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(54) **COMBUSTION SYSTEM FOR VEHICLE AND VEHICLE**

(57) A combustion system (100) and a vehicle. The combustion system (100) may comprise an air intake passage (10), an air exhaust passage (20), an air intake valve (30), and an air exhaust valve (40). The included angle between an axis of the air intake valve (30) and an axis of the air exhaust valve (40) is a preset angle. Furthermore, when the air intake valve (30) shuts down the air intake passage (10) and the air exhaust valve (40) shuts down the air exhaust passage (20), the center position of the air intake valve (30) is higher than the center position of the air exhaust valve (40). The combustion system (100) fixes the included angle between the axis of the air intake valve (30) and the axis of the air exhaust

valve (40). Furthermore, the height of the center position of the air intake valve (30) is designed to be higher than the height of the center position of the air exhaust valve (40). Therefore, airflow at the upper part of the air intake valve (30) flows along the inner wall of a combustion chamber (50) and a wall surface of the air exhaust valve (40) to enter the combustion chamber (50). A flow rate dead zone near the air exhaust valve (40) is reduced, thereby achieving high tumble flow conditions of gas in the combustion chamber (50). The combustion speed of the gas in the combustion system (100) of an engine is increased, the engine efficiency is increased, and requirements for engine power are met.

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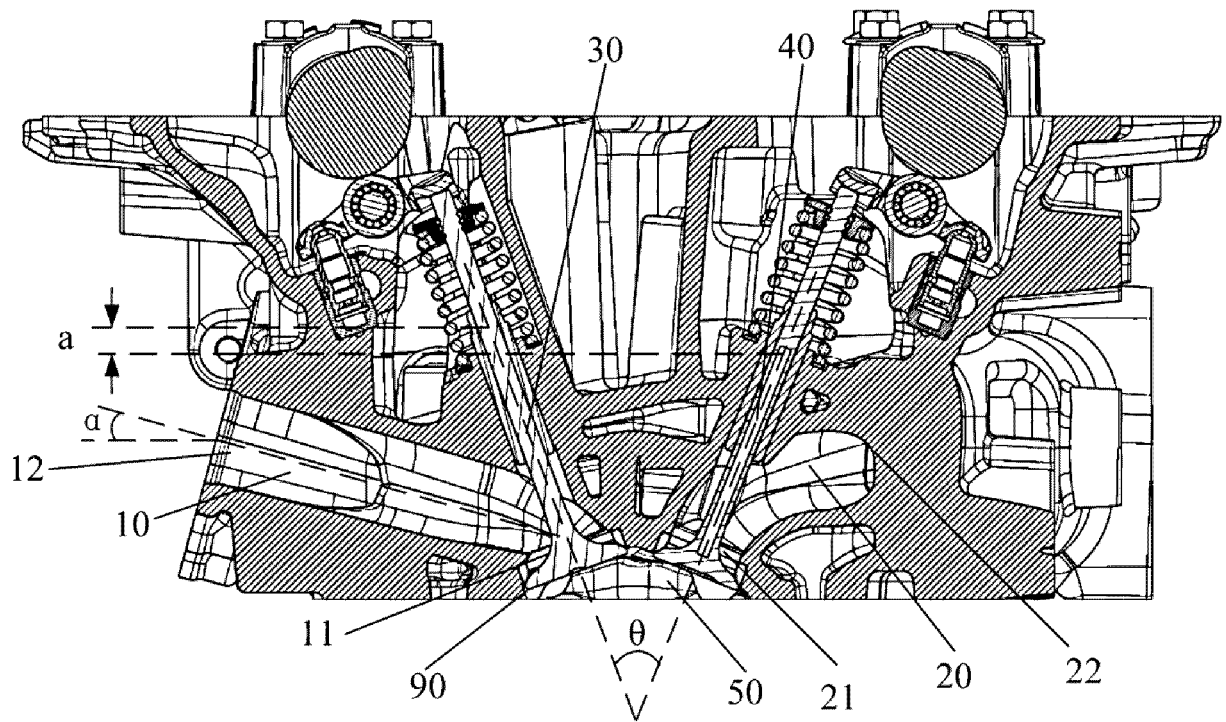


FIG. 1

Description

Technical Field

[0001] The present invention relates to the technical field of vehicles, and in particular to a combustion system for a vehicle and a vehicle.

Background

[0002] With increasingly stringent regulations on fuel consumption and emission and popularization of hybrid technology, more and more original equipment manufacturers begin to develop dedicated hybrid gasoline engines to achieve lower fuel consumption, lower emissions and better drivability, and support from more efficient combustion systems is needed to achieve these performances.

[0003] For an existing combustion system used in an engine with small cylinder diameter (cylinder diameter of 70 mm to 75mm), because of its structure having an air intake valve, an air exhaust valve, an air intake passage and a combustion chamber, a gas flow coefficient decreases greatly after the gas enters the combustion chamber from the air intake passage of the combustion system, which leads to a low combustion efficiency in the combustion chamber.

Summary

[0004] In view of the above problems, the present invention is proposed to provide a combustion system for a vehicle and a vehicle that overcome or at least partially solve the above problems.

[0005] An object of the present invention is to provide a combustion system for solving the problem that the combustion system in the prior art cannot simultaneously meet high tumble flow performance in a cylinder.

[0006] A further object of the present invention is to solve the problem of low combustion efficiency of engines in the prior art.

[0007] Another object of the present invention is to provide a vehicle including the above combustion system.

[0008] In particular, according to an aspect of an embodiment of the present invention, a combustion system for a vehicle is provided, including:

an air intake passage, an air exhaust passage, an air intake valve and an air exhaust valve, and one end of the air intake valve passing through one end of the air intake passage to open or close the air intake passage, and one end of the air exhaust valve passing through the air exhaust passage to open or close one end of the air exhaust passage;

wherein an included angle between an axis of the air intake valve and an axis of the air exhaust valve is a preset angle; and

when the air intake valve closes the air intake passage and the air exhaust valve closes the air exhaust passage, a center position of the air intake valve is higher than a center position of the air exhaust valve.

[0009] Optionally, a height difference between the center position of the air intake valve and the center position of the air exhaust valve is 0.5mm to 1mm.

[0010] Optionally, the preset angle is 35° to 50°.

[0011] Optionally, the combustion system further includes a combustion chamber, and the air intake passage and the air exhaust passage are communicated with the combustion chamber. An end of the air intake valve extends into the combustion chamber through an outlet of the air intake passage, and an inner wall of the combustion chamber is configured as a shielding structure that partially wraps the end of the air intake valve at a position close to the outlet of the air intake passage.

[0012] Optionally, the shielding structure is located on a side of the air intake valve away from the air exhaust valve.

[0013] Optionally, the shielding structure includes an air guide wall and an abutment plateau, and a cross section cut along a plane where the axis of the air intake valve is located is a step-shaped structure; the air guide wall is configured parallel to the axis of the air intake valve; and the abutment plateau is configured as a structure adapted to a contour of an end of the air intake valve, and the air intake valve abuts against the abutment plateau when the air intake valve closes the air intake passage.

[0014] Optionally, a cross section formed by cutting the shielding structure along an axis perpendicular to the air intake valve is a circular arc shape adapted to a structure of the end of the air intake valve, and a corresponding central angle of the circular arc shape is 110° to 180°.

[0015] Optionally, the shielding structure is further configured such that when the air intake valve closes the air intake passage, a minimum distance between the air intake valve and the air guide wall is 0.6mm to 1mm.

