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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) A RECIPROCATING ENGINE

(57) A reciprocating internal combustion engine characterized in that it comprises a cylinder-alternator assembly connected with a reservoir containing any liquid or combined oil with a gasoline content comprised between 10% and 30% of the total content of the mixture housed in the reservoir and a magnetohydrodynamic exchanger configured that the exhaust gases from the cylinder-alternator assembly enter an external tube of the exchanger forming a turbulent helical flow in the opposite direction to the turbulent helical flow of the preprocessed gases circulating in an internal tube of the exchanger, processing a preprocessed gas obtained in the tank before its admission into the cylinder-alternator assembly.

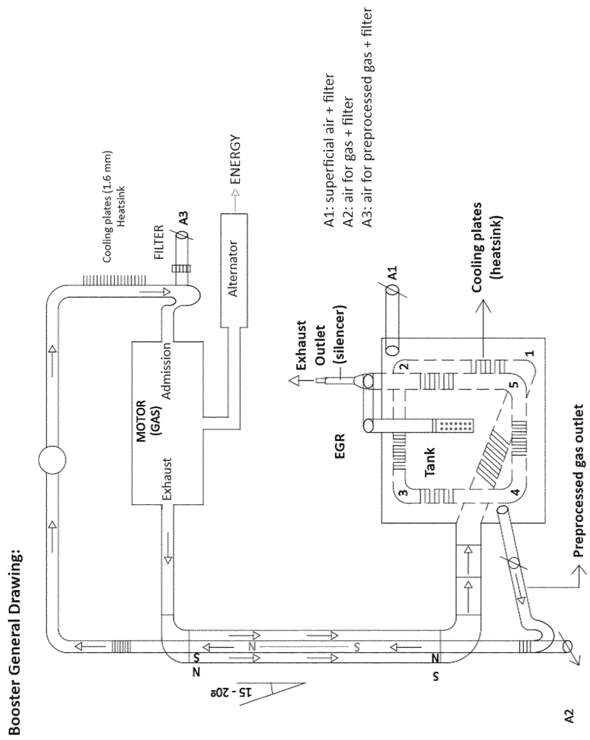

Figure 1

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Description

[0001] The present invention concerns a reciprocating internal combustion engine implementing a magnetohydrodynamic exchanger.

[0002] A magnetohydrodynamic exchanger works on the basis of production thanks to the reuse of waste heat and the behavior of helical gas flows in the same direction and opposite direction as an inductive winding, providing specific and special qualities to any gas with a predominance of hydrogen in its molecules, to produce a high-quality fuel for the operation of the internal combustion engine.

[0003] A number of terms are used in this description that need to be clarified. For example, "mesomerism" or "chemical resonance" is a tool used to represent certain types of molecular structures. Resonance consists of the linear combination of theoretical structures of a molecule (resonant structures) that do not coincide with the real structure, but which by their combination bring us closer to its real structure. The effect is used in a qualitative form and describes the electron attracting or electron releasing properties of substituents, based on relevant resonant structures, and is symbolized by the letter R or M (sometimes also by the letter K). The resonant or mesomeric effect is negative (-R/-M) when the substituent is an electron-attracting group, and the effect is positive (+R/+M) when, from the resonance, the substituent is an electron-donating group.

[0004] The net electron flow from or to the substituent is also determined by the inductive effect. The mesomeric effect as a result of p-orbital overlap (resonance) has no effect on this inductive effect, since the inductive effect is related exclusively to the electronegativity of the atoms, and their structural chemistry (which atoms are connected to which).

[0005] Magnetohydrodynamics (MHD) is a branch of physics that studies the behavior of conducting fluids, such as plasmas, under the influence of magnetic fields. In the following, some of the basic concepts of MHD as employed in the present invention are summarized.

[0006] A plasma is a state of matter in which atoms or molecules have ionized, i.e., have lost or gained electrons, thus creating electrically charged particles called ions and free electrons. Plasmas are electrically conductive and respond to the influence of magnetic fields.

[0007] The MHD equations are a set of equations that describe the behavior of a magnetized plasma. These equations combine the conservation equations of hydrodynamics (fluid flow) with the equations of electromagnetism (magnetic field) to account for magnetic interactions in the plasma. The MHD equations include the equations of conservation of mass, momentum, and energy. These equations describe how the density, velocity, pressure, and energy of the plasma vary in time and space.

