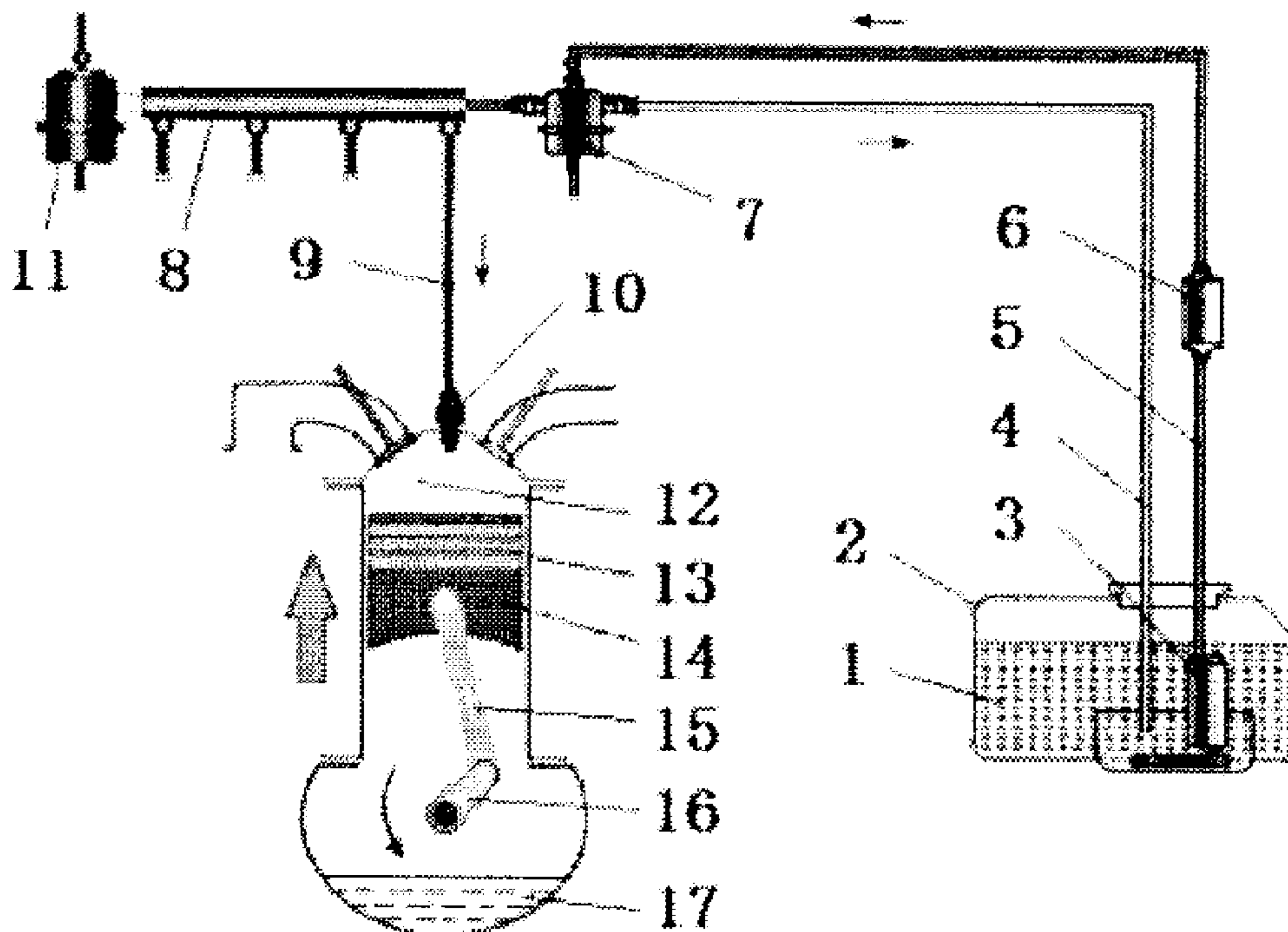




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(54) **Titre : UN MOTEUR A COMPRESSION-ALLUMAGE A ESSENCE A FAIBLE INDICE D'OCTANE**
(54) **Title: A COMPRESSION-IGNITION LOW OCTANE GASOLINE ENGINE**



(57) **Abrégé/Abstract:**

A compression-ignition low octane gasoline engine. The engine uses low octane gasoline and a compression-ignition method, does not require a spark plug, and compared with ordinary gasoline engines, increases thermal efficiency by approximately 40% and reduces green-house effects caused by emissions by approximately 45%. The "compression-ignition" of the low octane gasoline engine is a diffusion charge compression-ignition, differing from a homogeneous charge compression-ignition; the compression ratio in a cylinder can be 14 to 22, while an ordinary gasoline engine has a compression ratio of 7 to 11. The low octane gasoline engine has a simple structure, easy combustion control, a low noise level, and a low failure rate. As the low octane gasoline can be free of aromatic hydrocarbons, and not require the addition of antiknock agents such as MTBE and MMT, the present novel gasoline engine is a highly efficient, clean, and environmentally friendly internal combustion engine.

