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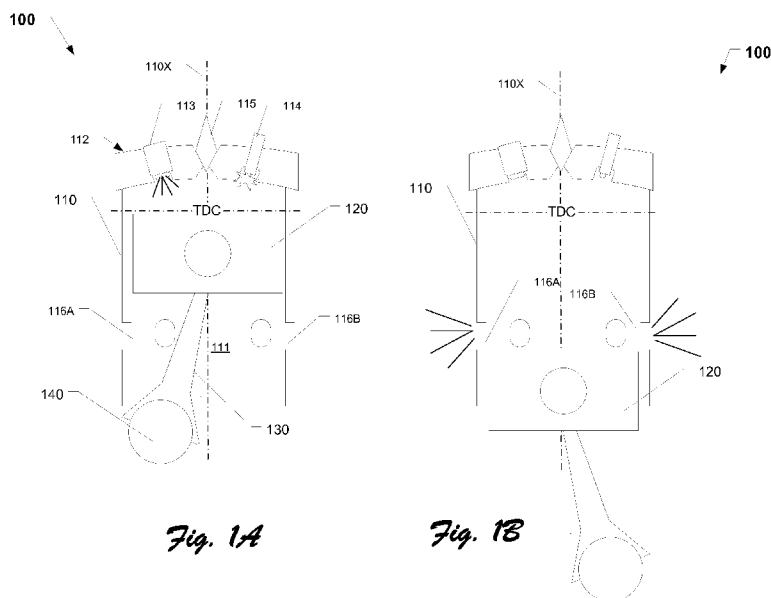
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(54) Title: LOW-COMPRESSION OXYHYDROGEN COMBUSTION ENGINE SYSTEMS, METHODS, AND COMPONENTS



(57) Abstract: The present inventors, devised, among other things, various embodiments of low-compression oxyhydrogen combustion engines. One exemplary combustion engine includes a combustion chamber, an oxygen-hydrogen fuel injector, an fuel igniter, and a controller configured to operate the injector and the igniter to realize a compression ratio of 3 or lower. Some embodiments include piston in the chamber. Operation of the engine at the lower compression ratio enhances efficiency.

LOW-COMPRESSION OXYHYDROGEN COMBUSTION ENGINE SYSTEMS, METHODS, AND COMPONENTS

Related Applications

5 The present application claims priority to U.S. Provisional Patent Application 61/800,752, which was filed on March 15, 2013, and to PCT Application PCT/US14/29792 which was filed March 14, 2014. Both of these applications are incorporated herein by reference.

Technical Field

10 Various embodiments of the present invention concern oxyhydrogen combustion engines and related power generation systems.

Background

15 Recent years have witnessed an intense and growing interest in alternatives to petroleum and other fossil fuels, for both ecologic and economic reasons. Among the promising alternatives are hydrogen and oxyhydrogen gas. These gases are seen as promising not only because of their high energy density (that is, the amount of energy per unit volume) and their zero carbon emissions, but also because they both can be
20 derived from water, one of the least expensive and most abundant substances of earth.

 More recently, breakthroughs, such as that described in Patent Pub. No. WO 2012/162434 A2, promise to reduce the cost of producing hydrogen and/or oxyhydrogen gas, finally making them cost-competitive with fossil fuels. As a result, more attention is turning to the issue of using these clean-burning gases in combustion
25 engines.

 In considering use of oxyhydrogen fuel in combustion engines, the present inventors have recognized at least one problem. The problem is that the efficiency of known combustion engines is directly proportional to the how much the fuel is compressed prior to combustion. In other words, increasing compression increases
30 efficiency, and decreasing compression decreases efficiency. However, compression also increases the temperature of a gas and makes it increasingly susceptible to an

engine performance problem, called auto ignition, which entails the gas spontaneously exploding before the optimal point in the engine cycle. This autoignition, also known as “knocking” because its characteristic sound, significantly stresses the engine and can cause premature failure of engine components. Like other combustible materials, oxyhydrogen gas is susceptible to auto ignition problems, potentially forcing engine makers to give up significant efficiency for longer engine life.

Accordingly, the present inventors have recognized for more efficient combustion engines that avoid the conventional tradeoff of efficiency and longevity.

Summary

To address this and/or one or more other problems, the present inventors, devised, among other things, a low-compression oxyhydrogen combustion engine. One exemplary engine includes a non-atmospheric combustion chamber and an igniter, with each combustion chamber coupled to receive oxyhydrogen gas and the igniter configured to ignite the gas when the engine exhibits a compression ratio less than or equal to 3. In some embodiments, the compression ratio is in the range of 0.1 to 1.5, inclusive, and in others, it is 1.0 to 1.5, inclusive. Also, in some embodiments, the combustion chamber takes the form of a piston chamber, and in others it takes the form of a gas turbine. The low compression ratio avoids the tradeoff found in conventional high compression engines, simultaneously reducing engine wear from autoignition and improving engine efficiency.

Moreover, some embodiments inject inert gas, water vapor, steam, and/or nano water into the combustion chamber along with the hydrogen-oxygen gas to amplify the impact of combustion. For example, injected water is converted to flash steam during combustion, amplifying the forces available to move a piston for example by as much as 1000 fold or more.

Brief Description of the Drawings

Various embodiments of the invention are described below with reference to the following attached figures. Note that the figures, none of which are drawn to scale, are numbered sequentially and annotated with reference numbers to facilitate identification

of various features and components. These drawings and numbers are referenced in the detailed description as a teaching aid, with like numbers referring to the same or similar features and components across the figures.

FIGs. 1A and 1B are cross-sectional schematic representations of an low-compression oxygen-hydrogen non-atmospheric intake combustion engine
5 corresponding to one or more embodiments of the present invention.

FIG. 2 is graphical representation of idealized conventional Otto cycle with a compression ratio of approximately 8 and a comparative no or low-compression cycle corresponding to one or more embodiments of the present invention.

10 FIG. 3 is a schematic diagram of an oxygen-hydrogen power generation system corresponding to one or more embodiments of the present invention.

FIG. 4 is a schematic diagram of an reciprocating linear alternator that corresponds to one or more embodiments of the present invention.

15 FIG. 5 is a schematic diagram illustrating an arrangement of conductive plates for use in oxyhydrogen generators corresponding to one or more embodiments of the present invention.

FIG. 6 is a block diagram illustrating an arrangement of neutral subsets, cathode plates and anode plates for use in various systems described herein and thus corresponds to one or more embodiments of the present invention.

20 FIG. 7 is a plan view showing an example of a plate for use in various systems described herein and thus corresponds to one or more embodiments of the present invention.

FIGS. 8A-8B are schematic diagrams illustrating alternative configurations for plates in a field generator.

25 FIG. 9 is a perspective cut away view of an oxyhydrogen generator or aqueous reactor for used in one or more of the systems described herein and thus corresponds to one or more embodiments of the present invention.

Detailed Description of Example Embodiments

This document, which incorporates the drawings and the appended claims, describes one or more specific embodiments of one or more inventions. These
5 embodiments, offered not to limit but only to exemplify and teach the invention(s), are shown and described in sufficient detail to enable those skilled in the art to implement or practice the invention(s). Thus, where appropriate to avoid obscuring the invention(s), the description may omit certain information known to those of skill in the art.

