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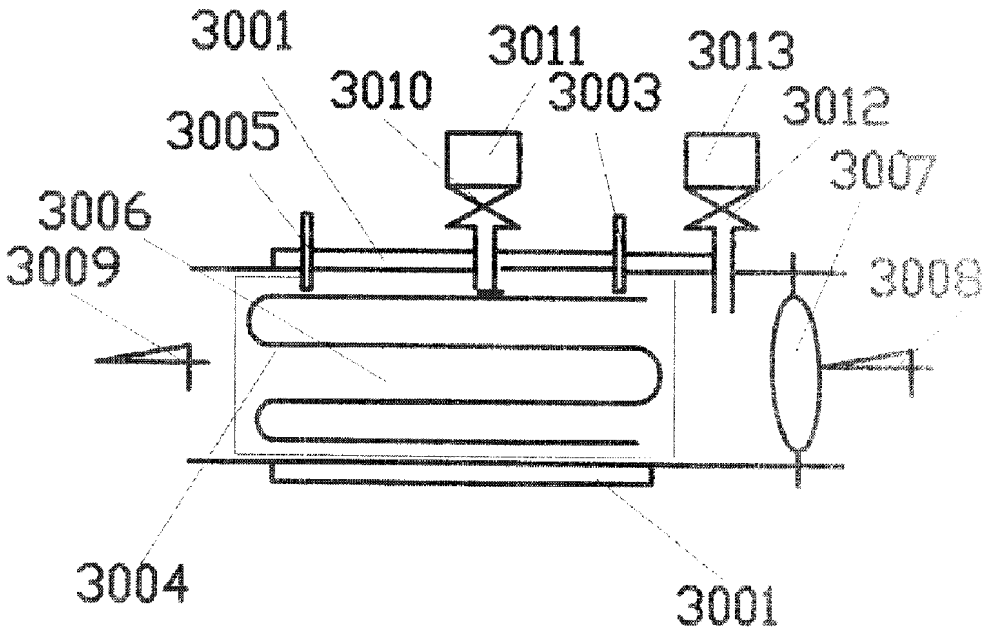
(72) Inventeur/Inventor:
HOLUBOWICZ, KAZIMIERZ S., CA

(73) Propriétaire/Owner:
HOLUBOWICZ, KAZIMIERZ S., CA

(74) Agent: NA

(54) Titre : MOTEUR POURVU D'UN DISPOSITIF DE TIR A EXPLOSION INTERNE MULTICARBURANT QUI CONVERTIT COMPLETEMENT L'ENERGIE DU CARBURANT EN TRAVAIL OU EN ELECTRICITE OU LES DEUX

(54) Title: FUEL FLEXIBLE INTERNAL EXPLOSION GUN-ENGINE THAT CONVERTS COMPLETELY ENERGY OF FUEL INTO WORK OR ELECTRICITY OR BOTH



(57) Abrégé/Abstract:
The invention is a gun-engine mainly comprised of a prior art engine, the cylinder head of which has been replaced with an explosion driven harmonic oscillator that allows speeding up energy release from fuel. It recompresses already expanded exhaust and delays building up pressure over work piston, therefore extra work strokes result from a single explosion of fuel, until all the energy released has been converted to work. Also, a different internal cooling that prevents heat loss does contribute to efficiency. In the gun-engine the maximum pressure meets the horizontal position of crank, which maximizes torque and power. The extra power strokes convert heat, previously wasted, to extra work. The internal cooling blocks formations of deadly NOx pollutants (100%) too. It is based on injections of water into explosion chamber, therefore the latent heat of water vaporization cools internal parts well and the heat is preserved in resulting steam. A simple water/exhaust separator preserves water for indefinite reuse, which minimizes needed capacity of a water tank. Also a magnet on the circumference of an oscillating mass of the harmonic oscillator and coil wound around cylinder does convert some energy released from fuel into electricity, so the invention could operate as an engine or as electric generator or both.

FUEL FLEXIBLE INTERNAL EXPLOSION GUN-ENGINE THAT COVERTS COMPLETELY ENERGY OF FUEL INTO WORK OR ELECTRICITY OR BOTH

Author: Kazimierz S. Holubowicz;
Owners: Holubowicz family represented by the author;

Abstract

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FUEL FLEXIBLE INTERNAL EXPLOSION GUN-ENGINE THAT CONVERTS COMPLETELY ENERGY OF FUEL INTO WORK OR ELECTRICITY OR BOTH

Author: Kazimierz S. Holubowicz;

Specification

Field of invention

This invention belongs to field of energy converting devices and specifically to engines.

Background

In the past, there have been several types of combustion engines. The most important are diesel and gasoline four stroke engines. Even though advertised as highly efficient or modern, these are neither efficient nor modern, as these are archaic and very inefficient, primitive machines that emit greenhouse gases and very harmful NOx pollutants, contributing the most to environmental and climatic changes that threatens our existence.

The operation of prior art is obvious and simple. Since nobody questions the simplicity or obviousness, combustion engines have not changed much since XIX century and have preserved all causes of the inefficiency, handed down from one generation of engines to another. It is so because the causes are buried deep into the design and are hard to spot.

The inefficiency of prior art engine is responsible for huge wastes of oil resources and the most of destructions of Earth's environment. It is also responsible for disruptions of oil market and the economy of World.

The most important cause of the inefficiency in prior art engine is the release of a huge part of heat generated by combustion into the environment, due to cooling that does not preserve heat.

Another not less important cause of the inefficiency is that the max pressure generated by combustion meets the alignment of crank with the centerline of cylinder. At that moment the potential is at the best, but the said pressure creates huge stress in crank and related parts without contribution to power or torque, so the highest potential is lost. This fault is also responsible for very unfavorable characteristics of power v. speed and torque v, speed, which calls for use of energy consuming reduction gears.

Another inherited fault in prior art engines is that the fuel is delivered into cylinder as a mist hanging in air. Some droplets of the mist, when in contact with hot internal parts, disintegrate into fast combusting Hydrogen and slow burning Carbon that does not burn completely. The unburned Carbon deposits as black engine deposits or is released as emissions of black particulates poisoning the environment. Therefore 6% to 10% of fuel is wasted, or even more during starting.

Since every prior art engine delivers one power stroke from a single combustion it does not convert all energy released from fuel into work and that calls for a cooling to prevent melting. The cooling is based on jackets around cylinder, through which coolant is pumped to remove the excessive heat.

Apart from causing huge energy losses, the prior art cooling is also responsible for a high internal temperature that activates Nitrogen, which is a non-reactive agent at normal conditions, but at

temperatures above 1,000 K degree the Nitrogen becomes active and bounds to Oxygen left from combustion. Even though the reaction is relatively slow, it forms pollutants referred to as NOx group of pollutants that harm people and the environment.

Another important fault of prior art engine is that it cannot withstand explosions of fuel due to:

- much higher pressure resulted from the explosion than from prior art combustion;
- much higher temperature due to fast energy release prior to TDC (top dead center);

Even though the engine's parts could be strengthened to withstand explosions, which is economic nonsense, the temperature presents a real problem. It is problematic because piston's crown is the worst cooled part in every prior art engine, so when exposed to explosions of fuel its crown melts.

The researchers have solved that for an explosive fuel (such as natural gas, propane, butane etc.,) by slowing down energy release, which prevents explosions, but the hydrogen is still problematic due to its highly explosive character.

Power is energy release in time. By slowing down energy release from fuel the available power from fuel consumption is suppressed. This approach assures functionality, but unfortunately does ad a new problem to the long list of inherited.

The purpose of this invention is to provide an alternative to prior art engine. Since the proposed gun-engine quadruples efficiency over that in prior art it might reverse already done harms, as the replacement of prior art engines with the invented would have the

same effect on the environment as taking out of our streets and roads more than 80% of cars and trucks and in addition would save 80% of fuel eliminating needs to import oil into North America.

To achieve these objectives several components such as: a fuel pre-processing device, gun-device, harmonic oscillator, internal cooling that preserves heat, cylinder with improved retention of oil etc, are combined into one internal explosion gun-engine.

Short description of the invention

The invention is mainly comprised of two parts: A prior art engine and a harmonic oscillator enforced with explosions of fuel. The purpose of harmonic oscillator is to convert energy released from fuel into harmonically varied pressure that acts on the piston of said prior art engine. Therefore a prior art expansion is imposed on harmonically varying pressure. That calls for a new mathematical model of energy conversion presented in the following detailed description.