[0016] Optionally, a height of the air guide wall of the shielding structure along an axial direction of the air intake valve is 3mm to 5mm.

[0017] Optionally, an included angle between a central axis of the air intake passage and a horizontal plane is 15° to 20°.

[0018] Optionally, the combustion system further includes a piston. A pit is arranged at a middle position of a top of the piston, and a vertical distance between a bottom end and a top end of the pit is 0.5mm to 1mm.

[0019] Optionally, an avoidance groove is provided at a top end of the piston and a position of the avoidance groove is matched with a position of the air intake valve or the air exhaust valve.

[0020] Optionally, two air intake valves are provided and share the air intake passage; two air exhaust valves are provided and share the air exhaust passage; a number of the avoidance grooves is a sum of the number

of the air intake valves and the number of the air exhaust valves.

[0021] Optionally, the combustion chamber is provided with an air squeeze structure; an outer periphery of the pit at the top of the piston is provided with an air squeeze surface; and the air squeeze structure and the air squeeze surface are matched with each other.

[0022] Optionally, the combustion system further includes a spark plug and a fuel injection nozzle. The spark plug and the fuel injection nozzle are arranged between the air intake valves and the air exhaust valves.

[0023] Optionally, connection lines between centers of top ends of the two air intake valves and the two air exhaust valves form a rectangle; the spark plug and the fuel injection nozzle are arranged side by side on one of the centerlines of the rectangle, and the spark plug and the fuel injection nozzle are located at two sides of the other centerline of the rectangle.

[0024] In particular, the present invention further provides a vehicle including the combustion system for vehicle described above.

[0025] In the combustion system of the present invention, the included angle between the axis of the air intake valve and the axis of the air exhaust valve is fixed, and the height of the center position of the air intake valve is designed to be greater than the height of the center position of the air exhaust valve. Therefore, airflow at the upper portion of the air intake valve flows along the inner wall surface of the combustion chamber and a wall surface of the air exhaust valve into the combustion chamber. Flow rate dead zones near the air exhaust valve are reduced, thereby achieving high tumble flow condition of gas in the combustion chamber. A combustion speed of the gas in the combustion system of an engine is increased, the engine's efficiency is increased, and requirements for engine power are met at the same time.

[0026] Furthermore, in the combustion system of the present invention, the shielding structure is designed to be at the lower part of the air intake valve, which can reduce the airflow at the lower part of the air intake valve, especially at low lift (lift < 3mm to 5mm), promote flow separation, and make most of the airflow enter the combustion chamber from the upper part of the air intake valve, greatly improve a tumble flow ratio of the low lift, accelerate mixing of oil and gas, improve uniformity of distribution of the mixed gas, and accelerate the combustion speed. At the same time, in the combustion system of this embodiment, the shielding structure is designed to be at the lower part of the air intake valve, which can reduce the airflow at the lower part of the air intake valve and guide the airflow to the exhaust side, reduce reverse tumble flow during an initial stage of an air intake stroke, and facilitate formation of large-scale forward tumble flow in the combustion chamber.

[0027] Further, the air intake passage according to the present invention is arranged at an angle such that the inlet of the air intake passage of the present invention is lower. Since most of the airflow in the air passage with

high tumble enters the combustion chamber through the upper part of the air intake valve, reduction of the inlet of the air intake passage results in that the air intake passage can guide most of the airflow to the upper part of the air intake valve, effectively improving the flow coefficient of the air intake passage with high tumble.

[0028] Further, the four avoidance grooves and the large central pit of the piston of the present invention are designed to form tumble flow along the inner wall of the combustion chamber after the gas enters the combustion chamber from the air intake passage through the upper right side of the end of the air intake valve, and the shallow pit at the upper part of the piston is designed to ensure that the tumble gas can flow along the shallow pit when the tumble gas flows to the piston, so that the tumble flow in the air intake stroke can be more easily maintained. When the piston reaches a compression top dead center, the strong airflow is broken, which generates strong turbulent kinetic energy, avoids quenching when the flame contacts with the top surface of the piston at the initial propagation, and improves the combustion efficiency.

[0029] The fuel injection nozzle of the present invention adopts an intermediate arrangement, which makes a combustion control strategy more flexible. During actual use, a strategy of multiple-times fuel injection can be adopted to form thick mixed gas in the center of spark plug, which improves combustion stability. At the same time, under a light-off working condition, light-off of a three-way catalytic converter is accelerated. Meanwhile, a proper distance kept between the fuel injection nozzle and the spark plug can prevent a problem such as carbon deposition on the spark plug due to an oil film generated on an electrode of the spark plug by a fuel spray coming into contact with the electrode of the spark plug.

[0030] Furthermore, in the present invention, the air squeeze structure in the combustion chamber can squeeze the gas flow toward the center of the cylinder. When the piston moves to the top dead center, through cooperation between the air squeeze structure and the air squeeze surface, the tumble flow of the gas can be broken, and a strong turbulent flow intensity can be formed in the middle of the combustion chamber, so that a flame propagation speed can be improved and a tendency of knocking can be reduced. In addition, the design of the air squeeze surface around the piston matched with the air squeeze structure of the combustion chamber is beneficial to maintaining the tumble flow in the cylinder and forming a higher turbulence intensity. At the same time, it can avoid quenching when the flame contacts with the top surface of the piston during initial propagation, and improve the combustion efficiency.

[0031] In addition, when the fuel injection nozzle of the combustion system of the present invention injects fuel, according to the structure of the combustion system of the present invention, a fuel spray forms an air layer on the top of the piston, thereby reducing contact between the fuel spray and the piston top and wall collision, reducing a risk of soot emission, which improves the com-

bustion efficiency. Finally, after use of the combustion system of the present invention, a highest thermal efficiency of the combustion system can be improved by 2% to 3%.

[0032] The above description is only a summary of the technical solutions of the present invention, which may be practiced in accordance with the contents of the specification, in order to enable a clearer understanding of the technical means of the present invention, and in order to make the above and other objects, features and advantages of the present invention more apparent, specific embodiments of the present invention are set forth below.

[0033] The above and other objects, advantages and features of the present invention will become more apparent to those skilled in the art from the following detailed description of specific embodiments of the present invention taken in conjunction with the accompanying drawings.

Brief Description of Drawings

[0034] Some specific embodiments of the present invention will be described in detail below by way of example rather than in a restrictive manner with reference to accompanying drawings. Identical reference numerals in the drawings designate identical or similar components or parts. It should be understood by those skilled in the art that these drawings are not necessarily plotted to scale. In the accompanying drawings:

FIG. 1 is a schematic cross-sectional view of a combustion system according to one embodiment of the present invention.

FIG. 2 is a schematic top view of a combustion system according to one embodiment of the present invention.

FIG. 3 is an enlarged schematic view of a shielding structure of a combustion system according to one embodiment of the present invention.

FIG. 4 is a schematic top view of a piston of a combustion system according to one embodiment of the present invention.

FIG. 5 is a schematic cross-sectional diagram of a combustion system according to one embodiment of the present invention.

FIG. 6 is a schematic cross-sectional view taken along section line A-A in FIG. 2.

FIG. 7 is a schematic cross-sectional view taken along section line B-B in FIG. 2.