[0008] The magnetic induction equation describes how the magnetic field changes with time due to the motion of the plasma and the electric currents induced in the plasma. The magnetic induction equation is based on Faraday's Law and Ampère's Law modified to include the effects of electrical conduction of the plasma.

[0009] Conductivity is a measure of the ease with which electrons can move through the plasma. In MHD, plasma conductivity is an important parameter, as it determines the efficiency with which magnetic fields are transmitted through the plasma. A highly conductive plasma allows for greater magnetic influence.

[0010] Special mention should be made of "Alfvén waves" and "Alfvén velocity". Alfvén waves are disturbances in the magnetic field that propagate along the plasma. These waves are present in MHD systems and are crucial in energy transport and mass transfer in the plasma. On the other hand, the Alfvén velocity represents the speed at which magnetic disturbances propagate through the plasma. The Alfvén velocity depends on the plasma density and the magnetic field strength and is defined as the square root of the ratio of the magnetic pressure to the plasma density.

[0011] More specifically, an Alfvén wave is a type of low-frequency electromagnetic wave that propagates along magnetic field lines in a plasma, which is an ionized gas composed of electrically charged particles.

[0012] Alfvén waves propagate in a magnetized plasma and depend on the interaction between the magnetic field and charged particles. Unlike sound waves, which require a material medium to propagate, Alfvén waves can propagate in a vacuum as long as a plasma is present. On the other hand, Alfvén waves are composed of magnetic field oscillations that are perpendicular to both the direction of wave propagation and the static magnetic field. In addition, the charged particles present in the plasma also experience small oscillations around their equilibrium positions.

[0013] Alfvén waves have several distinctive characteristics:

- Alfvén waves travel at a phase velocity determined by the properties of the plasma, such as its density and magnetic field. This phase velocity can be much higher than the speed of sound in the plasma.
- Alfvén waves are linearly polarized, which means that the direction of oscillation of the magnetic field remains constant as the wave propagates.
- Alfvén waves do not scatter as they propagate in a plasma, unlike other waves, such as sound waves. This means that they retain their shape and amplitude as they move away from their source.

[0014] The document US 2011/174277A1 discloses a device for pretreating fuel to provide a suitable fuel for combustion in a fuel burning apparatus having a fuel intake system and an exhaust system, the device comprising: a volatilization chamber for volatilizing the fuel in the volatilization chamber; a heated processor tube through which the volatilized fuel flows; a processor rod mounted in the processor tube around which the volatilized fuel flows as it flows through a reactor tube; a space between the processor rod and the heated processor tube through which the volatilized fuel flows forming a reaction zone thereby creating reacted fuel; and inlet means for directing the reacted fuel into the intake system of the fuel burning apparatus.

[0015] The document DE10124896A1 discloses a fuel gas generation method involves passing some of the exhaust gas air via a special converter to a tank and passing the new gas/air mixture present in the tank through the converter again to the internal combustion engine as a combustion gas. The converter acts on the counterflow principle and forms a self-generated magnet field within it.

[0016] Finally, document US2015/377189A1 discloses that fuel efficiency in a combustion engine is increased by treating the fuel in a reaction chamber prior to delivering the fuel into the combustion chamber of the engine. The method includes the step of entraining a stream of exhaust gas to travel upstream through the reactor chamber in a first flow pattern. The method also includes the step of entraining a stream of fuel to travel downstream through the reactor chamber in a second flow pattern, where at least one of the first and second flow patterns comprises a structured turbulent flow.

[0017] The present invention relates to a reciprocating internal combustion engine (MCIA) including a magnetohydrodynamic exchanger. It is an object of the present invention that the exchanger may be incorporated in any reciprocating internal combustion engine to reduce emissions from such an engine. This object is achieved by the system of claim 1. Alternative embodiments and/or aspects of the invention are described in the claims directly or indirectly dependent on the claim.

