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Studenroth

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[54] **CHAMBERED PISTON FOR AN INTERNAL COMBUSTION ENGINE**

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[51] **Int. Cl.²** **F02F 3/00;** F02F 3/26

[58] **Field of Search** .. 123/32 C, 32 D, 32 K, 32 ST, 123/32 SP, DIG. 4, 75 B, 191 S, 191 SP, 193 CP, 193 P, 8.47, 32 B

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[57] **ABSTRACT**

A piston for an internal combustion engine is provided with an interior chamber of relatively large cross-sectional area, e.g., about 30 percent of the piston area, and a nozzle of relatively smaller throat area, e.g., about 3 to 5 percent of the piston area, opening into the combustion chamber of the engine. Upon ignition, gases in the chamber in the piston act on a wall of said chamber opposite the nozzle and then expand through the nozzle into the combustion chamber to act also on the crown of the piston.

9 Claims, 5 Drawing Figures

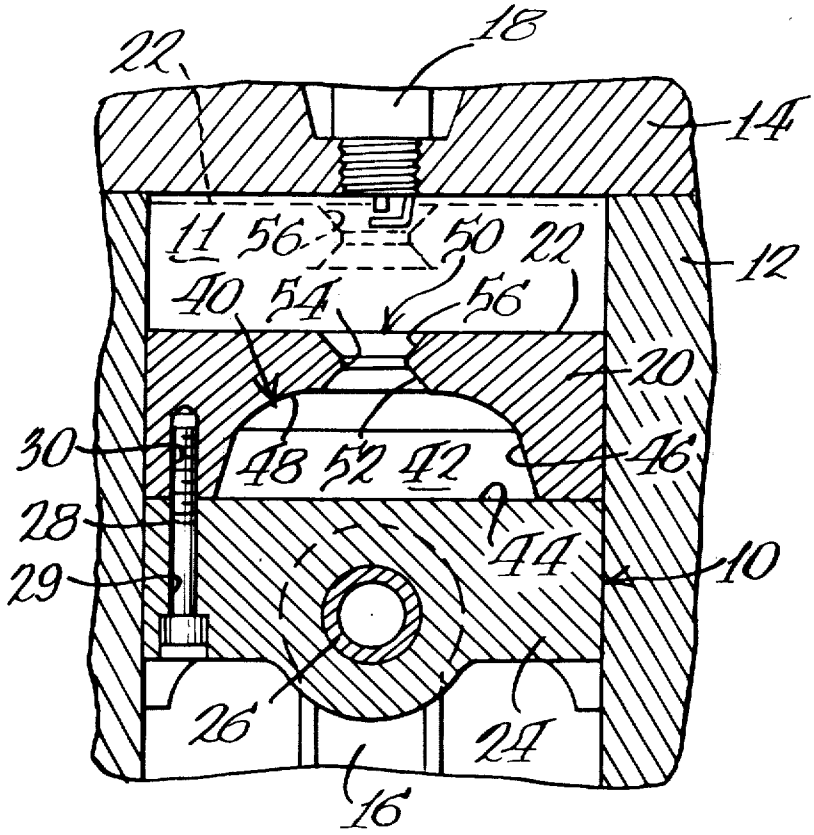


Fig. 1.

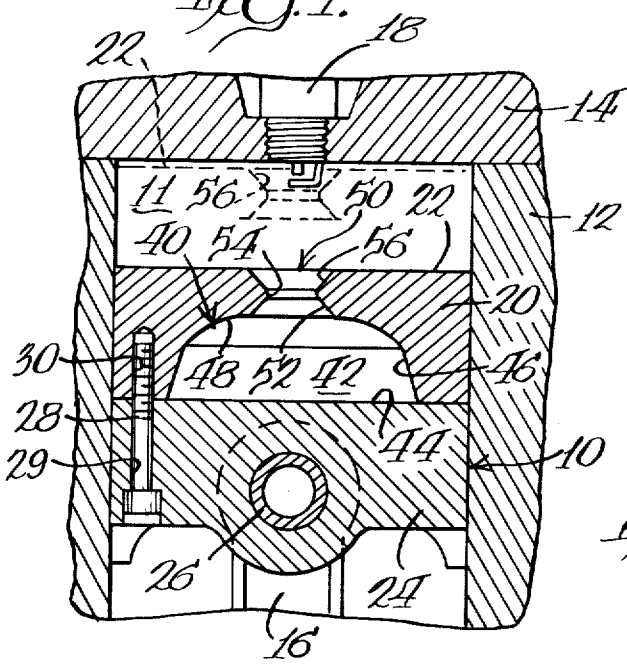


Fig. 2.

