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(54) **Piston combustion engine**

(57) Piston combustion engine characterised in that the basic engine unit is formed by a pair of cylinders 1, 2 with separate combustion chambers 12, 13, connected with each other by means of at least one through-conduit 7, arranged at a height between the bottom dead centre of the piston and the top dead centre of the piston of each of the cylinders forming a pair, wherein the intake port of the through-conduit may be arranged at a different height

than the exhaust port of that conduit, whereby one of the cylinders of the pair comprises at least one intake port 8, and the other of the cylinders of the pair comprises at least one exhaust port, and yet further, the working cycle of one piston is shifted in phase relative to the cycle of the other piston by an angle $\alpha \geq 0^\circ$. The engine may include more than one basic unit, forming a pair.

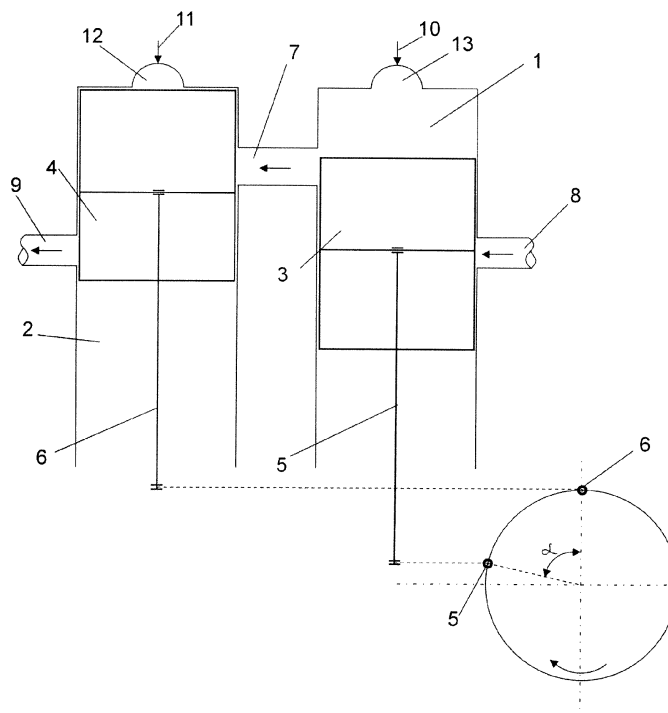


Fig.1

Description

[0001] The invention relates to a piston combustion engine. The engine is intended to be used in various types of vehicles and equipment. The engine may have spark or compression ignition and uses liquid or gas fuel.

[0002] Four-stroke reciprocating internal combustion engines with a piston mounted in a cylinder, with each cylinder head having an intake valve and an exhaust valve are known and used. Conventional four-stroke engines, regardless of their type, have valve heads, camshafts, which require actuation and control systems. Also two-stroke engines are known which do not have the valve head, with the cylindrical surface of the piston serving as a valve. One of their disadvantages are the fuel and lubricant admixtures used in these engines, which adversely affect the environment. Also are known engines comprising a pair of cylinders, connected via a combustion chamber with a common ignition, with power being simultaneously transmitted to the two pistons.

[0003] The object of the invention is an engine design that combines the advantages of a four-stroke engine, in which it is possible to control the opening phases of intake and exhaust valves, with a lightweight two-stroke engine, in which it is possible to produce more power while keeping the engine size and weight small.

[0004] The present invention relates to a piston combustion engine comprising a cylinder with a piston, an intake port (for feeding air or a fuel/air mixture) and an exhaust port (for letting out the exhaust gases) and a fuel supply component, characterised in that the basic engine unit is formed by a pair of cylinders with separate combustion chambers, connected with each other by means of at least one through-conduit, arranged at a height between the bottom dead centre of the piston and the top dead centre of the piston of each of the cylinders forming a pair, wherein the intake port of the through-conduit may be arranged at a different height than the exhaust port of that conduit, whereby one of the cylinders of the pair comprises at least one intake port, and the other of the cylinders of the pair comprises at least one exhaust port, and yet further, the working cycle of one piston is shifted in phase relative to the cycle of the other piston by an angle $\alpha \geq 0^\circ$. The angle α allows the uncovering moment of the intake port and the uncovering moment of the exhaust port to be adjusted separately. In this embodiment of the invention, the intake and exhaust ports are uncovered only when the top surface of the piston is below the given port. Throughout the remaining time, the ports are covered by the cylindrical surfaces of the pistons. Geometric axes of the pair of cylinders forming the basic engine unit are arranged at an angle $\alpha_c \geq 0^\circ$. Preferably, the engine is equipped with a compressor for feeding compressed air into the engine intake port. The engine may comprise throttle valves for controlling the flow of intake and exhaust gases. The engine may include more than one basic unit. Preferably, the engine comprises two basic units, forming a pair, with the piston working

cycles being shifted relative to each other by an angle of 90° .