Detailed Description

[0035] Exemplary embodiments of the present disclosure will be described in more detail below with reference to the accompanying drawings. Although exemplary embodiments of the present disclosure are shown in the drawings, it should be understood that the present disclosure may be implemented in various forms and should not be limited to the embodiments set forth herein. Rather, these embodiments are provided to enable a more thorough understanding of the present disclosure and to fully convey the scope of the present disclosure to those skilled in the art.

[0036] As a specific embodiment of the present invention, as shown in FIG. 1 and FIG. 2, a combustion system 100 of this embodiment may include an air intake passage 10, an air exhaust passage 20, an air intake valve 30, an air exhaust valve 40, a combustion chamber 50, a fuel injection nozzle 60, a spark plug 70, and a piston 80. The air intake passage 10 is located on a side of the air intake valve 30. Specifically, as shown in FIG. 1, the air intake passage 10 may be located on a left side of the air intake valve 30. The air exhaust passage 20 is located on a side of the air exhaust valve 40 and one end of the air intake valve 30 passes through an outlet 11 of the air intake passage 10 to open and close the air intake passage 10. Specifically, the air exhaust passage 20 may be located on a right side of the air exhaust valve 40 and one end of the air exhaust valve 40 passes through an inlet 21 of the air exhaust passage 20 to open and close the air exhaust passage 20. Specifically, two air intake valves 30 and two air exhaust valves 40 may be provided in this embodiment. The air intake passage 10 and the air exhaust passage 20 are both communicated with the combustion chamber 50. Gas enters the air intake passage 10 through an inlet 12 of the air intake passage 10, and then enters the combustion chamber 50 through the outlet 11 of the air intake passage 10 for combustion. After combustion, the gas enters the air exhaust passage 20 through the inlet 21 of the air exhaust passage 20 and is discharged through an outlet 22 of the air exhaust passage 20. The air intake valve 30 and the air exhaust valve 40 are used to open and close the corresponding air intake passage 10 and the air exhaust passage 20. Specifically, the combustion system 100 of this embodiment is more suitable for engines with small cylinder diameter (cylinder diameter 70mm to 75mm).

[0037] Specifically, as shown in FIG. 1, since an included angle between an axis of the air intake valve 30 and an axis of the air exhaust valve 40 affects amount of the tumble flow of the gas entering the combustion chamber 50, the included angle between the axis of the air intake valve 30 and the axis of the air exhaust valve 40 of the combustion system 100 of this embodiment is a preset included angle θ , and when the air intake valve 30 closes (or blocks) the air intake passage 10 and the air exhaust valve 40 also closes (or blocks) the air exhaust passage 20, a center position of the air intake valve

30 is higher than a center position of the air exhaust valve 40. In this embodiment, the center position of the air intake valve 30 may refer to a geometric center position of the air intake valve 30. Likewise, the center position of the air exhaust valve 40 may refer to a geometric center position of the air exhaust valve 40. Of course, when the air intake valve 30 and the air exhaust valve 40 block the air intake passage 10 and the air exhaust passage 20, respectively, a height difference between the geometric center positions of the air intake valve 30 and the air exhaust valve 40 is the same as a height difference between lowest point positions of the air intake valve 30 and the air exhaust valve 40. When the height difference is actually designed, a height difference between a position of the outlet 11 of the air intake passage 10 and a position of the inlet 21 of the air exhaust passage 20 can be designed so that the center position of the air intake valve 30 is higher than the center position of the air exhaust valve 40 when the air intake valve 30 closes the air intake passage 10 and the air exhaust valve 40 also closes the air exhaust passage 20.

[0038] In this embodiment, the included angle between the axis of the air intake valve 30 and the axis of the air exhaust valve 40 is fixed, and a height of the center position of the air intake valve 30 is designed to be greater than a height of the center position of the air exhaust valve 40. Therefore, airflow on top of the air intake valve 30 flows along an inner wall surface of the combustion chamber 50 and a wall surface of the air exhaust valve 40 into the combustion chamber. Flow rate dead zones near the air exhaust valve 40 are reduced, thereby achieving high tumble flow condition of gas in the combustion chamber 50. A combustion speed of the gas in the combustion system 100 of an engine is increased, the engine's efficiency is increased, and requirements for engine power are met at the same time.

[0039] Specifically, the preset angle θ in this embodiment may be 35° to 50° . For example, θ may be 35° , 40° or 50° . The height difference a between the center position of the air intake valve 30 and the center position of the air exhaust valve 40 in this embodiment is 0.5mm to 1mm. For example, a may be 0.5 mm, 0.8 mm or 1mm. In this embodiment, the design of the included angle between the axis of the air intake valve 30 and the axis of the air exhaust valve 40 is combined with the height difference between the center position of the air intake valve 30 and the center position of the air exhaust valve 40, which can ensure that when the airflow at the top of the air intake valve 30 flows along the inner wall surface of the combustion chamber 50 and the wall surface of the air exhaust valve 40 into the combustion chamber, flow rate dead zones near the air exhaust valve 40 are reduced, thereby achieving high tumble flow condition of gas in the combustion chamber 50.

[0040] As an embodiment, as shown in FIG. 1 and FIG. 3, an end of the air intake valve 30 in this embodiment extends into the combustion chamber 50 through the outlet 11 of the air intake passage 10, and the inner wall of

the combustion chamber 50 is configured as a shielding structure 90 that partially wraps the end of the air intake valve 30 at a position close to the outlet of the air intake passage 10.

[0041] Specifically, the shielding structure 90 of this embodiment is provided only at the inner wall of the combustion chamber 50 along the end of the air intake valve 30 and on a side away from the air exhaust valve 40. Specifically, as shown in FIG. 1 and FIG. 3, the shielding structure 90 of this embodiment is located at a lower left position of the air intake valve 30. There is no shielding structure at the upper right position of the end of the air intake valve 30. Due to the presence of the shielding structure 90, most of the gas flowing from the air intake passage 10 to the combustion chamber 50 flows into the combustion chamber 50 from the upper right position of the end of the air intake valve 40. Further, since the height of the center position of the air intake valve 30 is greater than the height of the center position of the air exhaust valve 40, the gas entering the combustion chamber 50 from the upper right side of the air intake valve 30 flows along the inner wall of the combustion chamber 50, thereby making formation of turbulence easier.

[0042] Specifically, the shielding structure 90 of this embodiment may include an air guide wall 91 and an abutment plateau 92, and has a step-shaped cross-section cut along a plane where the axis of the air intake valve 30 is located. The air guide wall 91 is configured to be substantially parallel to a central axis of the air intake valve 30, and the abutment plateau 92 is configured to be substantially adapted to the contour structure of the end of the air intake valve 30 at a side of close to the air intake passage 10, and the air intake valve 30 abuts against the abutment plateau 92 when the air intake valve 30 blocks the air intake passage 10.

[0043] Specifically, the cross section of the shielding structure 90 formed by cutting along an axis perpendicular to the air intake valve 30 is a circular arc shape adapted to the structure of the end of the air intake valve 30 (as shown in FIG. 2), and a central angle β corresponding to the circular arc (i.e., an angle of a sector formed by a center of the circular arc shape and the circular arc shape) is 110° to 180° . For example, β may be 110° , 120° , 150° or 180° .

[0044] More specifically, the shielding structure 90 of this embodiment is configured such that when the air intake valve 30 blocks the air intake passage 10, a minimum distance between the air intake valve 30 and the air guide wall 91 is b , where b may be 0.6mm to 1mm. For example, b may be 0.6 mm, 0.8 mm, or 1mm. In addition, a height c of the air guide wall 91 of the shielding structure 90 along the axial direction of the air intake valve 30 may be 3mm to 5mm. For example, c may be 3mm, 4mm or 5mm.

