COMPLEX INNOVATIVE PROJECTS AS A RESULT OF REMOTE CONTROL AND MONITORING USE ON EXAMPLE OF TECHNOLOGIES DEVELOPMENT ANALYSIS FOR THE MODIFICATION OF ALL TYPES OF FUEL MIXTURES

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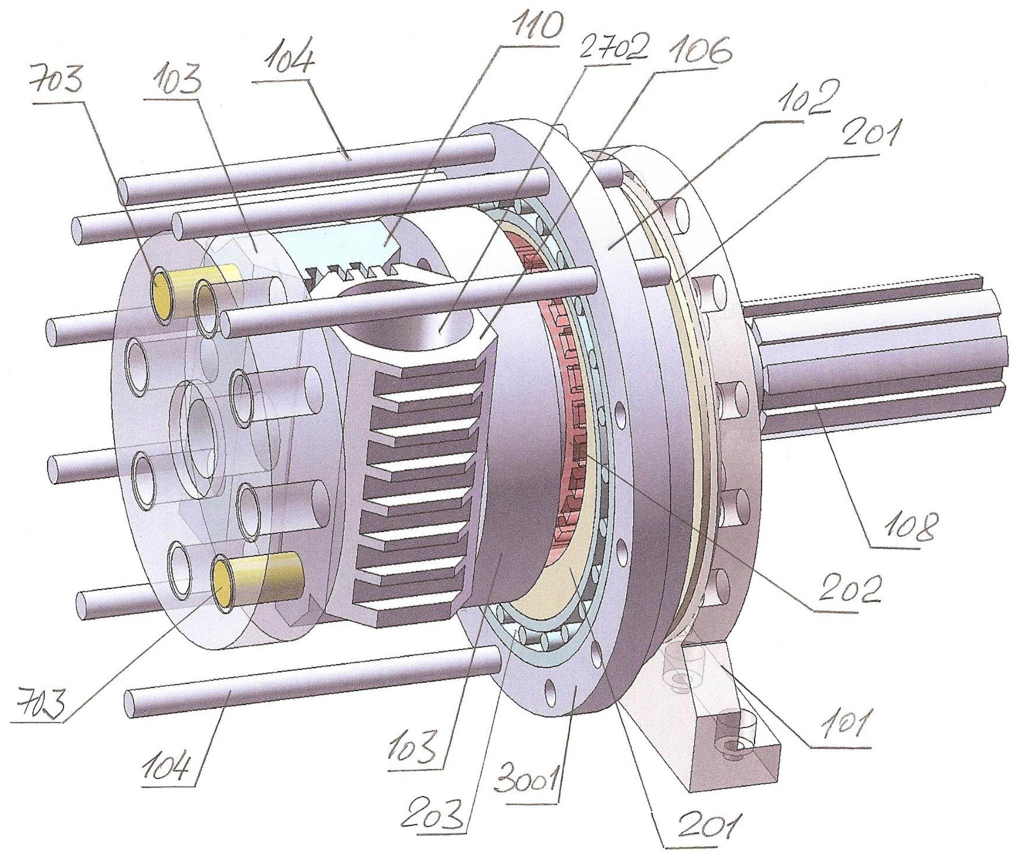

Figure 1. The figure shows a three-dimensional model of a rotary engine that implements Otto's thermodynamic cycle, while the piston group of the engine and the crank mechanism do not differ from the standard ones.

Marked numbers on the picture:

101 – carrier engine stand with eccentrically located bearing carrier

102 – rotor flange eccentric against to the axis of rotation

103 – rotary coupling flanges

104 – axes of an eccentric rotor directly kinematically connected to crank - connecting rod mechanisms

106 – cylinder

108 – output shaft

110 – cylinder body adjacent to body 106

201 – eccentric groove

202 – bearing

203 – bearing

703 – connecting and fixing axles

2702 – cylinder cavity

3001 – bearing outer ring 203

As the statistics of innovation projects shows, the algorithmic component, including the logistics of the entire innovation process, has an increasing influence on the commercial value and efficiency of these projects, starting from the formulation and synthesis of the innovation idea and completing the integration process into a specific production and commercial structure.

Task setting, selection of evaluation criteria and determination of the nature of the ways to achieve the necessary results often also determine the success or failure of the implementation process.

Since the author has experience and technological and commercial developments in the most popular technologies for modifying fuel mixes today, he suggests to consider as an example the algorithmization of this group of innovative projects, which are the final stage after passing through multifunctional stages of transportation and delivery, while usually including system remote monitoring, including combined with aerial photography processes or using unmanned vehicles.

Currently, according to information that can be obtained from open sources, there is a tendency to modify and modernize internal combustion engines in areas related to the improvement of automatic control systems for the process of supplying and burning fuel;

In studies involving the use of alternative fuels, such as ethanol or methanol, the problem of mixing ethanol, methanol and gasoline or ethanol, methanol and diesel fuels clearly emerges;

More than a century-old problem associated with the adopted mechanical system for converting linear to rotary motion is not considered or is considered in local aspects that are not of fundamental importance for solving the problem as a whole, namely mechanical problems eat up 50% of the efficiency of any internal combustion engine;

In the author's developments there are submitted applications for inventions, in which the complex of problems described above is solved.

The problem of mixing ethanol and gasoline at filling stations is completely solved by the invention, which has a prototype made for churning butter, but the same prototype and basic principles of its work can be used to present ideas and solve the problem of mixing and turning the mixture into a stable emulsion mixing fuel components such as diesel fuel and various types of technical alcohol, including glycerol; ethanol and gasoline and many others, including those of inorganic origin;

In addition to all the systems and methods of various automatic control systems known from publications, the author proposes a system of contactless control of the real state of the fuel mixture, including the level of air saturation and the level and nature of foaming of the fuel mixture before it is injected or fed to a high-pressure fuel pump. as it takes place in diesel engines; application for an invention filed last year;

At the same time, the author notes that one of the most important conditions for the successful commercial application of these innovations is the condition that allows for the most sophisticated remote sensing methods to be used for online monitoring and monitoring in conjunction with aerial photography processes or for controlling or monitoring using unmanned aerial vehicles.