Abstract

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15 combustion engine.

A compression-ignition low octane gasoline engine

This invention belongs to the technical field of internal combustion engine in mechanical
5 industry. It relates to a novel internal combustion engine, and in particular to a
compression-ignition gasoline engine.

Comparison between diesel engine and gasoline engine

10 Generally, as compared to gasoline engines (spark-ignition engines), diesel engines
(compression-ignition engines) increase thermal efficiency by approximately 30% (20-40%
claimed in some references) and reduce green-house effects caused by emissions by
approximately 45%. They also have a lower carbon monoxide and HC emission. Diesel engines
have simple structures and low failure rate, but have the defect of emitting large harmful
15 particles.

As compared to diesel engines, gasoline engines are different in fuel storage and delivery
system. Gasoline is more volatile and wettable. Gasoline engines and diesel engines have
different manners in fuel feeding. For gasoline engines, gasoline is injected into air passage and
20 mixed with air before entering into cylinders, while for diesel engines, air is firstly compressed
with cylinder pistons and then diesel is injected into cylinders with injection nozzle.

In recent years, there appears a GDI (gasoline direct injection) gasoline engine in market,
wherein part of gasoline is pre-injected into cylinders to be pre-blended with air during the
25 compression phase, and after the piston arrives at top dead centre, gasoline is injected into
cylinders for multiple times, adopting spark plug ignition. This engine uses high rating gasoline,
and its compression ratio is fairly improved but not too much. Another Homogeneous Charge

Compression Ignition (HCCI) gasoline engines is still under research phase, which may achieve compression-ignition and multi-ignition through pre-injection (premixing gasoline with air) and multiple injection gasoline, appropriately elevating compression ratio and heating with heater plug. Nevertheless, HCCI gasoline engines have problems in combustion controlling and rough operations, and are difficult to be popularized.

As to rough operations of diesel engines: since diesel's kinematic viscosity is rather high, diesel has to be injected into cylinders with high pressure oil pump so as to be sufficiently atomized. To achieve sufficient mixing of diesel with air, this oil pump injection pressure sometimes may reach as high as 1800 to 2000 atmospheric pressure. Therefore, conventional diesel engines generally inject diesel into cylinders within a very short period, so that the atomized diesel spontaneously ignites after mixing with air, causing deflagration by igniting multiple sites at the same time, raising much noise and vibration, hence resulting in rough operations.

15

Modern diesel engines have already adopted some advanced technologies, such as turbocharging, intercooler, direct injection, catalytic conversion of exhaust gas and particle collection, etc. The emissions of diesel engine vehicles have met the Euro III, Euro IV and even Euro V emission standards.

20

Theoretically, the higher the compression ratio is, the more efficient the engine. The general compression ratio of gasoline engine is 7 to 11, high octane rating (high grade) gasoline needs to be used. The general compression ratio of diesel engine is 15 to 18, and some may reach as high as 18 to 22. Nevertheless, due to the limitation of the strength of cylinders materials, its compression ratio cannot be too high.

25

Fuel consumption rate refers to fuel quantity (based on the unit g) consumed in 1 hour for each 1kw efficient power the engine produces. Obviously, the lower the fuel consuming rate, the more economic the engine.

5 Gasoline contains xylene, ethylbenzene, toluene, methyl-ethyl benzene or other benzene derivatives, which are all named aromatic hydrocarbon. Aromatic hydrocarbon generally has a high octane rating, but is slightly toxic. The exhaust gas produced by the combustion of aromatic hydrocarbon contains PAHs, which will cause cancer.

10 In order to increase gasoline's octane rating, refineries generally adopt "reforming" process, converting straight-chain alkanes into aromatic hydrocarbon. This process consumes a large amount of energy and wastes part of the raw materials.

