mixer passages. Said multi-temperature cooling steams and said pressurized water can be mixed together by said steam water mixer into said mixed steam water. Said steam water mixer mists a portion of said pressurized water. Said steam water mixer vaporizes a portion of said pressurized water. Said mixed steam water can be delivered into said combustion chamber through said mixed steam passage. A portion of said water to heat recovery steam generator passage and said multi-temperature cooling steams entering said combustion chamber and said steam water mixer can be optimized to operate said hydrogen hybrid cycle system at maximized cycle performance. A portion of said water to heat recovery steam generator passage and said multi-temperature cooling steams entering said combustion chamber and said steam water mixer can be optimized depending on safe and efficient operation of said hydrogen hybrid cycle system. A portion of said water to heat recovery steam generator passage and said multi-temperature cooling steams entering said combustion chamber and said steam water mixer can be optimized depending on operational parameters in said hydrogen hybrid cycle system.

Said load can be selected from among an AC generator, a DC generator, a transmission drive, one or more pumps, one or more compressors, a locomotive, and one or more mechanical rotational loads.

The invention claimed is:

1. A hydrogen hybrid cycle system configured to convert heat into mechanical work by burning a H2 and an O2, wherein:

said hydrogen hybrid cycle system comprises a H2 source, an O2 source, a combustion chamber, a first steam injected gas turbine, a load, a heat recovery steam generator, a water reservoir having a water, and a water pump;

said H2 source provides said H2 to said combustion chamber;

said O2 source provides said O2 to said combustion chamber;

said combustion chamber burns portions of said H2 and said O2;

said hydrogen hybrid cycle system burns said H2 and said O2 at or near stoichiometry in said combustion chamber;

said hydrogen hybrid cycle system cools said combustion chamber with at least one of a cooling steam and a water;

said combustion chamber creates a generated steam;

said water pump is configured for

pulling said water from said water reservoir,

pressurizing said water into a pressurized water,

pumping a portion of said pressurized water to said heat recovery steam generator, and

pumping a remaining portion of said pressurized water to said combustion chamber as a cooling water;

said generated steam turns said first steam injected gas turbine; and

said first steam injected gas turbine is coupled with said load.

2. The hydrogen hybrid cycle system from claim **1**, wherein:

said H2 source is configured to store and provide said H2 in a selectable form, either as a liquid hydrogen or a gaseous hydrogen;

said hydrogen hybrid cycle system comprises a hydrogen phase management system configured to maintain said H2 in said gaseous phase when stored and to convert said liquid hydrogen to said gaseous hydrogen before delivery to said combustion chamber; and

said hydrogen phase management system includes a hydrogen pump for delivering said gaseous hydrogen at a necessary elevated pressure for operation, and a hydrogen vaporizer for converting said liquid hydrogen to gaseous hydrogen at a necessary pressure for operation.

3. The hydrogen hybrid cycle system from claim **1**, wherein:

said H2 comprises an impurity ratio;

said impurity ratio comprises an industrial standard of 99.9% pure hydrogen; and

said hydrogen hybrid cycle system is configured to accommodate said impurity ratio being below said industrial standard depending on a final temperature, a pressure, a quality and a usage of a generated steam by said combustion chamber.

4. The hydrogen hybrid cycle system from claim **1**, wherein:

said O2 source is configured to store and provide O2 in a selectable form, either as a liquid oxygen or a gaseous oxygen;

said hydrogen hybrid cycle system comprises an oxygen phase management system configured to maintain said O2 in said gaseous oxygen form when stored and to convert said liquid oxygen to gaseous oxygen before delivery to said combustion chamber;

said oxygen phase management system includes an oxygen pump for delivering said gaseous oxygen at a necessary elevated pressure for operation, and an oxygen vaporizer for converting said liquid oxygen to gaseous oxygen at a necessary pressure for operation.

5. The hydrogen hybrid cycle system from claim **1**, wherein:

said O2 comprises an impurity ratio;

said impurity ratio comprises an industrial standard of ninety-nine point nine percent pure oxygen;

said impurity ratio comprises an industrial grade; and

said hydrogen hybrid cycle system is configured to accommodate said impurity ratio being below said industrial standard.

6. The hydrogen hybrid cycle system from claim **1**, wherein:

said water reservoir of said hydrogen hybrid cycle system is configured to store water for operational use within the system; and

said water reservoir stores said water which is demineralized with chemical additives to optimize its suitability for system operations.

7. The hydrogen hybrid cycle system from claim **1**, wherein:

said hydrogen hybrid cycle system further comprising a feed water cooler;

said feed water cooler comprising a feed water to feed water cooler input passage, and a feed water to feed water cooler output passage;

a water reservoir feeds said water to said water pump through a feed water passage;

said feed water to feed water cooler input passage pulls a portion of said water out of said feed water passage;

said feed water cooler cools said portion of said water; and said feed water to feed water cooler output passage returns a portion of said water back into said feed water passage.

8. The hydrogen hybrid cycle system from claim 7, wherein:

said feed water cooler comprises a cooling equipment selected from among air cooling, and hydrogen cooling; and

said feed water cooler is configured to optimize a temperature of said water to optimize said hydrogen hybrid cycle system.

9. The hydrogen hybrid cycle system from claim 1, wherein:

said combustion chamber receives:

said H2 from said H2 source through a H2 passage,

said O2 from said O2 source through an O2 passage,

said water from a water reservoir through a feed water passage, and

said cooling steam from said heat recovery steam generator through a steam passage.