[0005] The invention is applicable in particular for use in vehicles and mobile equipment in which it is important to ensure low weight and small dimensions of the engine. The engine according to the invention does not have a valve head or a conventional timing system, which means a lower cost of manufacture and a reduced weight to displacement ratio. The valve head is replaced by a simple solution with the cylinder ports being covered thus resulting in a reduced failure rate. Due to reduced number of mechanical elements there is less overall friction in the engine, which translates into greater efficiency and quieter operation of the engine. Higher speed, achieved through elimination of inertial masses of moving parts in the head, allows to increase the power to displacement ratio. The engine can be powered by liquid fuel injected into the cylinder working space or by gaseous fuel which can be fed through the intake port along with the air.

[0006] Illustrative embodiments of the invention are shown on the drawings, where Fig. 1 is a schematic sectional view of the pair of engine cylinders in the first embodiment, Fig. 2 is a schematic sectional view of the pair of cylinders in V arrangement in the second embodiment and Fig. 3 is a schematic sectional view of two pairs of cylinders in the third embodiment.

[0007] The piston combustion engine in the first embodiment shown in Fig. 1, where $\alpha > 0^\circ$, $\alpha_c = 0^\circ$, comprises a pair of cylinders 1 and 2, provided with pistons 3 and 4, moved by connecting rods 5 and 6 connected to the crankshaft. The angle between the axes of engine cylinders pair $\alpha_c = 0^\circ$. Phase shift of piston working cycles is contingent upon the size of angular shift of the crankshaft cranks, for piston 3 and piston 4, respectively. The cylinders are connected by a through-conduit 7. Cylinder 1 has an intake port 8 and cylinder 2 has an exhaust port 9. Fuel supply components 10 and 11 are arranged at the top of each cylinder. The engine has two separate ignition chambers 12 and 13.

[0008] Operation of the engine is such that piston 4 in cylinder 2, in its movement is ahead of piston 3 in cylinder 1. In the position of pistons in the embodiment shown in Fig. 1, the air fed through the uncovered intake port 8 fills the cylinder chamber above piston 1 and, via a through-conduit 7, the cylinder chamber above piston 2. Exhaust port 9 is covered because of the position of piston 4 in cylinder 2. When moving to the top of the cylinder, pistons 3 and 4 cover the intake port 8 and compress the air. First, ignition of fuel takes places in chamber 12 of cylinder 2, followed by the power stroke of piston 4 of that cylinder, then, ignition of fuel takes places in chamber 13 of cylinder 1, followed by the power stroke of piston 3 of that cylinder. After piston 4 has reached the bottom dead centre in cylinder 2, the exhaust port 9 is fully uncovered, causing the exhaust gases to escape cylinder 2 and, via a through-conduit 7, cylinder 1, which gives direction to the flow of gases. After piston 3 has reached the bottom dead centre in cylinder 1, the intake port 8 is fully uncov-

ered and the supplied air fills the chambers above pistons 3 and 4, and then, with the exhaust port 9 being fully covered by the upward movement of piston 4 of cylinder 2, the next engine cycle begins. For each crankshaft rotation there is one power stroke of each piston.

[0009] Another embodiment of the invention is shown in Fig. 2, in which a schematic sectional view of an engine in V arrangement, $\alpha_c > 0^\circ$, $\alpha = \alpha_c$ is illustrated.

[0010] The reciprocating internal combustion engine comprises a pair of cylinders 1 and 2, provided with pistons 3 and 4, moved by connecting rods 5 and 6 connected to the crankshaft by means of single crank. The cylinders are arranged relative to each other at an angle α_c so that their centre lines axes form a V. The cylinders are connected by a through-conduit 7. Cylinder 1 has an intake port 8 and cylinder 2 has an exhaust port 9. Fuel supply components 10 and 11 are arranged at the top of each cylinder. Piston working cycles shifted in phase relative to each other by an angle $\alpha = \alpha_c$. The engine has two separate ignition chambers 12 and 13.

