United States Patent [19]

Arai

[11] **3,906,906**

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[54] **ROTARY PISTON ENGINE**

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Feb. 23, 1973 Japan 48-22451

[52] **U.S. Cl.** **123/8.13**
[51] **Int. Cl.**[2] **F02B 53/04**
[58] **Field of Search**.... 123/8.09, 8.11, 8.13, 33 VC, 123/33 C, 32 ST

[56] **References Cited**

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[57] **ABSTRACT**

A rotary piston engine wherein an auxiliary mixture chamber into which fuel is injected from a nozzle is provided between a suction port and an ignition plug in a center housing. A mixture injection member which reciprocatingly slides in accordance with the rotation of a rotor is provided in the auxiliary mixture chamber, and a communicating hole of the auxiliary mixture chamber communicates with each of the working chambers of the rotary piston as each chamber moves past the hole. As each working chamber goes through its suction stroke, a portion of the lean air/fuel mixture sucked in from the carburetor is also sucked into the auxiliary mixing chamber for mixture with fuel from the nozzle to produce a rich air/fuel mixture which is subsequently ejected into the lean air/fuel mixture in the working chamber. The lean and rich mixtures of air/fuel are then compressed in the working cylinder and ignited by the ignition plug.

2 Claims, 4 Drawing Figures

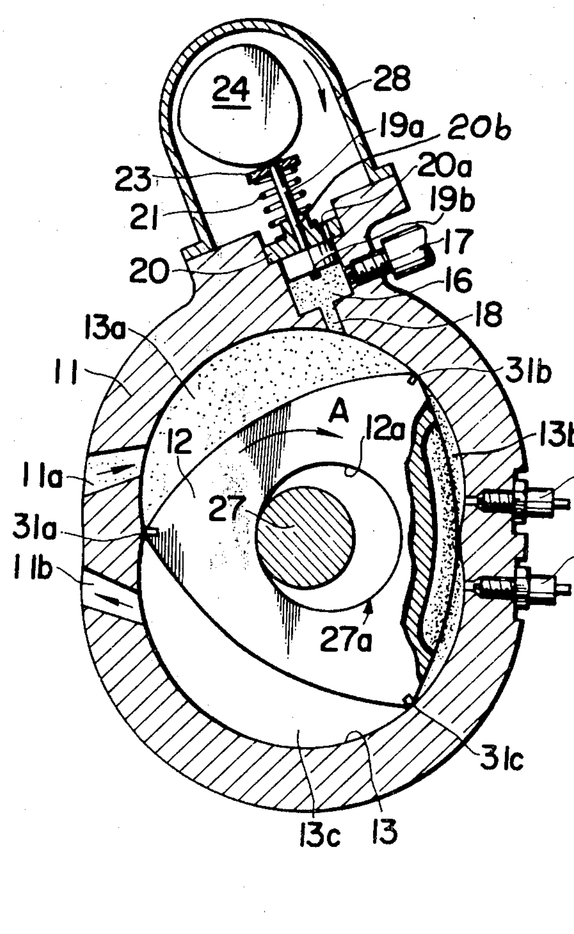

FIG. 1

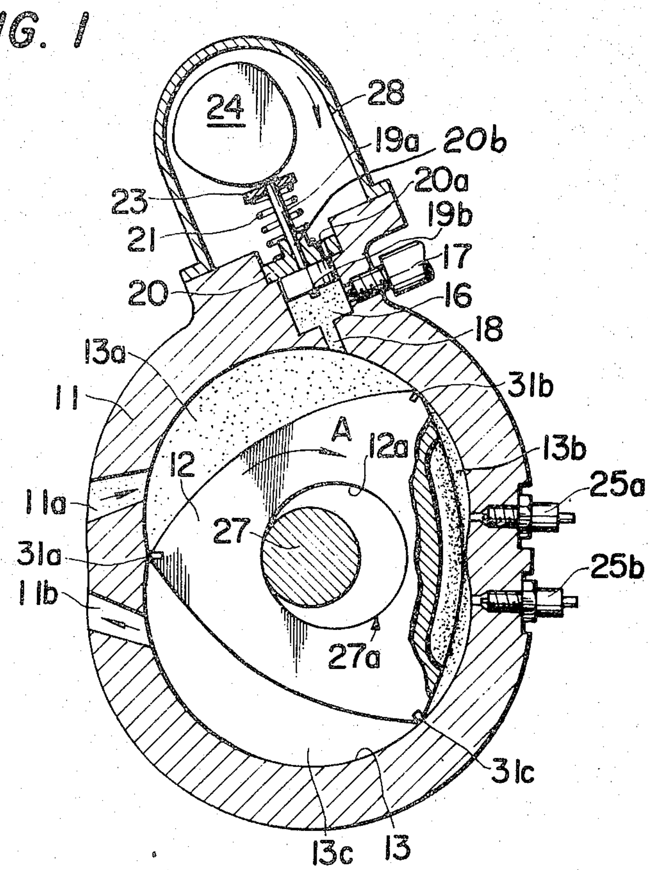
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FIG. 2

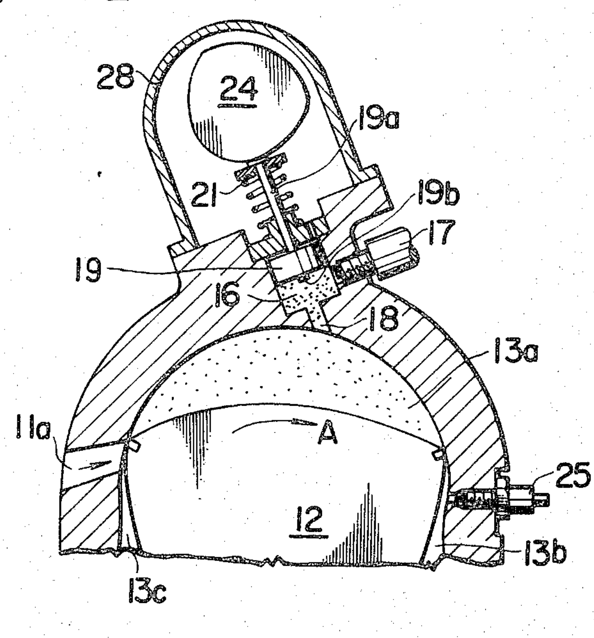
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FIG. 3

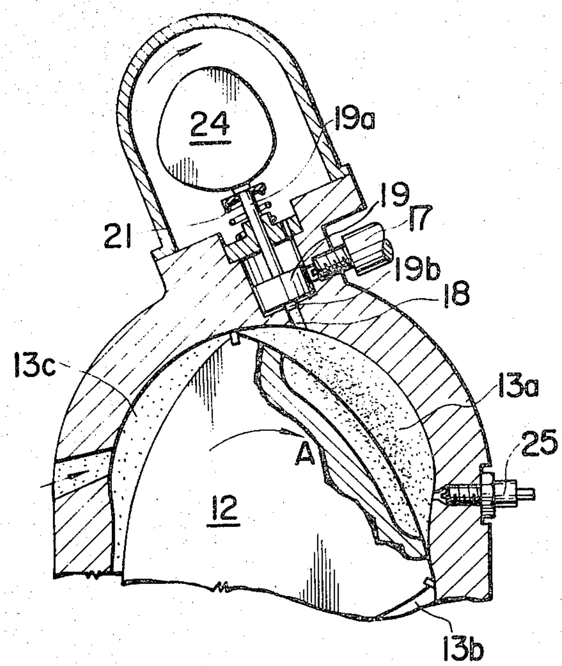
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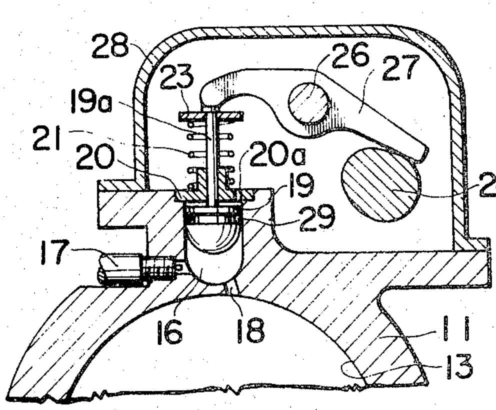
FIG. 4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ROTARY PISTON ENGINE