The author collaborates with the creative team, which proposed solving mechanical problems in all types of internal combustion engines by changing the design of the mechanism for converting linear to rotary motion, without any changes in the fuel system of the internal combustion engine; application for invention filed in April last year;

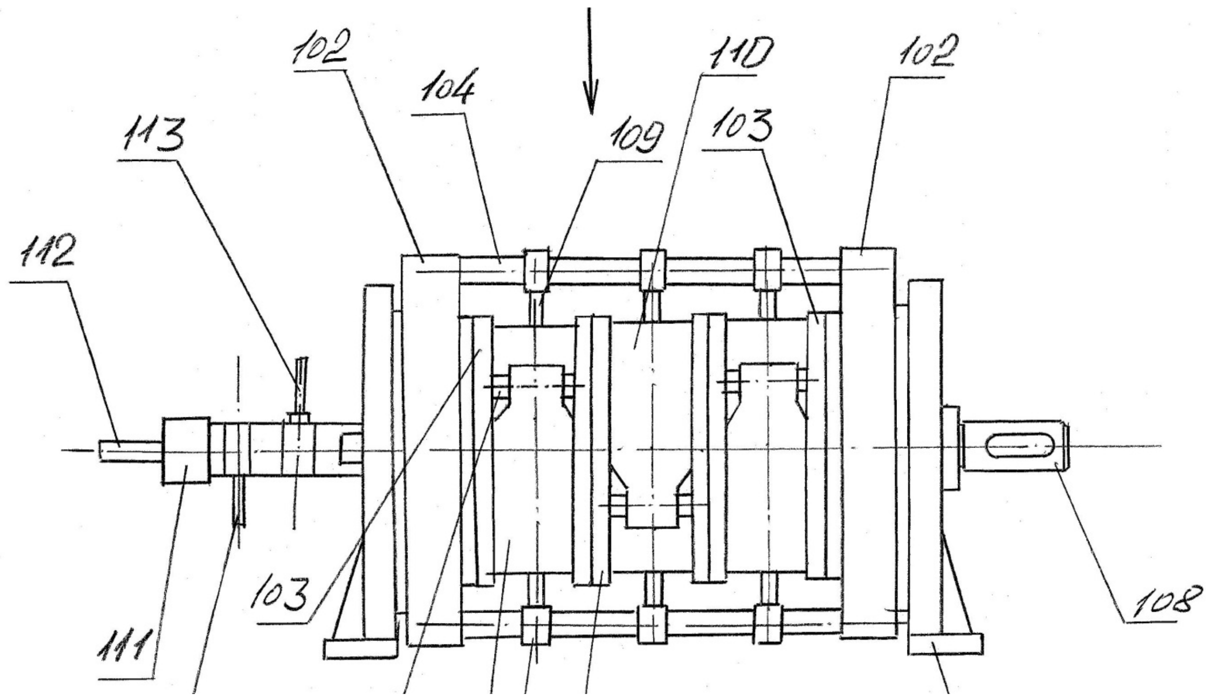

Figure 2. Rotary internal combustion engine with built-in homogenization of the fuel or fuel mixture.

Marked numbers on the picture:

102 – rotor flanges of the engine kinematics

103 – engine cylinder mounting sections

104 – axles for outputting crank and connecting rod mechanisms of engine cylinders

108 – engine output shaft

109 – crank connecting rods - engine mechanisms

110 – engine cylinders

111 – device for online homogenization of fuel mixtures or mono-fuel

112 – fuel input and fuel mixture into the device for online homogenization of fuel mixtures or mono - fuel

113 – radial inlets of air or fuel mixture components or fuel emulsion components into a device for on-line homogenization of fuel mixtures or mono-fuel

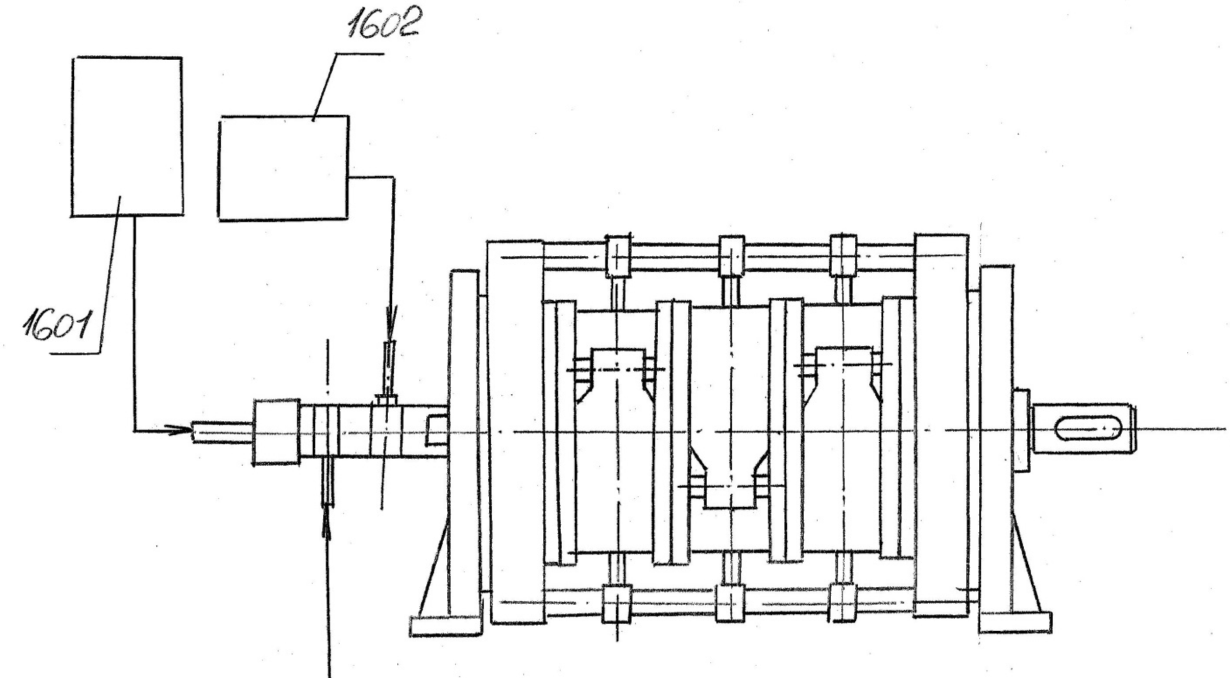

Figure 3. Rotary internal combustion engine with integrated homogenization of the fuel or fuel mixture, indicating the functional interaction with the tank for liquid fuel and with the tank for fuel components or with a compressor for compressed air.