Due to fuel explosions that replaced prior art combustions, the amplitude of pressure variations is up to twenty times that of prior art engines and the average pressure over the piston quadruples that in prior art, without increasing fuel consumptions.

Due to replacement of prior art cooling with injections of water, into cylinder that cools the cylinder internally, heat is preserved in the resulting steam and not wasted, thus could be converted to extra work.

Due to introduction of an oscillating mass, the building up pressure over work producing piston is delayed. The delay causes

meetings of the said maximum pressure with horizontal position of crank, so the resulting torque is boosted up many times during starting and slow operations, while the average pressure over the piston quadruples that in prior art engines, which quadruples the energy conversion and efficiency.

The improvement is possible due to the said preservation of heat in said steam, so multiple expansions, of the mix of exhaust with steam, gradually convert all the heat released from fuel into work. Indeed some minor heat and friction losses have to be considered.

List of drawings:

Fig. 1 is a block diagram of the invention;

Fig. 2 is a gun-engine;

Fig. 3 is a fuel preprocessing device;

Fig. 4 is a gun-engine as in Fig. 2 in which the air cushion is replaced with a spring 4001

Fig. 5 is a hydraulic actuator to manipulate valves;

Fig. 6 is a one phase electric generator;

Fig. 7 is an air cushion for a small gun-engine;

Fig. 8 is cylinder head with electromagnetic actuation of valves;

Description of parts:

Fig. 1

1001harmonic oscillator; 1002 prior art engine; 1003 water pump; 1004 exhaust release;1005 exhaust water separator;1006 water filter; 1007 fuel tank; 1008 fuel injector;1009 fuel preprocessing device; 1010 starter; 1011 optical wheel; 1012 source of light such as LED;1013 photo detector;1014 fuel pump;1015 lubrication pump;

1016 fuel filter; 1017 lubricant filter; 1018 electronic controller; 1019 electromagnetic valve; 1020 fly wheel; 1021 oil spraying jet; 1022 air filter; 1023 exhaust/fog conduit; 1024 homogenous fuel conduit; 1025 temperature probe; 1026 water injector; 1030 automatic valve to compensate pressure losses; 1031 air tank; 1032 air compressor; 1033 LPG cylinder; Hydrogen or natural gas cylinder; 1035 water tank;

Fig.2

1001 harmonic oscillator enforced with explosions of fuel; 1002 prior art engine or reciprocating compressor; 2001 long cylinder; preferably twice that of prior art; 2002 induction valve; 2003 exhaust evacuating valve; 2004 water injector; 2005 cylinder head; 2006 explosion chamber; 2007 boiling chamber; 2008 limiter;2009 gas or air cushion; 2010 prior art work producing piston; 2011 piston rode; 2012 crankshaft; 2013 crank; 2014 free oscillating mass;

Fig. 3

3001 exhaust/fog evacuation conduit; 3002 fuel evaporation chamber placed in 3001 conduit; 3003 fuel injector or a calibrated fuel valve; 3004 electric heater; 3005 temperature probe; 3006 metal wool filling; 3007 choke (optional); 3008 airflow; 3009 explosive fuel/air flow into harmonic oscillator; 3010 one way dosing valve for gaseous fuel supply; 3011 quick connection for gaseous fuels (hydrogen, NG etc.); 3012 one way dosing valve for LPG (Propane, Butane etc.); 3013 quick connector for LPG or bio-fuels;

Fig.4

1001 a harmonic oscillator;1002 prior art engine; 2002 induction valve; 2003 exhaust valve; 2004 water injector; 2009 air; 2010 work piston; 2011 piston rode; 2012 crankshaft; 2013 crank; 401 spring;

Fig.5

8004 valve's spring; 8005 spring's retainer; 8016 Stem's sealing (silicon or rubber); 8017 valve's stem; 5001 Teflon O-ring; 5003 Pressurized space;5004 Piston producing force; 5005 El. magnetic valve to activate the actuator; 5006 A tank to compensate resistance to flow; 5007 Air space; 5008 El. magnetic relive valve to de-activate the actuator; 5009 Source of hydraulic pressure; 5010 Piping to direct the released oil back to oil tank; 5011 Cylinder head (Interface to valve stem); 5012 Actuator housing; 8004 Valve's spring; 8005 Spring's retainer; 8016 Valve's gland; 8017 Valve's stem; 8019 Cylinder head (Valve's seat part); 5013 cavity to improve the oil retention of cylinder wall; 5014 cylinder's insert preferably made of aluminum brass; 5015 Piston ring; 5016 Free oscillating mass; 5017 Exhaust with fog out; 5018 Premixed homogenous fuel in; 519 Teflon seal; 5020 Compressed air supply; 5021 Air cut-off valve

Fig. 6

2001 Long cylinder; 2002 Induction valve; 2003 exhaust valve; 2004 Water injector; 2005 Cylinder head; 2010 Prior art piston; 2012 Piston rode; 2013 Crank; 2016 Piston ring; 2017 Teflon O-ring; 2018 crankshaft; 4001 Magnet ring for electric power generation; 6001 Space between cylinder wall and air cushion; 6002 Air space in the air cushion; 6003 External compress ring; 6004 Internal ring; 6005 Detail presented in Fig.7; 6006 Actuator manipulating the exhaust

valve; 6007 Actuator manipulating the induction valve;6009 Induction coil for electric power generation

Fig. 7

2010 Piston; 2014 free oscillating mass; 6003 External crimping ring; 6004 Internal crimping ring; 7001 Rubberized Kevlar or Flexon;

Fig.8

8001 Supply of explosive mix into cylinder; 8002 Exhaust evacuation; 8003 Valve's gland; 8004 Valve's spring; 8005 Spring's retainer; 8006 Ferromagnetic tip of the exhaust valve; 8007 Electromagnetic water injector; 8008 Ferromagnetic tip of the induction valve; 8009 Electromagnet to manipulate a valve; 8010 Cavity to receive water injections; 8011 Valve's stem made of non-ferromagnetic material;

8012 Cylinder head preferably made of stainless steel; 8013 Valve in its valve seat; 8014 Piston rings; 8015 Explosion chamber; 8016 Free oscillating mass; 8017 Magnet (for electric generator) 8018 Housing for electromagnets; 8019 housing for valve's springs;

Detailed description

With reference to fig.1, the invention is a prior art engine 1002, the cylinder head of which is replaced with a harmonic oscillator 1001. The harmonic oscillator comprises a long cylinder 2001 (see fig. 2) that prolongs the cylinder of the said prior art engine.

A free oscillating mass 2014, anchored to a piston 2010 with a limiter 2008, floats on an air cushion 2009. The air cushion for small versions of the invention, fewer than 100 HP, could be a pressurized flexible container presented in Fig. 7, or a space between the free

oscillating mass and piston 2010; for larger versions ranging from 200HP up to 200,000,00 HP.

A starter 1010 turns crankshaft during starting in the similar way as in prior art engine. A light beam produced by source of light 1012 shines at an optical wheel 1011 on which apertures are made. The identification of crankshaft position is "borrowed" from robotics, since the patent already expired.

Embedded software stored in the microprocessor memory, also referred to as firmware, produces outputs to control entirety of the invention operation that is based on the said identification of crankshaft position. It consists of procedures that:

1. Manipulate valves;
2. Manipulate fuel and water injections;
3. Monitor and control lubrication;
4. Monitor and control fuel pre-processing;
5. Monitor and control water/exhaust separation;
6. Control each mode of possible operations;
7. Control switching from one mode of operation to another, as requested;
8. Control sequencing the modes of operation;
9. For external ignition version of the invention, control the initiation of explosions of fuel;
10. Monitor or block operation of the invention in cases of low level of oil, fuel or cooling water;
11. Refer to a table storing set points for comparison with the readings of actual speed from sensors;

12. Refer to a table storing set-points to correct the phase of oscillations of the mass 2014;
13. Make decisions regarding the amounts of fuel or water to be injected;

When a command to start the invention is received by the controller 1018, it resets itself first. Then it refers to a temperature probe 1025 and compares the reading to a set point stored in its memory and if the reading is below the set-point, it switches an electric heater 3004 on and waits until the pre-set temperature is established. Then it selects a proper procedure to start up the invention. Either wise it just selects the said procedure to start up the invention without waiting.

During start-up, due to certain heat capacity of internal parts, the invention is not cooled, to heat up the gun-engine fast, so water injections are blocked.

To ease cranking, the controller opens up the exhaust valve 2003 (see Fig. 2) and continually referring to a photo-detector 1013 activates a starter 1010 and fuel injector 1008, so the process of vaporization of fuel and pre-mixing it with air commences.