BACKGROUND OF THE INVENTION

The present invention relates to a rotary piston engine, and more particularly to a rotary piston engine of the trochoid structure.

As compared with a reciprocating engine, a rotary piston engine is large in the ratio between the surface area of combustion chamber S and the volume of the combustion chamber V, that is S/V. For this reason, the cooling effect of the surface of the combustion chamber is great, and the combustion temperature is low. The rotary piston engine consequently has the advantage of little NO_x exhaust.

In the rotary piston engine, however, the combustion temperature is low, and the quenching zone, in which the mixture is incombustible due to the cooling, is in the vicinity of the surface of the combustion chamber. Therefore fuel particles supplied into the cylinder which have not perfectly vaporized are incompletely combusted and adhere to the cylinder surface, and are exhausted in such condition. As a result, the quantities of exhaust of unburnt HC and CO attributed to the incomplete combustion are large, which is a cause of air pollution. Also such poor combustion results in large and excessive fuel consumption.

SUMMARY OF THE INVENTION

An object of the present invention is to eliminate the deficiency of the rotary piston engine that the exhaust of HC and CO is of large amount, without spoiling the advantage of same that the exhaust of NO_x is of small amount.

A further object of the present invention is to reduce the fuel consumption of the rotary piston engine.

In order to accomplish these objects, according to the present invention, a lean air/fuel mixture portion is formed on the cylinder surface side within the cylinder of a rotary piston engine, while a rich air/fuel mixture portion is formed at the central part of the cylinder or around an ignition plug, to effect the so-called stratified mixture supply, whereby the exhaust of NO_x is reduced and an incomplete combustion portion within the cylinder is also prevented without raising the combustion temperature.

BRIEF DESCRIPTION OF THE DRAWING

In the accompanying drawing:

FIG. 1 shows a cross section of the central part of a rotary piston engine according to the present invention;

FIGS. 2 and 3 show cross sections of a part of FIG. 1 in different operating positions; and

FIG. 4 shows a cross section of a modification of the part in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A rotary piston engine **10** is shown in FIG. **1** and includes a center housing **11** which has an inner peripheral surface of a cotyledonous peritrochoid or epitrocoid curve. At each end of the center housing **11**, side plates (not shown) are hermetically secured. Thus, a cylinder **13** is defined inside the center housing **11.** At the central parts of both the side plates, an output shaft **27** of the rotary piston engine **10** is pivotally supported through bearings (not shown). The shaft **27** has an eccentric portion **27***a* eccentric thereto at the part at which it is held within the cylinder **13.** At the central part of a piston **12**, there is provided a bearing surface **12***a* on which the eccentric portion **27***a* of the output shaft **27** is fittedly supported. The piston **12** is shaped into a substantially triangular plate whose outer pierphery is formed into the inner envelope of the peritrochoid, and is rotatably fitted into the cylinder **13.** Piston **12** is rotated in such manner that seal members **31***a*, **31***b* and **31***c* respectively fitted into grooves at the three corners of the substantially triangular plate are incessantly held in airtight contact with the inner peripheral surface of the center housing **11.**

In both side surfaces of the piston **12**, grooves (not shown) are provided in which seal members (not shown) are placed for keeping airtightness between both the side surfaces and both the side plates.