Example Low-Compression Oxyhydrogen Combustion Engine

Fig. 1A shows an exemplary combustion chamber portion of a non-atmospheric low-compression internal combustion engine 100. Engine 100 includes one or more combustion chambers 110, a piston 120, a piston rod 130, and a crankshaft 140.
15 Chamber 110, which is formed of a suitable metallic alloy or other high temperature resistant durable material, generally defines a right cylindrical interior volume 111. Chamber 110 further includes a top portion 112 having an oxyhydrogen injector 113, an igniter 114, and a one-way relief valve 115. Within interior volume 111 is piston 120.

Piston 120, which is sized and formed according known techniques, such milling,
20 lathing, die casting, and so forth, has a right cylindrical form sized to engage with and form a substantially fluid type seal with the sidewalls of interior volume 111 and thus define an adjustable chamber volume V as the piston moves back and forth along a central axis 110X of chamber 110. Piston 120 is pivotably linked to connecting rod 130, which is itself pivotably linked to crankshaft 140. As piston 120 moves down within
25 chamber 110 in response to combustion and/or expansion of gases, such as oxyhydrogen alone or combination with steam, nano-water, etc., that are injected via injector 113, it drives connecting rod 130 against crankshaft 140, applying torque that rotates the crankshaft.

Fig. 1A shows that injector 113 is injecting fuel mixture 113A and igniter is
30 providing ignition spark 114A at approximately the same time as piston 120 is at top-dead-center (TDC) position to avoid compression of the fuel mixture. In the exemplary

embodiment, control circuitry (shown, in Fig. 3) is configured to operate engine 100 with a compression ratio in the range of 0.1 to 3 (for example, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2, 2.25, 2.5, 2.75, 3.0), where the compression ratio G or Γ is defined as the ratio of the volume of the cylinder at the time of fuel intake and the volume of the cylinder at the time of fuel ignition. The exemplary embodiment uses a fuel mixture of hydrogen and oxygen gases, preferably as stoichiometric 2:1 mixture of hydrogen to oxygen. Other embodiments, however, use other hydrogen-oxygen mixtures. Some embodiments also include steam, water vapor, nano-water, or inert gases (e.g., argon) in the fuel mixture, providing separate injectors in some instances to provide these additives to the chamber.

Fig. 1A shows the result of piston 140 moving downward past exhaust ports 116A and 116B, allowing steam and water vapor to escape chamber 110. Note that in the exemplary embodiment, engine 100 is configured for a two-stroke cycle. Both two and four stroke engines have four steps in the cycle, but two-strokes have one piston up and down motion per cycle and four strokes have two up and down motions per cycle. The exhaust port design for the cylinder in the figure is evident of a two stroke, whereas a four stroke embodiment would generally include separate valved exhaust ports at the top of the cylinder.

Fig. 2 shows a graph of how the zero- or low-compression non-atmospheric engine 100 performs relative to conventional high-pressure Otto cycle internal combustion engine. For simplicity in providing a comparison with a conventional internal combustion engine, the pressure-volume diagram is provided for air; similar diagrams can be created for other combustion chamber gases. Produced work is equal to the area contained within the cycle curves. For a given maximum combustion chamber pressure and volume, the hydrogen/oxygen cycle encompasses a significantly larger volume, which translates to a greater amount of work being done, by 15-20% in the example provided. In practical embodiments, a higher maximum combustion chamber pressure could be achieved than in the conventional engine, resulting in even greater work in some embodiments of the present invention.

For conventional atmospheric internal combustion engines, fuel intake typically occurs at maximum displacement of the piston face from top-dead-center (TDC)

position where the piston volume is at a maximum and ignition is timed to occur after intake when the piston has moved to a point that defines 1/6 maximum cylinder volume, thus providing a compression ratio of 6. In conventional atmospheric combustion engines, ratios greater than 10 are generally avoided due to pollutants, such as nitrous oxides, that are formed at the higher operating temperatures created at the higher ratios. The pollutants require use of exhaust equipment that ultimately takes away the efficiency gains that would otherwise be available at higher ratios. Additionally, there are practical limits of component and lubricant temperature tolerance and undesirable auto-ignition of the fuel mixture at higher compression ratios that produces the well-known phenomenon of knocking. Thus, conventional engines must either operate at lower temperatures to minimize production of harmful pollutants or they must employ additional equipment, which necessarily introduces inefficiencies, to remove such chemicals. This condition is true for hydrogen and hydrocarbon-fueled engines.

Exemplary Power Generation Systems Incorporating Low Compression Combustion

Fig. 3 shows an exemplary computer-controlled power generation system 300 which includes an engine block 330 which includes six combustion chambers and pistons like those described for engine 100, denoted 110A-110E. Additionally, system 300 includes a oxyhydrogen generator 310, a fuel and ignition controller 320, a flywheel 340, a coupler 350, and an energy collector 360.

Controller 320 includes processing circuitry 321 (for example, a microprocessor, programmable logic controller, application specific integrated circuit) and/or memory 322. In operation, controller 320, in accord with instructions stored on non-volatile memory 322 alternates the firing of individual cylinders to maintain rotation of flywheel 340 at a desired RPM. Coupler 350 couples the rotational energy of flywheel 330 to energy collector or converter 360. Energy collector or converter 360 is generally representative of one or more power collection or conversion devices, in various embodiments taking the form of one or more electrical generators, air pumps, hydraulic pumps, and/or vacuum pumps.

Some embodiments include one or more portions of system 300 within a water containment chamber or vessel 370. The water containment vessel includes distilled

water and completely submerses the components of the system, particularly the engine block 330 and its cylinders. In some embodiments, the oxyhydrogen generator is also contained within the vessel, supplied by the reservoir of water it contains or by a separate supply of distilled water. Some embodiments place energy collector 360
5 outside the water containment vessel. Exemplary benefits of the water containment vessel include containment of accidental hydrogen gas explosions and mitigation of system noise and vibration.

FIG. 4 shows an exemplary reciprocal linear alternator or generator 400. Generator 400 includes two non-atmospheric low-compression combustion cylinders 110A and 110B placed opposite each other. Generator 400 also includes a two-headed
10 piston 420, which includes a piston rod 421. Mounted along the length of rod 421 are permanent magnet disks 430. Adjacent to the magnetic disks are electrically conductive coils 440. Coils 440 are electrically connected to inverter 450.

In operation, hydrogen-oxygen gas mixture is alternatively injected and ignited in
15 the cylinders realizing a zero or low compression ratio and generating a reciprocating action in piston 420 and piston rod 421. Magnets 430 move in unison with the piston rod and via magnetic induction induce an alternating electric current in coils 440, which feeds inverter 450.

20 Other Considerations, Embodiments and Enhancements

It is noted that the engines of the present invention may be operated using any oxygen/hydrogen production device that atomizes water thereby producing atomized oxygen and hydrogen gases. An example of such a device includes, but is not limited to, the devices disclosed or suggested in Patent Pub. No. WO 2012/162434 A2, the
25 entire contents of which are incorporated by reference herein. Furthermore, the fuel used in the engine of the present invention may be any combination or mixture of oxygen and hydrogen gases, such as HHO or H₂ and O₂ mixed as they are injected separately. For example, HHO at a mixture that is substantially stoichiometric (e.g. 67% hydrogen and 33% oxygen) may be used in the engines of the present invention.

30 In various embodiments, an engine according to the present invention, can take the form of either internal (e.g., a piston engine, a rotary engine, a Wankel rotary

engine) or external (e.g., a gas turbine, a Tesla turbine) combustion. Various embodiments may also incorporate the injection of liquid water (i.e., a wet hydrogen/oxygen mixture) into the combustion chamber. The heat of combustion of the hydrogen/oxygen fuel, plus any supplemental fuel if used, will result in the vaporization and 1700-fold expansion of the liquid water, enhancing pressure within the combustion chamber and the conversion of chemical energy to mechanical work (e.g, movement of a piston or spinning of a turbine). Beneficially, water may be added to the combustion chamber without any connection between the chamber and the atmosphere.