Upon receiving signal, from the photo-detector 1013, that the work piston 2010 is in TDC, (top dead center position) the controller closes the exhaust valve and opens up an induction valve 2002 fueling the harmonic oscillator from a fuel pre-processing device 1009, (see Fig.1 and Fig. 2) due to under pressure. At the end of the induction stroke the photo-detector produces a pulse indicating the BDC (bottom dead center position) of the work piston, so the

controller closes the induction valve and the compression stroke squeezes inducted fuel vapor with air.

For compression heat version of the invention, close to the TDC the temperature of a compressed premixed vapor has risen so high that a shy blue flame appears, yet the compression is still rising, so at TDC a sudden initiation of detonation releases energy from fuel very violently causing high pressure (up to 700 $\frac{kg}{cm^2}$) and high temperature (above 7000K degree) that heats up the invention fast.

For external ignition version of the invention an electric spark, or infrared laser beam, initiates the detonation precisely at TDC and that releases energy from fuel rapidly.

The pressure, even that high cannot move the free oscillating mass instantly, due to inertia, so mass accelerates squeezing the air cushion 2009. The move releases tension in the limiter 2008, which balanced pressure in the air cushion defining the compression ratio of the invention, extended to its limit. Therefore the compression could be manipulated with a simple control of the said initial pressure.

The said tension release causes sudden force acting on the work producing piston 2010 of prior art engine 1002. As the piston is connected to crank, the resulting torque turns the crankshaft producing work.

The move expands exhaust while compressing the air cushion over work piston 20010; first linearly and then the pressure saturates.

At certain moment energies; stored in the air cushion, in exhaust and in oscillating mass equalize, so the mass decelerates, but the kinetic energy pushes squeezing further the air cushion.

When the kinetic energy stored in the mass 2014 is exhausted, the pressure over the piston 2010 is at its pick, which bounces the mass back. This is referred to as harmonic oscillations.

During starting the numerous bouncing of mass varies pressure over work producing piston, which causes plurality of partial expansions gradually converting the energy released from fuel into work. The summation of the said partial work conversions does improve energy conversion during starting, especially due to the elimination of a counteracting torque caused by advancements of injections in every prior art engine.

In addition, each bounce of the mass causes huge pressure over the work piston when crank moved out of the alignment with the centerline of the cylinder. That improves torque, during starting up to forty times and the torque could be as high as during maximum speed. In addition the torque is independent from speed, which eliminates need for energy consuming reduction gears.

Continuous readings of the optical wheel 1011, by the photo sensor 1013, inform the controller 1018 to open the exhaust valve 2003 to evacuate exhaust at the BDC position of piston 2010. It is the energy stored in air cushion 2009 that pushes the exhaust away and that prevents a fault by design to use energy already stored in the fly wheel in every prior art engine.

After evacuation, the exhaust valve 2003 closes up at TDC and the induction valve 2002 opens commencing the next cycle that begins the mode of operation to reach the destine speed.

At that moment the controller switches to the said procedure 7 that selects a four stroke mode of operation, which differs from the

starting mode. The difference is that a water injector 2004 (see Fig.2) is activated and injects water directly into cylinder or at the induction valve. Whether the injections of water into cylinder could be during compression stroke and at the said valve prior or during the induction stroke, and the fuel injector 1008 (see Fig.1) injects fuel into a fuel pre-processing device1009 during previous power stroke, so the fuel vaporizes premixing with air prior to induction stroke, which extends time to evaporate fuel.

While the free oscillating mass 2014 is in TDC position, oil jets 1021 (see Fig. 1) are activated and spray the mass with oil, so oil rings forms among piston rings. The up/down movements of the mass 2014 smudge the oil all over the cylinder's 2001 wall preventing dry conditions, which is important especially for slow speed versions of the invention. Also an electromagnetic valve 1030 is activated by the controller 1018, so the pressure in a compressed gas source 1031 acts on a one-way valve 1033 and compensates eventual loss of the initial pressure in the said gas or air cushion continuously, which assures functionality with aging of the gun-engine that could lead to eventual leaks of the said pressure.

After destine speed, defined by a push on the accelerator, is reached, the controller 1018 refers to a set-point table 11, where the amount of fuel to be injected is stored as a number and then it selects the most efficient mode of operation that enforces up to four strokes from a single explosion of fuel.

Since the gun-engine could be presented as two oscillating systems, one of which is enforced with explosions of fuel and the other with the output from the first , it is important to notice that these

systems have certain dynamic relation to each other, such as the following:

1. $\omega_{piston} < \omega_{mass}$
2. $\omega_{mass} = 1.25 \bullet \omega_{piston}$
3. $\omega_{mass} = \omega_{piston}$

Where:

- ω_{piston} is the angular frequency of the invention;
- ω_{mass} is the angular frequency of the harmonic oscillator 1001;

The relation 1. True for starting up and slow speeds;

The relation 2. True for speeds that maximize torque;

The relation 3. Valid for the most efficient speeds.

At that point the movements of said piston 2010 and mass 2014 oppose each other, which define a resonant. The resonant is a needed condition to produce a plurality of power strokes from a single explosion of fuel.

Since the angular speed of the oscillating mass depends from:

1. The bulk of the mass and;
2. The amount of exploded fuel;
3. The initial pressure in air cushion;

a simple control of the duration of the injection of fuel manipulates the angular speed of the oscillating mass (Pulse Width Modulation).

Therefore upon detecting the destine speed of the invention, the controller 1018 selects, from the set-point table 11, one number and from table12 and another number to correct the phase of said

mass 2014 and than, after comparison of the phase of the piston to the phase of the oscillating mass, it selects procedure 13 to inject needed amount of fuel to explode. The following injection of water and explosion of fuel causes needed condition to resonate both oscillating systems.

The explosion drives the said mass 2014 to the same angular speed as the speed of work piston 2010 and in addition adjusts its phase, so the mass 2014 moves opposite to the piston, creating huge pressure over the piston 2010 at the alignment of the crank with the centerline of cylinder and re-bounces up moving out of the piston. Since the speeds are the same, the re-bouncing compresses the exhaust at the TDC, so recompressed exhaust with steam expands again producing extra power stroke.

The extra power stroke expands exhaust again, with over heated dry steam, so the temperature drops and the repetition of the above causes following re-compression that re-heats these again, but the resulting temperature is lower, due to conversion of some heat into work and to overcome always existing friction.

The process of re-compressing/expanding caused by harmonic oscillations converts the heat, previously damped into the environment with hot exhaust, into extra work first. The complete conversion of that heat is indicated by appearance of fog mixed with exhaust during expansion. The continuation of the process causes conversion of the heat, previously released through radiator, to extra work.

The following re-compressions/expansions convert the rest of the heat, released by the explosion of fuel, to extra work. The

complete conversion of energy in fuel to work is indicated by the existence of fog after the last recompression. That is assumed after four extra work strokes, since furthering the process would not contribute much.

Therefore after four extra power-strokes the controller 1018 opens up the exhaust valve 2003 and evacuates the exhaust with fog into an exhaust water separator 1005, so pure exhaust is released and the water is reused for cooling indefinitely.

With reference to Fig. 3 another embodiment of the invention is a fuel pre-processing device to vaporize fuel pre-mixing it with air. The fuel is injected onto metal-wool 3006, filling internal chamber3020, surrounded with exhaust flowing around 3001, as it is placed into an exhaust evacuation installation 3021. The device is also connected to a supply of air 3008 that passes trough the said metal wool 3006 from air filter 1022. In addition an electric heater 3004 wrapped up with the wool assures functionality during starting ups.

The metal wool conducts heat well, so fuel heats up boiling and vaporizes fast. As the airflow increases speed of vaporization and mixes air with the resulting vapor, explosive mix delivered to the said explosion chamber of said harmonic oscillator results. An air filter1022 is placed at air intake.

With reference to Fig. 6 a novel generation of alternating electric power is presented, as another embodiment of the invention. An oscillating mass 2014, at the bottom of which a magnet 4001 is placed, oscillates harmonically inside a cylinder 2001, around which an induction coil 6009 is wound. The coil is exposed to a varying

magnetic field. Due to the motions of the magnet 4001, induction of electric current in the said coil results. Due to harmonic oscillation of the magnet the inducted electric power output is sinusoidal.