[0045] In the combustion system 100 of this embodiment, the shielding structure 90 is designed to be at the lower part of the air intake valve 30, which can reduce airflow at the lower part of the air intake valve 30, espe-

cially at low lift (lift < 3mm to 5mm), promote flow separation, and make most of the airflow enter the combustion chamber 50 from the upper right part of the air intake valve 30, which greatly improves a tumble flow ratio of the low lift, accelerates mixing of oil and gas, improves uniformity of distribution of the mixed gas, and accelerates the combustion speed. At the same time, in the combustion system 100 in this embodiment, the shielding structure 90 is designed to be at the lower left part of the air intake valve 30, which can reduce airflow at the lower part of the air intake valve 30 and guide the airflow to the exhaust side, reduce reverse tumble flow at an initial stage of an air intake stroke, and facilitate formation of large-scale forward tumble flow in the combustion chamber 50.

[0046] As a specific embodiment, an angle α between the central axis of the air intake passage 10 and a horizontal plane is 15° to 20° (as shown in FIG. 1). For example, α may be 15° , 16° or 20° . The air intake passage 10 according to this embodiment is arranged at the angle such that the inlet 12 of the air intake passage 10 of this embodiment is lower. Since most of the airflow in the high tumble air passage enters the combustion chamber 50 through the upper right part of the air intake valve 30, reduction of the inlet 12 of the air intake passage 10 results in that the air intake passage 10 can guide a larger part of the airflow to the upper right part of the air intake valve 30, which effectively improves a flow coefficient of the high tumble air intake passage 10.

[0047] The combustion system 100 of this embodiment ensures that the gas is in a state of high tumble flow and high flow coefficient when the gas enters the combustion chamber 50, by making the center height of the air intake valve 30 higher than the center height of the air exhaust valve 40 in combination with the design of the lower inlet 12 of the air intake passage 10 in this embodiment.

[0048] As an embodiment, as shown in FIG. 4 and FIG. 5, the combustion system 100 may further include a piston 80. The piston 80 reciprocates in a cylinder of the engine, and a top surface of the piston 80 forms a bottom surface of the combustion chamber 50. The reciprocating motion of the piston 80 within the cylinder of the engine causes a volume of the combustion chamber 50 to change accordingly.

[0049] As one embodiment, a pit 82 is further provided at a top middle position of the piston 80 of this embodiment, and the pit 82 is recessed inward from a position close to a side wall of the piston 80 as a start point to form a large shallow pit. Specifically, a height of the bottom of the pit 82 is lower than those at other positions. A vertical distance d between a bottom end and a top end of the pit 82 may be 0.5mm to 1mm. For example, d may be 0.5 mm, 0.8 mm, or 1mm.

[0050] As a specific embodiment, an avoidance groove 81 is provided at the top end of the piston 80, and a position of the avoidance groove 81 matches the position of the air intake valve 30 or the air exhaust valve 40. Specifically, one air intake passage 10, two air intake

valves 30, one air exhaust passage 20 and two air exhaust valves 40 are included in this embodiment. The two air intake valves 30 share one air intake passage 10 and the two air exhaust valves 40 share one air exhaust passage 20. A number of the avoidance grooves 81 is the same as a total number of the air intake valves 30 and the air exhaust valves 40. Specifically, in this embodiment, four avoidance grooves 81 are designed on the top of the piston 80, and sizes and positions of the four avoidance grooves 81 are adapted to corresponding air intake valves 30 and air exhaust valves 40 respectively.

[0051] The four avoidance grooves 81 and the large central pit 82 of the piston 80 of this embodiment are designed to form tumble flow along the inner wall of the combustion chamber 50 after the gas enters the combustion chamber 50 from the air intake passage 10 through an upper right side of an end of the air intake valve 30, and the shallow pit 82 on the top of the piston 80 is designed to ensure that the tumble gas can flow along the shallow pit 82 when the tumble gas flows to the piston 80, so that the tumble flow in the air intake stroke can be more easily maintained. When the piston 80 reaches a compression top dead center, the strong airflow in the combustion chamber is broken, which generates strong turbulent kinetic energy, avoids quenching when flame contacts with the top surface of the piston 80 during initial propagation, and improves the combustion efficiency.

[0052] As an embodiment, as shown in FIG. 2, FIG. 6 and FIG. 7, an air squeeze structure 51 (shown in FIG. 2) is provided within the combustion chamber 50. An air squeeze surface 83 is provided at an outer periphery of the pit 82 on the top of the piston 80, and the air squeeze structure 51 and the air squeeze surface 83 are matched with each other. Specifically, the air squeeze structure 51 within the combustion chamber 50 is located at a side-wall position of an upper part of the combustion chamber. The air squeeze structure 51 is provided in a step-shaped air squeeze structure or an inward inclined air squeeze structure. For example, in FIG. 6, a step-shaped air squeeze structure 511 is at the left side and an inclined air squeeze structure 512 is at the right side. That is, the step-shaped air squeeze structure 511 is provided at the left side of the combustion chamber 50, and the inclined air squeeze structure 512 is provided at the right side of the combustion chamber 50. In FIG. 7, both sides of the combustion chamber are provided with step-shaped air squeeze structures 511, that is, step-shaped air squeeze structures 511 are provided at both a front side and a rear side of the combustion chamber 50. The air squeeze surface 83 at an outer circumference of the shallow pit 82 on the top of the piston 80 is a flat surface. The flat surface is parallel to the step-shaped air squeeze structure 511. In this embodiment, the air squeeze structure 51 in the combustion chamber 50 can squeeze the gas flow toward a center of the cylinder. When the piston 80 moves to the top dead center, through cooperation be-

tween the air squeeze structure 51 and the air squeeze surface 83, the tumble flow of the gas can be broken, and a strong turbulent flow intensity can be formed in the middle of the combustion chamber 50, so that a propagation speed of flame can be improved and a tendency of knocking can be reduced. In addition, the design of the air squeeze surface 83 around the piston 80 matched with the air squeeze structure 51 of the combustion chamber 50 is beneficial to maintaining the tumble flow in the cylinder and forming a higher turbulence intensity. At the same time, it can avoid quenching when the flame contacts with the top surface of the piston 80 during initial propagation, and improve the combustion efficiency.

[0053] As a specific embodiment, a spark plug 70 and a fuel injection nozzle 60 of the combustion system 100 of this embodiment are both disposed between the air intake valves 30 and the air exhaust valves 40 (as shown in FIG. 2). Specifically, connection lines between centers of the top ends of the two air intake valves 30 and the two air exhaust valves 40 form a rectangle. The spark plug 70 and the fuel injection nozzle 60 are arranged side by side on one of centerlines of the rectangle, and the spark plug 70 and the fuel injection nozzle 60 are located on two sides of the other centerline of the rectangle.

[0054] An intermediate arrangement is used for the fuel injection nozzle 60 of this embodiment, which makes a combustion control strategy more flexible. During actual use, a strategy of multiple times of fuel injection can be adopted to form a thick mixed gas in a center of spark plug 70, which improves combustion stability. At the same time, under a light-off working condition, the light-off of the three-way catalytic converter is accelerated. Meanwhile, a proper distance kept between the fuel injection nozzle 60 and the spark plug 70 can prevent a problem such as carbon deposition on the spark plug 70 due to an oil film generated on an electrode of the spark plug 70 by a fuel spray coming into contact with the electrode of the spark plug 70.