To increase gasoline octane rating, engineers have also developed antiknock agents, e.g.,
15 methyl cyclopentadienyl manganese tricarbonyl (MMT), methyl tert-butyl ether (MTBE), TAME, etc. Use of MMT and MTBE often causes secondary contamination to the environment. MTBE is prohibited in some states in US by regulations.

Among the quality indexes of diesel, cetane value is a primary index determining whether
20 diesel can be compressively ignited. Generally, diesel should have a cetane value of 40 to 60, and the higher the cetane value, the easier diesel engines can be compressively ignited. Research shows that a cetane value of 40 is equivalent to an octane rating of 50, and a cetane value of 60 is equivalent to an octane rating of 30. As a matter of fact, the lower the gasoline octane rating is, the easier it can be compressively ignited.

25

Engine with diesel engine advantages in combination with gasoline engine advantages

A diesel engine has a heat efficiency higher than gasoline engine, mainly because it has a higher compression ratio and a higher air-fuel ratio. Gasoline has a better volatility than diesel, and a better air-mixing homogeneity than diesel. The carbon black particle impurity left in the exhaust gas is less than diesel.

The present invention relates to a compression-ignition gasoline engine with high compression ratio.

Taking advantage of the characteristic that low octane rating gasoline has a fairly low spontaneous ignition temperature, and that the heat efficiency of compression ignition internal combustion engine is higher than spark ignition internal combustion engine, a compression-ignition gasoline engine is proposed, which uses low octane gasoline as the fuel, elevates the heat efficiency of gasoline engines (compression-ignition low octane rating gasoline engine) to the level of diesel engines, and at the same time reduces green-house effects produced by gasoline engine emission.

Compression-ignition low octane rating gasoline engines adopts diffused compression ignition, which is different from homogeneous charge compression ignition.

20

Experimental data shows that, the specific fuel consumption of compression-ignition low octane gasoline engines is 10 to 15% lower than that of diesel engines. That is, the heat efficiency conversion rate of compression-ignition low octane gasoline engines is 10 to 15% higher than diesel engines. Therefore, the heat efficiency conversion rate of compression-ignition low octane rating gasoline engines is about 30 to 55% higher than spark ignition gasoline engines.

Due to the difficulty and technological complexity in producing high octane rating gasoline (gasoline having octane rating above 90, research method), the appearance of compression-ignition low octane gasoline engines will reduce difficulty and technological complexity in gasoline production of refineries.

5

The present invention seeks to provide a technical solution and a technical measure for compression-ignition low octane rating engine.

Technical problems sought to be solved by the preferred embodiments of the present invention

10

(1) To solve the problems that the compression ratio of gasoline engines is lower than diesel engines, heat efficiency and power output performance is inferior to diesel engines, and the gasoline fuel is less economic than diesel.

15

(2) To overcome the difficulties that low octane gasoline cannot be used in diesel engines, and to avoid the problems of lubrication and abrasion of plunger and rotating elements when using fuel pump and fuel nozzle of diesel engines in injecting low octane gasoline fuel.

20

(3) To optimize combustion control, solve the problems of rough operations and noise of compression-ignition internal combustion engine (including diesel engines and low octane rating gasoline engines), and further improve the engine efficiency.

(4) To solve the problems of diesel engines in their emission of large amount of carbon black and other granular impurities and carbon monoxide, and of gasoline engines in their emission of large amount of polycyclic aromatic hydrocarbon and hydrocarbon.

25

(5) To solve the problem that gasoline requires anti-knocking agent and to achieve the target of clean, no-aromatic hydrocarbon containing gasoline.

According to a first aspect of the present invention, there is provided a gasoline internal combustion engine, comprising: a crankshaft, a connecting rod, a piston and a cylinder, the piston and cylinder defining a combustion chamber, a high pressure gasoline injection pump, a nozzle, a lubricating oil system suitable for gasoline engine, wherein the gasoline internal combustion engine is configured to intake air substantially without gasoline mixed therewith into the combustion chamber during an intake stroke in which the piston moves from a top dead centre to a bottom dead centre; wherein the gasoline internal combustion engine is configured to inject gasoline into the combustion chamber during a compression stroke in which the piston moves from the bottom dead centre to the top dead centre; wherein the gasoline internal combustion engine is configured to run using a gasoline with a Research Octane Number less than 60; and wherein the gasoline internal combustion engine is a forced induction engine, and has a compression ratio from 14 – 22 to 1.