Marked numbers on the picture:

1601 – multifunctional tank, for a case with on-line homogenization of mono-fuel, either as an option with on-line homogenization of fuel blends (with a blending system built into the tank), or as an option with on-line homogenization of fuel emulsions (with a re-blending system - emulsification built into the tank); The system should also include a low-pressure pump and all associated control and instrumentation.

1602 – multifunctional tank, for the case of giving the device the functions of mixing and homogenization, in which, in the case of blending with ethanol, ethanol is contained, in the case of blending with methanol, methanol is contained, in the case of fuel emulsions, water is contained

The system should also include a low-pressure pump and all associated control and instrumentation.

In the case of a variant using gasified fuel, this is a compressor with all the associated control and equipment.

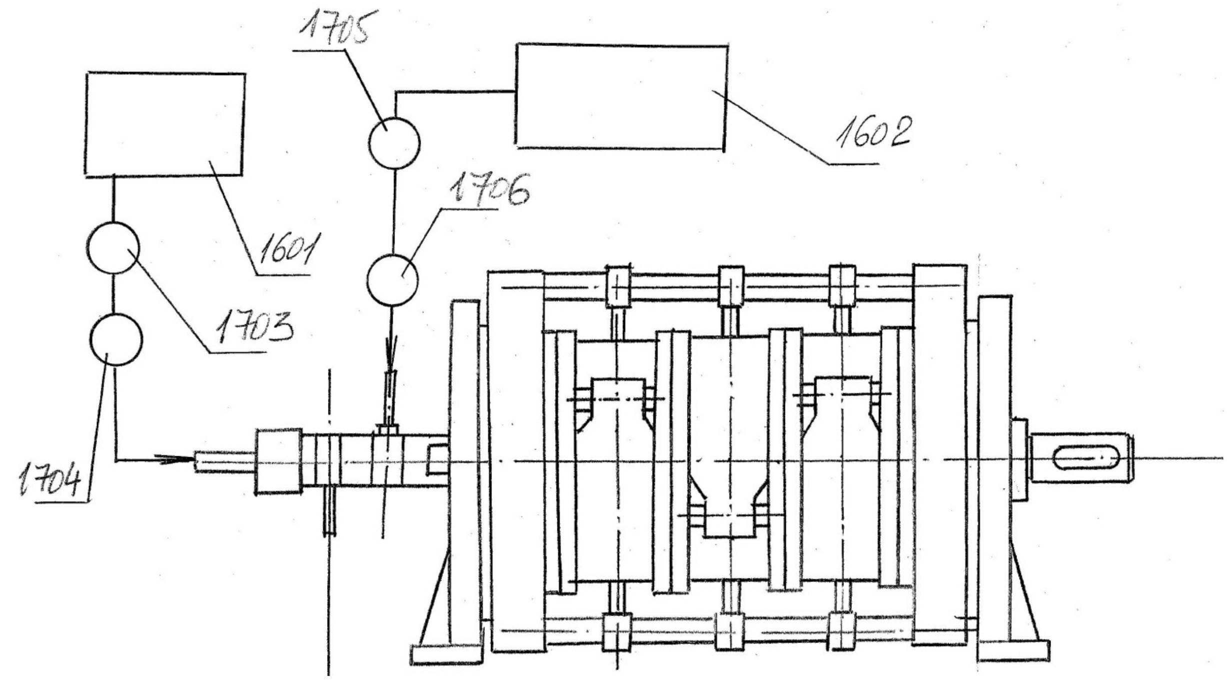

Figure 4. Rotary internal combustion engine with integrated homogenization of the fuel or fuel mixture, indicating the functional interaction with the liquid fuel tank and with the tank for fuel components or with a compressor for compressed air and with all associated control and equipment

Marked numbers on the picture:

1601 **-** multifunctional tank, for the case of on-line homogenization of mono-fuel, either as an option with on-line homogenization of fuel blends (with a blending system built into the tank), or as an option with on-line homogenization of fuel emulsions (with a re-blending system - emulsification built into the tank); The system should also include a low-pressure pump and all associated control and instrumentation.

1602 - multifunctional tank, for the case of giving the device the functions of mixing and homogenization, in case of blending with ethanol - ethanol is contained, in the case of blending with methanol - methanol is contained, in the case of fuel emulsions - water is contained

1703 – a pump with a system of valves, check valves, pressure gauges, pressure regulators, pressure stabilizers, pulsation stabilizers and, as an option, an impedance-resonance flow sensor — the composition of the components of the fuel mixture

1704 – flow meter with valve system of check valves, pressure gauges, pressure regulators, pressure stabilizers, pulsation stabilizers and, as an option - impedance - resonant flow sensor - composition of the fuel mixture components

1705 – a pump with a system of valves, check valves, pressure gauges, pressure regulators, pressure stabilizers, pulsation stabilizers and, as a option, an impedance-resonance flow sensor — the composition of the components of the fuel mixture

1706 – flow meter with valve system of check valves, pressure gauges, pressure regulators, pressure stabilizers, pulsation stabilizers and, as a version - impedance - resonant flow sensor - composition of the fuel mixture components

All of these technologies can be applied when performing a number of fundamental conditions.

To ensure timely and complete combustion in a short period of time, the fuel must meet the following requirements:

1) have good pumpability to ensure reliable operation of the high-pressure fuel pump (at

an optimal viscosity of 2-6 mm2 / s and a temperature of 20 ° C); good low temperature characteristics; lack of mechanical impurities and water;

Good pumpability is the most important factor allowing online contactless monitoring of all types of liquids in pipelines along with aerial photography or using remote monitoring and monitoring methods using unmanned aerial vehicles.

2) provide the necessary spray, good mixing and evaporation; fuel must have an optimal viscosity and a certain fractional composition;

3) possess the necessary flammability so that a cold engine can be easily started, a smooth pressure build-up and complete smokeless combustion (these characteristics depend on the chemical and fractional composition of the fuel, as well as the viscosity);

4) do not cause increased formation of soot and other deposits on valves, rings, pistons, coking of the spray needle (the tendency of the fuel to soot depends on the chemical and fractional composition, viscosity, content of mechanical impurities and water);
5) do not contain corrosive products (the corrosive characteristics of the fuel depend on the presence of mineral and organic acids, sulfur compounds and water);

6) have the highest possible heat of combustion;

7) have a high pumpability of fuel with minimal leakage through the gaps in the plunger pairs with minimal wear of the rubbing pairs.