In order to best control the volume of fluid within the engine, as well as the gas flow rate and temperature, an inert gas may also be added to the combustion chamber of the engine of the present invention. The inert gas can be any of many species or a mix thereof. For example, some embodiments use argon, which does not react with the hydrogen/oxygen fuel, nor with other supplemental fuels. Moreover, argon can be readily separated from the exhaust stream of the engine. For example, in the case of hydrogen/oxygen as the combustion fuel, with or without supplemental water, then the only molecules in the exhaust stream of the engine are water and argon, which can be separated by cooling the stream below 100 degrees centigrade, at which point the water will condense and can be removed (and recirculated to hydrogen/oxygen separation devices, if desired).

The efficiency of a combustion engine is generally related to the flame speed of the combustible fuel, that is, the rate at which the combustible fuel burns. Generally, the higher the flame speed, the higher the efficiency because the combustion products more rapidly increase in pressure, resulting in a higher maximum pressure before the mechanical components of the engine can move to dissipate the pressure. Early experiments undertaken by the inventors suggest that the flame speed of a hydrogen/oxygen mixture may be increased with the addition of a small percentage of carbon dioxide. Thus, we allow the addition of some CO₂ to the engine of the present invention.

Conventional internal combustion engines, such as four and two-stroke piston engines, ideally follow the Otto cycle during their operation, which proceeds as follows: isentropic compression, isochoric pressure increase during combustion, isentropic

expansion of the combustion chamber, and isochoric pressure decrease in the cylinder during exhausting of combustion products. Of course, the real engine follows a less-ideal cycle, but the ideal cycle is illustrative for the present purposes. The efficiency of the Otto cycle is directly proportional to the compression ratio during the compression stroke, with the thermal efficiency defined as

$$(\text{efficiency}) = 1 - 1/((V1/V2)^{(y-1)}),$$

where $V1$ = the volume of the combustion chamber at the onset of compression, $V2$ = the volume of the combustion chamber at the completion of compression, and y = the ratio of constant pressure to constant volume heat capacities. Thus, the greater the compression, the higher the efficiency of the conventional internal combustion engine. However, as previously noted, there are practical limits to the compression ratio, given engine material properties and auto ignition of the combustion products.

Consequently, in some embodiments of the present invention, it is considered advantageous to operate the hydrogen/oxygen engine with substantially zero compression. In this configuration, hydrogen/oxygen and any supplemental materials are injected into the combustion chamber immediately prior to combustion. In the case of an internal combustion piston engine, intake of combustible materials takes place just before, at, and/or just after piston top-dead-center. With hydrogen/oxygen fuel, with or without supplemental fuel products, the combustion cycle can generate more work than comparable Otto cycles. See Fig. 2 for an example comparison.

As previously indicated, some embodiments of the present invention operates without connection to the atmosphere but rather by using a mixture of hydrogen and oxygen. The engine may also make use of a supplemental carbon-based fuel, including but not limited to hydrocarbons, carbon dioxide, carbon monoxide, or elemental carbon. To ensure combustion of these supplemental fuels, an oxidizer must be injected into the combustion chamber together with the hydrogen/oxygen and the supplemental fuel. The oxidizer may be pure oxygen, which may be extracted from the atmosphere using equipment known in the art or synthesized from water. This fuel composition serves to increase the amount of energy that can be harnessed per unit of carbon-based fuel (i.e., because hydrogen/oxygen also contribute to the net energy input of the system). Moreover, the products of the combustion are substantially water and carbon dioxide,

which may be separated and captured for use and disposal using equipment known in the art (e.g, equipment to condense the water out of the exhaust stream, thereby providing a clean carbon dioxide product).

Further benefits of the various embodiments include the ability to use this engine in a submersed oxyhydrogen power generation system, such as is disclosed or implied in PCT/US14/29792 requiring no connection to the atmosphere. In addition, for a given combustion engine, maximum pressure and combustion chamber volume (or effective volume), the design of the present engine may generate more work (e.g., see Fig. 2) and thermal energy conversion efficiency than other hydrogen/oxygen combustion engines. Consequently, hydrogen/oxygen combustion engines may more readily compete with the efficiency of hydrogen/oxygen fuel cells but at a fraction of the cost (to note, it is generally understood that hydrogen/oxygen fuel cells have higher thermal efficiency but also substantially higher costs than combustion engines that generate similar amounts of work).

Exemplary Assembly and Operation of the Non-Atmospheric Intake Combustion Engine

Assembly and operation of various embodiments of the non-atmospheric intake combustion engine may proceed according to the following methodology. Various embodiments of the engines and systems disclosed herein are assembled as is generally understood in the art for internal and external combustion engines, with specific novel modifications. In particular, for internal combustion engines, the combustion product intake timing is adjusted such that intake occurs under substantially zero or low compression. For external combustion engines, such as a gas turbine, the engine may be modified to remove compressors.

Additionally, the intake ports on the engine are connected to hydrogen/oxygen production units by means of non-corrosive tubes or pipes. In some embodiments, the intake ports may also be connected to carbon-based supplemental fuel reservoirs, oxidizer storage or separation units, and/or an inert gas reservoir and/or recycling unit. The exhaust stream out of the engine may be vented to the atmosphere and/or may be processed to extract and/or capture useful products, such as argon and carbon dioxide.

The shaft of the engine may be connected to a generator or other energy capture device by means of a gearbox or direct linkage, generating electricity for distribution. The shaft may also be connected to other devices to provide mechanical work. All equipment in the non-atmospheric engine is electronically connected to control
5 equipment to permit optimal operation.

Example Oxyhydrogen Generators

FIGs 5-9 show examples of oxyhydrogen generation components and systems used in some embodiments of the invention. Fig. 5 shows that a field generator 500 for
10 use in an aqueous reactor preferably comprises an array 502 of electrically conductive parallel spaced-apart plates 504a - 504j supported by a non-electrically conductive framework or member 506. The array of plates 502 may comprise one or more cathode plates 504a, 504c (collectively, 508) at a first end of the array, one or more anode plates 504h, 504j (collectively, 510) at a second end of the array 502 opposite to the first end.

15 The array of plates may further comprise a plurality of neutral plates 504b, 504d-g, 504i interposed between the cathode plates 508 and the anode plates 510. The neutral plates 504b, 504d-g, 504i may be arranged in interleaved neutral subsets 512, 514 each comprising at least three electrically connected plates. As mentioned above, interleaving of the neutral subsets means that each subset 512, 514 includes at least
20 one plate (e.g., 504b, 504f, 504i) that is interposed between two plates of an adjacent subset, of the cathode plates, or of the anode plates, and also includes at least two plates (e.g., 504d and 504f of subset 512, or 504e and 504g of subset 514) disposed around one plate of another adjacent subset, of the cathode plates, or of the anode plates. Each of the neutral subsets 512, 514 may be electrically isolated from other
25 ones of the neutral subsets, from the cathode plates, and from the anode plates. For example, each of the neutral subsets 512, 514 may be electrically isolated from every other one of the neutral subsets. In a low power mode, the cathode plates 508 may be configured for connecting to a negative polarity source of applied electrical power, for generating hydrogen. The anode plates 510 may be configured for connecting to a
30 positive polarity source of applied electrical power for generating oxygen. The neutral subsets are not connected to any source of electrical power.

