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(54) **Internal combustion engine with rotary valves**

Brennkraftmaschine mit Drehventilen

Moteur à combustion interne à soupapes rotatives

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Description

[0001] The present invention relates to an internal combustion engine with rotary valves such as known from US-A-3 362 391.

[0002] Internal combustion engines with rotary valves have been known since 1910 with the conception of the Burt McCollum engine. There has been influence on this concept from Minerva, Panhard and Levassor and Mercedes producing this combustion engine - patented by Knight - till 1939. Due to sealing problems the concept of the Burt McCollum engine had to be abandoned. Conventional cylinder heads with oscillating valves have the well known disadvantages of offering restricted performance and discontinuous supply of fuel-mixture. Major drawbacks result from the valves, the ignition and the sealings, that need constant surveillance and maintenance with the involved costs.

[0003] US 2 245 743 discloses a rotary valve assembly for internal combustion engines with a head of a valve member mounted to rotate about its axis in a coacting conical surface of the head whilst its stem is carried by two roller bearings. Major drawbacks result from the valves being exposed with their frontal surface to the combustion chamber and thus being exposed to heavy pressure and thermal loads. Another drawback is to be seen in the conical surface of the valve that serves as passageway and as slide bearing without clearly separating these two functions.

[0004] The present invention is aiming at internal combustion engines with rotary valves overcoming the above mentioned disadvantages while offering advantages for the construction and the efficiency of the engine.

[0005] The present invention proposes internal combustion engines with rotary valves with the features of claim 1. Preferred embodiments of the present invention are outlined in the subclaims.

[0006] According to the present invention is provided an internal combustion engine with rotary valves in axial bores to control opening and closing of transfer ports in a cylinder head or cylinder block for fluid communication between the ports and a combustion chamber of the engine, and a valve drive shaft arranged perpendicular to the rotary valves, the shaft being provided with helical gaps to cooperate with gears fixed to the free ends of the rotary valves for driving the rotary valves in accordance with the operating cycle of the engine with each rotary valve being provided with a passage duct in the valve head opening into the ports. The respective axial bores of the cylinder head or cylinder block are formed as a casing around the rotary valves such that the rotary valves are only exposed via the ports to the combustion chamber of the engine. With the axial bores in the cylinder head or cylinder block providing a casing the rotary valves are protected from the alternating high pressure pikes and the thermal load from the operating combustion chamber. The rotary valves being shielded from the

combustion cycles of the engine is providing for smooth operation and improved endurance of the rotary valves, the drive of the rotary valves and the entire engine.

The internal combustion engine with rotary valves according to the present invention is less consumptive while emitting less exhaust gases and presenting a higher performance due to the continuous and constant supply of fuel mixture. The rotary valves according to the present invention may be implemented onto an existing engine with a cylinder head replacing conventional oscillating valves after changes in the cylinder head, i. e. replacing the conventional cam shaft(s) with the valve drive shaft arranged perpendicular to the rotary valves and altering the cylinder head to accommodate the rotary valves.

[0007] According to a preferred embodiment of the present invention the respective axial bores are accessible for the rotary valves from the side of the cylinder head or cylinder block remote from the combustion chamber of the engine. With the respective axial bores being milled into the cylinder head or cylinder block remote from the side of the combustion chamber a better shielding and an improved mounting procedure for valve assemblies can be achieved.

[0008] According to a preferred embodiment of the present invention the valve drive shaft is driven by the crankshaft of the engine or by a separate electro motor allowing better electronic control.

[0009] According to another preferred embodiment of the present invention the cylinder block is an integral unit comprising intake and exhaust channels, comprising the bores for the rotary valves and comprising the side walls till the casing of the crankshaft of the engine. A cylinder head sealing is obsolete with this new concept of an internal combustion engine with rotary valves.

[0010] According to another preferred embodiment of the present invention each rotary valve is being held in position in the cylinder head or cylinder block by a ball bearing remote from the ports and conically shaped slide bearings above and below the ports. With the inventive arrangement of bearings there is substantially no leakage around the rotary valve, being smoothly spinning at low resistance levels.