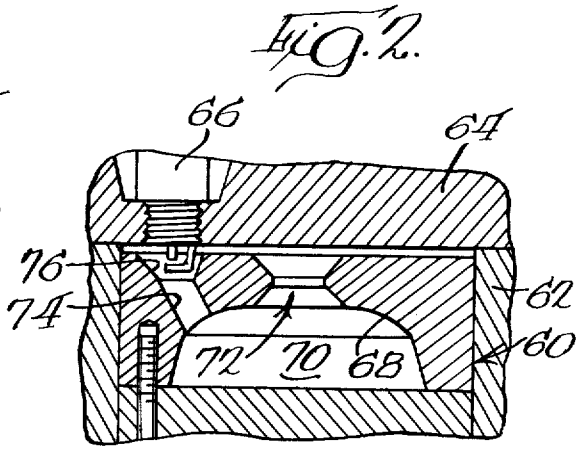


Fig. 3.

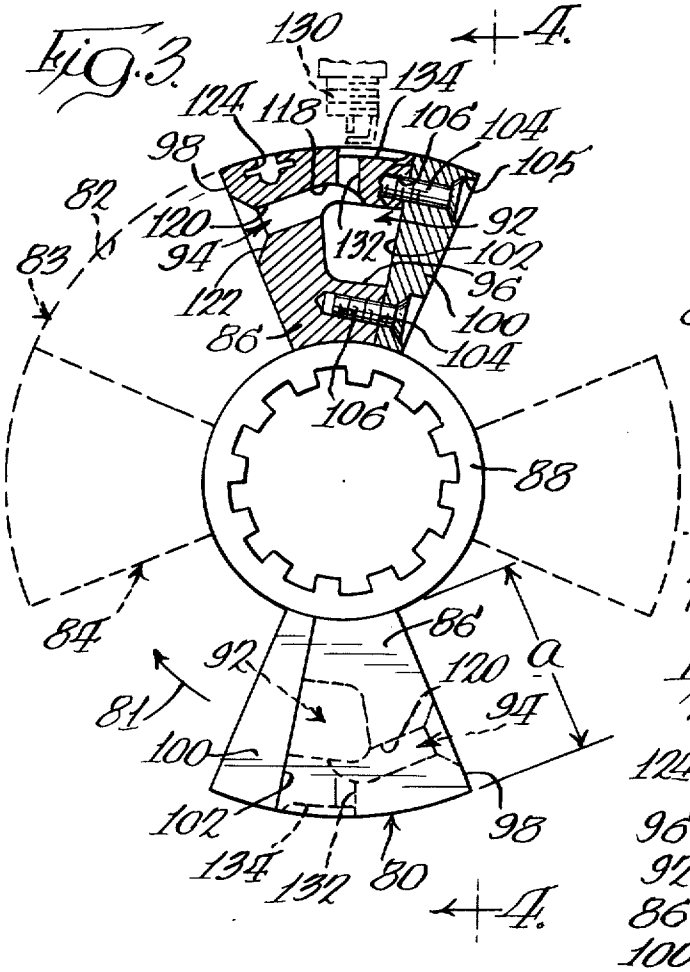


Fig. 4.