[0011] Another embodiment of the invention is shown in Fig. 3, in which a schematic sectional view of an engine comprising two pairs of cylinders for $\alpha = 90^\circ$, $\alpha_c = 0^\circ$ is presented.

[0012] The reciprocating internal combustion engine comprises two pairs of cylinders 1, 2 and 1A, 2A, provided with pistons 3, 4, and 3A, 4A, moved by connecting rods 5, 6 and 5A, 6A, connected to the crankshaft. Working cycles of pistons 3 and 4 are shifted in phase with respect to working cycles of pistons 3A and 4A by 180° . In the preferred embodiment, the angular shift of cranks of the pairs of pistons $\alpha = 90^\circ$. Cylinders of each pair are connected by means of through-conduits 7 and 7A. Cylinders 1 and 1A have intake ports 8 and 8A, and cylinders 2 and 2A have exhaust ports 9 and 9A. Fuel supply components 10, 11, and 10A, 11A are arranged at the top of each cylinder. The engine has four separate ignition chambers 12, 13 and 12A, 13A.

[0013] Operation of the engine is such that piston 4 in cylinder 2, in its movement is ahead of piston 3 in cylinder 1 and piston 4A in cylinder 2A is ahead of piston 3A in cylinder 1A. In the position of pistons in the embodiment shown in Fig. 3, the air fed through the uncovered intake port 8 fills the cylinder chamber above piston 1 and, via a through-conduit 7, the cylinder chamber above piston 2. Exhaust port 9 is covered because of the position of piston 4 in cylinder 2. When moving to the top of the cylinder, pistons 3 and 4 cover the intake port 8 and compress the air. First, ignition of fuel takes places in chamber 12 of cylinder 2, followed by the power stroke of piston 4 of that cylinder, then, ignition of fuel takes places in chamber 13 of cylinder 1, followed by the power stroke of piston 3 of that cylinder. After piston 4 has reached the bottom dead centre in cylinder 2, the exhaust port 9 is fully uncovered, causing the exhaust gases to escape cylinder 2 and, via a through-conduit 7, cylinder 1, which gives direction to the flow of gases. After piston 3 in cylinder 1 has reached the bottom dead centre, the intake

port 8 is fully uncovered and the supplied air fills the chambers above pistons 3 and 4, and then, with the exhaust port 9 being fully covered by the upward movement of piston 4 in cylinder 2, the next engine cycle begins.

5 Movement of pistons 4A and 3A in cylinders 2A and 1A takes place in an identical fashion. For each crankshaft rotation there is one power stroke of each piston. The difference in the angular shift on the crankshaft of cranks for connecting rods 5 and 6, that connect pistons 3 and 4, respectively, to the crankshaft, is 90° . Also, 90° is the difference in the angular shift on the crankshaft of cranks for connecting rods 5A and 6A, that connect pistons 3A and 4A, respectively. The angular shift cranks for connecting rods 5 and 5A is 180° , similarly like for connecting rods 6 and 6A. The engine in this embodiment performs four strokes of work for each revolution of the shaft, evenly every 90° .

10 **[0014]** Alignment of the compression ratio in all cylinders can be achieved by changing the cylinder bore and/or piston stroke.

Claims

- 25 1. Piston combustion engine comprising a cylinder with a piston, an intake port and an exhaust port and a fuel supply component, wherein the basic engine unit is formed by a pair of cylinders (1), (2) with separate combustion chambers (12), (13), **characterised in that** the cylinders are connected with each other by means of at least one through-conduit (7), arranged at a height between the bottom dead centre of the piston and the top dead centre of the piston of each of the cylinders forming a pair, whereby one of the cylinders of the pair comprises at least one intake port (8) and the other of the cylinders of the pair comprises at least one exhaust port (9), while the piston working cycles shifted in phase relative to each other by an angle $\alpha \geq 0^\circ$.
- 30 2. Piston combustion engine according to claim 1, **characterised in that** the intake port of the through-conduit (7) and the exhaust port of that conduit are at the same height.
- 35 3. Piston combustion engine according to claim 1, **characterised in that** the intake port of the through-conduit (7) and the exhaust port of that conduit are at different heights.
- 40 4. Reciprocating internal combustion engine according to claim 2 or 3, **characterised in that** the geometric axes of the pair of cylinders forming the basic engine unit are arranged at an angle $\alpha_c \geq 0^\circ$.
- 45 5. Piston combustion engine according to claim 4, **characterised in that** it comprises at least one basic engine unit forming a pair.
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6. Piston combustion engine according to claim 5, **characterised in that** it is provided with a compressor for feeding compressed air into the intake port (8) of the engine.