The plates 504a-j are preferably copper-tungsten or other highly conductive material. For the creation of hydrocarbon based fuels, the highly conductive material includes a catalytic surface such as is provided by nickelplating. The nickel-plated surface treatment of the conductive plates has been observed to have a catalytic effect on the operation of the aqueous reactor. The plates 504a-j are preferably substantially planar and of substantially uniform thickness "t". It is believed desirable to make the plates thick enough to be durable and rigid during operation of the reactor, and optimal thickness may therefore depend on the selected plate material and plate mounting details. If copper-tungsten is used, the plates are advantageously .125" to avoid accidental bending of the soft material. The plates in the array will preferably be spaced substantially uniformly apart a distance "d" in a range of about 0.125 inches from one another. Further aspects of the field generator "plate" are described in connection with Fig. 7.

The non-electrically conductive framework or member 506 comprises edge supports spaced around a periphery of the plates. Edge supports are believed advantageous to ensure that each plate remains in place during operation. A support member preferably includes other features, for example nozzles 506 for a recirculation manifold as discussed herein. In an embodiment, plate edges were supported by slots formed in blocks of a polymer material, to support the array around a periphery of the plate edges. However, any suitable support structure may be used.

Although the field generator is not limited to a particular number of the plates 504a-j, in one embodiment the apparatus preferably comprises not less than nine and not more than 48 neutral plates. An array having properties as described herein is believed to be effective, and perhaps optimally effective, using twenty-five total plates comprised of two cathode plates 602, two anode plates 604, and 21 neutral plates divided into seven triplets 606a-g.

Fig. 6 shows such an array 600 in a highly schematic form to illustrate an example of an interleaved plate topology for a field generator 600. The illustrated manner of connecting plates in a triplet, anode or cathode is highly schematic, and should not be understood as illustrating or suggesting an actual physical configuration, apart from the illustrated and described topological aspects.

Each of the neutral subsets 606a-g is preferably comprised an odd number of plates, for example, three or five. Three plates per neutral subset (i.e., a triplet) is believed advantageous, although any odd number of three or greater enables interleaving of the neutral subsets, as clearly depicted in Figs. 5 and 6. Interleaving is
5 believed to be advantageous to operation of the field generator for electrolysis of water and other reactions, at least for use with the applied electrical power waveforms as described herein. In the interleaved embodiment shown in Fig. 6, the cathode plates 602 are interleaved with a first neutral triplet 606a, and the anode plates 604 are interleaved with a last neutral triplet 606g. The first and last triplets 606a, 606g are
10 interleaved with their adjoining triplets 606b, 606f, respectively. The intermediate triplets 606b-f are each interleaved with an adjoining triplet. Fig. 1 shows a similar arrangement.

The array 600 may comprise an odd or even number of neutral subsets such as the triplets 606a-g. An odd number of neutral subsets is believed advantageous, at least
15 for use with the applied electrical power waveforms as described herein. Fig. 7 shows a plan view and dimensions for an example of a plate 700 used to construct a field generator as described herein. Plate 700 as shown is employed for the neutral plates 504b, 504d-g, 504i of Fig. 5. Highly conductive materials may be suitable, for example, copper, nickel-plated copper, nickel, platinum or palladium plated metals, or graphite.
20 Other metals have also been used. Any structural conductive material may be used that is either coated or will not be appreciably corroded by the working fluid of the aqueous reactor during use. Any surface material selected may have an effect on the operation of the field generator. There appears to be a catalytic effect observed when nickel plating covers the plates 504a-j in the electrolytic process. Additionally, the presence of
25 nickel, palladium, platinum or other catalysts may be helpful in facilitating a desired reaction at lower temperatures. Various surface treatments can enhance operation of the field generator, although robust hydrolysis of water in a potassium hydroxide solution was even observed using untreated 316 L stainless steel.

The plate 700 may be characterized by opposing generally parallel primary
30 surfaces. One of these surfaces 702 is shown in the plan view of Fig. 7. The opposite surface of plate 300 comprises the second surface. This characteristic enables

construction of a field generator as described in connection with Figs. 5 and 6. These primary surfaces are not necessarily flat and planar, and may be contoured so long as maintaining a generally parallel orientation with respect to the adjacent surface of its closest neighboring plate.

5 The dimensions and shape shown in Fig. 7 are provided by way of example only, and not by limitation. The depicted dimensions and shape are believed useful for, but not critical to, construction of a field generator. The plate 700 includes a central hole 704 to accommodate a non-conductive support member used to support plates in the field generator. The plate 700 could preferably include any number of holes or cutouts
10 and may be made in a variety of shapes. The plate 700 may include a tab 706 for use as an electrical connector to an adjacent plate, to an external power source, or both. As used herein, "plate" is not limited to generally planar components, or to components made of plate stock. Instead, a "plate" should be understood to be preferably generally flat, contoured or folded, with any number of through holes and formed of any suitable
15 material. For example, a grid or wire mesh material, so long as sufficiently rigid to hold its shape in operation, may be configured as a "plate" in the field generator as described herein.

 Substantially all stated above in reference to plate 700 applies to the anode plates 504h, 504j and cathode plates 504a, 504c. In certain of the processes described,
20 the anode plates 504h, 504j and cathode plates 504a, 504c have found further efficiency using holes in these plates. This is particularly true for the hydrocarbon and carbon conversion process. Such anode and cathode plates may include an rectangular matrix of holes of an wide variety of shapes and sizes, for example circular, square, rectangular. The object is to significantly cover the plate with holes. The employment of
25 this type of plate for the anodes and cathodes has been found to cut power requirements and increase production of gas. In this specific embodiment, a plate of copper-tungsten plated with nickel and having a nominal height/width/depth of 6"x6"x1/8" is perforated uniformly before plating with holes 5/16" square. The holes may be spaced apart 1/8", giving a hole center-to-center distance between adjacent holes of
30 7/16". A slightly wider structural border may extend around the periphery of the plate for structural integrity.

Although plate 700 may be generally flat or planar, the field generator is not limited to use of planar plate elements. For example, contouring or folding may be used to increase surface area of a plate, while maintaining a generally parallel relationship with an adjacent plate. Fig. 8A shows a top view of two adjacent contoured plates 802, 804 in a configuration 800 wherein each of the plates 802, 804 includes respective contoured surfaces 806, 808 maintaining collinear (or near collinear) normals for substantially their entire respective extents. A drawback of this configuration is that in an array made up of plates of equal area, exact parallelism cannot be maintained between adjacent plates without individually contouring each plate. This can be avoided by using an alternative configuration 850, shown in Fig. 8B, in which folded adjacent plates 852, 856 present multiple folds defining respective virtual surfaces 856, 858, which are substantially parallel. Adjacent plates 852, 856 may therefore share substantially the same or identical contoured geometries while still providing an aspect of parallelism between adjacent plates. The alternative configurations 800, 850 are currently untested and may not, on balance, be advantageous over flat plates. Advantages of flat plates include simplicity of fabrication, lower cost, easily achieved parallelism and less resistance to fluid flow between adjacent plates.

Fig. 9 shows an example of a field generator 502 assembled into an aqueous reactor (oxyhydrogen generator) 900. The reactor 900 includes a substantially closed vessel or container 904, constructed for holding a liquid working fluid so as to immerse the field generator 902. The field generator 902 may comprise an array of plates, for example, the neutral plate 700 as shown in Fig. 7 and a perforated rectangular anode/cathode plate as described above, supported by a non-electrically conductive framework 906.