According to a second aspect of the present invention, there is provided a method of starting the gasoline internal combustion engine of the first aspect of the present invention, comprising injecting no gasoline into the cylinder before the gasoline internal combustion engine reaches a predetermined speed below an idle speed of the gasoline internal combustion engine.

The compression ratio of gasoline engine is increased to be in the range of 14 – 22 to 1, in order to improve the heat efficiency conversion rate of gasoline engines. For gasoline engines adopting inlet air compression technique, including turbocharging technique and intercooling technique, the compression rate can be within the range of 15 – 18 to 1.

Embodiments of the invention may use gasoline having octane rating of 30 to 50 as fuel, the cetane value of such gasoline is equivalent to 40 to 60, which can be compression-ignited under said compression ratio. In practice, according to the compression ratio and relevant parameters of

the compression-ignition gasoline engines, the gasoline octane rating can be appropriately adjusted, e.g., to 55, 59, etc., as long as gasoline can be ignited and has reliable compression ignition.

5 Embodiments of the invention use a high pressure gasoline oil pump and a high pressure gasoline injection nozzle so that gasoline having a low octane rating can be effectively injected into cylinders, and that gasoline is injected into the cylinders at such a pressure that gasoline can be homogeneously dispersed in the air within cylinders. This high pressure gasoline oil pump has a lower injection pressure than that of a diesel oil pump.

10

Embodiments of the invention use a gasoline storage and delivery system, e.g., fuel tank, fuel pump, fuel tube, valve, fuel meter, etc.

Embodiments of the invention may provide greater combustion control and improved
15 engine efficiency through extending injection time and decreasing injection speed. Additionally, knocking by mixture of air and fuel, overly high pressure in the combustion chamber when piston is near top dead centre, and the engine's rough operations may be prevented. Controlling gasoline fuel to be combusted before forming a 90 degree angle and after the formation of a 60 degree angle between crank arm and connecting rod is the second important technical means for
20 improving engine efficiency of the preferred embodiments of the present invention.

Optionally, combustion control can be optimized with multiple injection fuel supply technology. Where multiple injection fuel supply technology is not adopted, the engine structure will be simplified, even without containing circuit and electron components.

25

Embodiments of the present invention are advantageous in that:

(1) Compression-ignition low octane rating gasoline engines have advantages of both diesel engines and the gasoline engines. It has high efficiency and high power as in diesel engines (the diameter of cylinders may be increased like that of a diesel engine, but having no risk of knocking); it also has low emission as in gasoline engines (the emission of carbon black and other granular impurities as well as carbon monoxide of gasoline engines are lower than that of diesel engines); the hydrocarbon emission index is lower than the lately marketed GDI gasoline engines, and is also lower than (HCCI) gasoline engines.

Since the volatility of gasoline is better than that of diesel, low octane gasoline, after injected into the cylinders, may rapidly be mixed with air and burned sufficiently, hence exhaust gas has no granular impurities like carbon black, and the emission of carbon monoxide is very low (as compared with diesel engines using diesel). Therefore, its efficiency is 10 to 15% higher than diesel engines, and 30 to 55% higher than ordinary gasoline engines.

(2) Using the technique of extending fuel injection, low octane rating gasoline engines may be simple mechanical devices comprising no circuits and electronic components. Hence, in addition to high heat efficiency conversion rate, it has the advantage of low malfunction rate.

(3) When using the technique of extending fuel injection, diesel engines may not only comprise no circuits and electronic components, but also have the advantage of low malfunction rate, under which circumstance they may have an improved efficiency, soft operation and lowered noise.

(4) Exhaust gas of low octane rating gasoline engines does not comprise aromatic hydrocarbon.

(5) Using multiple injection fuel supply technique, the combustion control of compression-ignition low octane rating gasoline engines can be further optimized, and heat efficiency conversion rate can be further improved.

5 (6) Some internal combustion engine experts commented that: low octane gasoline is a fuel more suitable for diesel engines diesel than fuel, while compression-ignition low octane rating gasoline engines may be the most perfect internal combustion engine in history.

Conception of low octane gasoline

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Generally, gasoline having an octane rating less than 60 is called as low octane gasoline. Similar to high octane rating gasoline, low octane rating gasoline number can be determined by its octane rating, e.g., gasoline having an octane rating of 40 can be called Gasoline #40. The smaller the number of low octane rating gasoline, the better it suits different compression ratio of compression-ignition gasoline engines, but the higher its cost is. For example, Gasoline #10
15 (octane rating of 10) has a better compatibility to compression-ignition gasoline engines of lower compression ratio than Gasoline #30 (octane rating of 30).