[0018] Throughout the description and the claims, the word "comprises," and variants thereof are not intended to exclude other technical features, additives, components, or steps. To those skilled in the art, other objects, advantages, and features of the invention will be apparent in part from the description and in part from the practice of the invention. The following examples and drawings are provided by way of illustration and are not intended to restrict the present invention. Furthermore, the present invention covers all combinations of particular and preferred embodiments indicated herein.

[0019] The following is a very brief description of a series of drawings which help to better understand the invention, and which relate expressly to an embodiment of said invention which is presented as a non-limiting example thereof.

Figure 1. Shows a schematic of the booster system that is the subject of the present invention.

Figure 2. Shows a schematic diagram representative of the operation of the system of the invention.

Figure 3. Shows a schematic of the operation of the exchanger that is part of the system of the invention.

[0020] As can be seen in the attached figures, the present invention comprises: a tank, a magnetohydrodynamic exchanger, a preprocessed and processed gas duct system, and a reciprocating internal combustion engine cylinder-alternator assembly. A schematic diagram illustrating the operation of the system is shown in Figures 1 and 2.

[0021] The reciprocating internal combustion engine typically comprises a preprocessed fuel intake inlet and an exhaust gas outlet. The system is configured for the absorption of engine exhaust gases, giving it properties of magnetism, frequency, entropy, and energy rise (temperature) through a first (external) tube of a ferromagnetic material with North - South polarity. These exhaust gases, after passing through the external tube of the exchanger, heat the fluid (passing through the internal ducts or coil inside the tank, which also includes dissipative fins) contained inside a tank causing a 10%-30% mixture with any other fluid to emulsify and become a preprocessed gas. This pre-processed fuel generated in the tank passes through a second tube (inner tube with respect to the first one) made of an equally ferromagnetic material with North-South polarity (although placed in the opposite direction to the outer tube) towards the engine intake inlet, which is where the processing of the preprocessed fuel obtained from the tank takes place. In other words, the engine intake inlet is connected to the inner tube to receive the preprocessed fuel, while the engine exhaust outlet is connected to the tank through the first tube or outer tube.

[0022] The structure of the tank consists of a circular path or inlet, with dissipating fins, with which the heat from the engine exhaust gases is transferred to the fluid or fuel or fuel mixtures contained in the tank. The function of the tank and its morphology is that the heat produced by combustion is transferred in the most thermodynamically efficient way. The helically rotating exhaust gases, with their magnetic and resonant properties, will transmit all their heat energy to the fluid to obtain the preprocessed gas that flows through the second tube or inner tube, where a mesomeric magnetohydrodynamic effect (MHDM) is produced.

[0023] As can best be seen in Figure 3, the exhaust gases circulate in the external tube in the form of a helical vortex in a clockwise (N/S) direction and the preprocessed gases also circulate in the same way, but in a counterclockwise direction, in the internal tube. In other words, two turbulent gases circulate in opposite directions rotating helically with a certain frequency and magnetism, due to the fact that the tubes are ferromagnetic with opposite polarities to each other. When the preprocessed gases circulating turbulently in helical form reach the inner core (of equally ferromagnetic material) they are compressed, at first gently, and more abruptly the closer they get to the center of the core.

[0024] The compressed preprocessed gases, when they reach the center of the core, are abruptly and spontaneously decompressed again. This abrupt and spontaneous decompression generates the processed gases that feed the engine, which are hydrogen, oxygen, and more refined hydrocarbons, together with water vapor.

[0025] As indicated, the exchanger consists of an outer tube, an inner tube concentric with respect to the outer tube and a core of cylindrical profile housed internally and concentrically in the central zone of the inner tube. These elements, as indicated, are made of a ferromagnetic material having the following polarities:

Outer tube: polarity S/N
Inner tube: polarity N/S
Core: S/N polarity

[0026] In general, the polarities of the outer tube and inner tube should be opposite. The polarity of the core should be opposite to that of the inner tube, i.e., equal to that of the outer tube.

[0027] On the other hand, the exchanger must be inclined between the tank and the exhaust outlet. This inclination has been determined to be optimal in the range of 15° - 20°, although other inclinations greater or lesser are valid, although not optimal. In addition, the area of the exhaust outlet in the engine must be greater than the area of the outer tube minus the area of the inner tube.

[0028] It is important to note that the exhaust gases enter the external tube of the exchanger through an elbow with a 90° angle, which facilitates the helical and turbulent rotation of the exhaust gas in a clockwise direction.

