(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 February 2013 (21.02.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/025651 A1

(51) International Patent Classification:
F02F 3/12 (2006.01) *F02F 1/00* (2006.01)
F01L 3/04 (2006.01) *F02B 23/00* (2006.01)

(21) International Application Number:
PCT/US2012/050662

(22) International Filing Date:
13 August 2012 (13.08.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/523,275 12 August 2011 (12.08.2011) US

(71) Applicant *(for all designated States except US)*: **MCALISTER TECHNOLOGIES, LLC** [US/US]; 3349 E. Blackhawk, Phoenix, AZ 85050 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **MCALISTER, Roy, Edward** [US/US]; 3349 E. Blackhawk, Phoenix, AZ 85050 (US).

(74) Agents: **BETCHER, Susan, D.** et al.; Perkins Coie LLP, P.O. Box 1247, Seattle, WA 98111-1247 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: COMBUSTION CHAMBER INSERTS AND ASSOCIATED METHODS OF USE AND MANUFACTURE

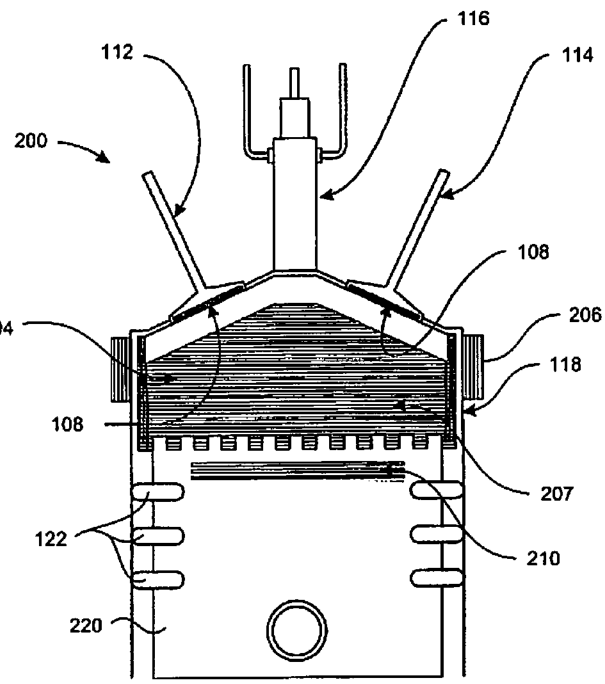

FIG. 2

(57) Abstract: Combustion chamber inserts and associated methods of use and manufacture are disclosed herein. In some embodiments, a combustion chamber assembly comprises a cylinder having a cylinder wall at least partially defining a combustion chamber, an intake valve, an exhaust valve, and a piston. The intake valve has an intake valve surface exposed to the combustion chamber, the exhaust valve has an exhaust valve surface exposed to the combustion chamber, and the piston has a piston surface exposed to the combustion chamber. At least one of the cylinder wall, the intake valve surface, the exhaust valve surface, and/or the piston surface includes an insulative portion composed of a synthetic matrix characterization of crystals that is configured to retain heat in the combustion chamber that is generated from a combustion event in the combustion chamber.

WO 2013/025651 A1

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

COMBUSTION CHAMBER INSERTS AND ASSOCIATED METHODS OF USE AND MANUFACTURE

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of and priority to U.S. Provisional Application No. 61/523,275, filed August 12, 2011, entitled, "COMBUSTION CHAMBER INSERTS AND ASSOCIATED METHODS OF USE AND MANUFACTURE," which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The following disclosure relates generally to combustion chamber inserts and, more specifically, to combustion chamber inserts having heat blocking, heat retaining, heat transferring, and/or insulative properties.

BACKGROUND

[0003] Internal combustion systems include combustion of a fuel with an oxidizer in a combustion chamber. The hot gases produced by the combustion event occupy a greater volume than the original fuel and create an increase in pressure within the limited volume of the chamber. This pressure can be used to do work (e.g., move a piston), generating useful mechanical energy. Internal combustion systems are generally most efficient when there is more complete fuel burning at higher temperatures in the chamber. However, combustion chamber liners or coatings designed to improve wear-resistance often increase thermal conduction of the heat outside the combustion chamber. Accordingly, there exists a need for mechanisms to improve combustion efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Figure 1 is a schematic cross-sectional side view of a combustion chamber assembly configured in accordance with an embodiment of the disclosure.

[0005] Figure 2 is a schematic cross-sectional side view of a combustion chamber assembly configured in accordance with another embodiment of the disclosure.

[0006] Figure 3 is a schematic cross-sectional side view of a combustion chamber assembly configured in accordance with another embodiment of the disclosure.