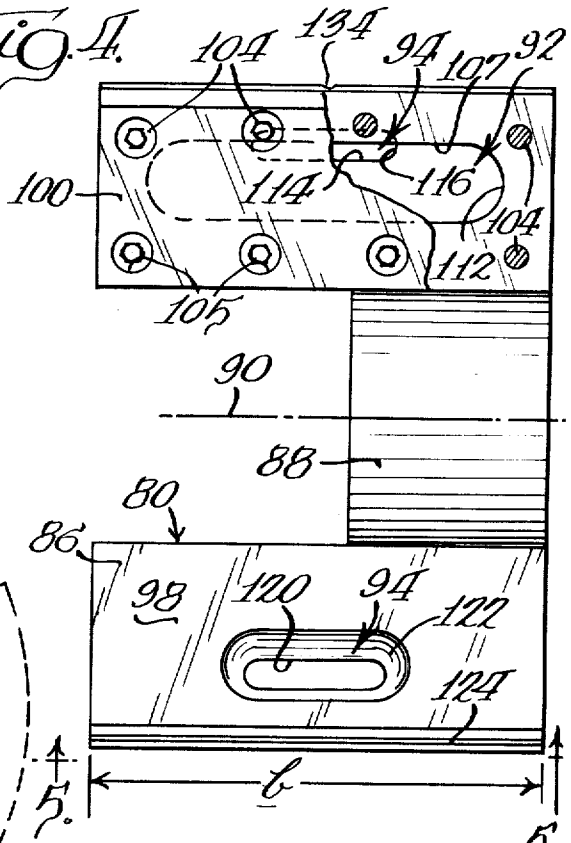
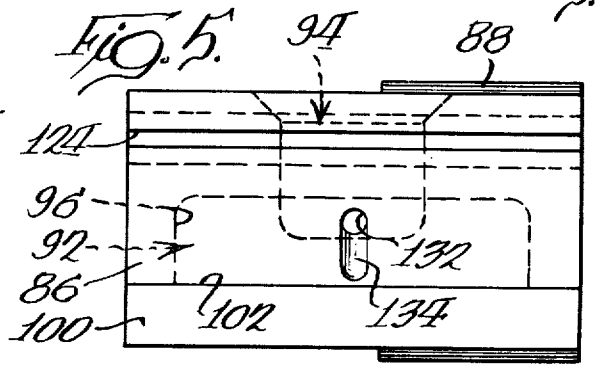


Fig. 5.



CHAMBERED PISTON FOR AN INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

Heretofore, internal combustion engines have been provided with chambers of various designs forming parts of the combustion chambers of the engines. Such chambers were located either in the cylinder heads or in the pistons. Typically, the chambers in the pistons were generally saucer-like or cup shaped recesses, having the largest cross-sectional area thereof open directly to the combustion chamber. Such chambers were used mainly in the pistons of diesel engines to concentrate the air prior to receiving the injected fuel. Such chambered pistons were infrequently used in spark ignition engines. Because of the shape of the chamber, the prior art chambered piston did not appreciably produce more power than a conventional "flat top" piston.

SUMMARY OF THE INVENTION

The chamber in the piston of the present invention has a unique shape, somewhat like a bottle, with an interior of relatively large cross-sectional area and a neck or nozzle portion with an opening or throat of relatively small cross-sectional area. The piston chamber preferably has a flat wall at the end opposite the nozzle opening, the flat wall being normal to the direction of travel of the piston. From the flat wall, the piston chamber tapers and/or curves convergingly toward the smaller nozzle opening. The nozzle portion, itself, first converges toward a minimum diameter throat and then diverges to open onto the outer surface or crown of the piston. To facilitate formation of the chamber inside the piston, the piston may be made of two members which are secured together.

In operation, the air, in case of a fuel-injection engine, and/or fuel-air mixture, in case of a spark ignition engine, is concentrated in the chamber of the piston during the comprssion stroke. Upon ignition, either by compression or spark, the expanding gases first act on the flat wall of the piston chamber opposite the nozzle opening and then expand out the nozzle to act on the outer surface or crown of the piston in a conventional manner to drive the piston so that the expanding gases do additional work and produce additional power.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of one embodiment of a chambered piston of the present invention for a reciprocating engine;

FIG. **2** is a cross-sectional view of a second embodiment of a chambered piston of the present invention for a reciprocating enging;

FIG. **3** is a cross-sectional view of a third embodiment of a chambered piston of the present invention for a rotary engine;

FIG. **4** is an elevational view taken in the direction of the arrows **4**—**4** in FIG. **3** with a portion broken away; and