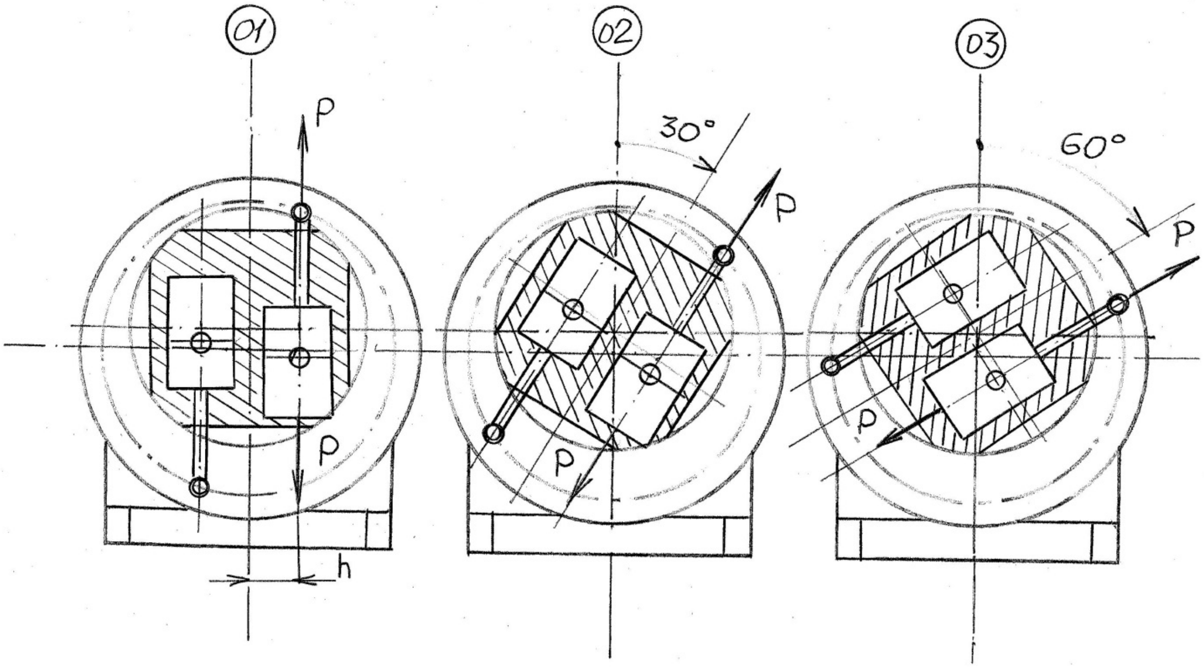

Figure 5. The figure shows the first three positions of the rotor with a cylinder-piston group of rotor kinematics every 30 degrees of rotation of the rotor

As can be seen from the diagrams, the presence of eccentricity in the rotor installation allows us to exclude the so-called dead zones and in turn allows to obtain torque even at the points of coincidence of the connecting rod direction of the crank - connecting mechanism with vertical or horizontal axes, in which in conventional engines the torque is zero

Now, to imagine that this is an engine of a pumping or compressor station on the main pipeline, it is necessary to exclude any fluctuations of controlled liquids or mixtures so that there would be a real opportunity to conduct reliable monitoring of the parameters of the flow of liquid products in the pipeline.

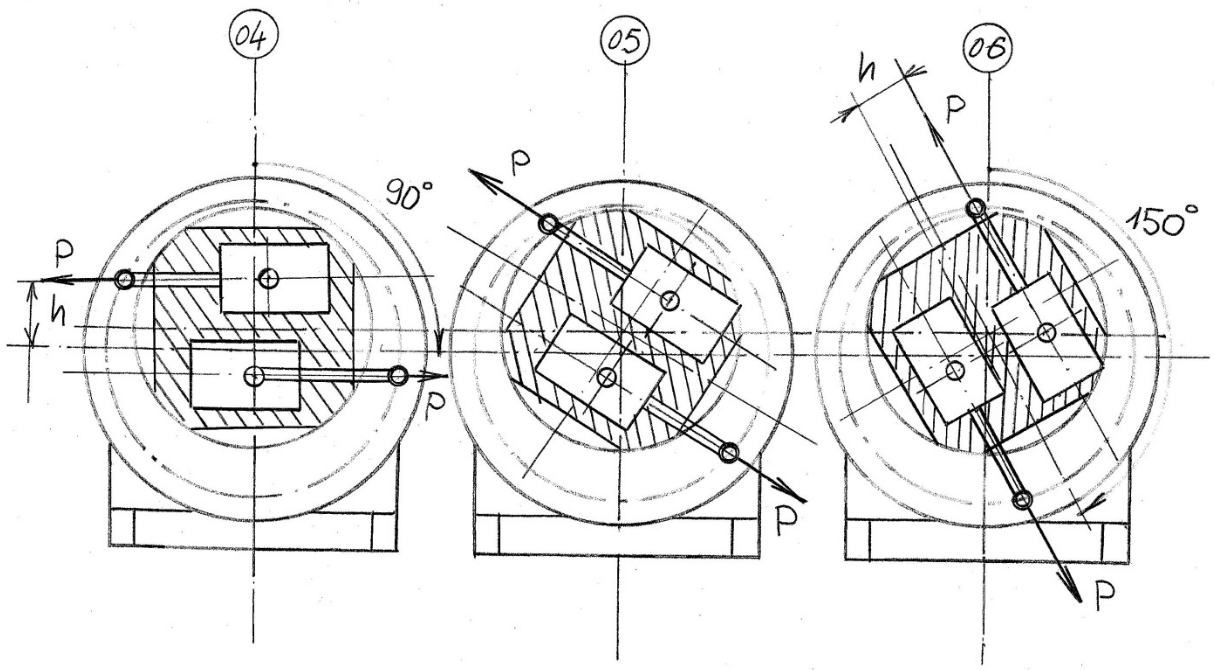

Figure 6. The figure shows three subsequent rotor positions with a cylinder-piston rotor kinematic group every 30 degrees of rotation of the rotor, from 90 degrees of rotation to 150 degrees of rotation of the rotor

As can be seen from the diagrams and in subsequent stages of rotation, the presence of eccentricity in the rotor installation allows to exclude the so-called dead zones and in turn allows to obtain torque even at the points of coincidence of the connecting rod direction of the crank - connecting rod mechanism with vertical or horizontal axes, in which conventional engines torque is zero

The exceptional interest is the option of using gaseous fuel instead of liquid in a rotary engine.