It is only to provide a three cylinder gun-engine, with three oscillating magnets compressed in the said oscillating masses and a coil wound around each cylinder to produce three-phase electric generator, providing the cranks of its crankshaft are spaced 120 deg to each other. Thus a three cylinder gun-engine could be used as an engine or a three-phase generator, or a set of three one-phase generators, or a combination of an engine and three-phase generator, the frequency of the electric power output of which could be easily controlled with variations of fuel supply.

Prior art motor vehicles, motorized military hardware or heavy machinery use reduction gears or transmissions to compensate much undesired characteristics of prior art engine. Since the efficiency of any today's transmissions hardly exceeds 30%, the use of these contributes a lot to the abuse of oil resources and the environment. This invention prevents that, as in this invention there is no need to employ neither reduction gears nor transmissions. Thus there is yet another embodiment of this invention related to the application of gun-engine to motor vehicles or other hardware that might use the gun-engine, especially a transmission free motor vehicle that comprises: a prior art vehicle, in which a prior art power train is replaced with the invented gun-engine clutched to wheels directly that could be fueled with a variety of fuels including liquid, LPG (liquefied pressurized gases) or gaseous such as hydrogen or even futuristic fuels not yet developed.

Due to imposing of prior art expansion on a harmonically varied pressure output from harmonic oscillation, the mathematical model of the invention differs from that of prior art engine (4).

(4) $W=[0.351 P_{explosion} e^{-\beta t} + P_{aircushion}]V$

Where:

- $P_{explosion}$ is amplitude of pressure induced by explosions of fuel;
- β reflects damping to overcome friction and work extraction;
- $P_{aircushion}$ is static pressure in air cushion;
- V is volume displaced by work piston;
- ω is the natural angular frequency of oscillation of the mass of used harmonic oscillator;
- W is work resulted from energy conversion

Appendix 1

Mathematical prove of improvement of energy conversion and efficiency in an engine that is a combination of a prior art engine and explosion driven harmonic oscillator

By Kazimierz Holubowicz (inventor)

Abstract

This presentation proposes a combination of traditional engine with detonation enforced harmonic oscillator. It also proves that the combination does improve the resulting efficiency many times, which leads to one order of fuel consumption savings and 90% cuts of the GHG emissions from cars and trucks. The purpose of harmonic oscillator is to allow explosions of fuel and meetings of highest pressure acting on the piston of traditional engine with horizontal position of crank, thus it does improve torque many times (98 times for compression ratio 14) and that indeed allows developing a transmission free vehicle. While the use of harmonic oscillator converts completely the energy releases from fuel into work, the combination is cooled well by numerous expansions of exhaust and does not need cooling, which eliminated cooling pump and radiator.

Introduction

Prior art engines use slow combustion to release energy from fuel. For over century long history of the development of engines, engineers have made huge effort to prevent explosions of fuel in engines, because prior art engines cannot withstand detonations of fuel.

The trend intensified in 70-ties of the last century, as researchers tried to adapt traditional engines to gaseous fuels that have very explosive nature. One of the methods to prevent explosions is very lean operation of prior art engine. To assure igniting lean mix, a small amount of diesel fuel is injected into cylinder that ignites easily and that initiates igniting the lean mix of gaseous fuel. Even though the above assures functionality, the result is a very poor efficiency.

Detonations of fuel yield much higher pressure and temperature, which destroys prior art engines. Even though it is possible to strengthen parts, so these could withstand higher pressure, the temperature presents real challenge because the piston crown melts as it is the worst cooled part of every prior art engine.

The energy conversion in prior art engine hardly exceeds 20% and that has devastating effect on the environment, as require huge fuel consumption responsible for humongous emissions. The emissions from cars and trucks are directly responsible for an epidemic proportion of 40% increase of asthma cases among these living in urban areas densely crowded with cars and trucks in the last decade. More than sixty percent of New Yorkers suffer from the asthma and

even more from other respiratory diseases related to these emissions. The solution to the above is to develop efficient engine. This invention is the best ever solution to that problem.

Energy conversion in prior art engine is defined by the expression (1).

(1) $W = P \bullet V$; where: P is the average pressure;
V is volume displaced with piston;

It is important to notice that replacing traditional combustion with explosions of fuel would certainly improve the energy conversion, (increase of P value), so there is one and only one conclusion that preventing explosions of fuel in engines is a blunder, which preserves faults in engines and prevents efficient operation of engines.

Ideal engine efficiency defines the limit of the efficiency of every heat engine, including IC engines. The limit is imposed by the second law of thermodynamics stated by German physicist Clausius and then re-instated by Planck. The limit is defined as the expression (2), but explosions raise the temperature so it also increases the theoretical limits imposed by the second law.

(2) $e = (1-\frac{T_{ambient}}{T_{comb}}) \times 100\%$; where:

T_{comb} Temperature of combustion;
T_{amb} Ambient temperature;

In average prior art IC engine the combustion temperature hardly exceeds 3000 K^{o} and the engine operates in ambient temperature $300K^{o}$, so its efficiency limit is about 90%, but when fuel explodes the temperature could be four times higher and that indicate the efficiency limit increase up to 98%.

Even though the limit of the efficiency imposed by Nature is 90%, the efficiency of average traditional engine is only 20%. The major cause of the difference is an incomplete expansion of exhaust that calls for cooling and the cooling is the major cause of the inefficiency in every prior art engine.

Energy stored in fuel, when released, produces power that is available to run engines. The power is defined as energy release in time, so slow release of energy does contribute to inefficiency, as it limits all, the pressure, temperature and available power to run engine.

The invention proposes to replace traditional slow combustion with a very rapid release of energy from fuel by detonations. The detonation of fuel produces a pulse of pressure much higher than slow combustion. How much higher?

To answer the question lets consider that prior art combustion generates max pressure 100 to 150 $\frac{kG}{cm^{2}}$ (experimental data). Also consider that in a properly tuned engine the max pressure is established when crank is aligned with the centerline of cylinder. In addition, the energy released from fuel at that very moment is only 7% of all energy stored in fuel (as a rule of thumb).

Body of the presentation

In the combination an explosion should be initiated at TDC (Top Dead Centre position), therefore the explosion yields a pressure within volume equal to that defined by the clearance between the piston's crown at TDC and cylinder head, in prior art engine. Thus the pressure increase is in proportion to the increase of energy released from fuel according to the expression (3).

$$(3)\ P_{expl.} = \frac{P_{100\%}}{P_{7\%}} \bullet P_{\max.diesel} = \frac{100\%}{7\%} \bullet P_{\max.diesel} = 14 P_{\max.diesel}$$

A static pressure of this value would call for strengthening of the cylinder, which is possible but economically not visible. Therefore the invention proposes to convert the resulting pressure into sinusoidal variations, the amplitude of which lasts relatively short (about 0.0003 to 0.001 of the duration of power stroke). The shortening of the duration calls for a very rapid energy release from fuel that should be up to 1000 times faster than prior art combustion and that would require a vaporization of liquid fuels (like gasoline or diesel) and premixing the vapor with air in explosive proportion. Thus the invention also proposes a device that vaporizes liquid fuels and premixes the vapor with air.

As the invention utilizes harmonic variations of pressure acting on work producing piston, the average pressure over the piston differs that of the prior art engine's average pressure, which is defined by expression (4) well known to those skilled in the art.

$$(4)\ P_{av.diesel} = P_{\max.diesel} \int_0^{\pi} e^{-\beta t} dt;$$

According to publications, like "Advanced Mathematics for Engineers and Scientists" by Murray R. Spiegel, a damped harmonic oscillator that converts a pulse of pressure into oscillating pressure could be described as (5) & (6);

$$(5)\ \underset{exhaust}{P}(t) = P_{expl.} \bullet \cos(\omega t)\, e^{-\beta t};$$

$$(6)\ \underset{output}{P}(t) = P_{expl} \bullet \sin(\omega t)\, e^{-\beta t};$$

- ω is a natural frequency of oscillation;
- t is time
- $\underset{exhaust}{P(t)}$ Pressure oscillations at input
- $P_{expl.}$ Pressure pulse;

- $P(t)_{output}$ Pressure acting on the piston;
- β Damping caused by energy extraction to overcome friction and load;

The variations of pressure have equivalent value of a constant pressure referred to as an effective pressure that is defined by the root mean square value of sinusoidal variations. For sinusoidal variations of pressure its effective value is 0.707 /2=0.356. Therefore expression (7) defines the effective pressure over work piston in the invented engine, in which the internal pressure varies harmonically during power strokes.

$$(7)\ P_{effective} = 0.353\, P_{explosion} \int_0^{\pi} e^{-\beta t} dt = 4.456\, P_{\max.diesel} \int_0^{\pi} e^{-\beta t} dt;$$

Substituting (4) into (7) finally the effective pressure over work piston in the invented engine could be expressed in terms of pressure in diesel engine as expression (8).

$$(8)\ P_{effective} = 4.456 \bullet P_{av.diesel};$$ wherein:

- $P_{effective}$ Effective pressure over work piston in the invented engine;
- $P_{av.diesel}$ Average pressure over piston in diesel engine

The expression (8) indicates that energy conversion in the invented engine increased 4.456 times, so did the efficiency described by expression (9).

$$(9)\ e_{invention} = 4.456 \bullet e_{diesel} = 4.456 \bullet 20\% = 89.12\%;$$

Wherein:

- $e_{invention}$ Efficiency of invention;
- e_{diesel} Efficiency of diesel engine;

The (8)&(9) prove that the invented engine is more efficient and that invention is the best solution to problems related to environmental and ecological disasters in urban area especially because the engine has zero toxic emissions. To prevent bursting of cylinder the author of this invention proposes to limit the fuel supply to 1/14 of max fuel consumption in traditional engines like diesel, Wankel or gasoline.