[0029] Thus, the reservoir of the invention can have a very variable content such as, for example, and non-limitingly, any liquid or oil combined with a gasoline content comprised between 10% and 30% of the total content of the mixture housed in the reservoir. The mixture added to the tank will bubble upon impact of the hot exhaust gases and produces a gasification of different gases depending on the liquids or oils added to the tank together with the gasoline.

[0030] At the initial start-up, the combustion process takes place -exclusively- the gases generated by the gasoline, because the mixture in the tank is not yet hot enough to generate the preprocessed gas. As time goes by (which will depend on the engine and the tank, but approximately 30 seconds) the mixture contained in the tank and a gasification of the complex mixture housed in the tank and already preprocessed towards the inner tube takes place.

[0031] On the other hand, an injection of CO_2 from the engine's EGR system (exhaust gas recirculation system) takes place in the tank. The EGR valve will inject CO_2 into the mixture to be combusted inside the tank, as it is important for the improvement of the MHDM hydrolysis, since it favors the work of the exchanger to be more efficient.

[0032] The tank is completed with an air intake for combustion improvement (AFR). The air-fuel ratio is ideally matched by a valve installed in the tank, which is in direct contact with the emulsified mixture.

[0033] The exchanger is the essential part of the invention. This exchanger is made up of two concentric tubes, an outer tube, and an inner tube, inside which there is a solid core, and which are subjected to an electromagnetic field with north-south (N/S) polarity. In the exchanger, the exhaust gases circulate helically in the form of a clockwise (N/S) vortex and the pre-processed gases also circulate in the same way, but in an anti-clockwise direction. In short, the exchanger is made up of two gas coils rotating in the opposite direction, subjected to a magnetic field and a specific frequency.

[0034] Well, the preprocessed gases travel through the inner tube into the core and this is when the MHDM phenomenon occurs. These gases, when they touch the core, begin a gentle compression that becomes very abrupt near the center of the core. Upon reaching the center, a radical and spontaneous change occurs, and the preprocessed gases abruptly decompose into processed gases, particularly hydrogen, oxygen, refined hydrocarbons, and water vapor.

[0035] The operation of the exchanger is as follows:

First, the exhaust gases flow into the external tube (of the exchanger), which is made of ferromagnetic material, and rotate forming a "helical vortex" clockwise in its total length, in N/S direction, forming an ionic flow coil (stator function) with respect to the inner tube. These gases heat the fluid inside the tank producing the necessary bubbling to emulsify the mixture and

produce a pre-processed gas.

Secondly, these preprocessed gases are directed towards the inner tube, whose remaining magnetism is arranged in the opposite position to that of the outer tube, in the form of a counterclockwise helical vortex, forming a coil of ionic flow (rotor function) where the magnetic direction is N/S. In the inner tube a negative pressure will be produced by the compression of the cylinder-alternator set of the engine, also a phenomenon occurs in the preprocessed gas called MHDM, where the molecules will act under the properties of an inductive winding, amplifying the remaining magnetism due to electromagnetic phenomena established in the laws of Maxwell - Gauss. In the inner tube is where the gas processing takes place.

[0036] The solid core is made of a ferromagnetic material and is finished with a point. The core is housed inside the inner tube, with specific dimensions and geometry, which will depend on the motor power, whose polarity is arranged in S/N and produces a very abrupt compression and decompression of the complex preprocessed mixture in a small space, which coincides with the perfect center of the solid tube, the S/N direction, where the preprocessed gas is converted into processed gas. This conversion is based on the mesomeric effect.

[0037] The transformation space or path is 1-2 mm mixing pitch (i.e., helical pitch), leading to the decomposition of the preprocessed gas molecules into a processed gas with simpler molecules. In the case of the original fuel gases (e.g., gasoline), a much more refined, lighter, and volatile fuel is generated. In the case of water vapor, a certain amount of hydrogen (H_2) and oxygen (O_2) is produced, improving the potential of the useful fuel, favored by the presence of CO_2 (which has been added in the tank through the EGR valve) which is a compound that acts favoring that it is not necessary so much temperature for the processing of the gas inside the exchanger.