A cylindrical non-conductive support member (not shown) may pass through a central hole 907 in the plates to secure the plates to the supporting framework. The plates may be connected to provide cathode plate sets, anode plate sets, and neutral sets as described herein, using connectors (not shown) placed across selected connecting tabs at the upper end of the generator 902. During operation, the liquid level in the container 904 may be maintained below the level of the plate connecting tabs, for example the tab 908 that is connected to an electrical cable 910 supplying electrical

power to the field generator 902. A complementary electrical cable, not visible in this view, may similarly be connected to a plate of opposite polarity located at an opposite end of the array 902. The cable 910 or its complement may be passed through a wall of the container 904 using a feed-through 912 designed to maintain a seal. Where power
5 straps are employed in the bath to distribute current, they too may be nickel coated and of a highly conductive material to reduce heat build-up and provide more catalytic surface area. The container 904 may be substantially sealed except for control inlet and outlet ports, examples of which are discussed below. In the illustrated unit 900, an O-ring seal 914 is disposed around a base; however, any suitable seal may be used.

10 A liquid inlet 918 and outlet 920 in the base 916 may be provided for connecting to a recirculation system, which may comprise a pump, heat exchanger, and connecting lines. The recirculation system, among other things, may circulate the working fluid through an array of nozzles in the base 916. The nozzles preferably inject the working fluid in between individual plates in the field generator 902. Fluid injection between the
15 plates is believed helpful for enhancing fluid movement, heat transfer and mixing between the plates, and help strip accumulated gas bubbles from the plate surfaces. Upper ports include one or more liquid addition ports 524 and 526 for addition and make-up of working fluid constituents, and a solids entry/inspection port 528.

20 Conclusion

This document describes specific embodiments of one or more inventions. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the invention(s) as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an
25 illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present teachings.

The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the
30 claims. The scope of any invention described herein is defined solely by the appended

claims including any amendments made during the pendency of this application and all equivalents of those claims as issued.

Moreover in this document, relational terms, such as second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms “comprises,” “comprising,” “has,” “having,” “includes,” “including,” “contains,” “containing” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises, has, includes, contains a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by “comprises a”, “has ...a”, “includes ...a”, “contains ...a” does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises, has, includes, contains the element. The terms “a” and “an” are defined as one or more unless explicitly stated otherwise herein. The terms “substantially”, “essentially”, “approximately”, “about” or any other version thereof, are defined as being close to as understood by one of ordinary skill in the art, and in one non-limiting embodiment the term is defined to be within 10%, in another embodiment within 5%, in another embodiment within 1% and in another embodiment within 0.5%. The term “coupled” as used herein is defined as connected, although not necessarily directly and not necessarily mechanically. A device or structure that is “configured” in a certain way is configured in at least that way, but may also be configured in ways that are not listed.

The Abstract of the Disclosure is provided to allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a

single disclosed embodiment. Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.

CLAIMS

What is claimed is:

1. A Oxygen/Hydrogen Non-atmospheric Intake Combustion Engine System comprising:
an air-tight combustion chamber configured to eliminate atmosphere intake and without connection to an operable atmosphere intake mechanism,
an oxygen/hydrogen injection system operably adjoined to the combustion chamber to inject an oxygen and hydrogen mixture into the chamber;
an igniter system configured to ignite an oxygen and hydrogen mixture,
an exhaust system,
a piston configured to reciprocate within the combustion chamber; and
one or more oxygen/hydrogen production devices that produces an oxygen and hydrogen mixture that is injected by the injection system into the combustion chamber.
2. The oxygen/hydrogen non-atmospheric intake combustion engine system of claim 1 further including one or more energy collecting devices.
3. The oxygen/hydrogen non-atmospheric intake combustion engine system of claim 2 wherein the energy collecting device is selected from the group consisting of an air pump, a hydraulic pump and a generator.
4. The oxygen/hydrogen non-atmospheric intake combustion engine system of claims 2 or 3 further including one or more flywheels for stabilizing engine RPM due to load fluctuations applied by the energy collection device.
5. The oxygen/hydrogen non-atmospheric intake combustion engine system of any of claims 1 – 4 further including one or more electronic controllers to control the injection system and the ignition system and turning cylinders on and off depending on power requirements.

6. The oxygen/hydrogen non-atmospheric intake combustion engine of any of claims 1-5 wherein liquid water and/or water in an ultrafine particle mist is injected into the combustion engine in conjunction with hydrogen and oxygen.
7. The oxygen/hydrogen non-atmospheric intake combustion engine of any of claims 1-6 wherein an inert gas is injected into the combustion engine in conjunction with hydrogen and oxygen, and wherein the inert gas is exhausted to the atmosphere and/or recycled for further use in the combustion engine.
8. The oxygen/hydrogen non-atmospheric intake combustion engine of any of claims 1-7 wherein carbon dioxide is injected into the combustion engine in conjunction with hydrogen and oxygen for the purpose of increasing the combustion flame speed.
9. The oxygen/hydrogen non-atmospheric intake combustion engine of any of claims 1-8 wherein a combustible fuel in addition to hydrogen/oxygen is injected into the combustion engine together with sufficient quantity of an oxidizer to ensure appropriate combustion of the supplemental fuel.
10. The oxygen/hydrogen non-atmospheric intake combustion engine of claims 9 wherein the supplemental combustible fuel is selected from the list of hydrocarbons, carbon dioxide, carbon monoxide, and elemental carbon, such that the products of combustion are substantially carbon dioxide and water, allowing separation and capture of the carbon dioxide.
11. The oxygen/hydrogen non-atmospheric intake combustion engine of any of claims 1-19 wherein the intake combustion engine is an internal combustion engine and the compression ratio of the intake stroke is substantially zero.
12. The oxygen/hydrogen non-atmospheric intake combustion engine of any of claims 1-9 wherein the intake combustion engine is an internal combustion piston

engine and hydrogen/oxygen intake is timed to occur substantially at the point of top-dead-center and combustion is timed to occur immediately thereafter, including at and/or after top-dead-center.

13. A method of producing energy comprising:
operating an oxygen/hydrogen non-atmospheric intake combustion engine system, the combustion engine system comprising an air-tight combustion chamber configured to eliminate atmosphere intake and without connection to an operable atmosphere intake mechanism, an oxygen/hydrogen injection system operably adjoined to the combustion chamber to inject a gaseous oxygen and hydrogen mixture into the chamber, an igniter system configured to ignite an oxygen and hydrogen mixture, an exhaust system, a piston configured to reciprocate within the combustion chamber, and one or more oxygen/hydrogen production devices that produces the gaseous oxygen and hydrogen mixture that is injected by the injection system into the combustion chamber; and
collecting the energy produced by the combustion engine system with one or more energy collection devices operably adjoined to the combustion engine system to produce electricity from the rotation of one or more devices.
14. An oxygen/hydrogen non-atmospheric intake combustion engine system as disclosed and described herein.
15. A method of operating a combustion engine, the method comprising:
providing an substantially closed combustion chamber having an interior volume operatively coupled to an igniter and a fuel injector;
injecting a hydrogen-oxygen fuel mixture into the interior volume via the fuel injector; and

automatically operating the igniter to initiate combustion of the injected hydrogen-oxygen fuel mixture so that the combustion engine exhibits a compression ratio less than or equal to 3.