Also the torque produced by invention is improved: It is improved because of the delay of building up of pressure over the work producing piston due to inertia of mass to allow the max pressure meetings with the horizontal position of crank and that causes a much higher torque than in diesel. How much higher?

In diesel the maximum torque also relates to horizontal position of the crank, but at that moment piston is located in the half of cylinder position, so the pressure has expanded and is lower. How much lower?

As the diesel compression ratio is 14, or higher, (to ignite by compression heat) the pressure is half of the compression ratio number lower (torque 7 times lower than that resulting from potential of max pressure), therefore the max torque of the invented engine could be expressed in torque of diesel engine as (10)

(10) $T_{\max .inv} = Pincreses_{\exp losion} \bullet 0.5 r_{comprratio} \bullet T_{diesel} =;$

$= 14 \bullet 0.5 \bullet 14 \bullet T_{diesel} = 98\, T_{diesel}$; Wherein:

$T_{\max .inv.}$ Max torque of invention;

T_{diesel} Max torque of diesel engine;

$r_{compressio}$ Compression ratio of diesel;

$Pincreeses_{\exp losion}$ Increase of pressure by explosion of fuel;

The expression (10) indicates 98 times torque increase over that in diesel engine, which allows to use the invention without any transmission or reduction gears, therefore the invention does simplifies cars and trucks as it could be directly clutched to load.

The invented ID engine (internal detonation engine) has already been developed and tested by an independent lab. It is so cool (exhaust about 138 F degree) that the author decided to run the engine without cooling at all. Its temperature rose slightly but the author could not sense that by touching the exhaust manifold. This is the most remarkable invention in times of huge fuel pricing increase and predicted shortages of oil resources.

Attention!

1. The factor 4.456 measured during preliminary experimentation has slightly lower value 4.452, which is caused by a negligible energy dissipation to overcome friction in the harmonic oscillator that is a very negligible cause of the inefficiency.

2. The torque of invention in expression (10) is valid for the same fuel consumption as in diesel, but the increase of the pressure would almost certainly burst the cylinder, so the invention proposes to lower the fuel supply to negligible 10% of that in diesel and the question is what would be the torque and power output when the fuel supply is limited?
3. The proposed combination (patent pending) has been already developed by the author and later by NuTorque Engine Corp. and tested by an independent lab of the Utah Valley State Collage-USA, because the Canadian government refused to support the invention (The refusal in 2000 by a low level NRC clerk Mr. Walter Wardrop);

Conclusions

1. The presented combination of traditional engine with explosion driven harmonic oscillator does eliminate all causes of the inefficiency (caused by bad design) in engines inherited from the first prototypes of Otto and Diesel invented in the XIX century;
2. One the most important cause of the inefficiency in every traditional engine is a single and incomplete expansion of exhausts that requires cooling, (to prevent melting) that is the most important cause of energy waste in every traditional engine, the proposed combination replaces the single expansion with plurality of recompressions and expansions, induced with harmonic oscillator that allows complete energy conversion and that allows practical engine efficiency to be in the vicinity of the efficiency of the ideal heat engine;
3. The harmonic oscillator requires a prolongation of cylinder of the traditional engine to accommodate an oscillating mass component and a gas pocket, on which the component floats, wherein the initial pressure, in the pocket defines the compression ration of the invented combination, which could be adjusted "on the fly" to any value to assure initiation of detonation of fuel by compression;
4. As the proposed combination expands exhaust completely and converts all the energy released from fuel into work, it does not need any external cooling at all.
5. To allow operation of the combination without cooling the manipulations of valves must be independent from positions of crankshaft, therefore traditional camshaft to manipulate valves must be replaced by more flexible electromagnetic or hydraulic actuations to allow up to fourteen stroke mode of operation of the combination, which completely converts energy released from fuel into work, so no need for external cooling at all;
6. To allow proper monitoring of the position detection of crank the author advises to use a microprocessor based control fed with data from a non-contact position sensor such as optical disk or magnetic;
7. Elimination of camshaft and associated gears do eliminate another cause of the inefficiency in engine;
8. Replacement of traditional combustion with rapid energy release from fuel prevents decomposition of fuel onto carbon and hydrogen, thus eliminates fuel losses, (infesting traditional engines) black engine deposits and emissions of black particulates;

9. Impact of the mass production of the invention on the World oil market could be the same as decimal increases of the supply of oil and that could lead to more prosperous and peaceful World;
10. The impact would include huge annual fuel savings that in Canada alone is about 60 billion of liter of gasoline and 20 billions of liters of diesel fuel and that presents monetary savings reaching almost $100 billions/year.
11. The saved money could be invested in profitable ventures (instead going in smoke out of cars and trucks) and that could lead to a never known "Golden Age" where every Canadian has access to good Health Care, without long waiting list, and has an access to excellent education according to interest and not economic needs.

I claim:

1. An internal energy release engine in which fuel releases energy either by combustion or detonation comprising:
   An energy release chamber having a cylinder, a cylinder head and a floating piston enclosing the chamber;
   intake and exhaust valves for admitting a mixture of air and fuel into the chamber and allowing the exhaust stream to leave the combustion chamber;
   a gas cushion for supporting the floating piston above a working piston operatively connected to a crankshaft of the said engine, the gas cushion including an amplitude limiter anchoring the floating piston to the working piston;
   a source of gas pressure, a controller and valves means, wherein the controller pressurises the gas cushion with the source of pressure by operating the valve means.

2. The engine according to claim 1, wherein the source of gas pressure is a compressor.

3. The engine according to claim 1 or claim 2, wherein the source of gas pressure comprises a gas reservoir.

4. The engine according to claim 1 to 3, wherein the gas cushion is an air cushion.

5. The engine according to any one of claims 1 to 4, wherein the cylinder includes lubricating ports substantially aligned with the position of the floating piston and the working piston at top dead center, respectively, such as to lubricate the floating piston and working piston.

6. The engine according to claim 1 to 5, wherein the cylinder includes a lubricating port substantially aligned with the position of the working piston at bottom dead center such as to lubricate the working piston.

7. The according to claim 1 to 6, wherein the exhaust stream of the internal combustion engine is routed to a water separator for separating water from the exhaust stream.

8. The engine according to claim 1 to 7, wherein a water reservoir is provided to accumulate water separated from the exhaust by the water separator.

9. The engine according to any of claims 1 to 8, wherein the valve means comprises a pulsing valve positioned above the position of the work piston at TDC.

10. The engine according to any one of claims 1 to 9, wherein the amplitude limiter comprises a flexible string comprising Kevlar or Titanium fibers.

11. The engine according to claim 10, wherein the flexible string is coated by rubber or nylon.

12. The engine according to any one claim 1 to 11, wherein a water injecting means injects water into the combustion chamber to cool the combustion chamber.

13. The engine according to any one claim of claims 1 to 12, wherein a fuel vaporiser is provided for vaporizing fuel for admission into the energy release chamber.

14. The engine according to claims 1 to 13, wherein the fuel vaporizer comprises a chamber having a fresh air intake port, an air/fuel vapor mixture exit port, a choke device to control a fresh airflow, a fuel injector, a metal wool for providing substantial contact surface between the fresh airflow and the fuel injected by fuel injector and an electric heater.

15. The engine according to any one of claims 13 or 14, wherein the fuel vaporizer includes a heat exchange interface providing heat from the exhaust stream of internal combustion engine for vaporizing fuel for admission into the combustion chamber.