10. The hydrogen hybrid cycle system from claim 1, wherein:

said heat recovery steam generator is configured to generate a multi-temperature cooling steams at multi-temperatures;

said multi-temperature cooling steams are delivered from said heat recovery steam generator to said combustion chamber through a portion of one or more cooling steam passages, carrying steam at various temperature at the same time to different sections of combustion chamber to be used as a cooling steam;

said hydrogen hybrid cycle system further comprises a steam water mixer configured for:

receiving a portion of said multi-temperature cooling steams and said pressurized water,

mixing said multi-temperature cooling steams and said pressurized water to create a mixed steam water, and

delivering said mixed steam water into said combustion chamber through a mixed steam passage.

11. The hydrogen hybrid cycle system from claim 10, wherein:

said combustion chamber is configured to burn said H2 and said O2 with said pressurized water and said cooling steam.

12. The hydrogen hybrid cycle system from claim 1, wherein:

said first steam injected gas turbine comprises one among a multi-stage turbines;

said multi-stage turbines comprises said first steam injected gas turbine, a second steam injected gas turbine, and a bypass steam passage;

said multi-stage turbines receives said generated steam from said combustion chamber into said first steam injected gas turbine and generates a reduced steam and powers said load;

said multi-stage turbines receives a reheated steam from said combustion chamber through a passage;

said reheated steam is fed into said second steam injected gas turbine and is converted into a turbine exit steam;

said reduced steam is reheated in said combustion chamber and comes out as said reheated steam;

said reduced steam is configured to increase a power output of said multi-stage turbines; and

for operational flexibility in different configurations and loading conditions, said reduced steam can bypass the re-heater in said combustion chamber and be injected directly into said second steam injected gas turbine through said bypass steam passage.

13. The hydrogen hybrid cycle system from claim 12, wherein:

said multi-stage turbines are configured to reinject a portion of said reduced steam into said second steam injected gas turbine through said bypass steam passage.

14. The hydrogen hybrid cycle system from claim 1, wherein:

said heat recovery steam generator receives a turbine exit steam through a turbine exit steam passage;

said turbine exit steam from said first steam injected gas turbine is harnessed in said heat recovery steam generator and used to convert said pressurized water into a multi-temperature cooling steams;

said heat recovery steam generator is configured to produce a multi-temperature cooling steams;

said multi-temperature cooling steams configured to increase heat recovery rate and cycle efficiency of said hydrogen hybrid cycle system;

said multi-temperature cooling steams comprises a low temp cooling steam, a medium temp cooling steam and a high temp cooling steam, as compared to one another, respectively;

a portion of said multi-temperature cooling steams are delivered to said combustion chamber through a portion of one or more cooling steam passages; and

a remaining portion of said multi-temperature cooling steams is delivered to a steam water mixer through one or more steam to steam water mixer passages.

15. The hydrogen hybrid cycle system from claim 1, wherein:

said heat recovery steam generator receives said pressurized water and a turbine exit steam;

said heat recovery steam generator generates said cooling steam from said pressurized water and heat from said turbine exit steam;

said heat recovery steam generator creates a residual steam from said turbine exit steam; and

said turbine exit steam and said pressurized water do not commingle with each other in said heat recovery steam generator.

16. The hydrogen hybrid cycle system from claim 1, wherein:

said hydrogen hybrid cycle system comprises a deaerator, an unburnt gas vent passage, and a water reservoir passage;

said deaerator receives a residual steam from said heat recovery steam generator through a passage;

said residual steam comprises condensate;

an unburnt gas is released from said deaerator into an atmosphere through said unburnt gas vent passage; and

said deaerator delivers a portion of said water to a water reservoir through said water reservoir passage.

17. The hydrogen hybrid cycle system from claim 1, wherein:

said hydrogen hybrid cycle system comprises said water pump, a first water passage, a feed water passage and a water to heat recovery steam generator passage;

said water is pumped out of a water reservoir through said feed water passage and into said water pump;

said water is converted into a pressurized water in said water pump;

said heat recovery steam generator produces a multi-temperature cooling steams; and said water pump comprises a plurality of pumps configured to pump said water into said heat recovery steam generator at a desired pressure.

18. The hydrogen hybrid cycle system from claim **1**, wherein:

a steam water mixer receives said pressurized water from said water pump through a pressurized water passage and a multi-temperature cooling steams from said heat recovery steam generator through one or more steam to mixer passages;

said multi-temperature cooling steams and said pressurized water are mixed together by said steam water mixer into a mixed steam water;

said steam water mixer mists a portion of said pressurized water;

said steam water mixer vaporizes a portion of said pressurized water;

said mixed steam water is delivered into said combustion chamber through said mixed steam passage;

a portion of said water to heat recovery steam generator passage and said multi-temperature cooling steams entering said combustion chamber and said steam water mixer are optimized to operate said hydrogen hybrid cycle system at maximized cycle performance;

a portion of said water to heat recovery steam generator passage and said multi-temperature cooling steams entering said combustion chamber and said steam water mixer are optimized for safe and efficient operation of said hydrogen hybrid cycle system; and

a portion of said water to heat recovery steam generator passage and said multi-temperature cooling steams entering said combustion chamber and said steam water mixer are optimized for operational parameters in said hydrogen hybrid cycle system.

19. The hydrogen hybrid cycle system from claim **1**, wherein:

said load is selected from among an AC generator, a DC generator, a transmission drive, one or more pumps, one or more compressors, a locomotive, and one or more mechanical rotational loads.

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