An analytical study of the development of a chemical reaction accompanied by heat generation in a laminar gas flow and with vigorous stirring of the reaction products with the initial substances revealed the hysteretic nature of the combustion theory solutions; increasing, for example, the initial temperature of the combustible gas, it is possible to achieve the moment when the gas is ignited; but in order to extinguish the gas burning at a high temperature, it is necessary to reduce the initial temperature significantly below that at which the ignition occurred. This example of the operation of a chemical reactor of ideal mixing also illustrates the fundamental property of the combustion process - the possibility of the existence of several stationary combustion regimes with the same given external parameters. This ambiguity significantly distinguishes stationary processes with a continuous supply of starting materials and removal of reaction products from a static thermodynamically equilibrium situation.

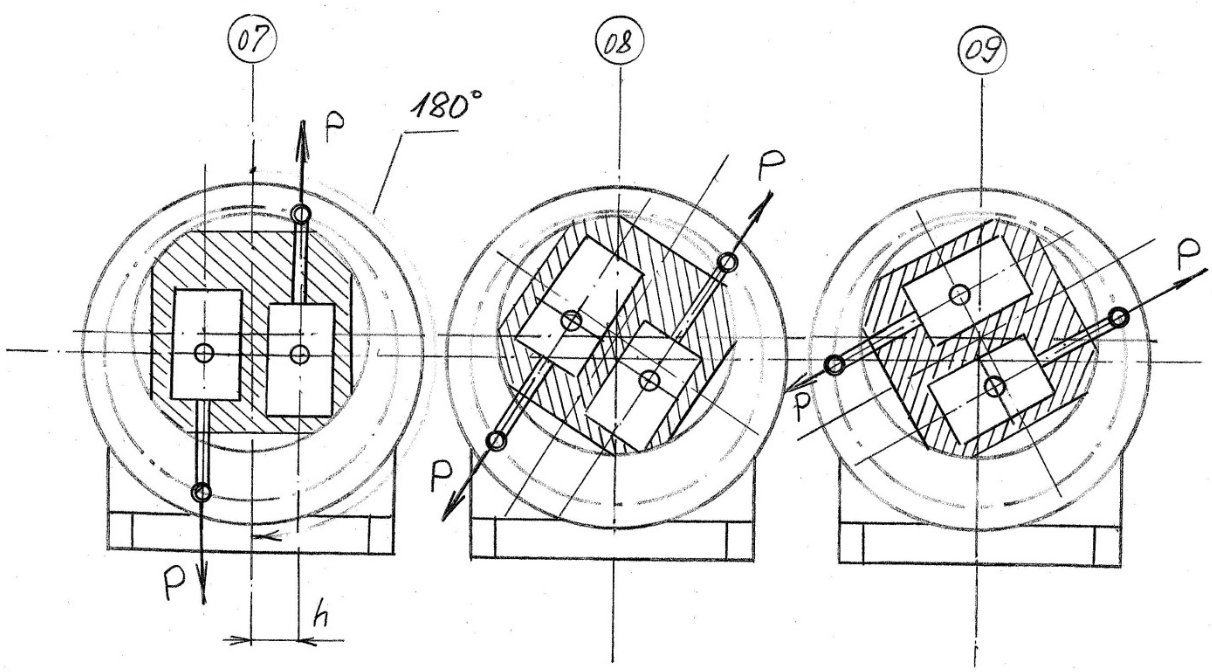

Figure 7. The figure shows the following three after the 150 degree position of the rotor with a cylinder-piston rotor kinematics every 30 degrees of rotation of the rotor, from 180 degrees of rotation to 270 degrees of rotation of the rotor

As can be seen from the diagrams and in subsequent stages of rotation, the presence of eccentricity in the rotor installation allows to exclude the so-called dead zones and in turn allows to obtain torque even at the points of coincidence of the connecting rod direction of the crank - connecting rod mechanism with vertical or horizontal axes, in which conventional engines torque is zero

The stability of the hydrodynamic or aerodynamic parameters of the proposed rotary engine and its local infrastructural features opens up new opportunities for improving efficiency, especially when preventing speeds that are uncertain in terms of geometry of pulsations

As defined, the velocity pulsations directed across the direction of combustion propagation cause asymmetry of the curvatures of the flame front, contribute to its turns and the formation of a complex structure.

The main task of the theory of turbulent combustion is the study of a stationary average turbulent flame: in a given turbulent flow field, it is required to find the time-average structure of the combustion zone and determine its statistical characteristics: average rate of combustion, average surface of the flame front, area width, on average occupied by a curved flame front and other characteristics.

An important role in this theory should be assigned to the leading points of the curved front of a laminar flame, made by turbulent pulsations towards the combustible gas, since they ensure the existence of the flame surface following them and determine the average burning rate.

The pulsations of the velocity of a turbulent gas flow with developed turbulence often exceed the normal flame propagation velocity. The speed of removal of the leading points in the combustible gas is mainly determined by the pulsation characteristics of the flow.

Thus, the prevention of velocity pulsations becomes even more important.