Operational process of compression-ignition low octane gasoline engines

20

Figure 1 shows a compression-ignition low octane gasoline engine according to an embodiment.

Reference to the details of the figure 1 is provided as below: 1. low octane rating gasoline; 2.
25 fuel tank; 3. fuel pump; 4. fuel pipe; 5. fuel pipe; 6. fuel filter of gasoline; 7. high pressure fuel pump; 8. high pressure fuel rail; 9. high pressure fuel pipe; 10. spray nozzle; 11. valve; 12. combustion chamber; 13. cylinder; 14. piston; 15. connecting rod; 16. crankshaft; 17. lubricating

oil system.

According to an embodiment in Figure 1, when piston 14 compresses air into the combustion chamber 12, piston 14 reaches or gets close to top dead centre, low octane rating gasoline 1 is injected into cylinders 13 with fuel pump 3 and spray nozzle 10, is automatically ignited and burned in the high temperature, high pressure air of the cylinders 13, produces even higher pressure and drives piston 14 to move towards bottom dead centre, and does work. By reducing injection speed and extending injection period, the mixing time of gasoline and air in the cylinders 13 is prolonged, the mixing is sufficient, burning is sufficient and soft, and noise is lowered.

Timing of fuel injection

The timing in this description concerning displacement of the piston, and the timing when spray nozzle 10 starts and ceases injection, are all relative and refers to the angle the crankshaft 16 rotates. For example, the running time of piston 14 from top dead centre to bottom dead centre is 180 degree angle, correspondingly the crankshaft 16 rotates 180 degree angle. Assuming that the spray nozzle 10 starts injection at 5 degree angle before top dead centre, and ends at 55 degree angle of top dead centre, the injection time is 60 degree angle, equivalent to the relative time that crankshaft 16 rotates 60 degree angle. When the injection time is 60 degree angle, if the engine rotates at a speed of 1200 rpm (1/20 second per rotation), the injection time is 1/120 second).

Difference between compression-ignition low octane gasoline engines and ordinary gasoline engines and diesel engines

(1) Difference in fuel is a first characteristic that distinguishes compression-ignition

gasoline engines from ordinary gasoline engines and diesel engines. Since diesel and gasoline are different in structure and composition, gasoline' volatility, permeability and wettability is stronger than diesel, diesel (high viscosity) has a higher kinematic viscosity than gasoline, the structure and performance of the fuel tank, fuel pipe, fuel pump and spray nozzle of compression-ignition low octane gasoline engines are greatly different from those of diesel engines. Hence ordinary diesel engines cannot be used as low octane gasoline engines.

However, even if the compression ratio of a compression-ignition gasoline engine is equivalent to that of a diesel engine, the compression-ignition gasoline engine and a diesel engine are two totally different types of internal combustion engine.

A compression-ignition gasoline engine uses low octane gasoline. As compared to high octane rating gasoline, low octane rating gasoline has three main advantages: clean - no aromatic hydrocarbon, and no anti-knocking agent; environmental friendly - the exhaust gas contains no polycyclic aromatic hydrocarbon; low cost - no need of molecular conversion technology such as "reformation" to improve gasoline octane rating.

Low octane rating gasoline is different from diesel, and grade is determined according to the octane rating that the auto-ignition point corresponds to, such as: Gasoline #45, Gasoline #40, Gasoline #35, Gasoline #30, Gasoline #20, etc., so as to be compatible with low octane gasoline engines with different compression ratios. Nevertheless, diesel does not have the grade number directed to diesel engines with different compression ratios.

The high pressure injection fuel pump and spray nozzle of low octane gasoline is different from those of diesel engines.

(2) And different manners of ignition is a second characteristic distinguishing compression-ignition gasoline engines from ordinary gasoline engines.

In compression-ignition gasoline engines fuel automatically ignites within the cylinders,
5 while ordinary gasoline engines adopt electronic ignition system, such as spark plugs.

Electronic ignition system can be absent from compression-ignition gasoline engines. Hence, the structure is simpler and the failure rate is lower than ordinary gasoline engines.

10 (3) Different compression ratio is a third characteristic which distinguishes compression-ignition gasoline engines from gasoline engines and diesel engines. Once compression-ignition low octane gasoline engine is modeled, the compression ratio is determined. The octane rating (gasoline grade) of the low octane rating gasoline has an upper limit. Only when using gasoline having a grade equal to or lower than the upper limit can a compression
15 ignition low octane rating gasoline engine work normally.