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7. Piston combustion engine according to claim 5 or 6, **characterised in that** it comprises throttle valves for controlling the flow of intake and exhaust gases.

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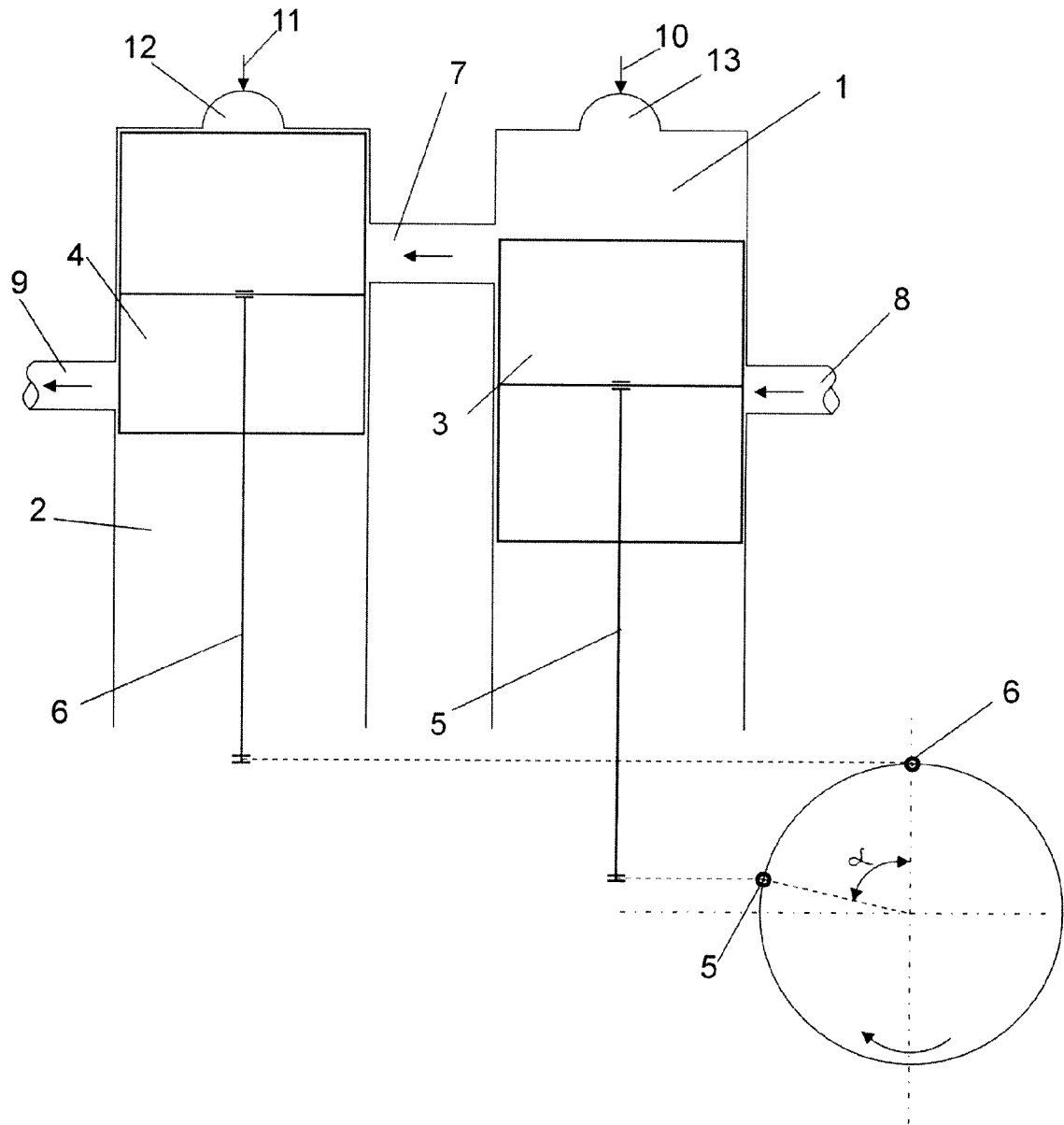