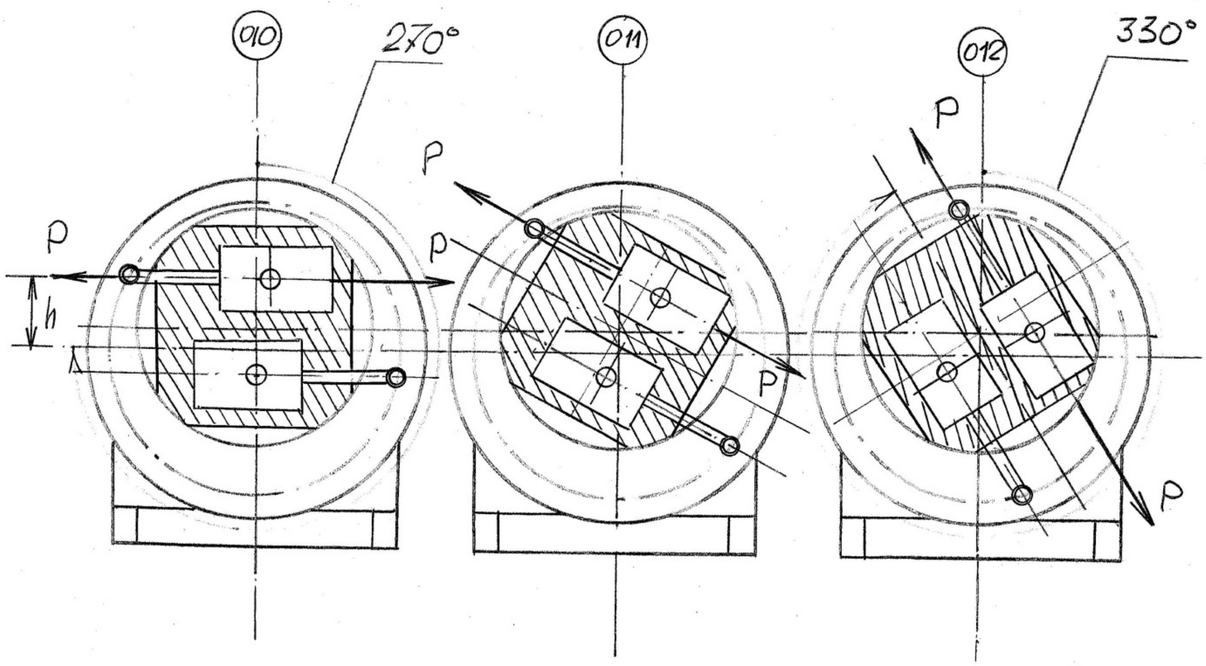

Figure 8. The figure shows the following three after the 150 degree position of the rotor with a cylinder-piston rotor kinematic group every 30 degrees of rotation of the rotor, from 270 degrees of rotation to 330 degrees of rotation of the rotor

As can be seen from the diagrams, and in subsequent stages of rotation, the presence of eccentricity in the rotor installation allows to exclude the so-called dead zones and in turn allows to obtain torque even at the points of coincidence of the connecting rod direction of the crank - connecting rod mechanism with vertical or horizontal axes, in which conventional engines torque is zero

It used to be that high-speed engine fuel should have a viscosity of at least 5 mm2 / s at 20 ° C. Studies have shown that fuel with a viscosity of up to 2 mm2 / s at 20 SS provides lubrication of fuel supply equipment. The minimum viscosity depends on the injection pressure and other design solutions. With an increase in the injection pressure, the viscosity of the fuel can increase 6-10 times.

(using the technology of complex activation of fuel mixtures in the form of a complex technology of emulsification according to the water-in-oil method where water is mixed with diesel fuel, forming a stable emulsion, then mixed with air bubbles where the internal pressure in the bubbles ranges from 10 to 20 bar, allows almost two times to reduce the required pressure, which reduces the viscosity of the fuel mixture in 3 - 5 times; in addition, the admixture of 10% water and 8 -12% of air in the same proportion reduces the initial viscosity of the fuel mixture)

Based on research and operational tests, the following values of fuel viscosity at 20 ° C have been established for high-speed diesel engines: in summer - 3.0-8.0 mm2 / s, in winter - 2.2-6.0 mm2 / s, for the harsh Arctic climate - 1.5-4 mm2 / s.

The pumpability of the fuel depends on its low-temperature characteristic, which affect the mobility of the fuel at low temperatures. Low-temperature characteristic is determined by the cloud point, the onset of crystallization and solidification.

The cloud point is the temperature at which the phase homogeneity of the fuel is lost. It begins to cloud due to the release of the smallest drops of water, solid hydrocarbons or microscopic ice crystals.

The temperature at which the first crystals appear, visible to the naked eye, is called the crystallization temperature.

The temperature of complete loss of mobility is called the pour point (for the proposed technology, the pour point of the mixture is proportional to the percentage of water and air in the mixture, and, in addition, a high level of turbulence of the mixture also contributes to lowering the pour point)

Mechanical impurities in the fuel standard are not provided (not allowed). Fuel is polluted if the rules of transportation, storage and refueling are not followed. Alumina quartzites are the most harmful because they have high hardness. Precision pairs of fuel pumps have gaps of 1.5-3.0 microns, so even a small percentage of mechanical impurities leads to significant abrasive wear.

(using proposed technology, the ingress of abrasives into the fuel pump is eliminated due to the special system of capillary channels in the device for the complex activation of diesel fuel; In these devices, the coaxial channels of the hydrodynamic interface have sizes from 25 microns to 100 microns)

In the fuel, to a greater or lesser extent, water is constantly present in the dissolved state. Its concentration depends on the ambient temperature. Water solubility in fuel is 10 ~ 5 kg / kg. Especially unpleasant is the presence of emulsion water at low temperatures. In this case, the ice system clogs the cleaning system and disrupts the engine.

Water has a negative effect on fuel equipment, especially on the high-pressure pump and injectors. It contributes to the appearance of corrosion of the surfaces of precision pairs and the coking of nozzle sprayers.

(in the proposed technology, the formation of ice crystals is impossible, and, in addition, the mixture may have a special section of on-line heating, which eliminates the appearance of ice crystals, reduces or completely eliminates the occurrence of corrosion and the formation of coke in nozzles sprayers)

Necessary spray, mixture formation and evaporation of the fuel largely determine the course of the workflow as a whole, its efficiency.

A portion of the fuel, measured by a high-pressure pump, is injected into the combustion chamber into dense, strongly swirling heated air. At some distance from the nozzle orifices of the nozzle, the jet splits into droplets, forming a torch of atomized fuel. The total number of drops reaches several million, and their size ranges from 50 to 150 microns. The distribution of drops in number and size is very uneven. The quality of spraying fuel is characterized by the number and size of droplets, the length, width and angle of the spray cone.

Drops of fuel introduced into the hot air do not ignite instantly. When ignited, the evaporation process is more intense due to the high temperature during the combustion process. Simultaneously with the acceleration of evaporation at this moment, there is some slowdown, as there are combustion products that impede the supply of oxygen to the evaporating fuel. This circumstance makes it necessary to conduct a working process in a diesel engine with some excess air.

(The proposed technology makes it possible to provide the necessary excess air and a high uniformity of air distribution in the volume of the fuel mixture; in addition, the three-dimensional encapsulation of the fuel mixture, when the capsules are spheres having a core of air with a shell of fuel, allows to obtain, during injection, separate evaporation of fractions, which gives the possibility of the expansion of air after injection to break the shell of the capsules into particles in the sub-micron range, which dramatically improves the efficiency of the combustion process in the cylinders engine)

The large heterogeneity of the air-fuel mixture in the combustion chambers is the cause of some of the advantages and disadvantages of diesel engines. An important advantage is that in diesel engines you can significantly impoverish the working mixture. This allows you to change the power only by supplying fuel. On the other hand, the heterogeneity of the mixture is a significant disadvantage of diesel engines, since it is impossible to achieve smokeless and complete combustion.