FIG. **5** is a plan view taken in the direction of the arrows **5**—**5** in FIG. **4.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates a chambered piston **10** according to the present invention which is suitable for use in an internal combustion engine having engine walls which in conjunction with the chambered piston **10** form a combustion chamber **11.** In this instance the engine is of the reciprocating type and has a wall **12** defining a cylinder which is closed at one end by a cylinder head **14.** The piston **10** is cylindrical and is received in the cylinder **12** for reciprocation therein. The piston **10** is connected to a crankshaft (not shown) through the medium of a connecting rod **16,** as is conventional. Also as is conventional, the piston would carry piston rings (not shown) for sealing engagement with the walls of the cylinder **12.** While the chambered piston **10** of the present invention may also be suitable for fuel injection or compression ignition engines, in this instance the chambered piston **10** is illustrated with a spark ignition engine having a spark plug **18** located centrally in the cylinder head **14.**

While the chambered piston of the present invention could have been formed in one piece, in this instance, to facilitate manufacturing, the chambered piston **10** is formed of two members, namely, a crown member **20** having a crown or surface **22** exposed to the combustion chamber **11** and a body member **24** which is adapted to be connected to the connecting rod **16** by a wrist pin **26.** The crown member **20** may be fastened or secured to the body member **24** by various means so that the crown member reciprocates with the body member. As shown in FIG. **1,** the crown member **20** may be secured to the body member **24** by a plurality of bolts **28** which fit in openings **29** in the body member and engage threaded openings **30** in the crown member.

The chambered piston **10** has formed therein a piston chamber **40.** In this instance, the piston chamber **40** is symetrical about the axis of the cylinder **12** and includes an interior portion **42** and a neck or nozzle portion **50.** The interior portion **42** includes a wall **44** opposite the nozzle, which is preferably essentially flat and normal to the direction of piston movement. The side walls of the chamber **40** converge from the flat wall **44** toward the nozzle **50** and are defined by an inwardly tapering conical wall **46** which joins an inwardly curved arcuate wall **48.** As is apparent from FIG. **1,** the cross-section area of the interior portion **42** is quite large.

The interior portion **42** of the piston chamber **40** is connected to the combustion chamber **11** through the nozzle portion **50** which comprises an inner converging portion **52,** a minimum area opening or throat **54,** and a diverging portion **56** which exists through the crown **22** of the piston **10** into the combustion chamber **11.**

The size of the combustion chamber **11** and of the piston chamber **40** will vary with the size and compression ratio of the engine, and the volume of the piston chamber **40** must be taken into consideration in order to achieve the desired compression ratio for the engine. In order to concentrate as much air and/or fuel-air mixture in the piston chamber **40,** to permit the largest size piston chamber for a given compression ratio, and to have the spark plug **18** extend into the piston chamber as far as possible, the clearance between the cylinder head **14** and the crown **22** of the piston **10** should be held to a minimum. Preferably, the piston chamber

should have as large a cross-sectional area in the interior portion as possible, e.g., 30 percent of the piston area, based on a piston area of π (Diameter of Piston)^2/4 and neglecting the area of the nozzle. The piston chamber should also be sized so that the piston has adequate wall thickness for structural strength. The area of the throat of the nozzle portion should be relatively small, e.g., 3 to 5 percent of the piston area. Preferably, the ratio of the largest cross-sectional area of the piston chamber, such as that of the flat wall **44**, to that of the nozzle or throat is in the range of 5:1 to 10:1. The other dimensions of the piston chamber should be such as to give the engine the desired compression ratio.

With the chambered piston **10** of the present invention, it is preferable to have the spark plug **18** (or the fuel injector) centrally located on the axis of the cylinder so that the nozzle portion **50** which is also centrally located along the piston axis receives the tip of the spark plug **18** (or fuel injector) when the piston **10** is in the position shown in dotted lines in FIG. **1**.

In operation in a four cycle engine, as the chambered piston **10** moves downward on the intake stroke, a fresh charge or air or fuel-air mixture is drawn into the cylinder through an intake port (not shown). On the compression stroke, the piston moves upward to substantially the cylinder head **14** so that almost all the air or fuel-air mixture is forced into the piston chamber **40**. Near the end of the compression stroke, the spark plug **18** is fired (or the fuel injected) to ignite the fuel-air mixture in the piston chamber **40**. The burning gases expand and raise the pressure in the piston chamber **40**. The high pressure gases act against the flat end wall **44** of the piston chamber and are discharged through the nozzle **50** with a rocket or jet type action which causes an opposite reaction tending to drive the piston downward on its power stroke. After leaving the piston chamber, the gases increase the pressure in the combustion chamber, and the gases in the combustion chamber act on the crown **22** of the piston in a conventional manner. Near the bottom on the power stroke, the exhaust port (not shown) is opened, and the piston moves upward on the exhaust stroke to drive the spent gases from the cylinder preparatory to receiving a new charge for the next cycle.