[0038] It should be noted that there is a small portion of the water vapor that is not hydrolyzed, useful in the combustion process, reducing the volatility and speed of ignition. With this, a good engine performance is achieved without the need for extraordinary modifications, such as RC compression ratio, ignition advance at PMS, or others. In addition, this amount of water vapor favors the work (W) by pressure in the engine cylinder, explained by the ideal gas laws PV=nRT.

[0039] Actually the processing of the fuel mixture obtained is the result of the MHDM favored by the increase of the exhaust gas outlet temperature, theoretically produced by the appearance of the low frequency waves or Alfvén waves due to the rhythms of the 4 strokes of the engine operation that added to the magnetism produced by the helical and turbulent circulation of the intermittent flows of the gases of the different zones of passage (external and internal tube) of the exchanger and its particular magnetism produced, besides the remnant of the ferromagnetic materials used in this exchanger.

[0040] The wave propagates in the direction of the magnetic field, although the waves exist in oblique incidence and smoothly changes in the magneto-sonic wave when the propagation is perpendicular to the magnetic field. The motion of the ions and the disturbance of the magnetic field are in the same direction and transverse to the direction of propagation. The wave has no dispersion.

[0041] It is the system of pre-processed and processed mixture ducts with their respective balancing elements to obtain a stable fuel flow, in addition to the inclusion of two fluid-gas decanters, which are configured as cylinders that balance the pressure and are a steam trap, one for pre-processing the mixture and the other before the admission of the cylinder-alternator set, where there is also an air inlet to handle the AFR (air-fuel mixture) to obtain an ideal mixture for combustion.

[0042] An adjustable air inlet valve for preprocessed air is located along the entire line of action of the duct system to promote AFR and cooling of the preprocessed complex mixture. The result of this air inlet is a lower inlet temperature to the heat exchanger, thus enhancing the thermal differential.

[0043] Thanks to the present invention, engine consumption is much more fuel efficient and stable with respect to engine torque. Fuel savings with this system exceed 80%.

[0044] The emissions results are as follows: CO (0.001 % vol.), CO2 (0.4 % vol.), HC (hydrocarbons 0000 ppm), O2 (21.10 % vol.).

Claims

1. A reciprocating engine **characterized in that** it comprises:

a cylinder-alternator assembly comprising:

an exhaust gas outlet, and
a gas intake inlet,

a reservoir containing any liquid or blended oil with a gasoline content of between 10% and 30% of the total content of the blend housed in the reservoir, wherein said reservoir comprises:

an exhaust gas inlet from the cylinder-alternator assembly, and
an outlet of preprocessed gases generated when the exhaust gases heat the fluids contained in the reservoir;

a magnetohydrodynamic exchanger comprising:

a first external ferromagnetic tube with a given polarity, which connects the exhaust gas outlet of the cylinder-alternator assembly with the exhaust gas inlet of the tank;
a second internal ferromagnetic tube, concentric with respect to the first external ferromagnetic tube, with a polarity opposite to that of the first tube, which connects the preprocessed gas outlet of the tank with the gas inlet of the cylinder-alternator assembly; and
a solid cylindrical ferromagnetic core, concentrically arranged inside the central part of the second inner tube;

in such a way that the exhaust gases from the cylinder-alternator assembly enter the external tube of the exchanger forming a turbulent helical flow in the opposite direction to the turbulent helical flow of the preprocessed gases circulating in the internal tube of the exchanger, processing the preprocessed gas before its admission into the cylinder-alternator assembly.

2. The engine according to claim 1 wherein the exchanger is to be inclined between the tank and the exhaust outlet.

3. The engine according to claim 2 wherein the inclination is between 15° - 20°.

4. The engine according to any one of the preceding claims, wherein the area of the exhaust outlet in the engine is to be greater than the area of the outer pipe minus the area of the inner pipe.

5. The engine according to any one of the preceding claims wherein the exhaust gases enter the outer tube of the heat exchanger through an elbow with an angle of 90°, which facilitates helical and turbulent turning of the exhaust gas in a clockwise direction.

6. The engine according to any one of the preceding claims wherein the reservoir structure comprises a circular path or inlet or coil, with dissipative fins, with which heat is transferred from the engine exhaust gases to the fluid or fuel or fuel mixtures contained in the reservoir.