(The proposed technology allows to obtain a high homogeneity of the mixture, which can be expressed by the size of the compressed air bubbles obtained during activation - 20 micrometers)

The process of mixing affects the viscosity of the fuel, an increase in which leads to a deterioration of atomization and evaporation of the fuel. At high viscosity, large droplets increase the length of the torch and fall on the walls, which significantly worsens the process of mixing, and at low viscosity the torch of fuel is shortened and the combustion chamber is not fully used.

(The proposed technology allows particle sizes of 3 to 5 microns to increase combustion efficiency; the viscosity of the mixture decreases in proportion to the percentage of impurities and the mixture is formed using the energy advantages of the Bernoulli effect, which improves the process)

Fractional composition of diesel fuels is estimated at the end of boiling: summer - 360 ° C, winter - 340 ° C, arctic - 330 ° C.

The complex processes of combustion and fuel mixing in high-speed engines occur in a very short period of time, about 10 times faster than in carburettor engines, at the same rotational frequency.

The intensity of combustion depends on many factors: pressure and temperature of compressed air, concentration of fuel vapor in the air, chemical composition, quality of atomization and evaporation of fuel.

With a delay in ignition of the fuel, the process of subsequent combustion occurs very intensively. You can hear the specific knocks of the engine (similar to detonation, but the causes are different).

All other things being equal, a decrease in the ignition delay period causes a smoother change in pressure, i.e. softer engine performance. However, an excessive reduction of this period leads to a decrease in the completeness of combustion. The process begins immediately after the supply of fuel, most of which is fed into the combustion products. Drops of fuel at the same time quickly evaporate, not reaching those areas of the chamber in which oxygen has not yet been used. The process of mixing dramatically deteriorates, decreases the power and efficiency of the engine.

To ensure a normal combustion process, it is necessary to use fuel with an optimal ignition delay period. Flammability of fuel is estimated by cetane number. The cetane number of diesel fuel is numerically equal to the percentage (by volume) of cetane in a mixture with alpha-methylnaphthalene, which is equivalent to the test fuel in terms of combustion (self-ignition). The cetane number is determined by three methods: by the critical degree of compression, the lag of auto-ignition, and by the coincidence of outbreaks.

Diesel fuels must have a cetane number in the range of 45-50 in the winter and 40-45 in the summer. Cetane number determines the starting characteristics of diesel fuels, slightly differing in fractional composition.

When operating diesel engines, it is of great importance to establish the optimum advance angle of fuel injection. With a large advance angle, fuel is supplied to insufficiently heated air, which increases the ignition delay period and the rigidity of work. The fuel can burn to the top dead center, which leads to a loss of power, as it creates back pressure. When the injection lags a significant part of the fuel burns on the expansion line, which causes a drop in power, incomplete combustion of the fuel, a decrease in engine efficiency.

Accumulation in high-speed diesel engines leads to overheating of the engine, coking of the injectors, and deterioration of fuel atomization. The increased accumulation of soot contributes to incomplete combustion of fuel, the presence of high-molecular complex substances and mechanical impurities in the fuel. The accumulation of resinous substances is significantly affected by the stability of the fuel. Indicators of the quality of diesel fuel that affect the carbonization and standardized by the following standards: coke number, tar, ash, mechanical impurities and sulfur compounds. Sulfur contained in the fuel affects not only the mass of the carbon produced, but also it's characteristics. Sulfur compounds, accumulating in soot, increase its density.

The corrosion characteristic of diesel fuels is determined by the content of sulfur compounds, water-soluble acids and alkalis, as well as water. The presence of sulfur compounds in the fuel is checked by a polished plate of electrolytic copper measuring 10 × 25 mm. This plate is immersed in a porcelain cup with fuel, which is placed in a drying cabinet with a temperature of 50 ° C and held there for 2-3 hours. The appearance of dark brown, gray or black deposits on the plate indicates the presence of active sulfur compounds in the fuel.

Corrosion of parts is caused mainly by sulfur compounds. Especially strongly liquid corrosion occurs in the cold season during start-up conditions. Increasing the sulfur content in the fuel from 0.2 to 0.5% increases the wear of the cylinder-piston group by 25-30%, to 1% - 2 times. Additives are added to reduce sulfur sulfide in the fuel. The most common is zinc naphthenate, which is added to the fuel (0.25-0.30% of the mass of fuel).

(The proposed technology completely eliminates the presence of sulfur compounds in the mixture and, if necessary, allows to raise the temperature of the mixture, which reduces corrosion of diesel engine parts by 80-85%)

The calorific value of diesel fuel is 42 705 kJ / kg.

Aspects of the phenomena of corrosion and corrosion processes in the construction elements of diesel engines using a fuel mixture in which diesel fuel is mixed with compressed air.

When mixing diesel fuel with compressed air, without water, corrosion processes are eliminated as in the previous case;

The second version of the technology consists of mixing only diesel fuel with compressed air and, while maintaining the conditions of the first version of the technology, ignition of the fuel mixture and the equivalent of cetane number, retain qualities similar to the first version;)

Everyone knows that after mixing ethanol and methanol bring water into the mixture - more ethanol, less methanol, but it is impossible to discount its presence and therefore emulsification becomes an extremely important process.

References and patent-licensed materials:

United States Patent Application	**20140318123**
Kind Code	**A1**
Cruz; Jose Lopez	**October 30, 2014**

ROTARY INTERNAL ***COMBUSTION ENGINE***

Abstract

A ***rotary engine rotary engine*** according to the present invention comprises a main housing assembly and a rotor assembly rotatably supported within the housing. The rotor assembly has two rotors, an intake/compression rotor rotatably disposed within the intake/compression housing, and a power/exhaust rotor rotatably disposed within the power/exhaust housing. The rotors have N number of apexes and sides, wherein N is an integer greater than 2. A rotating chamber is formed between each side of the each rotor and the inner wall of the respective housing. The stages of the thermodynamic cycle of the ***engine*** occur within these chambers. For example, if the rotors have three sides, the rotors will have a triangular-like shape with three apexes. The apexes form the outermost radial part of the rotors which engage the inner wall of the respective housing bore. Each of these chambers is split into two divided chambers by a reciprocating vane, thereby forming 2 times N divided chambers in each of the respective housing bores.