DETAILED DESCRIPTION

[0007] The present disclosure describes devices for providing combustion chamber assemblies with inserts for receiving, retaining, transferring, and/or insulating heat in a combustion chamber. The disclosure further describes associated systems, assemblies, components, and methods regarding the same. Certain details are set forth in the following description and in Figures 1-3 to provide a thorough understanding of various embodiments of the disclosure. However, other details describing well-known structures and systems often associated with internal combustion engines, combustion chambers, pistons, injectors, igniters, and/or other aspects of combustion systems are not set forth below to avoid unnecessarily obscuring the description of various embodiments of the disclosure. Thus, it will be appreciated that several of the details set forth below are provided to describe the following embodiments in a manner sufficient to enable a person skilled in the relevant art to make and use the disclosed embodiments. Several of the details and advantages described below, however, may not be necessary to practice certain embodiments of the disclosure.

[0008] Figure 1 is a schematic cross-sectional side view of a combustion chamber assembly 100 configured in accordance with an embodiment of the disclosure. As will be described in further detail below, the combustion chamber assembly 100 can include one or more heat-retaining portions, or inserts, capable of directional heat transfer. The inserts can have an insulative property for blocking heat from traveling in a first direction (e.g., to other parts of the engine), and can have efficient heat transfer properties for facilitating heat transfer or temporarily holding heat and then transferring heat in a second direction (e.g., downstream to facilitate a phase transition of exhaust products).

[0009] In the illustrated embodiment, the combustion chamber assembly 100 includes a combustion chamber 104 at least partially defined by an engine cylinder wall 118. An injector 116 is configured to provide fuel and/or coolant injection to the combustion chamber 104. In some embodiments, the injector 116 is a fuel-injector/igniter having features such as those described in U.S. Patent Application Number 13/027,051, titled, "FUEL INJECTOR ASSEMBLIES HAVING ACOUSTICAL

FORCE MODIFIERS AND ASSOCIATED METHODS OF USE AND MANUFACTURE," filed February 14, 2011, and incorporated herein by reference in its entirety.

[0010] The combustion chamber assembly 100 can further include one or more intake valves 112 and one or more exhaust valves 114 that allow fluid (e.g., air) flow into and out of the combustion chamber 104, respectively. The intake and exhaust valves 112, 114 can be movable between open and closed positions relative to the cylinder wall 118 and can have surfaces exposed to the combustion chamber 104. The combustion chamber assembly 100 can further include an energy transfer device, such as a piston 120, moveable relative to the cylinder wall 118. In some embodiments, the piston 120 can be a composite piston made of internally-reinforced material, such as ceramic, carbon-carbon composite, and/or nano-spaced arrays of laminar graphite or boron nitride. The piston 120 can be annularly surrounded by piston rings 122 configured to inhibit pressurized fluid from escaping the combustion chamber 104 via space between the piston 120 and the cylinder wall 118. The piston 120 can have one or more surfaces exposed to the combustion chamber 104.

[0011] The combustion chamber assembly 100 can further include a sensor and/or transmitting component for detecting and relaying combustion chamber properties and events such as temperatures and pressure and providing feedback to the controller 126. The sensor can be integral to the intake valve 112, exhaust valve 114, injector 116, or other components of the combustion chamber assembly 104 such as component 106. In some embodiments, for example, the sensor can include optical instrumentation, such as infrared temperature monitoring components in the fuel injector 116, and/or a suitable thermistors or thermocouples that monitor the combustion chamber or exhaust temperature. Combustion data can be transmitted via wireless, wired, optical, or other transmission mediums to the controller 126 or other components. Such feedback enables extremely rapid and adaptive adjustments for desired fuel injection factors and characteristics including, for example, fuel delivery pressure, fuel injection initiation timing, combustion chamber pressure and/or temperature, the timing of one, multiple or continuous plasma ignitions or capacitive discharges, etc. For example, the sensor can provide feedback to the controller 126 as to whether the measurable conditions within the combustion chamber 104, such as temperature or pressure, fall within ranges that have been predetermined to provide desired combustion efficiency. Upon combustion chamber components reaching the desired temperature, one or more cooling and work producing cycles are performed as may be indicated by the sensors.

[0012] As described above, the combustion chamber assembly 100 can include one or more inserts that can receive, retain, and/or transfer heat that would otherwise be wastefully dissipated from the combustion chamber 104. In the illustrated embodiment, the combustion chamber assembly 100 includes valve inserts 108 on the intake valve 112 and/or the exhaust valve 114. A piston insert 110 is coupled to a surface of the piston 120 facing the combustion chamber 104. The combustion chamber assembly 100 further includes a cylinder insert 106 on the cylinder wall 118. The valve inserts 108, the piston insert 110, and the cylinder insert 106 (referred to collectively as "inserts") can be integral to the combustion chamber assembly 100 or can be separate components coupled to the assembly 100. If the inserts are separate components, they can be attached to the combustion chamber assembly 100 by glue, solder, braze, screws, latches, or other attachment mechanisms. In embodiments in which the inserts are an integral portion of the combustion chamber assembly 100, the inserts can comprise a coating that is applied to combustion chamber assembly 100 components that are exposed to heat from combustion.