[0055] In addition, due to the cooperation between the air squeeze structure 51 and the air squeeze surface 83, the tumble flow of the gas can be broken, and a strong turbulence intensity is formed in the middle of the combustion chamber 50, that is, around the spark plug 70, which can improve the propagation speed of the flame and reduce the tendency of knocking.

[0056] In addition, when the fuel injection nozzle of the combustion system 100 of this embodiment injects fuel, according to the structure of the combustion system 100 of this embodiment, the fuel spray forms an air layer on the top of the piston 80, thereby reducing contact between the fuel spray and the piston top and wall collision, reducing a risk of soot emission and improving the combustion efficiency. Finally, after use of the combustion system of this embodiment, a maximum thermal efficiency of the combustion system can be improved by 2% to 3%.

[0057] As a specific embodiment, this embodiment further provides a vehicle and the vehicle includes the above

combustion system 100.

[0058] At this point, it will be recognized by those skilled in the art that while exemplary embodiments of the present invention have been shown and described in detail herein, many other variations or modifications consistent with principles of the present invention may be directly determined or derived from the disclosure of the present invention without departing from the spirit and scope of the present invention. Accordingly, the scope of the present invention should be understood and recognized as covering all these other variations or modifications.

15 Claims

1. A combustion system for a vehicle, comprising:

an air intake passage, an air exhaust passage, an air intake valve and an air exhaust valve, one end of the air intake valve passing through one end of the air intake passage to open or close the air intake passage, and one end of the air exhaust valve passing through the air exhaust passage to open or close one end of the air exhaust passage;

wherein an included angle between an axis of the air intake valve and an axis of the air exhaust valve is a preset angle; and

when the air intake valve closes the air intake passage and the air exhaust valve closes the air exhaust passage, a center position of the air intake valve is higher than a center position of the air exhaust valve.

2. The combustion system for the vehicle according to claim 1, wherein a height difference between the center position of the air intake valve and the center position of the air exhaust valve is 0.5mm to 1mm.

3. The combustion system for the vehicle according to claim 1, wherein the preset angle is 35° to 50°.

4. The combustion system for the vehicle according to claim 1, further comprising a combustion chamber; wherein

both the air intake passage and the air exhaust passage are communicated with the combustion chamber;

an end of the air intake valve extends into the combustion chamber through an outlet of the air intake passage, and an inner wall of the combustion chamber is configured as a shielding structure that partially wraps the end of the air intake valve at a position close to the outlet of the air intake passage.

5. The combustion system for the vehicle according to claim 4, wherein the shielding structure is located on a side of the air intake valve away from the air exhaust valve.
6. The combustion system for the vehicle according to claim 4, wherein the shielding structure comprises an air guide wall and an abutment plateau, and a cross section cut along a plane where the axis of the air intake valve is located is a step-shaped structure;

the air guide wall is configured to be parallel to the axis of the air intake valve; and

the abutment plateau is configured to be adapted to a contour structure of a side of an end of the air intake valve close to the air intake passage, and the air intake valve abuts against the abutment plateau when the air intake valve closes the air intake passage.
7. The combustion system for the vehicle according to claim 4, wherein a cross section formed by cutting the shielding structure along an axis perpendicular to the air intake valve is a circular arc shape adapted to a structure of the end of the air intake valve, and a corresponding central angle of the circular arc shape is 110° to 180°.
8. The combustion system for the vehicle according to claim 6, wherein the shielding structure is further configured such that when the air intake valve closes the air intake passage, a minimum distance between the air intake valve and the air guide wall is 0.6mm to 1mm.
9. The combustion system for the vehicle according to claim 6, wherein a height of the air guide wall of the shielding structure along an axial direction of the air intake valve is 3mm to 5mm.
10. The combustion system for the vehicle according to any one of claims 1 to 9, wherein an included angle between a central axis of the air intake passage and a horizontal plane is 15° to 20°.
11. The combustion system for the vehicle according to claim 4, further comprising a piston; a pit is provided at a middle position of a top of the piston, and a vertical distance between a bottom end and a top end of the pit is 0.5mm to 1mm.
12. The combustion system for the vehicle according to claim 11, wherein an avoidance groove is provided at the top end of the piston, and a position of the avoidance groove is matched with a position of the air intake valve or the air exhaust valve.
13. The combustion system for the vehicle according to

claim 12, wherein

two air intake valves are provided and share the air intake passage;

two air exhaust valves are provided and share the air exhaust passage;

a number of avoidance grooves is a sum of a number of the air intake valves and a number of the air exhaust valves.

14. The combustion system for the vehicle according to claim 11, wherein

the combustion chamber is provided with an air squeeze structure;

an outer periphery of the pit at the top of the piston is provided with an air squeeze surface; and

the air squeeze structure and the air squeeze surface are matched with each other.

15. The combustion system for the vehicle according to claim 13, further comprising a spark plug and a fuel injection nozzle, wherein the spark plug and the fuel injection nozzle are arranged between the air intake valves and the air exhaust valves.

16. The combustion system for the vehicle according to claim 15, wherein

connection lines between centers of top ends of the two air intake valves and the two air exhaust valves form a rectangle;

the spark plug and the fuel injection nozzle are arranged side by side on one of centerlines of the rectangle, and the spark plug and the fuel injection nozzle are located at two sides of the other centerline of the rectangle.