16. The engine according to any one of claims 1 to 15, wherein the energy release from fuel in the energy release chamber is initiated by a means from an electric spark, compression heat or an infrared laser beam.

17. The engine according to any one of claims 1 to 16, wherein an electric starter is provided for starting the internal combustion engine.

18. The engine according to claim 17, wherein the floating piston comprises at least one permanent magnet ring and wherein at least one induction coil is wounded around the cylinder such as to produce electricity in the at least one induction coil from the movement of the floating magnet.

19. The engine according to claim 18, wherein a south pole of the permanent magnet points towards a centerline of cylinder.

20. The engine according to claims 18 or 19, wherein a phase system of electricity produced is selected from single phase or three-phases.

21. The engine according to claims 1 to 20, in which fuel air mixture is an explosive mixture and thus the engine is an internal detonation engine, wherein the purpose of detonation is to speed up energy release from fuel to create better thermodynamic conditions for energy conversion and the efficiency because to increases power and thus more power results from less fuel.

22. A method of operating an engine according to anyone of claims 1 to 21, comprising the steps of:
    a. Pressurizing the gas cushion
    b. Providing the mixture into the combustion chamber
    c. Compressing the mixture in the combustion chamber
    d. Releasing energy from the mixture to generate combusted products and a pulse of pressure and temperature
    e. Allowing the force resulting from the pulse of pressure and temperature in the combustion chamber to force the floating piston down, thereby pressurizing the gas cushion and providing kinetic energy to the floating piston, which slows the decent and stops the movement of the floating piston
    f. Extracting torque from the crankshaft as the force acting onto the working piston rises due to the rise of the pressure in the cushion chamber
    g. Allowing the pressure and temperature in the cushion to force the floating piston to ascend in cylinder, to gain kinetic energy and recompress the combusted products under kinetic energy of the floating piston and thereby stopping the floating piston
    h. Performing steps e. to g. at least once and until the exhaust valves opens.

23. The method of claim 22, wherein in starting mode the exhaust valves opens after that the work piston crosses the dead bottom dead center.

24. The method of claim 22, wherein in a transient mode a step of injecting water into the combustion chamber is preferred before the step of compressing the mixture and wherein the exhaust valves opens when fog appearing in the combustion chamber and wherein the exhaust valve opens after the work piston crosses the bottom dead center

25. The method of claim 22, wherein in a multiple power stroke mode a step of injecting water into combustion chamber is performed before the step of compressing the mixture in the combustion chamber and wherein the exhaust valve opens when fog appearing in the combustion chamber is maintained during the last repetition of steps e. to g.

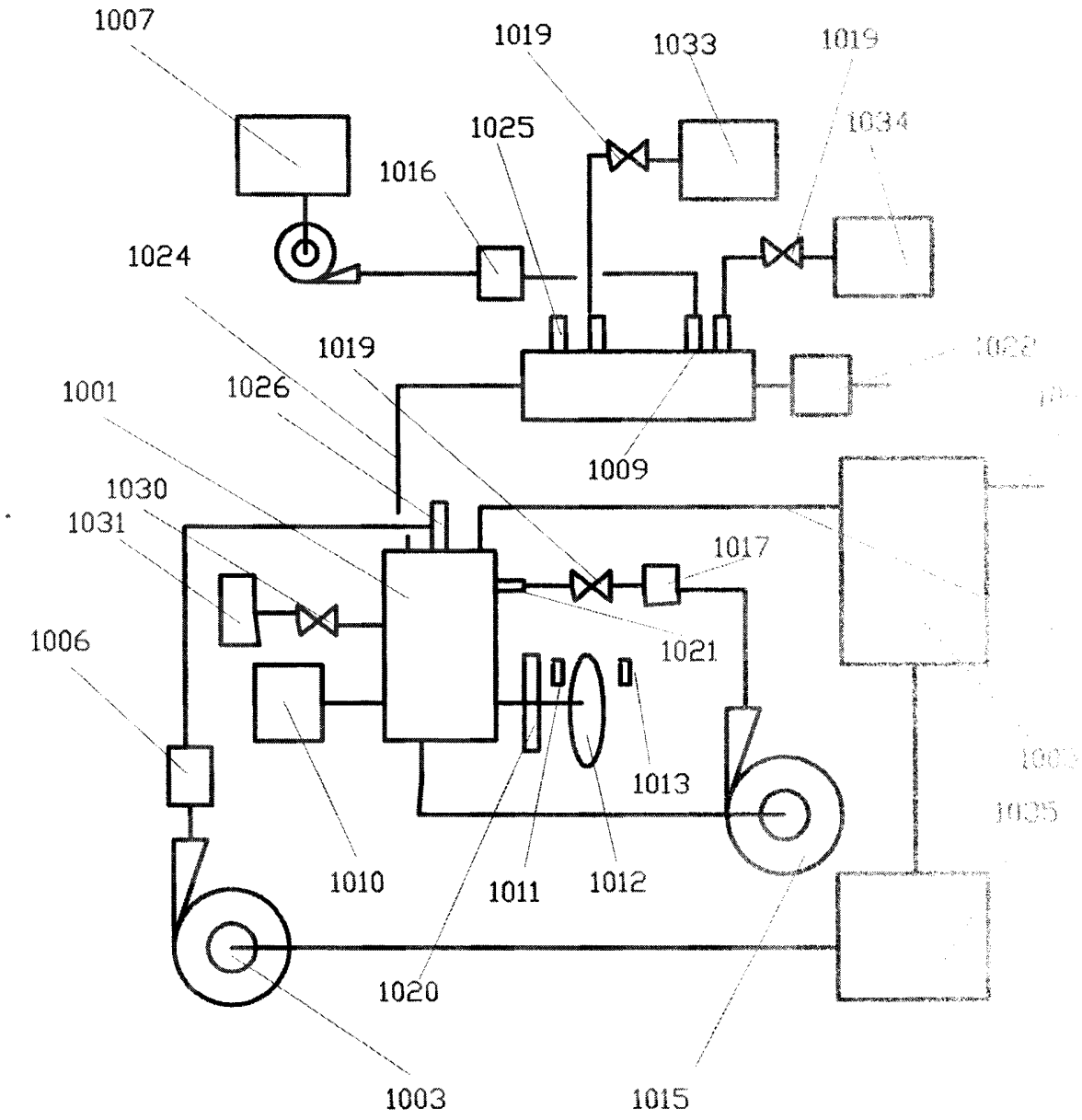
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Fig. 1