[0013] In various embodiments, the inserts can include the following materials: boron nitride, aluminum nitride, silicon nitride, graphite, graphene, carbon, beryllia, magnesium aluminum boride, carbon and boron, carbon and silicon, carbon and nitride, silicon carbide, silicon boride, an architectural construct, combinations of these materials, or other materials having similarly suitable thermal properties. In some embodiments, the coating material can include architectural construct, as described in U.S. Patent Application No. 13/027,214 titled, "ARCHITECTURAL CONSTRUCT HAVING FOR EXAMPLE A PLURALITY OF ARCHITECTURAL CRYSTALS," filed February 14, 2011, and herein incorporated by reference in its entirety. In some embodiments, the inserts comprise a synthetic matrix characterization of crystals that are configured to retain heat. In several embodiments, the material has a zero, or near-zero, thermal expansion.

[0014] Some factors that determine an appropriate material choice include the mass of the material, the specific heat, the latent heat of solidification, the surface to volume ratio, the surface finish/reflectivity, the color, the ability to include fins on the material for increased dimension and surface area, and the types of interaction the material has with flowing fluids, radiation, etc. In certain embodiments, the insert can include parallel, spaced-apart layers of microscopically-thin deposits of various materials chosen for particular thermal properties. For example, the insert can comprise spaced-apart graphite or graphene plates, which provide a low-density material having a relatively high heat-transfer. In further embodiments, the spaced-apart layers can be connected to cooling or heating sources to enhance conduction, radiation, and/or evaporation/condensation by/through the layers.

[0015] In some embodiments, the insert can include different materials on different layers or portions of the insert. For example, a material having low thermal conduction could contact a combustion chamber assembly 100 component, such as the cylinder wall 118 or the piston 120, and another material having a high heat capacity could be layered on the first material and could face the combustion chamber 104. In some embodiments, using combinations of multiple materials on the inserts supports multi-phase systems, particularly in large engines with relatively low piston or rotor speeds. For example, the inserts can include thermal shock resistance material such as spinels or can include an architectural construct as a piston insert 110; diamond-coating containing one or more annular rings of sodium, lithium, phosphorous, sulfur, or indium for a cylinder wall insert 106; and eutectoids and eutectics as valve inserts 108.

[0016] The insert coating can be applied by various techniques, including, for example, anodizing, diffusion bonding and/or processes that form carbides, borides, and nitrides (e.g., aluminum nitride ion implantation, boron ion implantation), carburizing with boron, carburizing with nitride, carburizing with molybdenum, and/or carburizing with magnesium. In some embodiments, a coating can be applied by hardening the surface of a component of the combustion chamber assembly 100. In some embodiments, the surface can be hardened with a material selected to provide the surface with extended wear capability, reduced starting friction, reduced sliding friction, and/or improved corrosion resistance. The process can further include smoothing at least one surface of the component and applying a treatment to the surface such as ion implantation, chemical vapor deposition, electroplating, electroless plating, sputtering, flame spraying, plasma spraying, diamond-like carbon deposition, magnesiumaluminumboron deposition, nickel deposition, chromium deposition, aluminum deposition, aluminum nitride deposition, and/or titanium boride deposition.

In other embodiments, the coatings can be applied using alternate or additional techniques.

[0017] In various embodiments, the inserts can be oriented in the combustion chamber assembly 100 to achieve a desired thermal effect. For example, in some embodiments, inserts (e.g., the crystal matrix of the insert material) can be oriented to be transverse to the direction of heat transfer to improve thermal retention. In further embodiments, inserts can have portions oriented at different angles relative to one another. For example, in a particular embodiment, one portion of an insert can insulate the top of the piston 120 while another portion insulates the cylinder wall 118. These portions of the insert can be oriented in different directions relative to one another (and yet both be oriented transverse to heat flow) to provide optimal insulation for the combustion chamber 104. In still further embodiments, a single insert can have layers oriented at nonzero angles relative to one another on the same portion of the insert. For example, an insert insulating the top of the piston 120 can have some layers oriented transversely to the heat transfer direction and other layers oriented obliquely to the heat transfer direction.

[0018] In operation, the inserts act as a thermal flywheel, and can provide inertia against temperature fluctuations in the components beneath or that support the inserts in combustion chamber 104. The inserts block, seal, reflect, or otherwise retain heat in the combustion chamber 104 to prevent the heat from conducting away from the combustion chamber 104. Heat that is not conducted and/or reflected into the combustion chamber can be held or retained in thermal flywheel heat transfer portions to be subsequently transferred to work, producing expansive substances during a cooling phase in the combustion chamber and/or in an additional expander. In some embodiments, the inserts can serve to as a thermal flywheels to heat/cool phase change substances. The inserts can be used in conjunction with cooling methods and systems described in U.S. Patent Application Number 13/027,170, titled, "METHODS AND SYSTEMS FOR ADAPTIVELY COOLING COMBUSTION CHAMBERS IN ENGINES," filed February 14, 2011, and herein incorporated by reference in its entirety.