Unlike a conventional piston which is driven solely by high pressure gases in the combustion chamber, the chambered piston of the present invention is also driven by the high pressure gases first acting on the flat wall **44** and being discharged out the nozzle into the combustion chamber.

A second embodiment of chambered piston of the present invention is shown in FIG. **2**. In this embodiment, the piston **60** is similar to the piston **10** previously described except for the features mentioned below. As illustrated in FIG. **2**, the piston **60** is mounted for reciprocation in an engine having a cylinder wall **62** and a cylinder head **64**. In this instance, instead of having a centrally located spark plug, the engine has a spark plug **66** offset to one side of the cylinder.

The chambered piston **60** has a chamber **68** generally similar to the chamber **40**, having an interior portion **70** and a neck or nozzle portion **72** which are generally similar to portions **42** and **50**, respectively, of the piston **10**. To accommodate the offset location of the spark plug **66**, the chambered piston **60** has an offset ignition opening **74** communicating between the interior portion **70** of the chamber **68** and the combustion chamber adjacent the spark plug **66**. As is shown in FIG. **2**, the ignition opening **74** is inclined toward chamber **68** and is enlarged somewhat at its outer end **76** to receive the tip of the spark plug **66**. Upon firing, the spark plug **66** ignites the gases in the opening **74** which in turn ignites the gases in the interior **70**. The operation of the chambered piston **60** is otherwise the same as that of the chambered piston **10** and will not be described.

A third embodiment of the chambered piston **80** of the present invention is illustrated in FIGS. **3–5**. Unlike the chambered pistons **40** and **60**, the chambered piston **80** is a rotor for a variable volume rotary engine. The rotor rotates on an axis in the direction of the arrow **81** within the confines of a stator wall **82** (shown in dotted lines) and cooperates with another similar piston **84** shown in dotted lines. The wall **82** and the pistons **80** and **84** define a variable volume combustion chamber **83**. As is shown in FIG. **3**, the rotor or piston **80** comprises two diamentrically opposed wedges **86** which are integral with a central tubular hub **88** located between the wedges. The hub is internally splined for cooperation with an engine drive shaft (not shown). The wedges **86** are provided with sealing slots **124** in the peripheral surfaces thereof for reception of sealing rings (not shown) which are adapted to engage the wall **82** to seal the rotor to the wall. As shown in FIG. **4**, the wedges **86** are elongated in the direction of the axis of rotation, and are at least twice the length of the hub **88**.

A chamber **92** is provided in the interior of each of the wedges **86**. Like the previously described chambers **40** and **60**, the chamber **92** has a neck or nozzle portion **94** and an interior portion **96**. Again, the nozzle portion **94** opens through a surface **98** of the piston **80** into the combustion chamber **83**. Preferably, the nozzle portion has a minimum cross-sectional area of 3 to 5 percent of the piston area and the interior portion has a cross-sectional area of about 30 percent of the piston area, the piston area being taken as dimensions $a \times b$ (FIGS. **3** and **4**).

To facilitate formation of the piston chamber **92**, each of the wedges **86** is in two pieces, having a plate **100** which closes one end of the chamber **92**. As shown in FIGS. **3** and **4**, the plate **100** has a flat inner wall or surface **102** that extends normal to the direction of travel of the rotor. The plate **100** is secured to the wedge **86** by fastening means or screws **104** which fit in openings **105** in the plate **100** and engage in threaded openings **106** provided in the wedge **86**.

In this instance the interior portion **96** of the chamber **92** in the form of an elongated slot **107** (FIG. **4**) having parallel walls and curve wall segments **112** at its ends. The nozzle portion **94** also is elongated and formed by an intersecting slot **114** having curved end segments **116**. The slots **107** and **114** are at an angle to each other so that the nozzle portion **94** has an inner converging section **118**, a minimum throat section **120**, and a diverging section **122** existing to the combustion chamber.