The lower the gasoline grade is, the lower can be the compression ratio of the compression-ignition gasoline engine, and the more smoothly and more stably the engine will run.

20

The standard data of what compression ratio corresponds to what grade of low octane gasoline can easily be obtained by persons skilled in the art by tests using test devices of gasoline octane rating.

25 The compression ratio of compression-ignition gasoline engines is higher than ordinary gasoline engines, but requires different grades of low octane gasoline.

In order to achieve a higher efficiency of the engine, the compression ratio of the compression-ignition gasoline engine can be designed within the range of 18 - 20 to 1 (even within the range of 19 - 22 to 1), this order of compression-ignition gasoline engine may use gasoline having a comparatively higher grade of the low octane rating gasoline products.

5 (4) Difference in fuel feeding

A compression-ignition gasoline engines uses spray nozzles to inject fuel into the cylinders, while ordinary gasoline engines use spray nozzle to inject fuel into the air pipe, where it is mixed with air before enters the cylinders. Of course, currently there are some ordinary gasoline engines adopt direct injection technique, but there is still the difference in manner of ignition.

(5) Difference in efficiency

The heat efficiency of compression-ignition gasoline engines is about 40 to 55% higher than gasoline engines (about 10 to 15% higher than diesel engines). For example: if an automobile with ordinary gasoline engine consumes 8L gasoline/100km (assuming No.93 gasoline , 40L gasoline may drive 500km), when this automobile uses compression-ignition low octane rating gasoline engine, the fuel consumption per 100km is about 5.7L (40L gasoline may drive 700km).

20 (6) Difference in fuel injection speed

In order to lower the noise and vibration of engines, compression-ignition low octane gasoline engines reduces the fuel feeding speed (injection speed) , which is equivalent to decreasing the burning speed of fuel-air mixture in the cylinders, relieves knocking gas against cylinders and piston.

(7) Different starting manner

a. In starting a compression-ignition gasoline engine, fuel feed amount to cylinders from spray nozzles is reduced by controlling spray nozzles, so as to prevent too much accumulation of fuel at the first compression ignition.

b. In starting a compression-ignition gasoline engine manually with a crank, the fuel path is cut before releasing an open-closing lever of the closing valve of the cylinders, so as to stop feeding cylinders with fuel.

(8) Difference in lubricating theory and lubrication system and lubrication oil

The lubrication system of compression-ignition low octane rating gasoline engines is different from that of diesel engines, and is closer to that of ordinary gasoline engines.

(9) Difference in greenhouse gas emission standard

Using fuel of the same unit quantity, green-house effect produced by compression-ignition gasoline engine emission is about 40 to 55% lower than that of an ordinary gasoline engine.

Persons skilled in the art are familiar with the working theory, mechanical structure and difference of compression-ignition engines and spark ignition engines, and hence this description omits detailed illustrations thereof without affecting understanding of the present invention for persons skilled in the art.

Compression-ignition gasoline engines have advantages of both gasoline engines and diesel engines, but are different from conventional gasoline engines and diesel engines.

In practice, the engine adopts a lubricating system and fuel storage-delivery system (i.e. fuel tank and fuel pump) corresponding to those of a spark-ignition engine, and a high pressure fuel pump and spray nozzle similar to that of a diesel engine, but the high pressure fuel pump and spray nozzle are specially designed to suit low octane rating gasoline.

In order to reduce shock and vibration toward the engine caused by knocking of mixed fuel and air after fuel is injected into the air tank through spray nozzle, adopting measures to slow injection speed of working process (prolong injection time), prolonging injection ending time to between 45 to 105 degree angle of the crankshaft rotation angle (when piston is at the top dead centre, the crankshaft rotation angle is 0), typically between 45 to 75 degree angle; so that the fuel burning time is close to ordinary gasoline engine. Under the circumstance that fuel consumption is the same, the output efficiency is further improved.

There is no need to pre-inject gasoline into the cylinders at a larger rotation angel (e.g., within the range of 50-60 degree angle) before the piston reaches the top dead centre, or to pre-blend gasoline when air enters air passage to form homogeneous fuel-gas mixing layer.

Injection starting time may be brought forward to 0 to 5 degree angle before piston reaches the top dead centre, or 5 to 10 degree angle, to make sure that a small amount of the first batch gasoline that is injected into the cylinders, after mixed with air, is ignited within 0-10 degree angle after the piston passes the top dead centre.