[0011] According to another preferred embodiment of the present invention each rotary valve is provided with spring means abutting against the ball bearing and the conically shaped valve head in the bores. The spring is biasing the rotary valve into the conically shaped valve seat in the cylinder head or cylinder block thus providing for improved sealing at reduced length of the stem of the rotary valve allowing thus reduced height of the cylinder head or cylinder block and thus less encumbrance for the entire new internal combustion engine with rotary valves. The spring is abutting against the central member of the ball bearing rotating with the rotary valve and is thus free from sheer forces.

[0012] According to another preferred embodiment of the present invention each rotary valve is provided with

a central passage duct in the conically shaped valve head opening into the ports in accordance with the operating cycles of the engine.

[0013] Additional features of the invention will become apparent and a fuller understanding obtained by reading the following detailed description made in connection with the accompanying drawings.

Fig. 1 shows a transversal section through an internal combustion engine with rotary valves according to the present invention,

Fig. 2 shows a schematic perspective view of a possible configuration of a rotary valve and a valve drive shaft for engine manufacturers according to the present invention, and

Fig. 3 shows a rotary valve according to the present invention.

[0014] Fig. 1, 2: An internal combustion engine 1 has rotary valves 2, 3 in axial bores 4, 5. Transfer ports, i. e. an intake port 6 and an exhaust port 7 in a cylinder block 8 allow fluid, i. e. fuel mixture, to communicate between the ports 6, 7 and a combustion chamber 23 of the engine 1. A piston 14 is connected to a crankshaft 21 via a rod 22.

[0015] The cylinder block 8. is an integral unit or is equipped with a cylinder head gasket (not shown), according to the engine manufacturers wishes, comprising the intake and exhaust ports 6, 7, comprising the bores 4, 5 for the rotary valves 2, 3 and comprising the side walls 20, 15 till the casing of the crankshaft 21 of the engine 1.

[0016] Each axial bore 4, 5 consists of a first section with a cylindrical shaped body 27 and a second section 24 with a bevel shaped body occupying the transfer ports 6, 7. The axial bores 4, 5 are drilled into the cylinder block or cylinder head 8 from the side remote to the combustion chamber 23 of the engine 1. The axial bores 4, 5 are entirely embedded in the cylinder block or cylinder head 8 apart from the surface accessed by the ports 6, 7.

[0017] Each rotary valve 2, 3 is being held in position in the axial bores 4, 5 of the cylinder block 8 by a circumferential member of a ball bearing 16 remote from the ports 6, 7. Conical shaped slide bearings 17, 18 are arranged above and below the ports 6, 7. A helical spring 19 is abutting against the central member of the ball bearing 16. Helical spring 19 is biasing the conically shaped valve head 13 into the second section 24 of the bores 4, 5.

[0018] The respective axis of rotation 25, 26 of the rotary valves 2, 3 are perpendicular to each other.

[0019] A valve drive shaft 9 is arranged perpendicular to the rotary valves 2, 3. The shaft 9 is provided with helical slots 10 around its entire surface to cooperate with gear wheels 11 fixed to the respective free ends of

the rotary valves 2, 3. Each rotary valve has a central passage duct 12 in the valve head 13.

[0020] The valve drive shaft 9 is driven by the crankshaft of the engine or by a separate electro motor (not shown).

[0021] Fig. 3: Each gear wheel 11 is fixed by a screw 27 to a threaded free end of the rotary valves 2, 3. A ball bearing 16 is mounted with its central member to a stem 28 of each rotary valve 2, 3. Each rotary valve has a central passage duct 12 in the bevelled valve head 13.

Operation of the internal combustion engine 1 with rotary valves 2, 3

[0022] In the following the rotary valves will be described in the context of their use with reciprocating type internal combustion engines. However neither some of the known nor the rotary valve embodiments in accordance with the present invention are limited to such applications.

[0023] Step 1: During the intake stroke the rotary valve 2 in intake port 6 is rotated by the helical slots 10 of valve drive shaft 9 in an angular position to open intake port 6 via its central passage duct 12. Exhaust port 7 remains closed by rotary valve 3.

[0024] Step 2: During the compression stroke the rotary valves 2, 3 in transfer ports 6, 7 are rotated by the helical slots 10 of valve drive shaft 9 in angular positions to close intake port 6 and exhaust port 7.