In order to ignite the charge in the chamber **92** a spark plug, indicated in dotted lines by the reference numeral **130**, is provided. The interior of the chamber **92** communicates with the spark plug **130** through a generally radial passage **132** in the wedge **86**. The outer end of the passage **132** intersects a groove or slot **134** located on the arcuate outer surface of the wedge **86**. As is shown in FIGS. **3** and **5**, the slot **134** is of sufficient length so that the plug **130** may ignite the charge in the chamber **92** even though the plug is not exactly

over the end of the radial opening **132.**

The operation of the piston **80** is somewhat similar to that of the pistons **40** and **60** previously described. On the intake stroke of the engine air or a fuel-air mixture is drawn into the combustion chamber **83.** On the compression stroke, the air or fuel-air mixture is compressed into chamber **92.** The pistons **80** and **84** rotate, and when the slot **134** of the piston **80** is adjacent the spark plug **130,** the spark plug is fired. The mixture in the chamber **92** ignites and raise the pressure in the chamber. The high pressure gases in the chamber **92** first act on the surface **102** of the chamber **92** and then are discharged out the nozzle portion **94** to provide a rocket or jet type reaction driving the piston. The discharged gases then raise the pressure in the combustion chamber and act on the surface **98** of the piston **80** to further drive the piston, as is conventional. After a certain time the exhaust port of the engine is opened, and the pistons **80** and **94** cooperate to drive the gases from the combustion chamber to ready it for the next cycle.

In a rotary engine or reciprocating engine having a chambered piston of the present invention additional power is produced during the power stroke by the gases acting against the wall of the piston chamber and being discharged out the nozzle. This additional power augments the power produced by the gases discharged to the combustion chamber which act on the outer surface of the piston. The use of the chambered piston of the present invention in an engine improves combustion, reduces octane requirement and improves fuel economy.

While only several embodiments of the chambered piston of the present invention has been described it shall be understood that variations, modifications and equivalent structures shall come within the scope of the appended claims.

I claim:

1. In a piston for a four cycle spark ignition internal combustion engine having a spark plug, the piston cooperating with the engine walls to define a combustion chamber of variable volume, the improvement comprising a piston member with a fixed piston area and having a piston chamber formed within said piston member, said piston chamber having a nozzle of an area of generally five or less percent of the piston area exiting through an outer surface of the piston member into said combustion chamber, said piston chamber having an interior of a cross-sectional area at least five times larger than the cross-sectional area of said nozzle, said piston chamber containing substantially all of a combustible mixture introduced into the combustion chamber of the engine and being in communication with said spark plug near the completion of the compression cycle, whereby upon ignition of the combustible mixture in said piston chamber by said spark plug, the gases generated by combustion are discharged from said piston chamber out said nozzle to drive said piston member by jet reaction and after being discharged into said combustion chamber act on said outer surface of said piston to further drive said piston member.

2. The piston member of claim **1,** wherein said nozzle of said piston chamber and said spark plug at the end of the compression cycle are aligned with one another, whereby said nozzle of said piston chamber receives said spark plug at the end of the compression cycle.

3. The piston member of claim **1,** wherein said nozzle and said spark plug are misaligned, said piston member having a second opening therein aligned with said spark plug to communicate the interior of said piston chamber with said spark plug at the end of the compression cycle.

4. The piston member of claim **1,** wherein said piston chamber has a flat surface opposite said nozzle and converges from the margins of said flat surface toward said nozzle, said nozzle first converging and then diverging to exit into the combustion chamber.

5. The piston member of claim **1,** wherein said piston member is in the form of a rotor for a rotary engine and includes an elongated wedge member in which said piston chamber is formed.

6. The piston member of claim **1,** wherein a pair of said piston members comprises a rotor for a rotary engine, each piston member includes a hub and a pair of elongated wedge-shaped members disposed on opposite sides of said hub and extending parallel to the axis of rotation of said hub, said wedge-shaped members being at least twice as long as said hub and being mounted at their inner ends on said hub, each of said wedge-shaped members having a pair of substantially radially extending faces and one of said piston chambers formed therein, said piston chamber being elongated and extending in a direction parallel to the axis of rotation of said hub, each of said wedge-shaped members having an elongated slot intersecting its associated chamber and extending substantially perpendicularly through one radial face of said wedge-shaped member to form said nozzle, the cross-sectional area of said chamber in a plane including said axis of rotation being at least five times larger than the cross-sectional area of said slot in a plane including said axis of rotation, and a radial passage extending from said chamber to the outer periphery of said wedge-shaped member for establishing communication between said piston chamber and said spark plug in the vicinity of the end of the compression cycle for the respective wedge-shaped member.