The cylinder **13** is partitioned into three working chambers **13***a*, **13***b* and **13***c* by the center housing **11,** both the side plates, and the piston **12.** Upon rotation of the piston **12** about shaft **27,** the working chambers **13***a*, **13***b* and **13***c* move around the shaft **26** while changing in volume. Above and below the central part of the left-hand side of the center housing **11,** that is, at parts communicating with the left lower part of the first working chamber **13***a* and with the left upper part of the third working chamber **13***c* when the piston **12** is in the position illustrated in FIG. **1,** there are respectively formed a suction port **11***a* and an exhaust port **11***b*. On the upper side of the center housing **11,** more specifically, past the suction port as viewed in the direction of rotation (the direction of an arrow A) of the piston **12** in FIG. **1** and adjacent one end of the first working chamber **13***a*, there is provided a communication hole **18** which provides a passage between an auxiliary mixture chamber **16** of a cylindrical shape and the first working chamber **13***a*. A fuel injection nozzle **17** for injecting fuel into the auxiliary mixture chamber is provided at a suitable position of the side wall of the auxiliary mixture chamber **16.** A mixture push-out member **19** is fittedly inserted into the auxiliary mixture chamber **16** in a manner to be hermitically sealed and slidable on the side wall thereof. Over the auxiliary mixture chamber **16** is a stopper **20** which limits upward movement of the mixture push-out member **19.** The stopper **20** may be press-fitted or screwed into housing **11.** Provided at the central part of the stopper **20** is a through hole **20***b*, through which a rod portion **19***a* of the mixture push-out member **19** penetrates. A spring retainer **23** is fastened at the upper end part of the rod portion **19***a*. Between the spring retainer and the stopper **20,** there is extended a spring **21,** which normally urges the mixture push-out member **19** upwards as viewed in the drawings. Above the rod portion **19***a* along its longitudinal axis, a cam **24** is disposed which is secured to and rotates about a shaft extending in a direction orthogonally intersecting the aforesaid axis of rod portion **19***a*. The cam **24** is driven by the output shaft **27** through a chain, gearing or the like, (not shown). The number of revolutions of cam **24** is made three times as large as that of the piston **12.** Shown at **28** is a cover which covers the cam **24,** the rod portion **19***a*, etc. An ignition plug **25** is disposed above the central part of the right-hand side of the center housing **11,** that is, above the central part of the second working chamber **13***b* as viewed when the piston **12** is in the position illustrated in FIG. **1.**

The operation based on the foregoing construction will now be explained.

It is well known that, in the rotary piston engine of the trochoid structure, the four strokes of suction — compression — explosion — exhaust are carried out by varying the volume of the working chamber with the rotation of the piston.

The first working chamber **13***a* in FIG. **1** is in the course of the suction stroke, and is sucking in a lean air/fuel mixture from a carburetor (not shown) through the suction port **11***a*. The second working chamber **13***b* is close to the end of the compression stroke. The third working chamber **13***c* is under the exhaust stroke. The mixture to be sucked in through the suction port **11***a* is approximately **18 – 22** in air/fuel ratio, and is leaner than the mixture of the ideal air/fuel ratio 14.7. When the piston **12** is in the position of FIG. **1**, the cam **24** is at a position at which the rod **19***a* of the mixture push-out member **19** can be shifted to the uppermost end by the force of the spring **21** in synchronism with the rotation of the piston **12.** While the mixture push-out member **19** comes from the lowermost end or the position shown in FIG. **3** to the uppermost end or the position shown in FIG. **1,** a portion of the lean air/fuel mixture which the first working chamber **13***a* has sucked in through the suction port **11***a* is sucked into the auxiliary mixture chamber **16** through the communication hole **18.** In the stroke in which the mixture push-out member **19** moves towards the uppermost end, immediately after the underside of the mixture push-out member **19** passes an opening at the fore end of the fuel injection nozzle **17,** fuel of an amount corresponding to a load is injected from the fuel injection nozzle **17** into the spiral vortices of the lean mixture generated within the auxiliary mixture chamber **16.** Thus, a rich mixture having an air/fuel ratio of, for example, about **10 – 13** is produced within the auxiliary mixture chamber **16.** Subsequently, when the piston **12** rotates to bring the various parts to approximately the position in FIG. 2 in which the communication between the first working chamber **13***a* and the suction port **11***a* is cut off, the first working chamber **13***a* terminates the suction stroke and transfers to the compression stroke. At this time, the cam **24** rotating in synchronism with the rotation of the piston **12** begins to press and shift the rod **19***a* of the mixture push-out member **19** downwards as viewed in the figure. Therefore, the mixture push-out member **19** begins to eject the rich mixture in the auxiliary mixture chamber **16** through the communicating hole **18** into the lean mixture of air/fuel in the first working chamber **13***a*.