[0019] The inserts can also be configured to rapidly give up retained heat during a cooling phase, such as when coolant is injected into the combustion chamber 104 such as during the intake, compression, power and/or exhaust strokes. The amount of energy retained by the inserts, and the ability to retain or release that heat, is determined by the size, placement, shape, and material choice of the inserts. The energy is released to the fluids in the combustion chamber by contact, radiation, or other energy-emission transfer. As described above, sensors in the combustion chamber 104 can provide data to the controller 126, including brake mean effective pressure indicators such as combustion chamber pressure, positive or negative flywheel acceleration, the temperature of the combustion chamber, and/or the temperature of the inserts. The controller 126 can in turn manipulate the combustion chamber 104 conditions by controlling, for example, the frequency of cooling intake, cooling compression, cooling work, and/or the cooling exhaust cycle in a combustion chamber 104. This sensor/controller 104 interaction thereby determines how much heat is reflected by the inserts and how much is held or retained.

[0020] In the illustrated embodiment, the valve inserts 108 face the combustion chamber 104 and have thermal properties that can receive, retain, and/or transfer heat in the combustion chamber 104. The piston insert 110 can block heat transfer to other portions of the piston 120 or combustion chamber assembly 100. The cylinder insert 106 can block heat transfer from the combustion chamber 104 to other zones of the engine assembly. The inserts can together hold the heat of combustion and release it back to the air and fuel and/or the combustion gases in the combustion chamber 104 for the next stroke. In various embodiments, the inserts can be applied to one or more of the piston 120; intake and/or exhaust valves 112, 114; exposed portions of the combustion chamber 104 head; cylinder wall 118; and/or piston rings 122 and/or to the exhaust gas passageways. In further embodiments, the combustion chamber assembly 100 can include more or fewer inserts than illustrated, and the inserts can be located on additional or alternate surfaces of the combustion chamber assembly 100.

[0021] The inserts can improve the efficiency of combustion by retaining heat in the combustion chamber 104, increasing fuel-combustion efficiency, and decreasing fuel requirements. The inserts can additionally reduce the demand for general cooling (e.g., a water jacket), as more of the heat generated in the combustion chamber 104 stays in the combustion chamber 104 and does not need to be dissipated. Furthermore, wear on engine parts caused by exposure to conducted heat is reduced, as fewer engine parts are exposed to high-temperature conducted heat from combustion.

[0022] The features of the combustion chamber assembly 100 described above with reference to Figure 1 can be included in any of the embodiments described below with reference to Figures 2 and 3 or in other embodiments of combustion chamber assemblies that have been described in publications that have been incorporated by reference herein. Furthermore, some or all of the features of the combustion chamber assembly 100 can be used with a wide variety of engines including, but not limited to, two-stroke and four-stroke piston engines, rotary combustion engines, gas turbine engines, or combinations of these. The features of the combustion chamber assembly 100 can likewise be used with a wide variety of fuel types including diesel, gasoline, natural gas (including methane, ethane, and propane), renewable fuels (including fuel alcohols—both wet and dry—and nitrogenous fuels such as ammonia), and designer fuels.

[0023] Figure 2 is a schematic cross-sectional side view of a combustion chamber assembly 200 configured in accordance with another embodiment of the disclosure. The combustion chamber assembly 200 includes several features generally similar to the combustion chamber assembly 100 described above with reference to Figure 1. For example, the combustion chamber assembly 200 includes an injector 116 configured to provide fuel and/or coolant injection to a combustion chamber 104. The combustion chamber 104 is formed from an engine cylinder wall 118, cylinder insert 206, piston 211, piston insert 207, engine head 201, valve 112, valve 114, and valve inserts 108. The combustion chamber assembly 200 can further include the mechanical operating assembly of one or more intake valves 112, one or more exhaust valves 114, and a moveable piston 220 annularly surrounded by piston rings 122.

[0024] As described above, the combustion chamber assembly 200 can include one or more inserts capable of acting as thermal flywheels to block, reflect, retain, insulate, or transfer heat. For example, in the illustrated embodiment, the combustion chamber assembly 200 includes valve inserts 108 on the intake valve 112 and the exhaust valve 114 facing the combustion chamber 104. The combustion chamber assembly 200 further includes a piston insert 210 attached or incorporated within the piston 220. The positioning of the piston insert 210 thereby inhibits heat from combustion from migrating below the piston insert 210 and the piston rings 122. In further embodiments, the combustion chamber assembly 200 can include additional piston inserts located on other or additional surfaces of the piston 220 and/or in head

201. In operation, the one or more inserts protect the engine by retaining the heat in the combustion chamber rather than allowing it to impacts the engine durability, the insert further directs and reradiates the heat from the combustion event through an exhaust port.