7. A process of operating a four cycle spark ignition internal combustion engine having a spark plug and a piston cooperating with other portions of the engine to define a variable volume combustion chamber, said piston having a piston chamber therein, said piston chamber having an interior portion and a nozzle portion exiting through an outer surface of the piston into the combustion chamber, the cross-sectional area of said interior portion being at least five times larger than the cross-sectional area of the nozzle portion, and the cross-sectional area of said nozzle portion being five or less percent of the piston area, comprising the steps of:

a. charging said combustion chamber with a combustible mixture,

b. compressing substantially all of said combustible mixture into said piston chamber,

c. igniting the combustible mixture in said piston chamber with said spark plug to increase the pressure in the piston chamber above that in the combustion chamber,

d. discharging the high pressure gases formed by combustion of said combustible mixture from said piston chamber through said nozzle portion into said combustion chamber to produce a jet type reaction driving the piston,

e. raising the pressure in the combustion chamber with the discharged gases from the piston chamber, the gases in the combustion chamber acting on the outer surface of the piston to further drive the piston, and

f. exhausting the gases from the piston chamber and combustion chamber,

whereby said piston is driven both by jet reaction of the gases discharged through the nozzle and by the discharged gases increasing the pressure in the combustion chamber and acting on the outer piston surface.

8. A rotating piston for a rotary internal combustion engine comprising a hub and a pair of elongated wedge-shaped members disposed on opposite sides of said hub and extending parallel to the axis of rotation of said hub, said wedge-shaped members having a pair of generally radial faces, being mounted on their inner ends to said hub and at least twice the length of said hub, said piston cooperating with a similar second piston and the engine walls to define a pair of variable volume wedgeshaped combustion chambers between the wedge-shaped members, each of said wedge-shaped members having a piston chamber formed therein extending in a direction parallel to the axis of rotation, a elongated slot intersecting said chamber and extending generally perpendicularly through one of said radial faces to form a nozzle exiting onto one of the combustion chambers, the cross-sectional area of said piston chamber in a plane including the axis of rotation being at least five times larger than the cross-sectional area of said slot in a plane including the axis of rotation, and a generally radial passage intersecting said piston chamber and extending to the outer periphery of said wedge-shaped member for communicating said piston chamber with a spark plug or fuel injector of the engine, whereby a combustible mixture may be burned in said piston chamber to raise the pressure in the piston chamber above that in the combustion chamber, the gases generated by combustion being discharged out the nozzle to the associated combustion chamber to first drive the piston with jet type reaction and then acting on the outer radial face of said piston to further drive the piston.

9. A process of operating a rotary internal combustion engine having a pair of wedge-shaped pistons cooperating with each other and other portions of the engine to define a wedge-shaped variable volume combustion chamber, one of said pistons having a chamber therein, said piston chamber having an interior portion and a nozzle portion exiting through an outer surface of the piston into the combustion chamber, the cross-sectional area of said interior portion being at least five time larger than the cross-sectional area of the nozzle portion, comprising the steps of:

a. charging said wedge-shaped combustion chamber with air or fuel-air mixture,

b. compressing substantially all of said air or fuel-air mixture between said wedge-shaped pistons and into said piston chamber,

c. igniting the fuel-air mixture to increase the pressure in the piston chamber above that of the combustion chamber,

d. discharging the high pressure gases formed through said nozzle portion into said wedge-shaped combustion chamber to produce a jet type reaction driving said one piston away from the other piston,

e. raising the pressure in the combustion chamber with the discharged gases from the piston chamber, the gases in the combustion chamber acting on the outer surface of said one piston to further drive said one piston away from the other piston, and

f. moving the other piston toward said one piston to exhaust the gases from the combustion chamber, whereby said one piston is driven both by the jet reaction of the gases discharged from the nozzle and by the discharged gases increasing the pressure in the combustion chamber and acting on the outer surface of said one piston.

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