At this time, since the piston **12** is continuing to rotate in the direction of the arrow A, the position of the various part shown in FIG. **2** is shifting to the positions of the various part shown in FIG. **3,** and the lean mixture in the first working chamber **13***a* is also rotating in the direction of rotation of the piston **12.** Since, however, the auxiliary mixture chamber **16** and the communication hole **18** are slanted in the direction of rotation of the piston **12,** the rich mixture ejected from the auxiliary mixture chamber **16** into the first working chamber **13***a* enters at substantially the central part of the flow of the lean mixture and is mixed with the lean mixture.

From the point of ejection of the rich mixture, the piston **12** is further rotated in the direction of the arrow A, and the compression stroke is almost terminated, the first working chamber **13***a* in FIG. **2** comes to the position of the second working chamber in FIG. **1.** At this time, as the working chamber rotates, the rich mixture of large specific gravity is moved outwardly by a centrifugal force, so that a mixture of good ignitability is produced in the vicinity of the ignition plug. As seen in the second working chamber **13***b* in FIG. **1,** there arises a distribution of two layers of air/fuel mixture in which the outer peripheral portion or layer consists of the lean mixture and the rich mixture of suitable strength is included in a portion or layer at the central part and in the vicinity of the ignition plug.

When the first working chamber **13***a* has come to the position of the second working chamber **13***b* shown in FIG. **1,** the mixture of suitable strength at the central part is ignited by the ignition plugs **25***a* and **25***b* (it will be understood that only one ignition plug **25***a* may be provided), and the combustion begins. Subsequently, the lean mixture at the outer peripheral part burns. Owing to the expansion of the gas at this time, a turning force is bestowed on the piston **12** in the direction of the arrow. The turning force is transmitted to the output shaft **27** through the eccentric portion **27***a*, and is taken out as output. Upon further rotation of the piston **12,** the first working chamber **13***a* rotates in the direction of the arrow A while increasing the area of working chamber. When the first working chamber **13***a* communicates with the exhaust port **11***b*, it decreases the area of working chamber while discharging the combustion gas through the exhaust port **11***b*. The engine at this point has terminated one complete cycle thereof. Thereafter, it comes to the position of the first working chamber **13***a* in FIG. **1** again, and the cycle which has thus far been explained is repeated.

The second working chamber **13***b* and the third working chamber **13***c* similarly operate with the respective phase shifts of 120° from the first working chamber. At the central part of the underside of the mixture push-out member **19,** there is provided a projecting portion **19***b* which fits in the communicating hole **18** in a nearly hermetic state when the mixture push-out member **19** has shifted to the lowermost end as shown in FIG. **3.** The projecting portion **19***b* diminishes the force by which the compression pressure of the compression stroke in the working chamber **13***a*, 13*b*, **13***c* acts on the mixture push-out member **19** after the ejection of the rich mixture from the auxiliary mixture chamber **16.** Shown at **20***a* is an air vent which communicates with the atmospheric air so that, when the mixture push-out member **19** is moved by the cam **24,** the movement may not be hindered.

A modified embodiment of the portion of the auxiliary mixture chamber **16** as well as the mixture push-out valve **19** of the present invention will now be described with reference to FIG. **4.** The same symbols in FIG. **4** as those in FIGS. **1–3** designate the same members or members effecting the same functions.