Fig.1

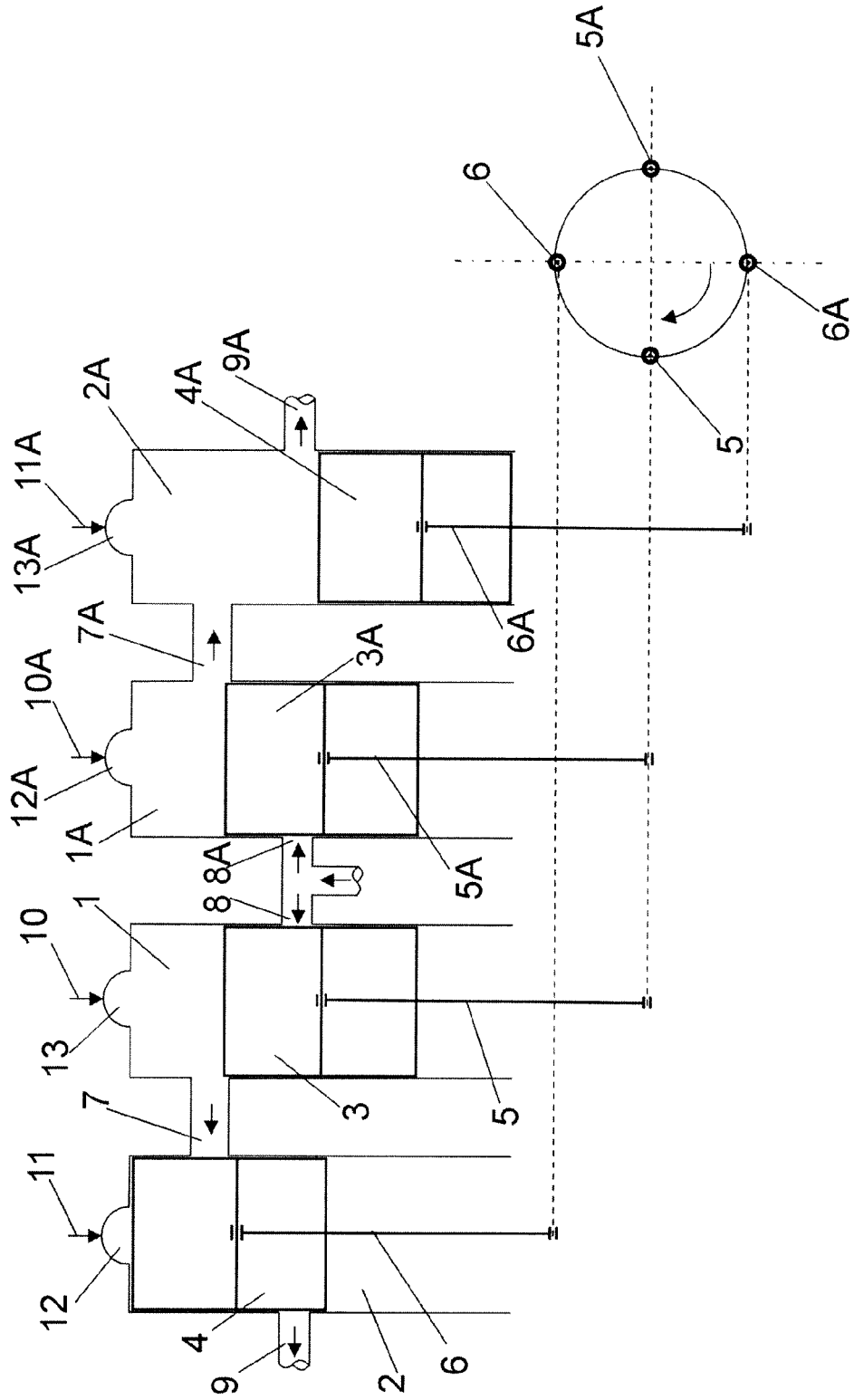


Fig.3