[0025] In addition to the valve and piston inserts 108, 210, the combustion chamber assembly 200 further includes a combustion chamber insert 207 that substantially covers an interior surface of the combustion chamber 104. The combustion chamber insert 207 can provide an increased surface area of thermal material to reflect or retain heat in the combustion chamber. A cylinder insert 206 can be attached to the cylinder wall 118 to further retain heat in the combustion chamber 104 and inhibit heat transfer to other parts of the engine. In some embodiments, the combustion chamber insert 207 and cylinder wall insert 206 are oriented at various angles such as offset to one another. In further embodiments, the combustion chamber insert 207 and the cylinder wall insert 206 are oriented at the same angle relative to one another. One or more of the inserts can be aligned in an orientation transverse to the movement of heat from combustion.

[0026] Figure 3 is a schematic cross-sectional side view of a combustion chamber assembly 300 configured in accordance with another embodiment of the disclosure. The combustion chamber assembly 300 includes several features generally similar to the combustion chamber assembly 100 described above with reference to Figure 1. For example, the combustion chamber assembly includes an injector 116 configured to provide fuel (illustrated by fuel spray lines 303) and/or coolant injection to a combustion chamber 304. The combustion chamber assembly 300 can further include one or more intake valves 112 and one or more exhaust valves 114 that allow fluid flow into and out of the combustion chamber 304, respectively, and a piston 320 moveable by a crank shaft and pressure from expanding gas in the combustion chamber 304. In the illustrated embodiment, the piston 320 includes a piston extension 305 attached to the piston 320 and configured to move with the piston 320 and may alter the size and shape of the combustion chamber 304. While the piston extension 305 in the illustrated embodiment includes a double-curved surface facing the combustion chamber 304, other shapes may be used in other embodiments.

[0027] The combustion chamber assembly 300 includes a piston insert 310 attached to the piston extension 305. The piston insert 310 lines at least a portion of the curved surface of the piston extension 305 and faces the combustion chamber 304. The piston insert 310 thereby blocks, seals, reflects, or otherwise retains heat in the combustion chamber 304 to prevent the heat from transferring away from the combustion chamber 304 to other zones of the engine assembly. In some embodiments, the piston insert 310 is oriented transverse to the direction of heat flow. In other embodiments, the piston insert 310 can have other orientations or can include layers or portions with different orientations. The piston insert 310 can be used alone or with any of the other inserts described above.

[0028] Many of the details, dimensions, angles, shapes, and other features shown in the Figures are merely illustrative of particular embodiments of the disclosure. Accordingly, other embodiments can have other details, dimensions, angles, and features without departing from the spirit or scope of the present disclosure. For example, the embodiments disclosed herein can be used with various types of engines or related systems known in the art. In addition, those of ordinary skill in the art will appreciate that further embodiments of the disclosure can be practiced without several of the details described below.

[0029] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. Thus, the occurrences of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. The headings provided herein are for convenience only and do not interpret the scope or meaning of the claimed disclosure.

[0030] It will be apparent that various changes and modifications can be made without departing from the scope of the disclosure. Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in a sense of "including, but not limited to." Words using the singular or plural number also include the plural or singular number, respectively. When the claims use the word "or" in reference to a list of two or more items, that word covers all of the following interpretations of the word: any of the items in the list, all of the items in the list, and any combination of the items in the list.

[0031] Features of the various embodiments described above can be combined to provide further embodiments. All of the U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet are incorporated herein by reference, in their entirety. Aspects of the disclosure can be modified, if necessary, to employ combustion chamber assemblies with various configurations, and concepts of the various patents, applications, and publications to provide yet further embodiments of the disclosure.

[0032] These and other changes can be made to the disclosure in light of the above detailed description. In general, in the following claims, the terms used should not be construed to limit the disclosure to the specific embodiments disclosed in the specification and the claims, but should be construed to include all systems and methods that operate in accordance with the claims. Accordingly, the invention is not limited by the disclosure, but instead its scope is to be determined broadly by the following claims.

[0033] The present application incorporates by reference in their entirety the subject matter of each of the following U.S. Patent Applications:

[0034] U.S. Patent Application Number 13/027,051, titled, "FUEL INJECTOR ASSEMBLIES HAVING ACOUSTICAL FORCE MODIFIERS AND ASSOCIATED METHODS OF USE AND MANUFACTURE," filed February 14, 2011; U.S. Patent Application No. 13/027,214 titled, "ARCHITECTURAL CONSTRUCT HAVING FOR EXAMPLE A PLURALITY OF ARCHITECTURAL CRYSTALS," filed February 14, 2011; U.S. Patent Application Number 13/027,170, titled, "METHODS AND SYSTEMS FOR ADAPTIVELY COOLING COMBUSTION CHAMBERS IN ENGINES," filed February 14, 2011.