Приложение 2

United States Patent Application	**20150152781**
Kind Code	**A1**
Oledzki; Wieslaw Julian	**June 4, 2015**

Rotary two-stroke internal ***combustion engine,*** particularly very high power very high speed ***engine*** fueled by solid particulate fuel like coal dust, destined for power generation

Abstract

Rotary positive displacement internal ***combustion*** two stroke ***engine*** with only one major moving part, i.e. ***engine's*** eccentric shaft, with cylinders encompassing eccentrics of the shaft, with said eccentrics being suitably sealed in said cylinders,

wherein ***combustion*** gases exert force directly on said eccentrics of said eccentric shaft. Gas forces can be nullified by suitably phasing shaft's eccentrics, thus nullifying gas forces loading shaft's bearings. The ***engine*** is naturally perfectly balanced. The ***engine*** possesses natural self-cleaning capability, and is capable of being fueled by coal dust. Units of the type developing 2 000 MW and 3 000-3 6000 rev/min, intended to replace steam turbines in power stations, can be built.

Приложение 3

United States Patent Application	**20180066520**
Kind Code	**A1**
Shkolnik; Alexander ; et al.	**March 8, 2018**

Rotary ***Engine***

Abstract

A ***rotary engine*** includes an intake port, an exhaust port, a rotor having an intake channel and/or an exhaust channel, and a rotor shaft coupled to the rotor. The rotor shaft has an inflow channel in communication with the intake channel and/or an outlet channel in communication with the exhaust channel. The ***rotary engine*** includes a housing having a working chamber formed between the housing and the rotor, the working chamber configured to handle, in succession, an intake phase, a compression phase, a ***combustion*** phase, an expansion phase, and an exhaust phase. The inflow channel cyclically communicates with the intake port and forms a passage between the intake port and the working chamber through the rotor shaft and the intake channel. The outlet channel cyclically communicates with the exhaust port and forms a passage between the exhaust port and the working chamber through the rotor shaft and the exhaust channel.

Приложение 4

United States Patent Application	**20160341042**
Kind Code	**A1**
Shkolnik; Alexander ; et al.	**November 24, 2016**

Rotary ***Engine***

Abstract

A ***rotary engine*** includes a housing having a working cavity, a shaft, the shaft having an eccentric portion, a rotor having a first axial face, and a second axial face opposite the first axial face, the rotor disposed on the eccentric portion and within the working cavity, the rotor comprising a first cam on the first axial face, the first came having an eccentricity corresponding to the eccentricity of the eccentric portion of the shaft, and a cover integral with, or fixedly attached to, the housing, the cover comprising a plurality or rollers, each roller engaged with the cam, wherein the cam guides the rotation of the rotor as the rotor rotates within the working cavity and orbits around the shaft.

Приложение 5

nited States Patent Application	**20180010456**
Kind Code	**A1**
GAUVREAU; Jean-Gabriel ; et al.	**January 11, 2018**

INTERNAL ***COMBUSTION ENGINE*** WITH ROTOR HAVING OFFSET PERIPHERAL SURFACE

Abstract

A ***rotary engine*** where the rotor cavity has a peripheral inner surface having a peritrochoid configuration defined by a first eccentricity and the rotor has a peripheral outer surface having a peritrochoid inner envelope configuration defined by a second eccentricity larger than the first eccentricity. Also, a ***rotary engine*** where the rotor cavity has a peripheral inner surface having a peritrochoid configuration defined by an eccentricity, and a rotor with a peripheral outer surface between adjacent ones of the apex portions being inwardly offset from a peritrochoid inner envelope configuration defined by the eccentricity.
The ***engine*** may have an expansion ratio with a value of at most 8. The ***rotary engine*** may be part of a compound ***engine*** system.

Приложение 6

United States Patent Application 20160222840

Kind Code A1

Vaseleniuck; Darrick ; et al. **August 4, 2016**

MODULAR ROTARY VALVE APPARATUS

Abstract

A modular ***rotary*** valve apparatus includes: a plurality of separate valve barrels coupled to each other and arranged end-to-end along an axis so as to define a valve shaft, each valve barrel having an annular peripheral surface extending between forward and aft end faces, and an aperture extending transversely therethrough communicating with the peripheral surface on opposite sides.

Приложение 7

United States Patent Application 20160160751

Kind Code A1

Koch; Randy **June 9, 2016**

Rotary Internal ***Combustion Engine***

Abstract

A ***rotary*** internal ***combustion engine*** includes an arcuate compression chamber, an arcuate expansion chamber, an output shaft, and a piston coupled to the output shaft for movement through the arcuate compression chamber and the arcuate expansion chamber. The piston has a leading end, a trailing end, an inlet valve that is located at the leading end of the piston for receiving a compressible fluid from the compression chamber and an outlet valve that is located at the trailing end of the piston for expelling a ***combustion*** gas into the arcuate expansion chamber.

Приложение 8

United States Patent Application **20160273446**

Kind Code **A1**

LARSON; GERALD L. **September 22, 2016**

ROTARY ***ENGINE***

Abstract

A ***rotary engine*** has a circular shaped rotor and stator. The rotor has an expansion chamber for ***combustion*** and the stator has thrust director gate that passes through a passageway through the stator face to alternatively ride along the face of the rotor or to ride within the expansion chamber of the rotor. Passageways through the stator and radially close to the thrust director gate allow for air, fuel, and an ignition source to pass through the stator allow for ignition and expansion of the fuel within the expansion chamber. The thrust director allows for thrust to be applied to the rotor to rotate the rotor. An exhaust manifold, also passing through stator, and also radially aligned with the expansion chamber allows exhaust gases from ***combustion*** to be released from the expansion chamber as the rotor rotates the expansion chamber adjacent to the exhaust manifold.

Приложение 9

United States Patent Application **20150101557**

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ROTARY PISTON INTERNAL ***COMBUSTION ENGINE***

Abstract

An internal ***combustion engine,*** and more particularly a ***rotary*** internal ***combustion engine, is provided with said engine*** having multiple ***combustion*** chambers delimited by piston heads and an ***engine*** housing wall that defines at least a section of a torus. Additionally, a method for operating the internal ***combustion engine*** is described.