16. The method of claim 15, wherein the compression is ratio is between 1.0 and 2, inclusive.
17. The method of claim 15 or 16, wherein the combustion engine has no atmospheric intake.
18. The method fo claim 15, 16, or 17, wherein the combustion engine is completely submerged under water.
19. A combustion engine comprising:
a substantially closed combustion chamber having an interior volume operatively coupled to an igniter and an injector for hydrogen-oxygen fuel mixture;
means for automatically controlling the fuel injector to inject the hydrogen-oxygen fuel mixture into the interior volume and the igniter to initiate combustion of the mixture at a compression ratio less than or equal to 3.
20. The engine of claim 19, wherein the compression is ratio is between 1.0 and 2, inclusive.



Fig. 1A

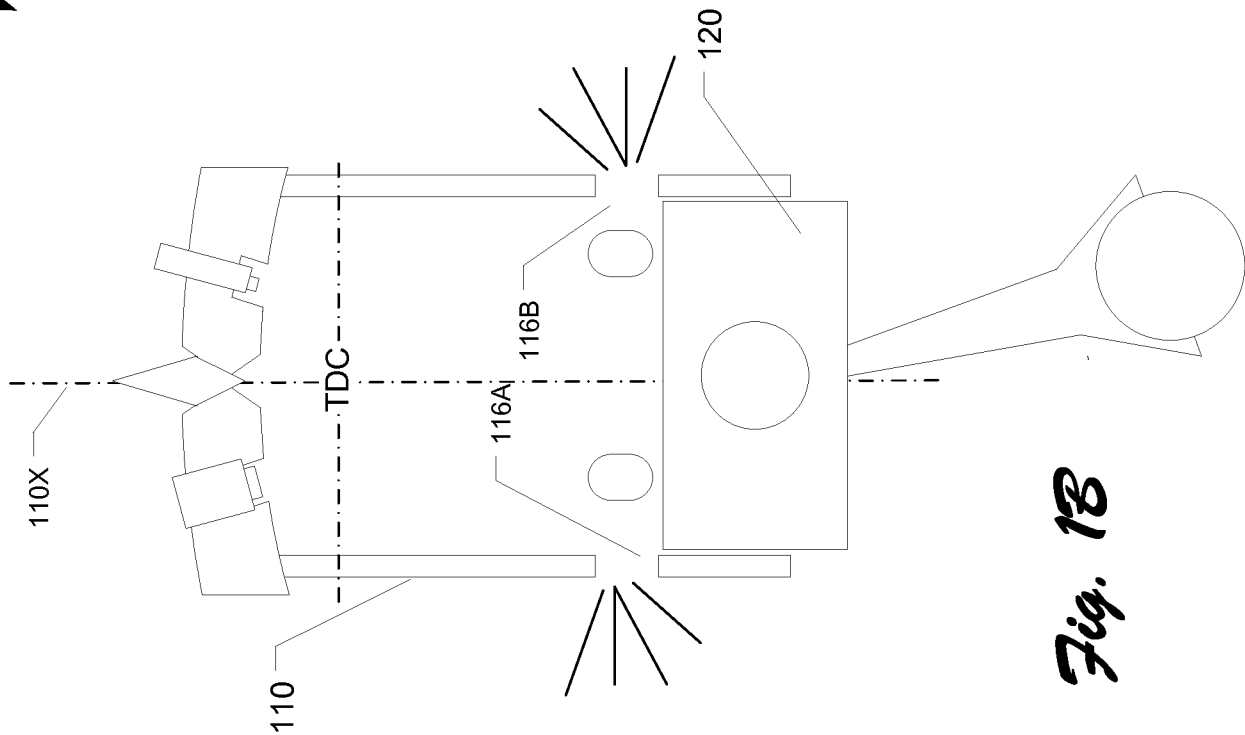


Fig. 1B

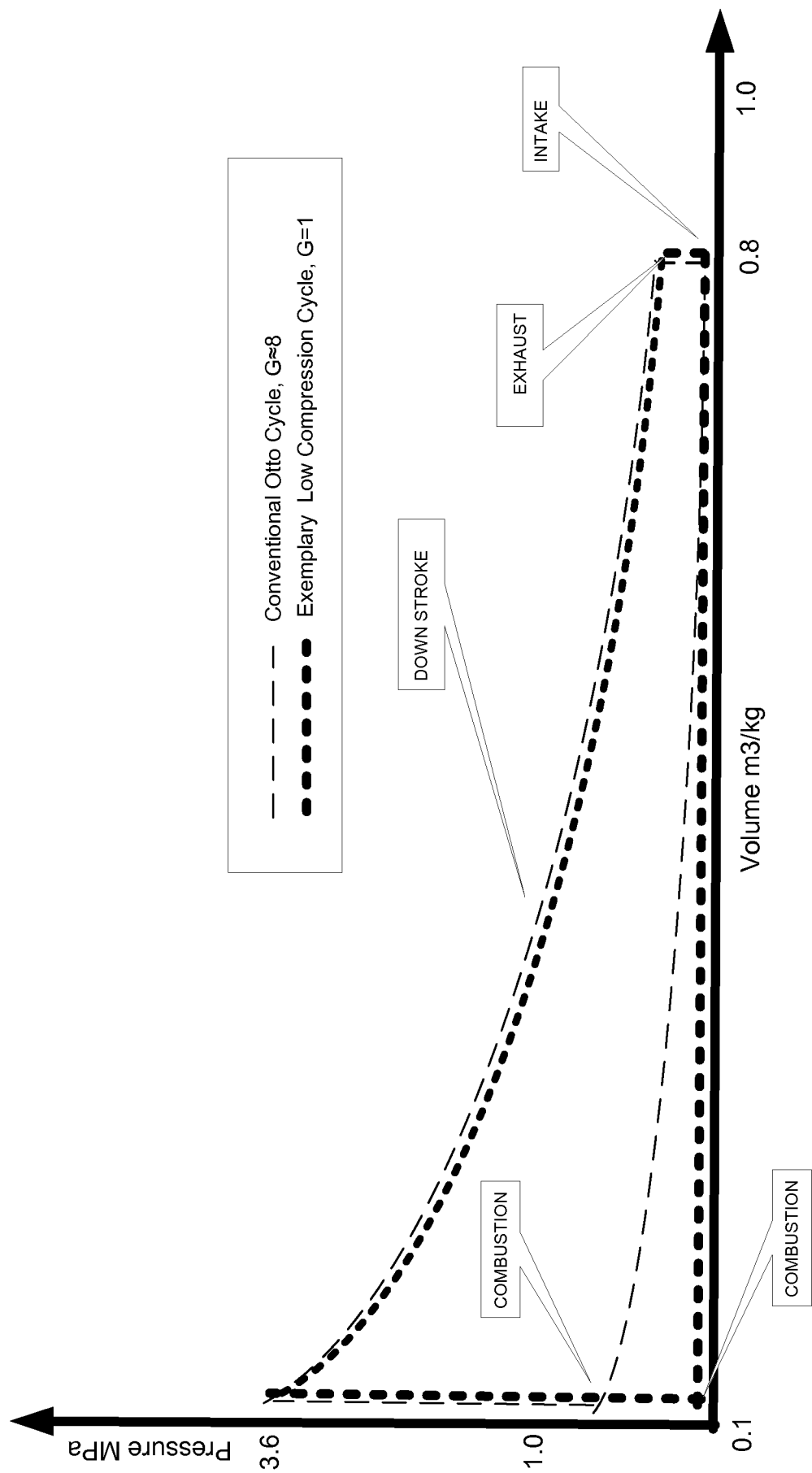
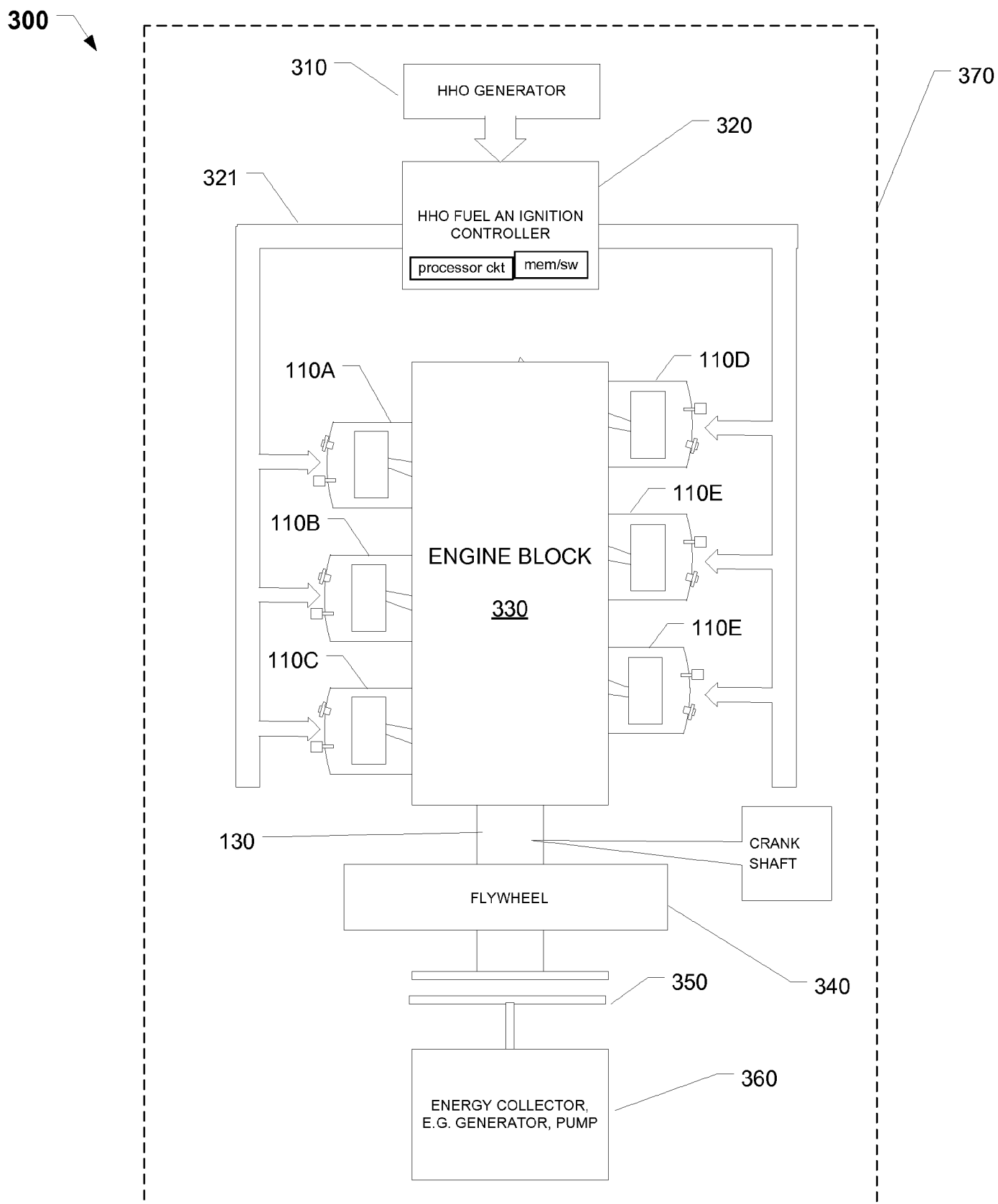