CLAIMS

I/We claim:

1. A combustion chamber assembly comprising:

a cylinder having a cylinder wall at least partially defining a combustion chamber;

an intake valve movable between open and closed positions relative to the cylinder wall, the intake valve having an intake valve surface exposed to the combustion chamber;

an exhaust valve movable between open and closed positions relative to the cylinder wall, the exhaust valve having an exhaust valve surface exposed to the combustion chamber; and

a piston movable relative to the cylinder wall, the piston having a piston surface exposed to the combustion chamber;

wherein at least one of the cylinder, cylinder wall, the intake valve, the intake valve surface, the exhaust valve, the exhaust valve surface, the exhaust liner, the piston and/or the piston surface includes an insulative portion composed of a synthetic matrix characterization of crystals that is configured to control heat transfer in the combustion chamber that is generated from a combustion event in the combustion chamber.

2. The assembly of claim 1 wherein the synthetic matrix characterization of crystals is configured to control heat transfer by providing thermal blocking in a first direction and thermal transfer in a second direction.

3. The assembly of claim 1 wherein the insulative portion comprises a separate insert attached to the corresponding cylinder wall, valve, and/or piston.

4. The assembly of claim 1 wherein the insulative portion comprises a coating applied to the corresponding cylinder, cylinder wall, intake valve, intake valve surface, exhaust valve, exhaust valve surface, exhaust liner, piston and/or piston surface.

5. The assembly of claim 1 wherein the insulative portion includes multiple spaced apart and parallel layers that are oriented generally transversely to a direction of thermal transfer resulting from the combustion event.

6. The assembly of claim 1 wherein the insulative portion comprises a fiber applied to the corresponding cylinder, cylinder wall, intake valve, intake valve surface, exhaust valve, exhaust valve surface, exhaust liner, piston and/or piston surface

7. The assembly of claim 1 wherein the insulative portion includes first spaced apart parallel layers that are oriented at a non-zero angle relative to second spaced apart parallel layers.

8. The assembly of claim 1 wherein the insulative portion is composed primarily of layers of graphene or graphite.

9. The assembly of claim 1 wherein the insulative portion is composed primarily from one of the following: carbon and boron, carbon and silicon, carbon and nitride, boron nitride, aluminum nitride, silicon carbide, and silicon boride.

10. An assembly comprising:

a combustion chamber at least partially defined by a first surface of a cylinder;

an air flow valve movable relative to the combustion chamber and having a second surface exposed to the combustion chamber; and

an energy transfer device movable relative to the combustion chamber and having a piston movable relative to the cylinder wall, the piston having a third surface exposed to the combustion chamber;

wherein at least one of the first, second, and third surfaces is at least partially composed of a thermally insulative synthetic matrix characterization of crystals.

11. The assembly of claim 10 wherein the insulative portion is a separate insert attached to the corresponding cylinder wall, valve, and/or piston.

12. The assembly of claim 10 wherein the insulative portion is a coating applied to the corresponding cylinder wall, valve, and/or piston.

13. The assembly of claim 10 wherein the insulative portion includes multiple spaced apart and parallel layers that are oriented generally transversely to a direction of thermal transfer resulting from the combustion event.

14. The assembly of claim 10 wherein the insulative portion includes first spaced apart parallel layers that are oriented at a non-zero angle relative to second spaced apart parallel layers.

15. The assembly of claim 10 wherein the insulative portion is composed primarily of layers of graphene.

16. The assembly of claim 10 wherein the insulative portion is composed primarily from one of the following: carbon and boron, carbon and silicon, carbon and nitride, boron nitride, aluminum nitride, silicon carbide, and silicon boride.

17. A device for a component of a combustion chamber, the device comprising:

a body having—

a first side configured to be attached to the combustion chamber component;

a second side configured to be exposed to a combustion event in the combustion chamber; and

multiple spaced apart and parallel layers extending between the first and second sides, wherein the layers are oriented in a direction generally transverse to a direction of thermal transfer from the combustion event.

18. The device of claim 17 wherein the first side of the body is configured to be attached directly to a piston.

19. The device of claim 17 wherein the first side of the body is configured to be attached directly to the combustion chamber.

20. The device of claim 17 wherein the layers are a first group of layers for a first direction of thermal transfer and the body includes a second group of multiple spaced apart parallel layers oriented at a second non-zero angle relative to the first group.

21. The device of claim 17 wherein the layers are comprised primarily of graphene or graphite.

22. The device of claim 17 wherein the layers are composed primarily from one of the following: carbon and boron, carbon and silicon, carbon and nitride, boron nitride, aluminum nitride, silicon carbide, and silicon boride.