7. The engine according to any one of the preceding claims wherein an injection of CO2 from the exhaust gas recirculation system cylinder-alternator assembly occurs in the reservoir.

8. The engine according to any one of the preceding claims, wherein the reservoir comprises an air intake for combustion enhancement.

Amended claims in accordance with Rule 137(2) EPC.

1. A reciprocating engine **characterized in that** it comprises:

   a cylinder-alternator assembly comprising:

      an exhaust gas outlet, and
      a gas intake inlet,

   a tank containing any liquid or blended oil with a gasoline content of between 10% and 30% of the total content of the blend housed in the tank, wherein said tank comprises:

      an exhaust gas inlet from the cylinder-alternator assembly, and
      an outlet of preprocessed gases generated when the exhaust gases heat the fluids contained in the tank;
      wherein the structure of the tank consists of a circular path with dissipating fins, with which the heat of the engine exhaust gases is transmitted to the fluid or fuel, or fuel mixtures contained in the tank;

   a magnetohydrodynamic exchanger comprising:

      a first external ferromagnetic tube with a given polarity, which connects the exhaust gas outlet of the cylinder-alternator assembly with the exhaust gas inlet of the tank;
      a second internal ferromagnetic tube, concentric with respect to the first external ferromagnetic tube, with a polarity opposite to that of the first tube, which connects the preprocessed gas outlet of the tank with the gas inlet of the cylinder-alternator assembly;

   and

      a solid cylindrical ferromagnetic core, concentrically arranged inside the central part of the second inner tube;
      wherein the magnetohydrodynamic exchanger is inclined between the tank and the exhaust outlet an angle comprised between 15° and 20°;

   in such a way that the exhaust gases from the cylinder-alternator assembly enter the external tube of the exchanger forming a turbulent helical flow in the opposite direction to the turbulent helical flow of the preprocessed gases circulating in the internal tube of the exchanger, processing the preprocessed gas before its admission into the cylinder-alternator assembly.

2. The engine according to claim 1 wherein the exhaust gases enter the outer tube of the heat exchanger through an elbow with an angle of 90°, which facilitates helical and turbulent turning of the exhaust gas in a clockwise direction.

3. The engine according to any one of the preceding claims wherein an injection of CO_2 from the exhaust gas recirculation system takes place in the tank, in such a way that an EGR valve injects CO_2 into the mixture to be combusted inside the tank.

4. The engine according to any one of the preceding claims, wherein the reservoir comprises an air intake for combustion enhancement.