The points of difference of the embodiment in FIG. **4** from the embodiment in FIG. **1** are as stated below. The lower end part of the mixture push-out member **19** is provided with a hemispherical surface, the lower end surface of the auxiliary mixture chamber **16** is also provided with a hemispherical surface coincident with the hemispherical surface of the member **19,** and the communicating hole **18** is slanted and spaced from the center of the hemispherical surface of the chamber **16,** so that upon suction, an intense spiral vortex is generated within the auxiliary mixture chamber **16**, and upon injection of the fuel from the fuel injection nozzle **17**, good mixing is conducted by the spiral vortex. A seal member **29** is interposed between the mixture push-out member **19** and the cylinder surface of the auxiliary mixture chamber **16.** A rocker arm **27** which is pivotally supported by a shaft **26** is provided between the cam **24** and the rod portion **19***a* of the mixture push-out member **19.**

As described above in detail, according to the present invention, an auxiliary mixture chamber is provided on the suction side of a center housing in a rotary piston engine which forms a layer of a rich mixture of suitable strength in the neighborhood of the central part of each working chamber and a layer of a lean mixture outside the rich mixture layer or at parts in contact with the center housing, side plates and piston, so that the stratified mixture supply is carried out to slowly and reliably burn the lean mixture by combustion of the lean mixture, thereby to prevent unburnt gas from being discharged and to prevent HC and CO from being discharged in large quantities. Besides, since the combustion speed can be made lower than in a prior art rotaty piston engine to which a uniform mixture having an air fuel ratio of about 14.7 is supplied, the combustion temperature can be lowered, and the exhaust concentration of NO_x can be made very low. Furthermore, since the wasteful exhaust of HC and CO is lessened, the fuel consumption is decreased.

What is claimed is:

1. In a rotary piston engine having a case which includes a center housing with a polyarcuate inner peripheral surface and side plate portions for hermetically sealing the side parts of said center housing, a polygonal piston being provided within said case in a manner to be eccentrically rotatable therein, said piston sliding along the inner peripheral surface of said center housing at corner end parts of said piston, the interior of said case being partitioned into a plurality of working chambers, the volume of said each working chamber being varied at the sliding of said piston within said case, a suction port and an exhaust port being provided in said case, the improvement comprising a cylindrical auxiliary mixture chamber at an outer peripheral part of said center housing, means defining a communication hole in said center housing for fluidly communicating said auxiliary mixture with the interior of the particular working chamber communicating with said suction port, a nozzle and a mixture push-out member within said auxiliary mixture chamber, said nozzle being adapted to inject fuel into said auxiliary mixture chamber, a shaft driven by said piston, said mixture push-out member sliding airtightly on a cylindrical inner peripheral surface of said auxiliary mixture chamber and reciprocatingly driven by said shaft driven by said piston to inject a mixture in said auxiliary mixture chamber into said particular working chamber, so that in an engine cycle suction stroke of sucking only a lean mixture of air/fuel through said suction port, after the particular corner end part of said piston within said particular working chamber as situated on the fore side in the direction of rotation passes said communication hole, said mixture push-out member is caused to suck a portion of said lean mixture of air/fuel from within said particular working chamber into said auxiliary mixture chamber and simultaneously to inject the fuel from said injection nozzle so as to produce a rich air/fuel mixture within said auxiliary mixture chamber, and that in a period of the cycle from the approximate termination of the suction stroke of said particular working chamber to the first half of a compression stroke, said mixture push-out member is caused to inject said rich mixture in said auxiliary mixture chamber into said particular working chamber through said communication hole.

2. In the rotary piston engine according to claim **1**, further comprising: an ignition plug, the front end of said mixture push-out member is hemispherical, seal means between said mixture push-out member and said cylindrical surface of said auxiliary mixture chamber, said communication hole is made eccentric to said mixture push-out member, and the interior of said communication hole is inclined towards said ignition plug.

* * * * *