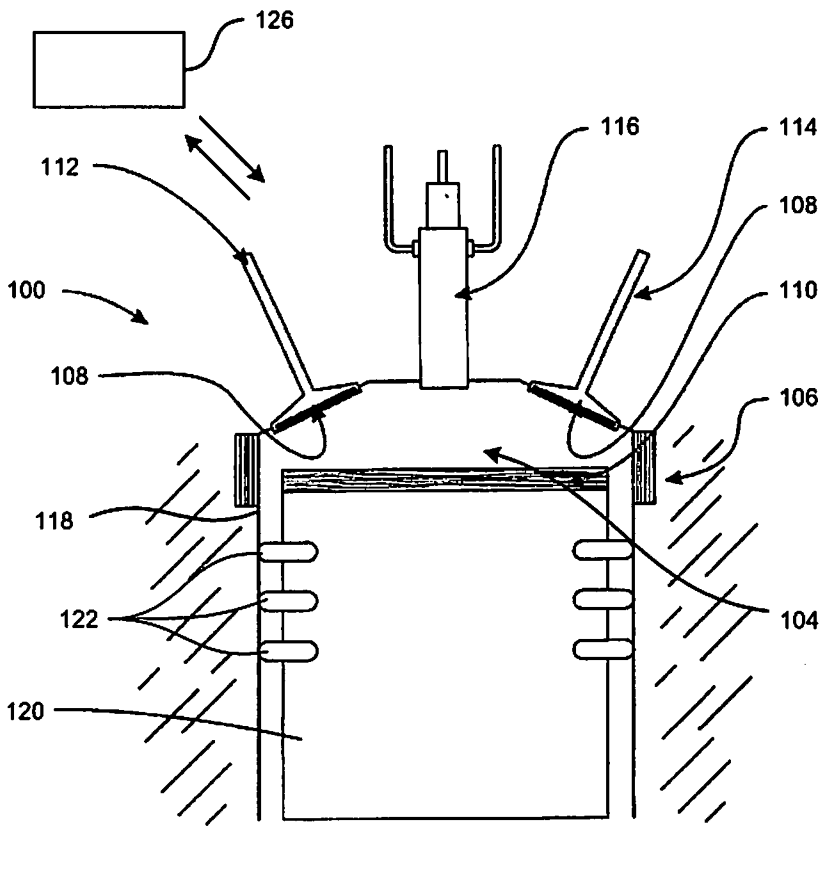

FIG. 1

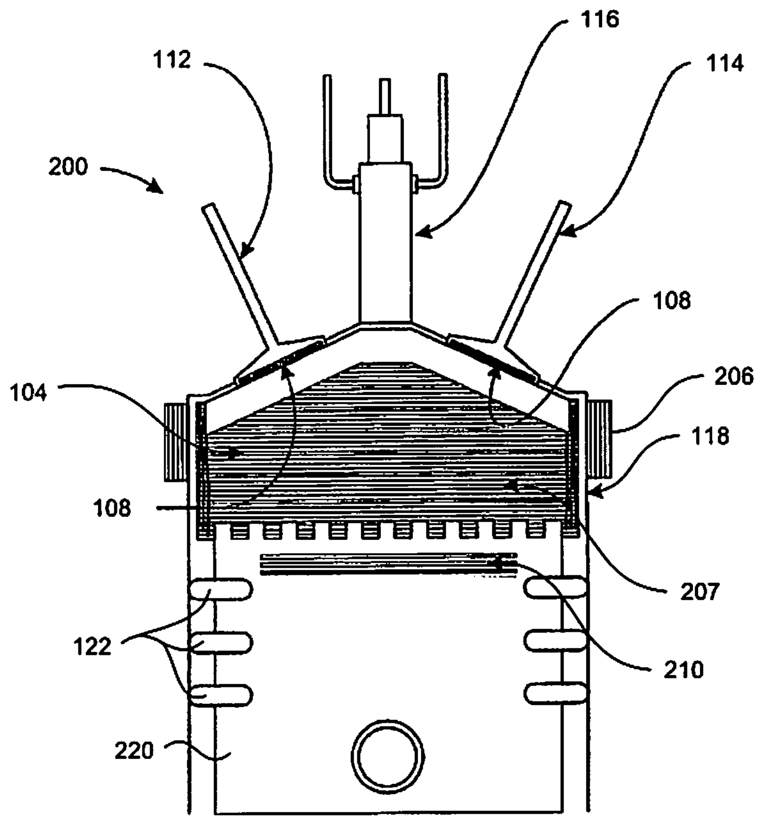

FIG. 2

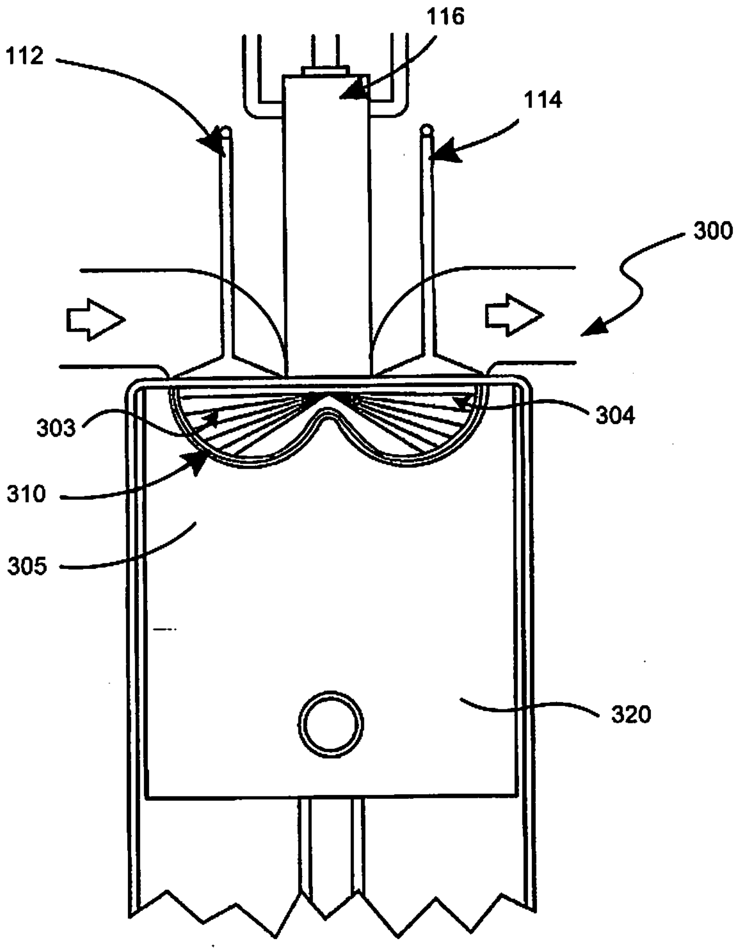

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/050662

A. CLASSIFICATION OF SUBJECT MATTER

F02F 3/12(2006.01)i, F01L 3/04(2006.01)i, F02F 1/00(2006.01)i, F02B 23/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F02F 3/12; F02F 1/00; F02B 23/00; F02B 75/08; F02B 19/00; F02F 3/00; F02F 3/14; F02B 77/11

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: insulating insert, piston, cylinder, intake, exhaust, valve

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	KR 10-2001-0110266 A (KIM, CHANG SUN) 12 December 2001 See abstract, pages 3,4; figure 1.	1-5,7,10-14,17-20 6 8,9,15,16,21,22
Y	US 5,018,489 A (HIRAI; KATSUNORI) 28 May 1991 See abstract and claim 11.	6
A	KR10-2010-0061432 A (KIM, CHANG SUN) 07 June 2010 See abstract, paragraphs [0020]-[0023]; figure 1.	1-22
A	JP 08-312369 A (MITSUBISHI HEAVY IND LTD) 26 November 1996 See abstract, paragraph [0004]; figure 1.	1-22