During the engine starting stage, respectively or simultaneously adopting the following two measures to reduce granular emission in tail gas produced by incomplete fuel burning including carbon black:

a. In starting state, reducing the amount of low octane gasoline that is injected into cylinders through spray nozzle during each working process;

5 b. Before the engine's rotation speed reaches a prescribed speed (e.g., the preset idling speed), cutting off the fuel path to stop feeding cylinders with fuel; when the engine's rotation speed reaches a prescribed speed (e.g., the preset idling speed), starting feeding cylinders with fuel, so as to avoid incomplete burning and appearance of carbon black and other granular impurities by too much fuel accumulation within the cylinders at the first compression ignition;

10 when starting the engine manually with crank, before releasing the lever (handle) of the cylinders closing valve, cutting off the fuel path of the high pressure fuel pump or spray nozzle, and stopping injection of fuel to the cylinders, namely that: when pressing the lever (handle) that opens closing valve of the cylinders, the valve that feeds fuel to high pressure pump or spray nozzle is closed; after releasing the handle, the valve that feeds fuel to spray nozzle is opened.

15

Experimental data

Example 1

A low octane rating gasoline compression feasibility test is carried out using a 4-stroke, 110mm single chamber internal combustion engine having a compression ratio of 17.6. The engine uses natural aspiration and manual starting with crank. As a result, the engine successfully ignites three low grade gasoline samples having octane ratings of 39.3, 25 and 12. 5. The engine runs normally after starting.

Example 2

25 A bench test is carried out using a 4-stroke, 93mm four-chamber internal combustion engine having a compression ratio of 18. The engine uses water cooling and natural aspiration. The result shows, according to the load curve and speed curve, the specific fuel consumption of the

compression-ignition low octane gasoline engine is 10-15% than the specific fuel consumption of diesel engine of the same type when using diesel.

Example 3

5 There is already available a high pressure gasoline injection pump having an injection pressure of 17MPa, basically meeting the requirement of compression-ignition low octane rating gasoline engines. In the future, when there is gasoline injection pump providing higher pressure matching compression-ignition low octane gasoline engines, it will meet the demand of compression-ignition low octane gasoline engines of even higher compression ratio.

10

While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not by way of limitation. It will be apparent to a person skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. Thus, 15 the present invention should not be limited by any of the above described exemplary embodiments.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word “comprise”, and variations such as “comprises” and “comprising”, will be 20 understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or 25 admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

CLAIMS

1. A gasoline internal combustion engine, comprising:
 - a crankshaft,
 - 5 a connecting rod,
 - a piston and a cylinder, the piston and cylinder defining a combustion chamber,
 - a high pressure gasoline injection pump,
 - a nozzle,
 - a lubricating oil system suitable for gasoline engine,
 - 10 wherein the gasoline internal combustion engine is configured to intake air substantially without gasoline mixed therewith into the combustion chamber during an intake stroke in which the piston moves from a top dead centre to a bottom dead centre;
 - wherein the gasoline internal combustion engine is configured to inject gasoline into the combustion chamber during a compression stroke in which the piston moves from the
 - 15 bottom dead centre to the top dead centre;
 - wherein the gasoline internal combustion engine is configured to run using a gasoline with a Research Octane Number less than 60;
 - wherein the gasoline internal combustion engine is a forced induction engine, and has a compression ratio from 14-22 to 1; and
 - 20 wherein the engine is configured to ignite the low octane gasoline by diffused compression ignition.
2. The gasoline internal combustion engine of claim 1, wherein the gasoline internal combustion engine is configured to inject gasoline into the combustion chamber
- 25 when the piston is from 10° before the top dead centre to the top dead centre.

3. The gasoline internal combustion engine of claim 1, wherein the gasoline internal combustion engine is configured to inject gasoline into the combustion chamber until the piston is between 45° to 105° after the top dead centre.

4. The gasoline internal combustion engine of any one of claims 1 to 3, wherein the
5 nozzle is configured to inject gasoline into the combustion chamber.

5. The gasoline internal combustion engine of any one of claims 1 to 4, further comprising a gasoline pump, a gasoline tank, a gasoline filter, a gasoline pipe system, an air booster, an air cooler, an exhaust treatment device, a particulate trap, or a combination
10 thereof.

6. A method of starting the gasoline internal combustion engine of any one of claims 1 to 5, comprising injecting no gasoline into the cylinder before the gasoline internal combustion engine reaches a predetermined speed below an idle speed of the
15 gasoline internal combustion engine.