17. A vehicle comprising the combustion system for the vehicle according to any one of claims 1 to 16.

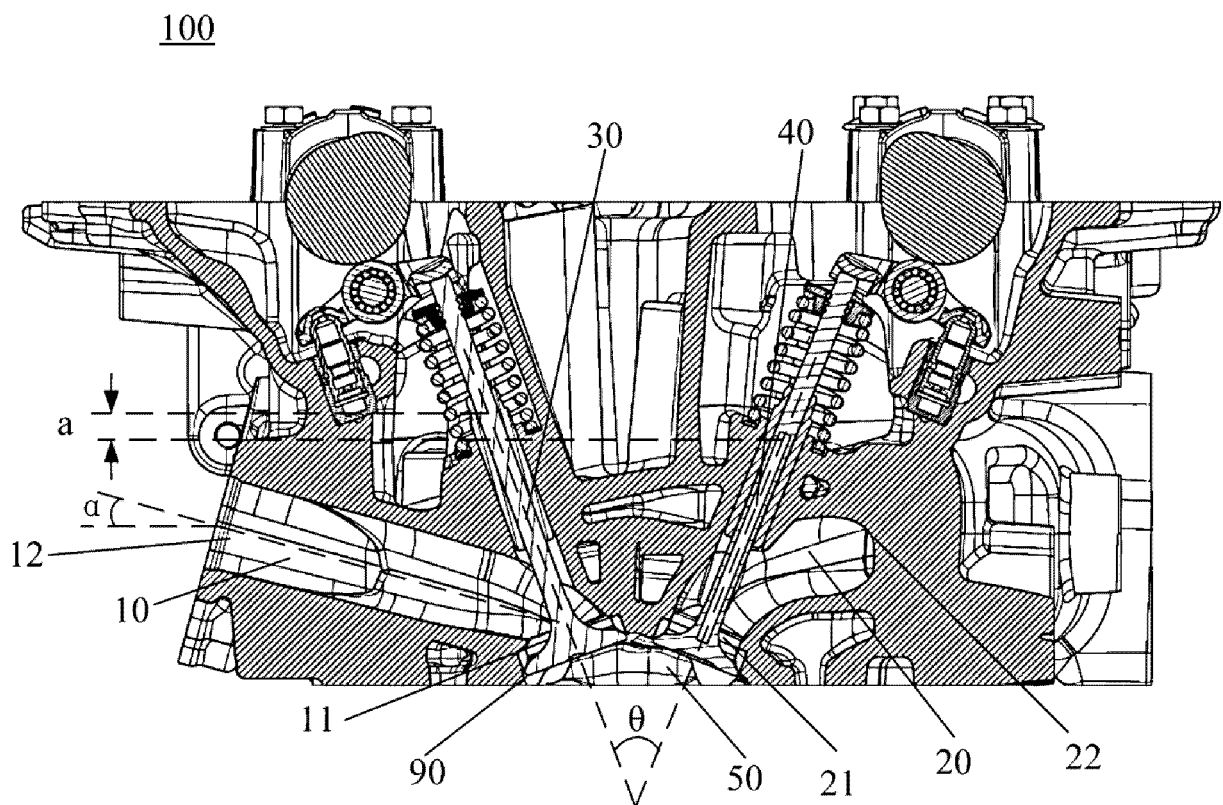


FIG. 1

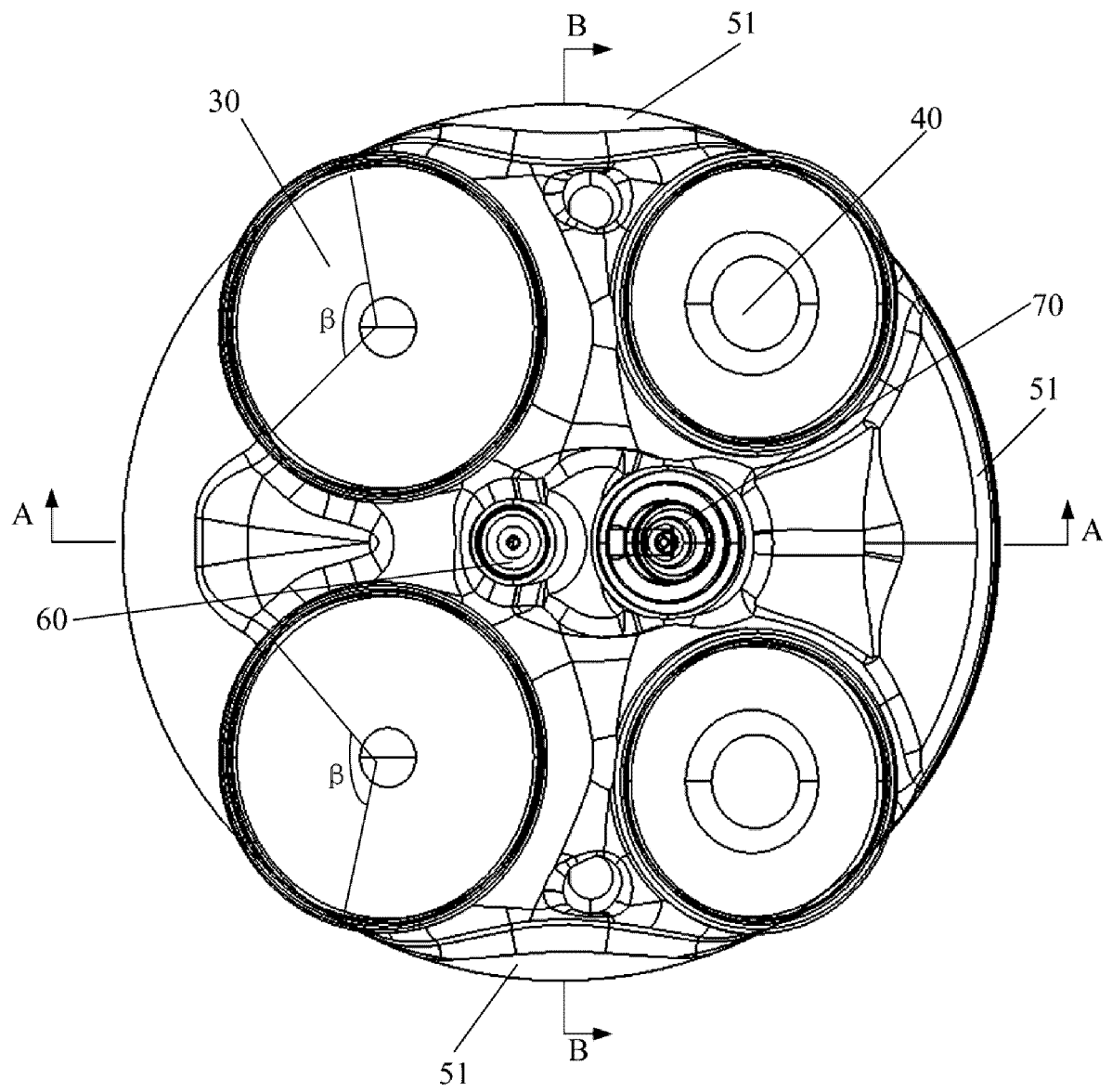


FIG. 2

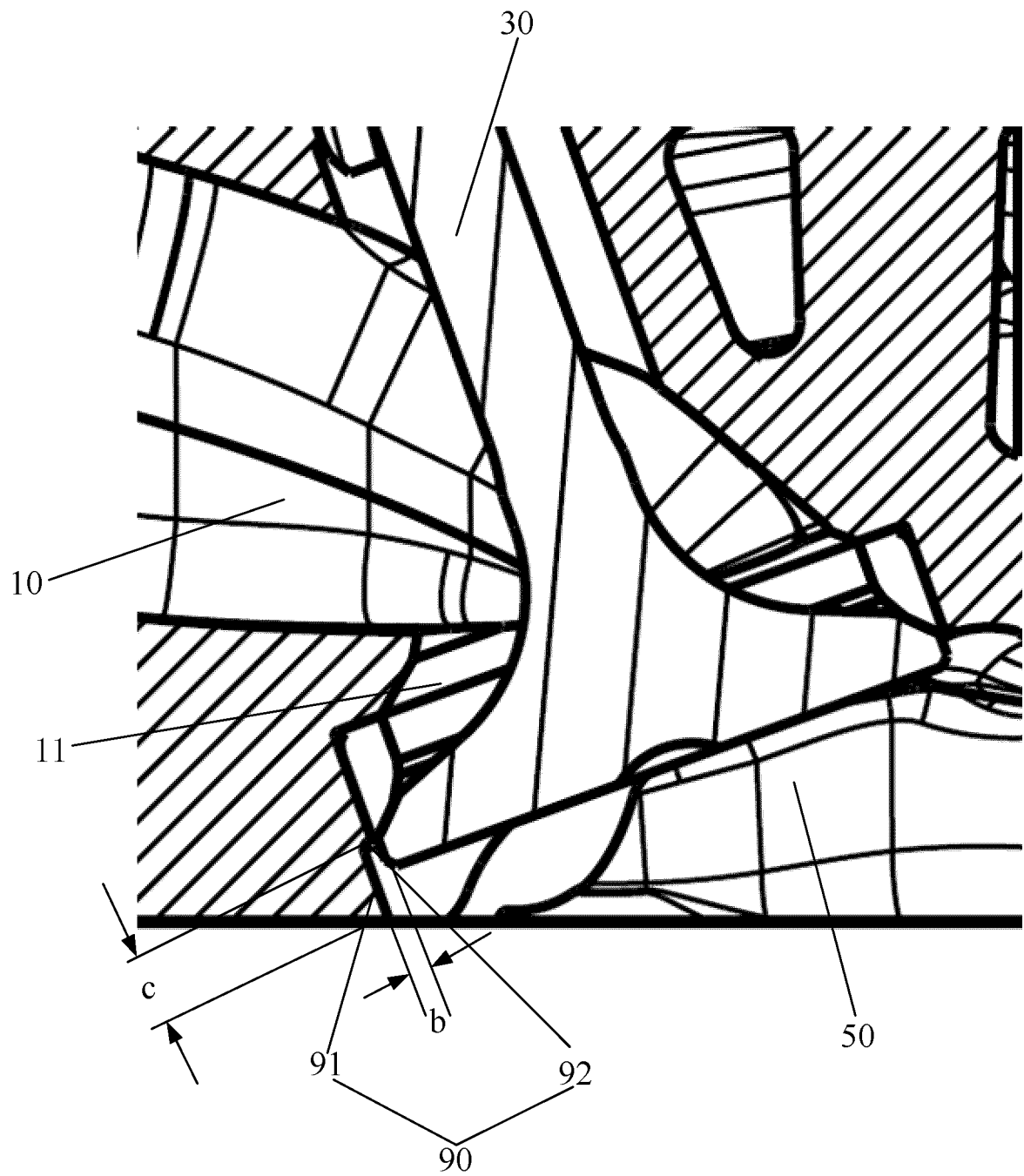


FIG. 3

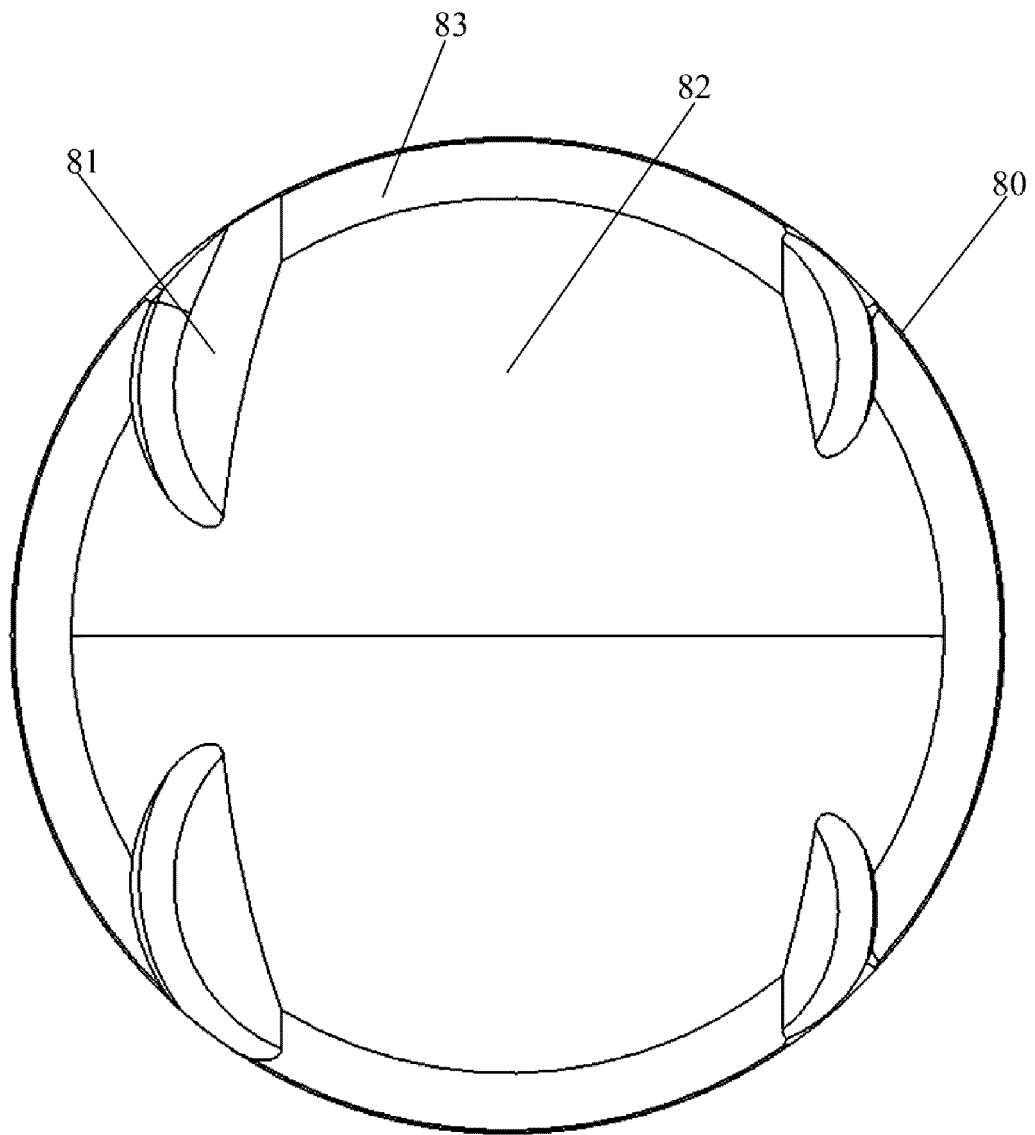


FIG. 4

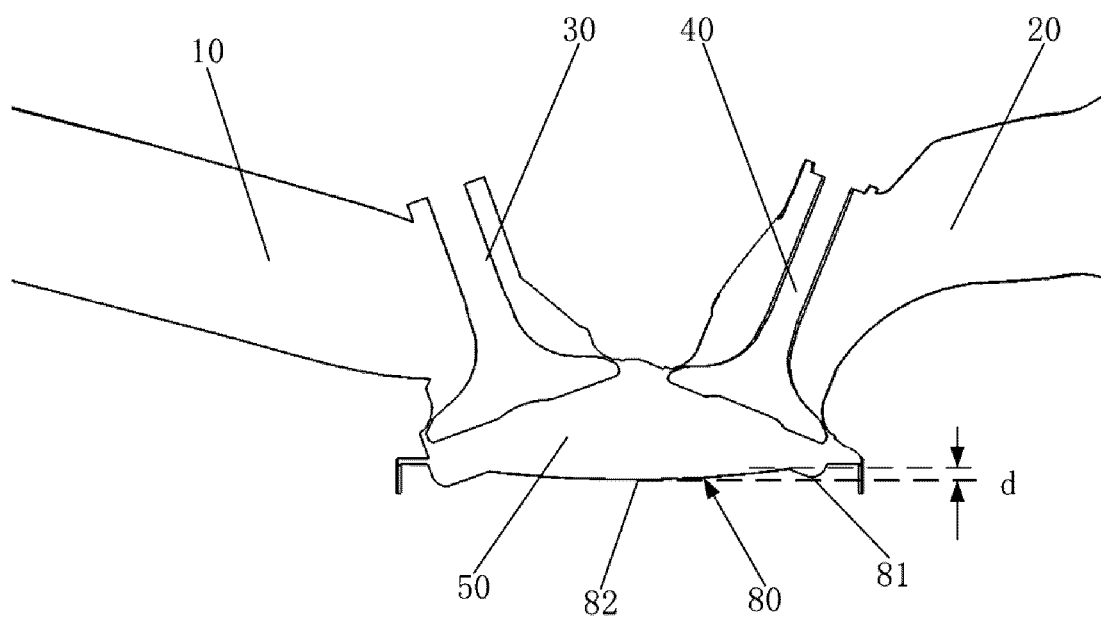


FIG. 5

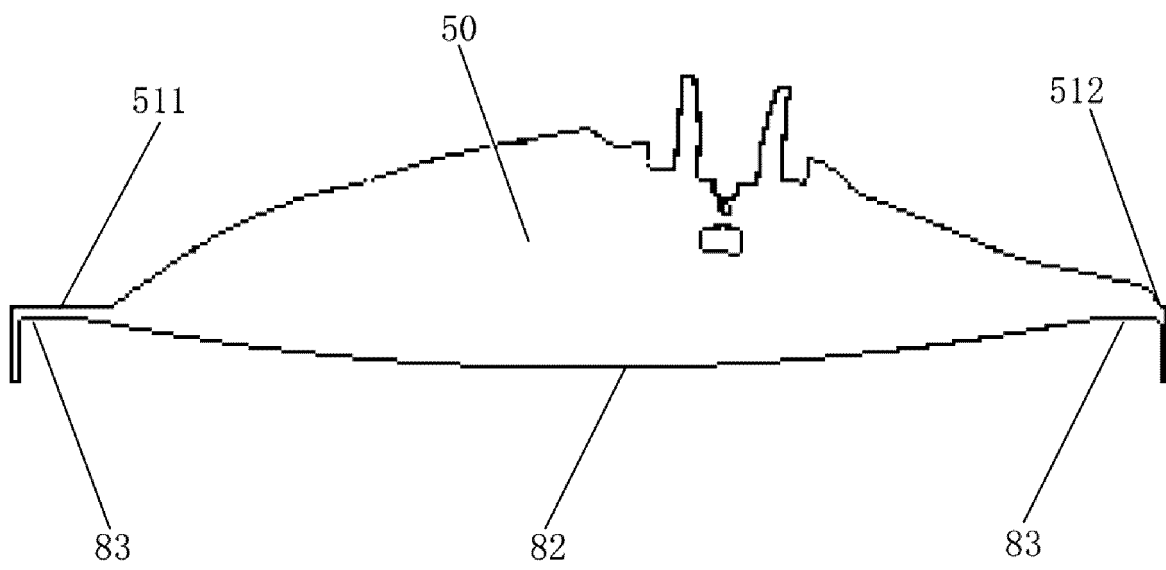


FIG. 6

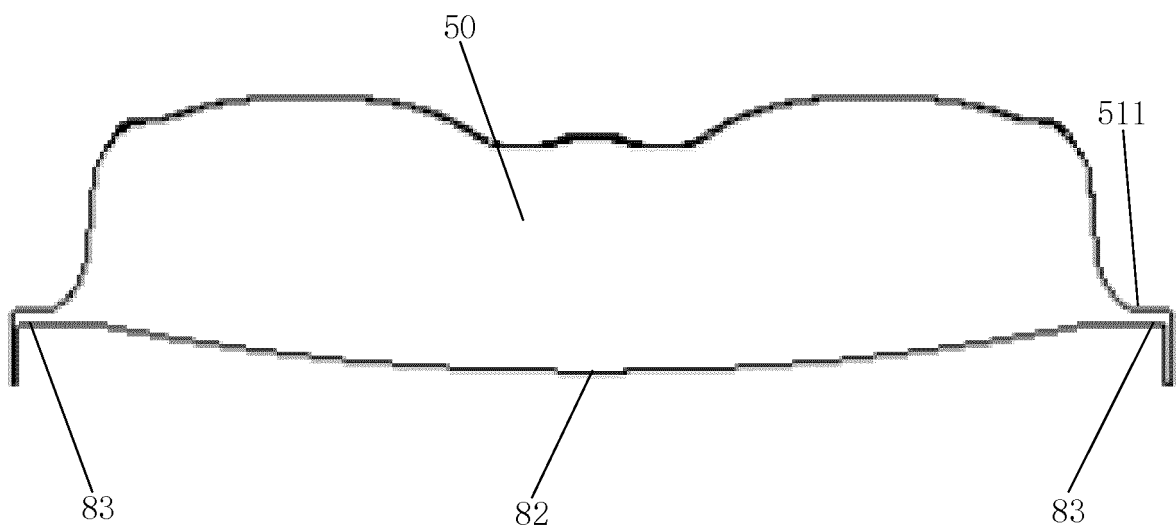


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/092307

5	A. CLASSIFICATION OF SUBJECT MATTER		
	F02B 23/10(2006.01)i; F02F 1/24(2006.01)i; F02F 3/26(2006.01)i; F02M 35/10(2006.01)i		
	According to International Patent Classification (IPC) or to both national classification and IPC		
	B. FIELDS SEARCHED		
10	Minimum documentation searched (classification system followed by classification symbols) F02B 23/-;F02F 1/-;F02F 3/-;F02M 35/-		