A	US 4,909,230 A (KAWAMURA; HIDEO) 20 March 1990 See abstract, column 4, lines 43 - 66; figures 1,2.	1-22

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 JANUARY 2013 (28.01.2013)	**29 JANUARY 2013 (29.01.2013)**

Name and mailing address of the ISA/KR

Facsimile No. 82-42-472-7140

Authorized officer
HAN Joong Sub
Telephone No. 82-42-481-5606

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 10-2001-0110266 A	12.12.2001	CN 1420264 A0	28.05.2003
		EP 1312778 A1	21.05.2003
		JP 2003-148239 A	21.05.2003
		KR 20-0288317 Y1	10.09.2002
		KR 20-0288318 Y1	10.09.2002
		KR 20-0288319 Y1	10.09.2002
		US 2003-0089108 A1	15.05.2003
		US 6581381 B2	24.06.2003
US 5,018,489 A	28.05.1991	EP 0417931 A1	20.03.1991
		EP 0417931 B1	13.01.1993
		JP 1939635 C	09.06.1995
		JP 3100356 A	25.04.1991
		JP 6068258 B2	31.08.1994
KR10-2010-0061432 A	07.06.2010	None	
JP 08-312369 A	26.11.1996	JP 3212481 B2	25.09.2001
US 4,909,230 A	20.03.1990	EP 0313340 A2	26.04.1989
		EP 0313340 A3	16.05.1990
		EP 0313340 B1	04.03.1992
		JP 1110863 A	27.04.1989
		JP 1962238 C	25.08.1995
		JP 6089713 B2	09.11.1994