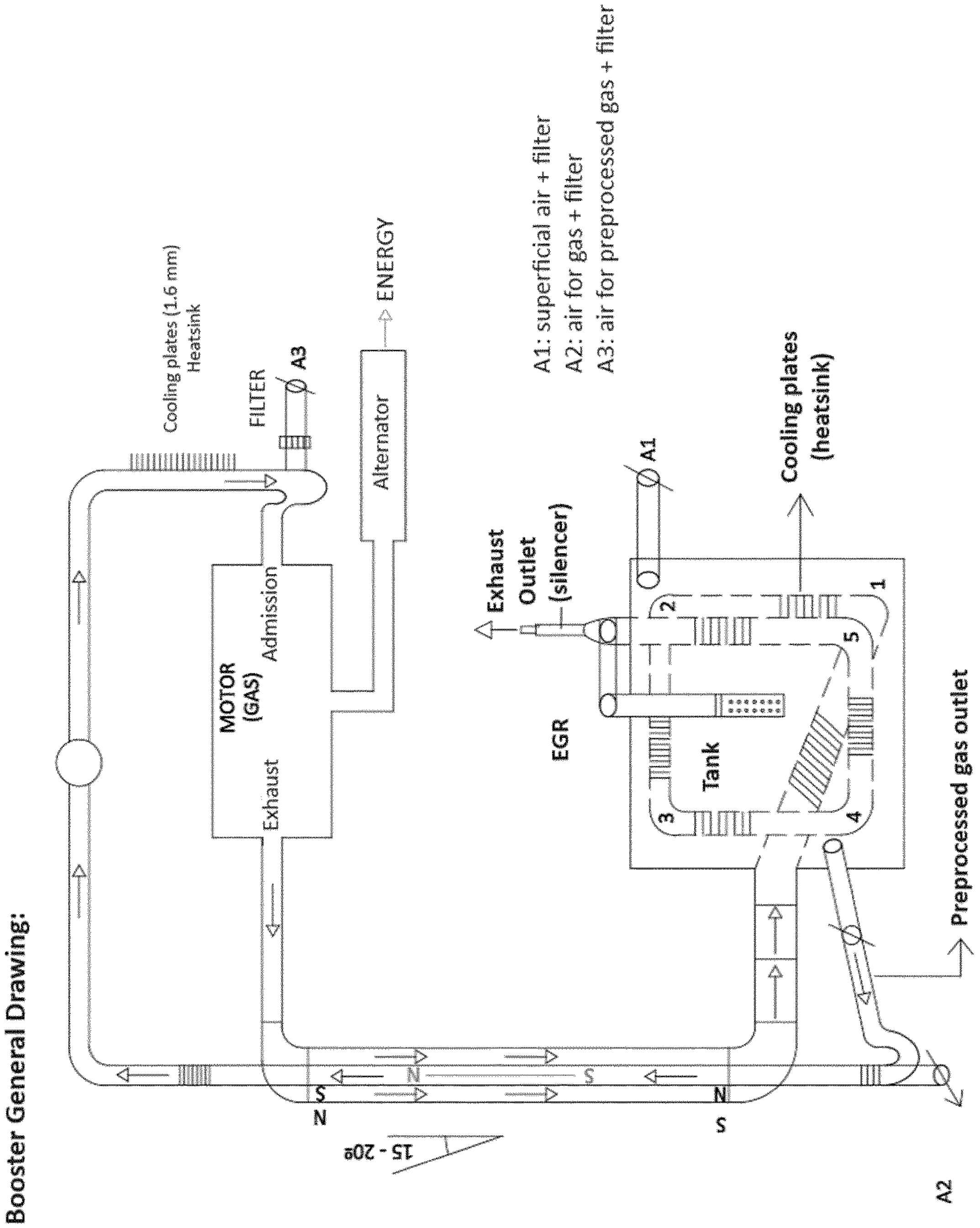

Booster General Drawing:
Cooling plates (1.6 mm)
Heatsink
FILTER
A3
ENERGY
Alternator
MOTOR
(GAS)
Admission
Exhaust
A1: superficial air + filter
A2: air for gas + filter
A3: air for preprocessed gas + filter
Cooling plates
(heatsink)
A1
Exhaust
Outlet
(silencer)
EGR
Tank
1
2
3
4
5
Preprocessed gas outlet
N
S
15 - 20º
A2