[0025] Step 3: During the ignition and expansion stroke the rotary valves 2, 3 in transfer ports 6, 7 are rotated by the helical slots 10 of valve drive shaft 9 in angular positions to keep closed intake port 6 and exhaust port 7.

[0026] Step 4: During the exhaust stroke the rotary valves 2, 3 in transfer ports 6, 7 are rotated by the helical slots 10 of valve drive shaft 9 in angular positions to keep closed the intake port 6 but to open exhaust port 7 via the central passage duct 12 of rotary valve 3.

[0027] With the next stroke the operating cycle starts again with step 1.

Claims

1. Internal combustion engine (1) with rotary valves (2, 3) in axial bores (4, 5) to control opening and closing of transfer ports (6, 7) in a cylinder head or cylinder block (8) for fluid communication between the ports (6, 7) and a combustion chamber (23) of the engine (1), the respective axial bores (4, 5) of the cylinder head or cylinder block (8) being formed as a casing around the rotary valves (2, 3) such that the rotary valves (2, 3) are only exposed via the ports (6, 7) to the combustion chamber (23) of the engine (1) and a valve drive shaft (9) arranged perpendicular to the rotary valves (2, 3), the shaft (9) being provided with

helical slots (10) **characterised in that** the helical slots (10) cooperate with gears (11) fixed respectively to the free ends of the intake and exhaust rotary valves (2, 3) for driving the rotary valves (2, 3) in accordance with the operating cycle of the engine (1). 5

2. Internal combustion engine (1) according to claim 1, **characterized in that** the respective axial bores (4, 5) are accessible for the rotary valves (2, 3) from the side of the cylinder head or cylinder block (8) remote from the combustion chamber (23) of the engine (1). 10

3. Internal combustion engine (1) according to claim 1, **characterized in that** the valve drive shaft (9) is driven by the crankshaft (21) of the engine (1). 15

4. Internal combustion engine (1) according to claim 1, **characterized in that** the valve drive shaft (9) is driven by an electro motor or by timing-belt, chain or gear. 20

5. Internal combustion engine (1) according to claim 1, **characterized in that** the cylinder block (8) is an integral unit comprising intake and exhaust ports (6, 7), comprising the bores (4, 5) for the rotary valves (2, 3) and comprising the side walls (20, 15) till the casing of the crankshaft of the engine (1). 25

6. Internal combustion engine (1) according to claim 1, **characterized in that** each rotary valve (2, 3) being held in position in the cylinder head or cylinder block (8) by a ball bearing (16) remote from the ports (6, 7) and conically shaped slide bearings (17, 18) above and below the ports (6, 7). 30

7. Internal combustion engine (1) according to claim 1, **characterized in that** each rotary valve (2, 3) is provided with resilient means (19) abutting against the ball bearing (16) and the conically shaped valve head (13) in the bores (4, 5). 35

8. Internal combustion engine (1) according to claim 1, **characterized in that** each rotary valve (2, 3) is provided with a central passage duct (12) in the conically shaped valve head opening in the ports (6, 7). 40

Patentansprüche 45

1. Verbrennungsmotor (1) mit

- Drehventilen (2, 3) in Axialbohrungen (4, 5) zum Steuern des Öffnens und Schliessens von Durchlässen (6, 7) in einem Zylinderkopf oder Zylinderblock (8) für einen Flüssigkeitstransfer zwischen den Durchlässen (6, 7) und einer Ver-

brennungskammer (23) des Verbrennungsmotors (1), wobei die entsprechenden Axialbohrungen (4, 5) des Zylinderkopfs oder Zylinderblocks (8) in einem die Drehventile (2, 3) umgebenden Gehäuse geformt sind, derart, dass die Drehventile (2, 3) nur über die Durchlässe (6, 7) der Verbrennungskammer (23) ausgesetzt sind, und mit

- einer senkrecht zu den Drehventilen (2, 3) ausgerichteten Ventilantriebswelle (9), die mit spiralförmigen Nuten (10) versehen ist,

dadurch gekennzeichnet,

dass die spiralförmigen Nuten (10) mit Verzahnungselementen (11) zusammenwirken, welche an den entsprechenden freien Enden der Einlass- und Ausstoss-Drehventile (2, 3) befestigt sind, um die Drehventile (2, 3) in Abstimmung auf den Arbeitszyklus des Verbrennungsmotors (1) zu steuern.

2. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass die entsprechenden Axialbohrungen (4, 5) für die Drehventile (2, 3) von der abseits der Brennkammer (23) liegenden Seite des Zylinderkopfs oder Zylinderblocks (8) zugänglich sind.

3. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass die Ventilantriebswelle (9) durch eine Kurbelwelle (21) des Verbrennungsmotors (1) angetrieben ist.

4. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass die Ventilantriebswelle (9) durch einen Elektromotor oder durch einen Steuerriemen, eine Steuerkette oder ein Getriebe angetrieben ist.

5. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass der Zylinderblock (8) eine integrale Einheit ist, welche die Einlass- und Auslassöffnungen (6, 7) aufweist, die Bohrungen (4, 5) für die Drehventile (2, 3) aufweist, und Seitenwandungen (20, 15) bis zum Gehäuse der Kurbelwelle des Verbrennungsmotors (1) aufweist.

6. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass jedes Drehventil (2, 3) im Zylinderkopf oder Zylinderblock (8) in Position gehalten ist durch ein abseits der Durchlässe (6, 7) angeordnetes Kugellager (16) und durch oberhalb und unterhalb der Durchlässe (6, 7) angeordnete konisch geformte Gleitlager (17, 18).

7. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass jedes Drehventil (2, 3) mit flexiblen Mitteln (12) versehen ist, welche am Kugellager (16) und am konisch ausgebildeten Ventilkopf (13) in den Durchlässen (6, 7) anliegen.

8. Verbrennungsmotor (1) nach Anspruch 1,

dadurch gekennzeichnet,

dass jedes Drehventil (2, 3) mit einem zentralen Durchflussskanal (12) im konisch ausgebildeten Ventilkopf (13) in den Durchlässen (6, 7) versehen ist.

Revendications

1. Moteur à combustion interne (1) avec

- des soupapes rotatives (2, 3) dans des alésages axiaux (4, 5), pour contrôler l'ouverture et la fermeture d'orifices de transmission (6, 7) dans une culasse ou un bloc de cylindre (8) pour le transfert de liquides entre les orifices (6, 7) et une chambre de combustion (23) du moteur (1), les alésages axiaux (4, 5) respectifs de la culasse ou du bloc de cylindre (8) étant formant une enveloppe autour des soupapes rotatives (2, 3), de telle manière que les soupapes rotatives (2, 3) ne sont exposées à la chambre de combustion que par les orifices (6, 7), et avec
- un arbre de transmission de soupapes (9), disposé perpendiculairement aux soupapes rotatives (2, 3), l'arbre (9) étant pourvu de rainures hélicoïdales (10)

caractérisé en ce que les rainures hélicoïdales (10) coopérant avec des engrenages (11) fixés aux extrémités libres des soupapes rotatives (2, 3) d'admission et d'échappement, pour entraîner les soupapes rotatives (2, 3) en accord avec le cycle d'exploitation du moteur (1).

2. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que les alésages axiaux respectifs (4, 5) sont accessibles par le côté de la culasse ou du bloc de cylindre (8) étant éloigné de la chambre de combustion (23) du moteur (1).

3. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que l'arbre de transmissions de soupapes (9) est entraîné par le vilebrequin (21) du moteur (1).

4. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que l'arbre de transmission de soupapes (9) est entraîné par un moteur électrique ou par une courroie, une chaîne ou un engrenage.

5. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que le bloc de cylindre (8) est une unité intégrale comprenant les orifices d'admission et d'échappement (6, 7), comprenant les alésages (4, 5) pour les soupapes rotatives (2, 3), et comprenant des parois latérales (20, 15) jusqu'à une enveloppe du vilebrequin du moteur (1).

6. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que chaque soupape rotative (2, 3) est positionnée dans la culasse ou le bloc de cylindre (8) par un roulement à billes (16) éloigné des orifices (6, 7) et par des roulements à glissière (17, 17) au dessus respectivement en dessous des orifices (6, 7).

7. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que chaque soupape rotative (2, 3) est pourvue de moyens flexibles (9) butant contre le roulement à billes (16) et une tête de soupape (13) de forme conique dans les alésages (4, 5).