Fig. 2

*Fig. 3*

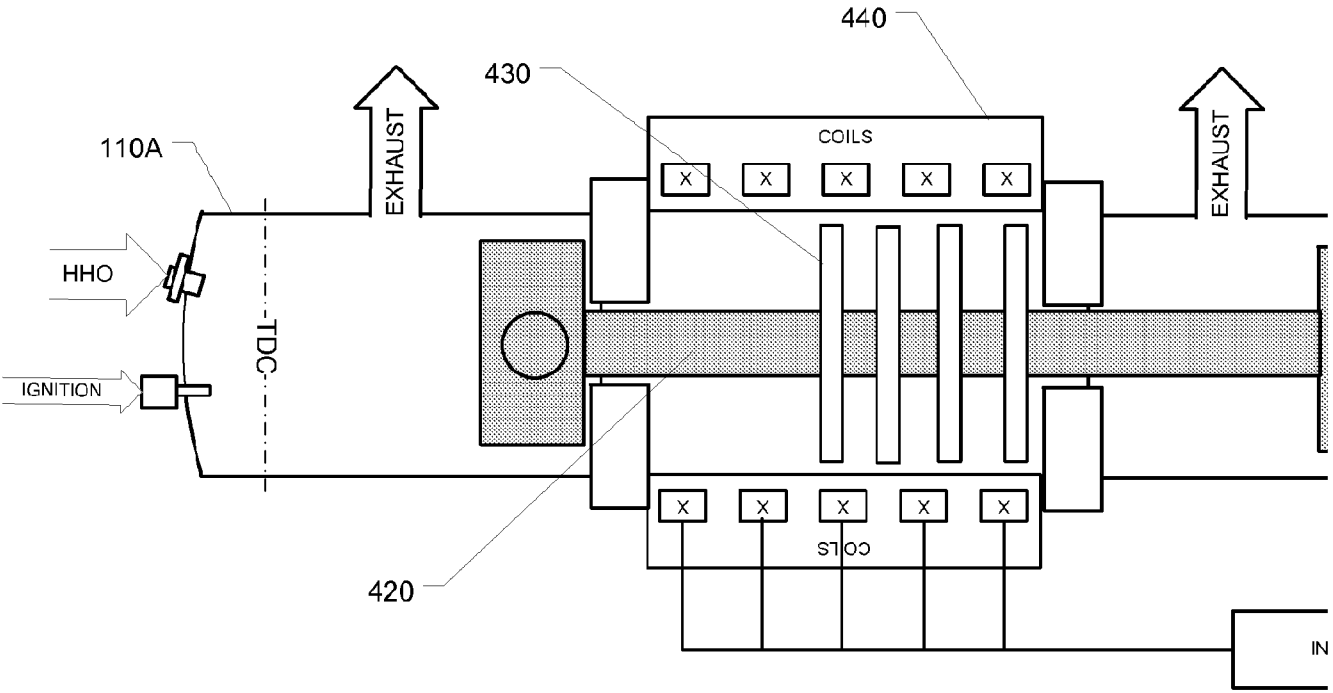


Fig. 4

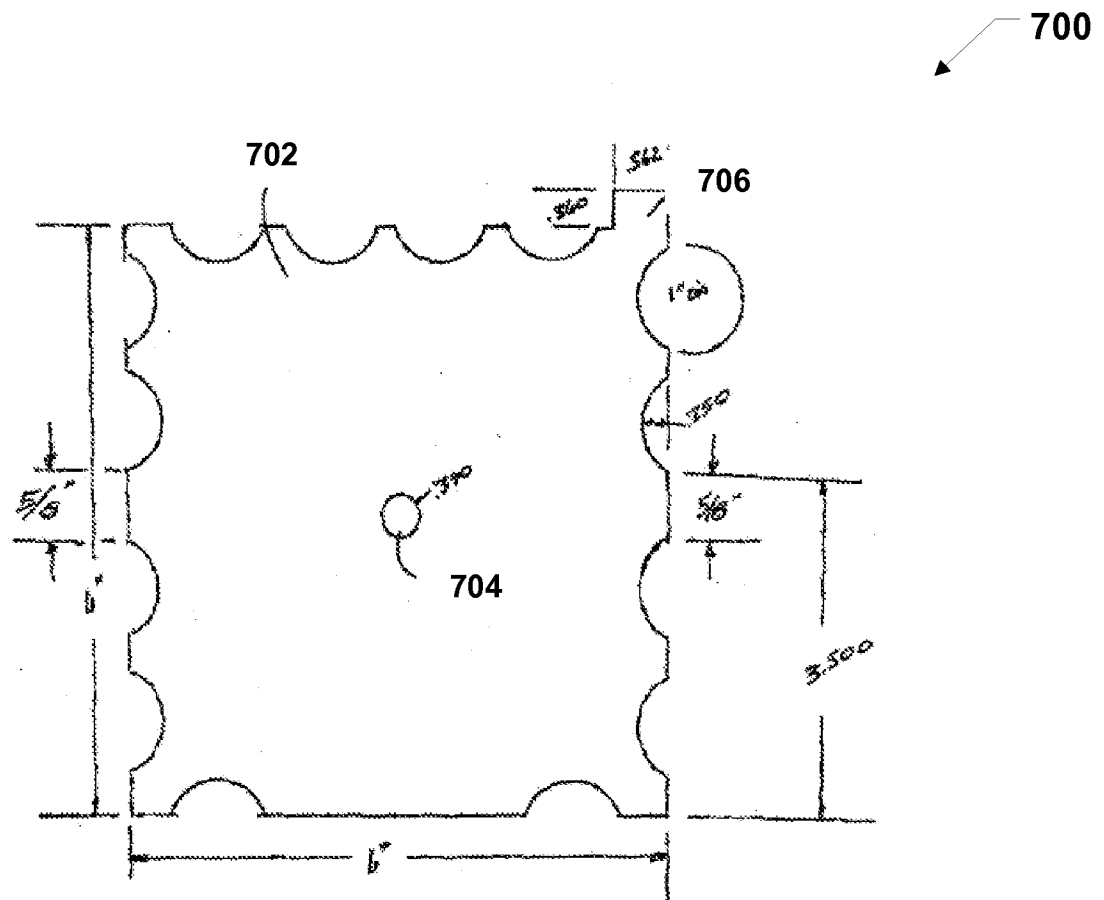


Fig. 7

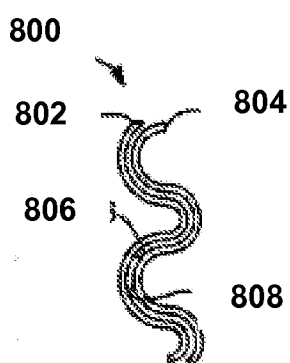


Fig. 8A

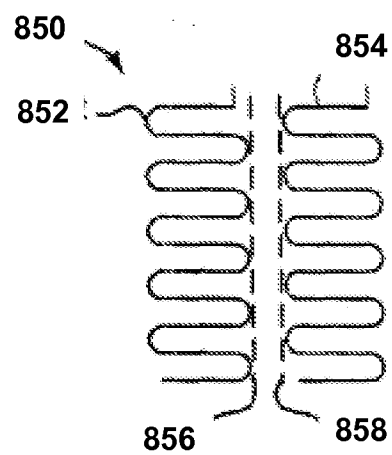


Fig. 8B

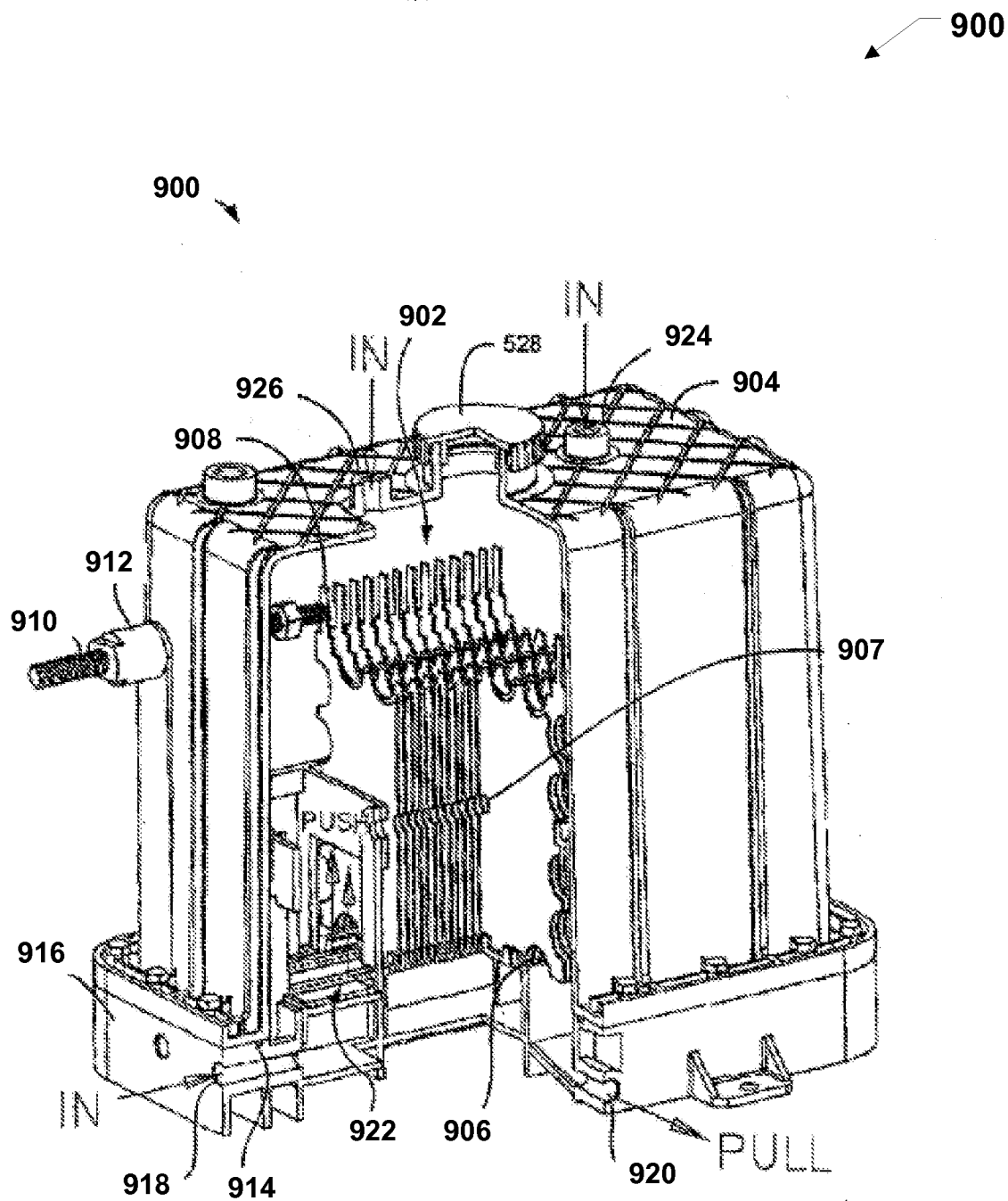


Fig. 9