7. The method according to claim 6, comprising: when starting the engine manually with crank, before the engine's rotation speed reaches a predetermined speed, pressing a handle that opens a valve to connect the atmosphere with the cylinders, and a valve that
20 feeds fuel to high pressure pump or spray nozzle is closed; after the engine's rotation speed reaches the predetermined speed, releasing the handle, the valve to connect the atmosphere with the cylinders is closed, and the valve that feeds fuel to spray nozzle is opened.

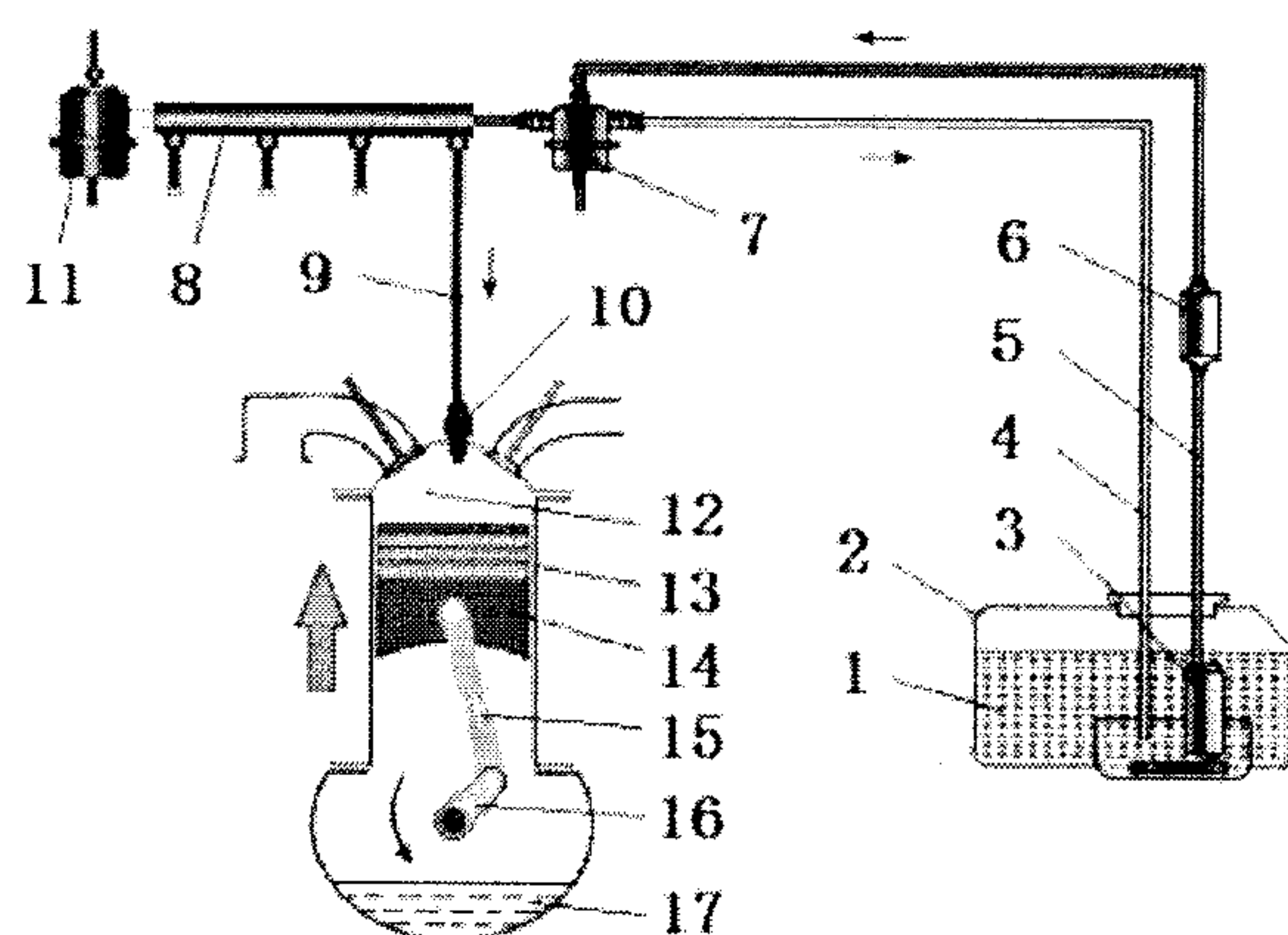


Figure 1