	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNABS, CNTXT, 中国期刊全文数据库, Chinese Journal Full-text Database, DWPI, PATENTICS: 吉利, 张沛毅, 王明明, 颜平涛, 田志松, 刘丽华, 李红洲, 张育春, 周武明, 肖逸阁, 王端平, 发动机, 燃烧, 缸, 活塞, 进气, 排气, 门, 阀, 通道, 滚流, 速度, 壁, 预设, 角, 遮蔽, 遮挡, 挤气, 火花塞, 喷油嘴, 导气, 抵接, 台阶, 凹, 坑, 避让, 槽, engine, motor, combustion, chamber, cylinder, piston, intake, exhaust, valve, passage, tumbl+, speed, wall, preset, angle, shad+, squeeze+, spark, plug, fuel, inject+, guid+, step+, pit, avoid+, slot		
20	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	X	CN 108869006 A (CHERY AUTOMOBILE CO., LTD.) 23 November 2018 (2018-11-23) description, paragraphs [0002]-[0014], and figures 1-3	1-3, 10, 17
25	Y	CN 108869006 A (CHERY AUTOMOBILE CO., LTD.) 23 November 2018 (2018-11-23) description, paragraphs [0002]-[0014], and figures 1-3	4-9, 11-16
	Y	CN 109488478 A (CHINA FIRST AUTOMOBILE WORKS GROUP CO., LTD.) 19 March 2019 (2019-03-19) description, paragraphs [0002]-[0027], and figures 1-4	4-9, 11-16
30	A	CN 201916044 U (DONGFENG MOTOR CORPORATION) 03 August 2011 (2011-08-03) entire document	1-17
	A	CN 103615334 A (ANHUI JIANGHUAI AUTOMOBILE GROUP CORP., LTD.) 05 March 2014 (2014-03-05) entire document	1-17
35	A	CN 1796781 A (MITSUBISHI MOTORS CORPORATION et al.) 05 July 2006 (2006-07-05) entire document	1-17
	☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
40	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
	Date of the actual completion of the international search 26 January 2022		Date of mailing of the international search report 11 February 2022
50	Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China		Authorized officer
55	Facsimile No. (86-10)62019451		Telephone No.

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A	JP 2017214914 A (SUZUKI MOTOR CORP.) 07 December 2017 (2017-12-07) entire document	1-17
A	US 2016298532 A1 (TOYOTA MOTOR CO., LTD.) 13 October 2016 (2016-10-13) entire document	1-17

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Information on patent family members

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				JP	2006183512	A 13 July 2006
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JP	2017214914	A	07 December 2017	None		
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