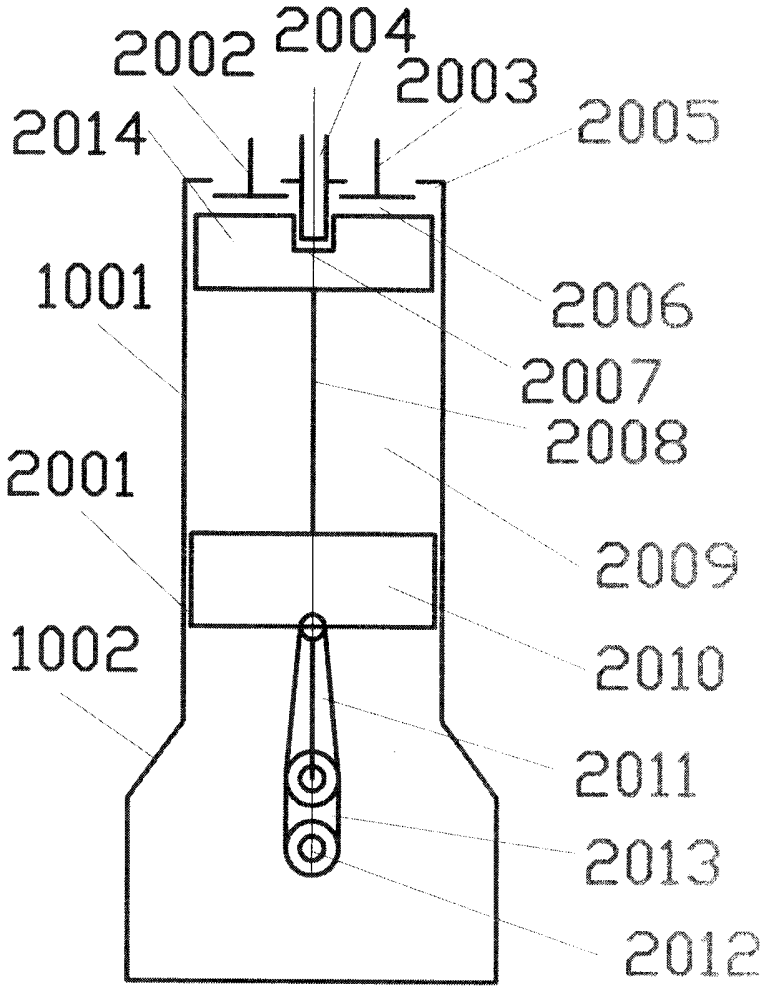
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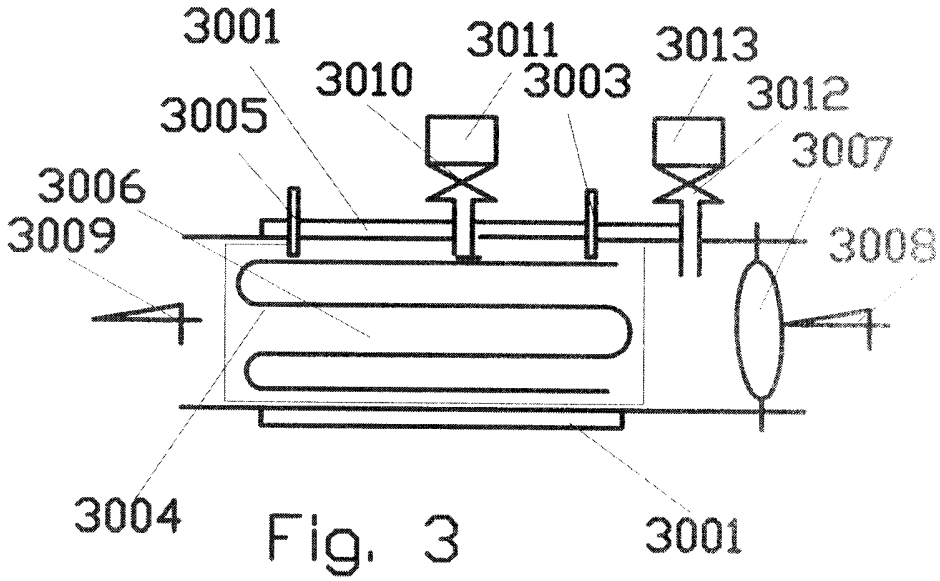
Fig. 2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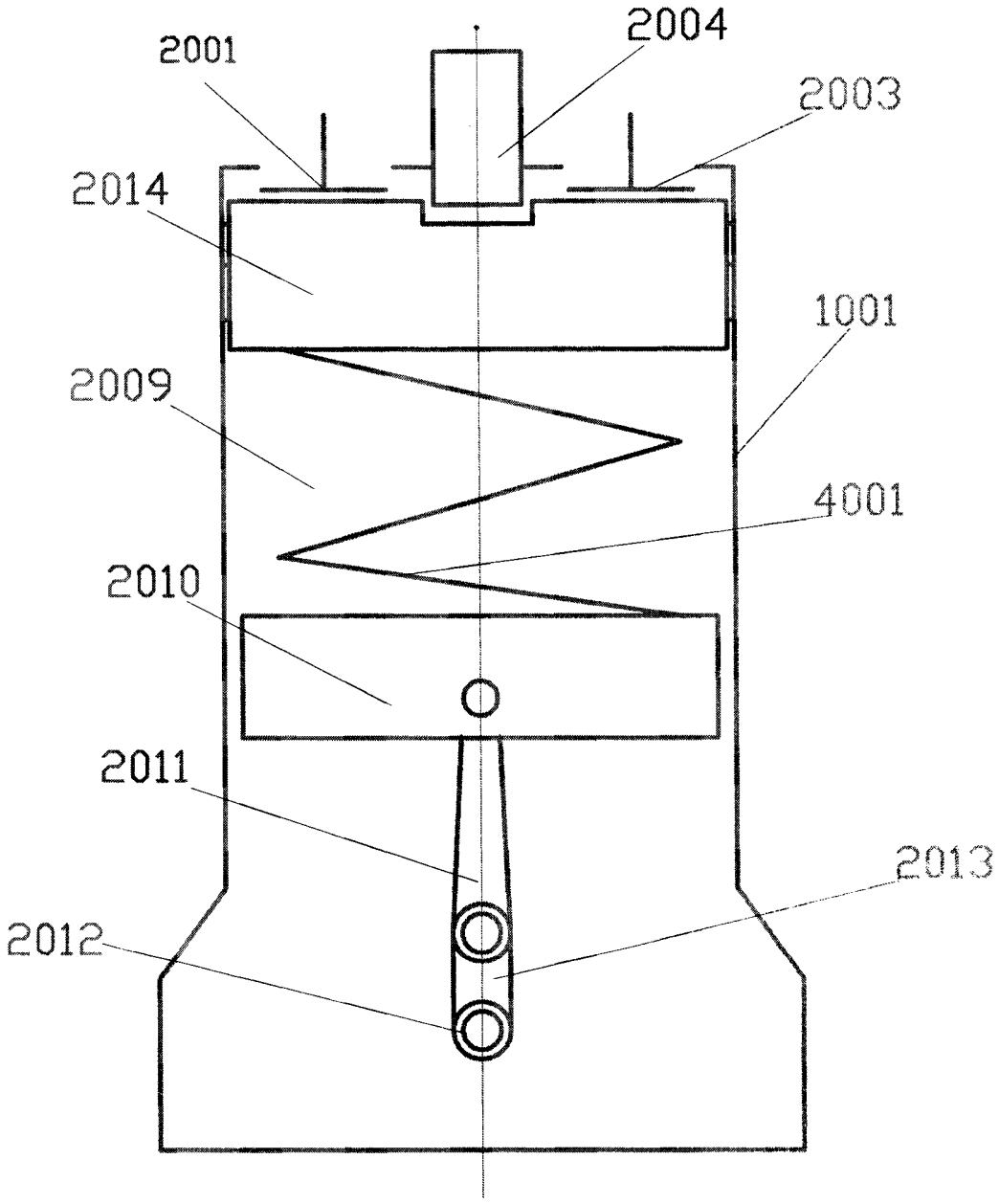

Fig.4

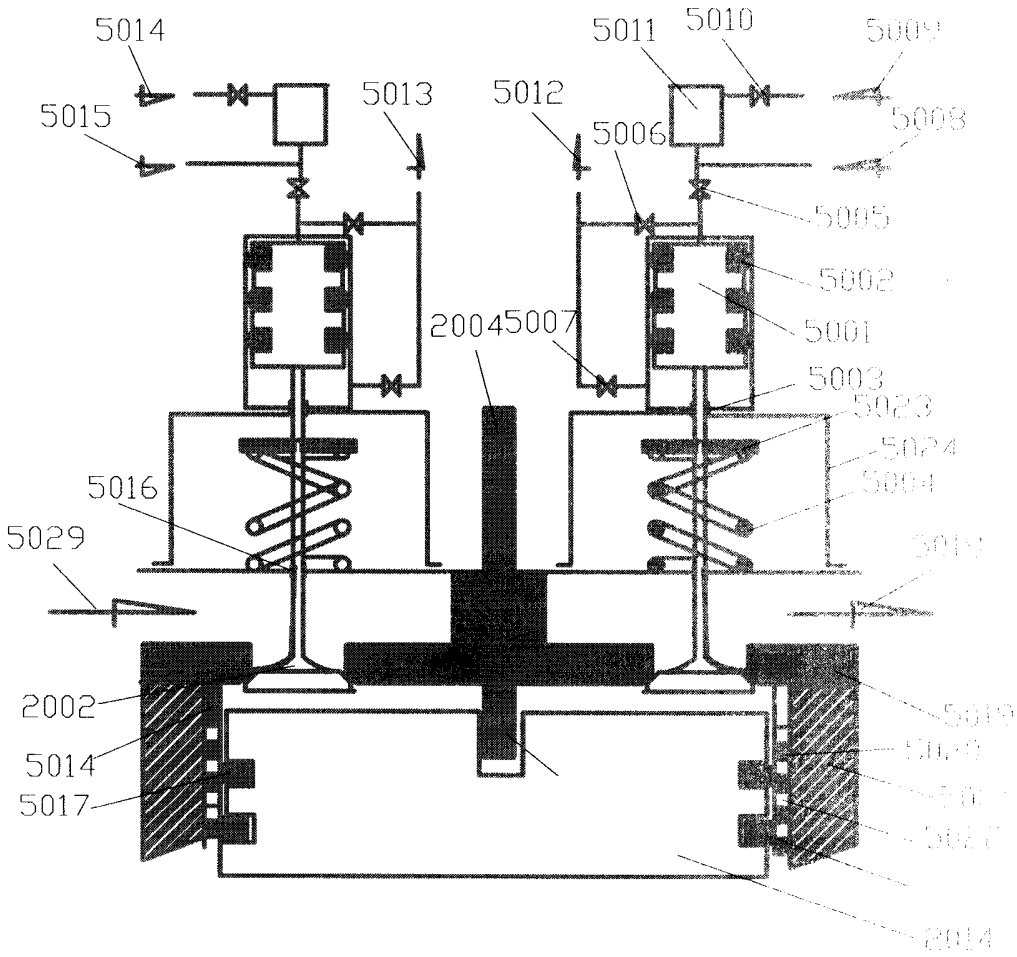
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Fig. 5