Figure 1

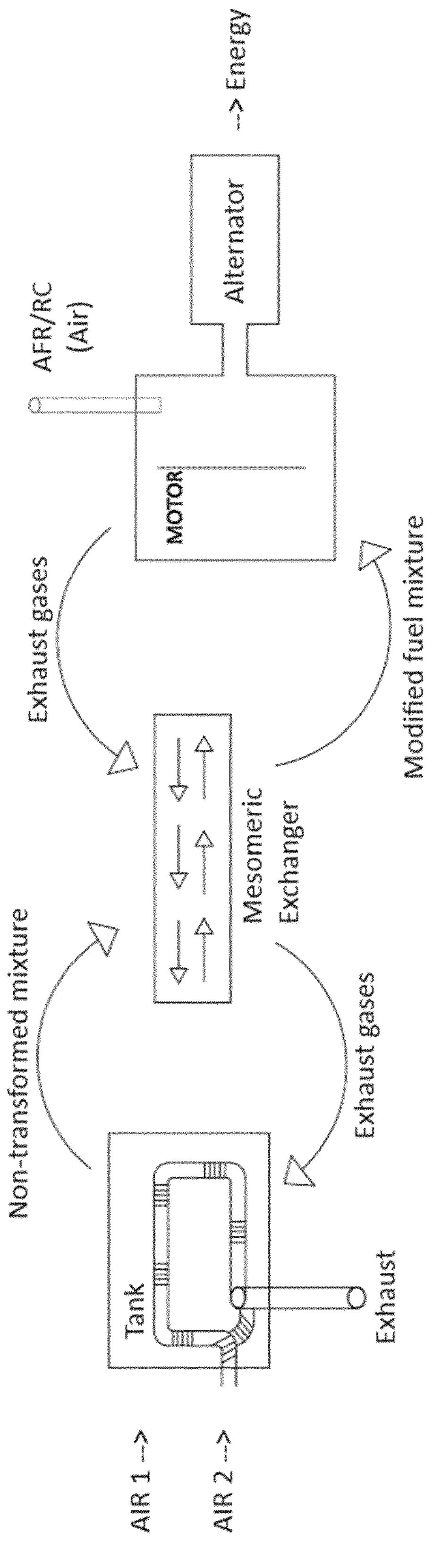
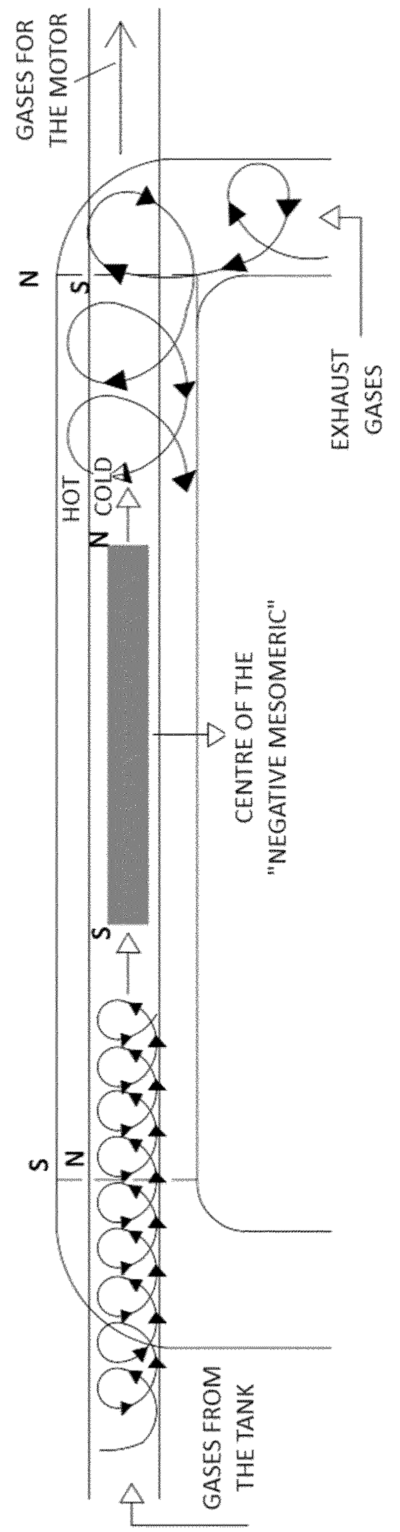

--> Energy
Alternator
AFR/RC
(Air)
MOTOR
Exhaust gases
Modified fuel mixture
Mesomeric
Exchanger
Non-transformed mixture
Exhaust gases
Tank
Exhaust
AIR 1 -->
AIR 2 -->

Figure 2


GASES FOR
THE MOTOR
N
S
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GASES
HOT
COLD
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CENTRE OF THE
"NEGATIVE MESOMERIC"
S
S
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GASES FROM
THE TANK

Figure 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 38 2793

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X	DE 101 24 896 A1 (ECKS MARCO [DE]) 28 November 2002 (2002-11-28) * abstract * * figure 1 * * claims 1, 2 * * paragraph [0006] - paragraph [0012] * -----	1-7	
A	US 2015/377189 A1 (HILL GARRETT [US] ET AL) 31 December 2015 (2015-12-31) * abstract * * figures 1-10 * * paragraph [0042] - paragraph [0079] * -----	1-8	
A	US 2008/041350 A1 (LEE DENNIS [US]) 21 February 2008 (2008-02-21) * abstract * * figures 1, 2 * * paragraph [0031] - paragraph [0041] * -----	1-8	TECHNICAL FIELDS SEARCHED (IPC) F02B F02G F01N F02M
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1

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 January 2024	Juvenelle, Cyril

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EP 23 38 2793

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