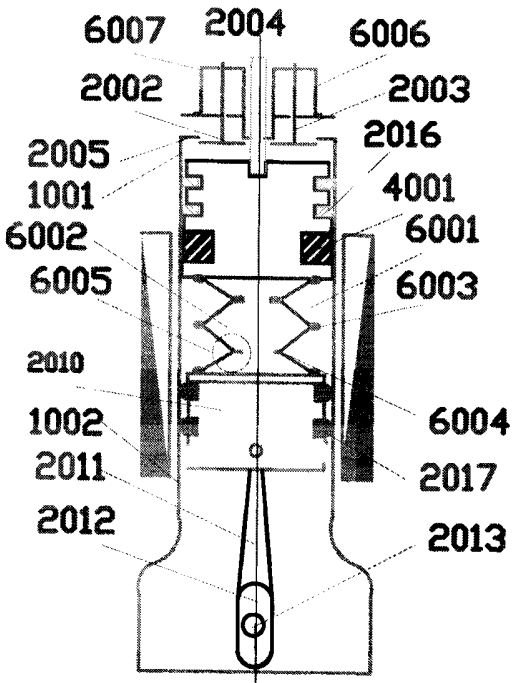


Fig.6

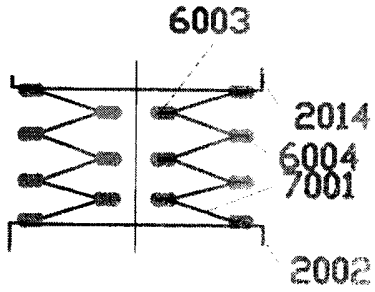


Fig. 7

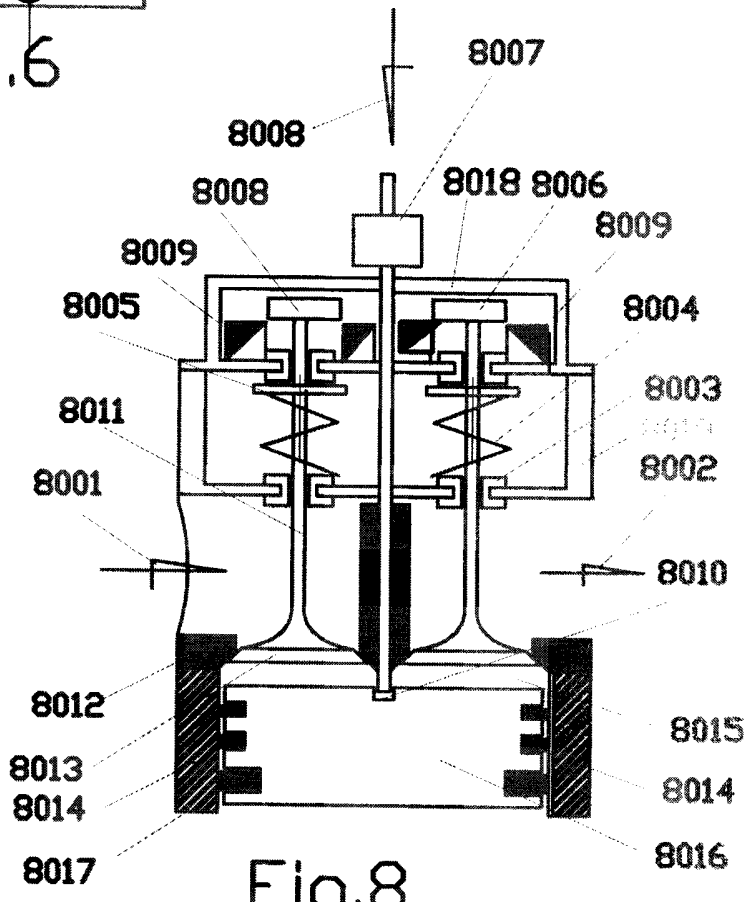
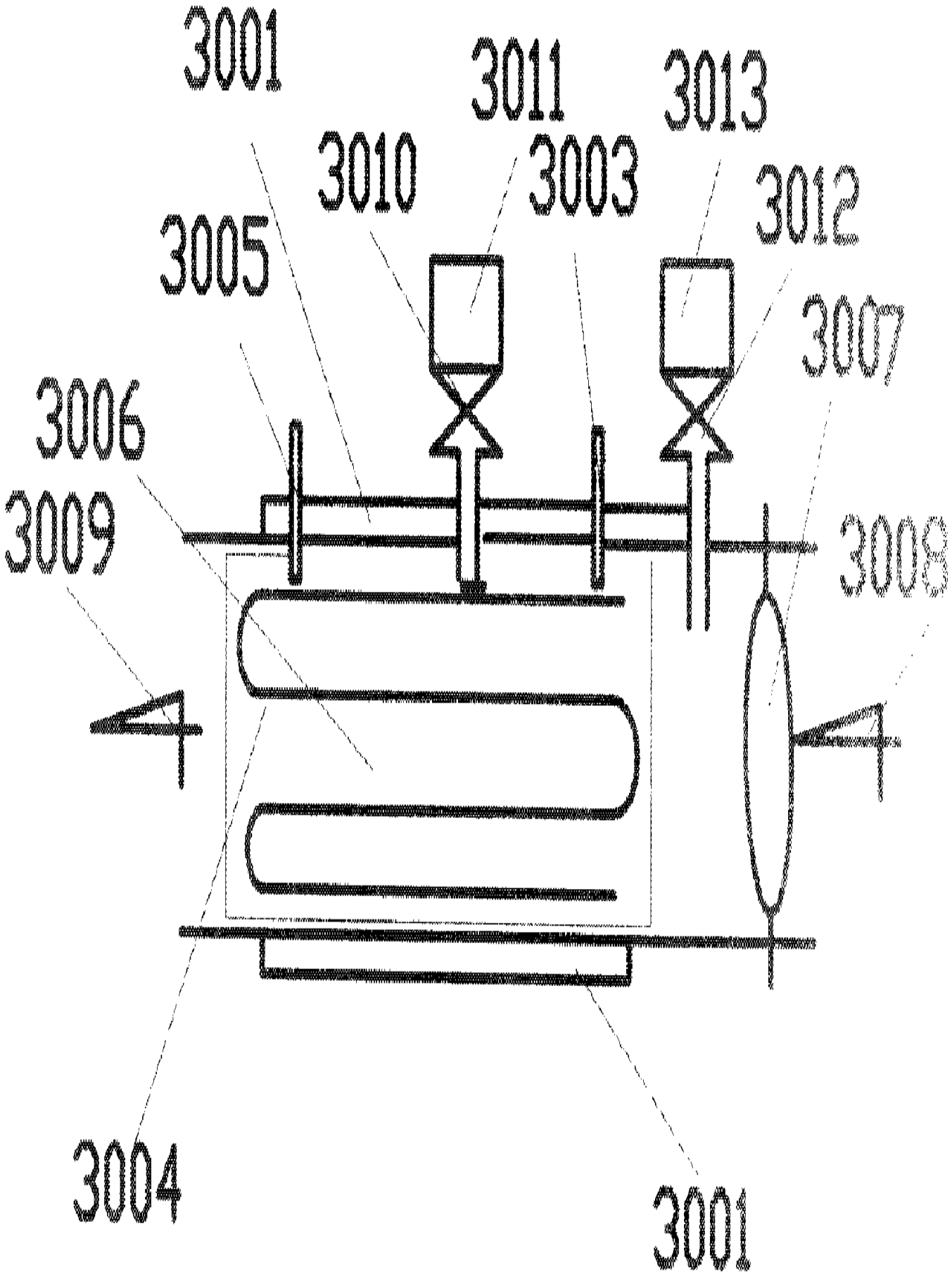


Fig.8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