8. Moteur à combustion interne (1) selon la revendication 1,

caractérisé en ce que chaque soupape (2, 3) est pourvue d'une galerie de conduite (12) dans une tête des soupapes conique s'ouvrant aux orifices (6, 7).

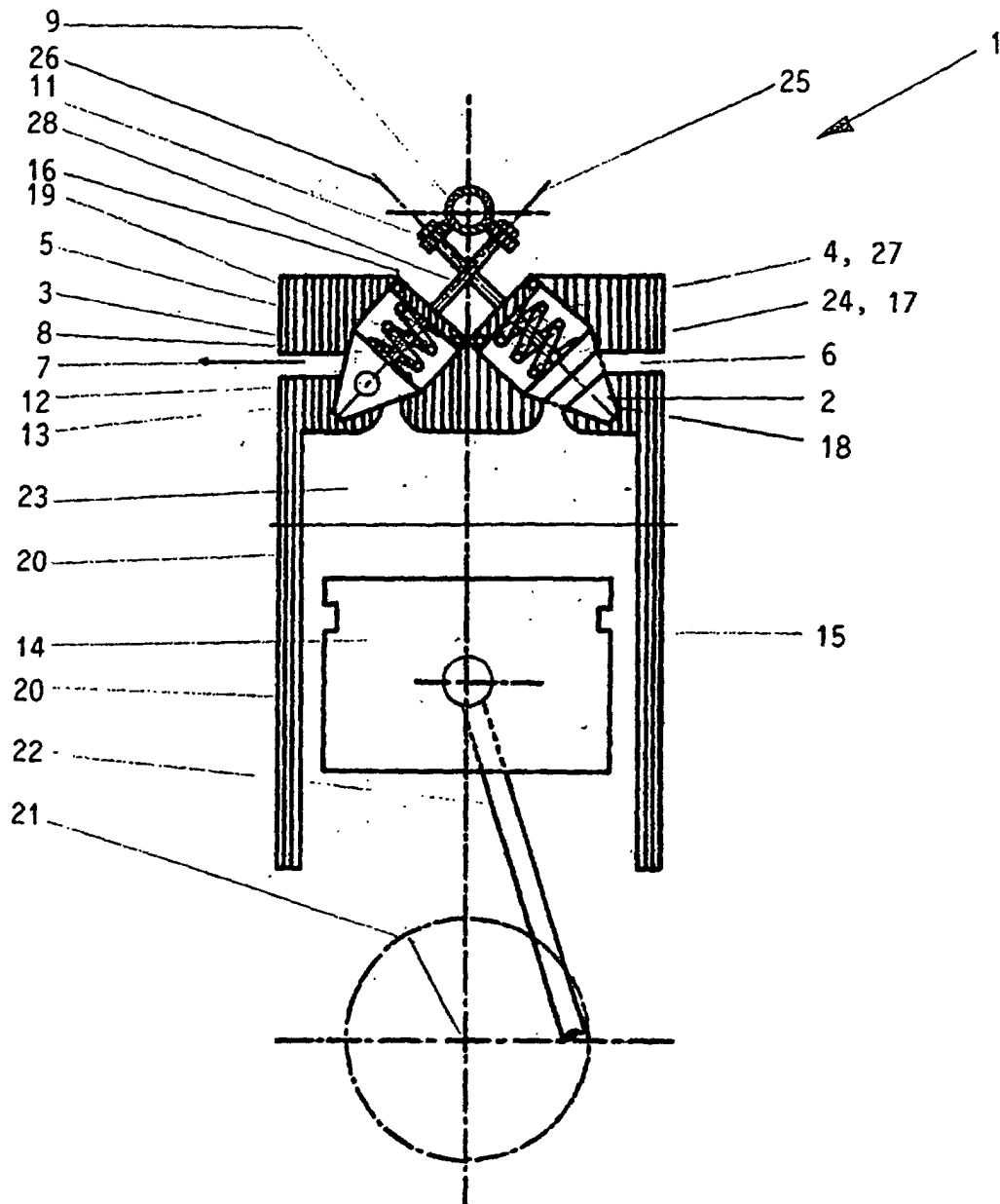


Fig. 1

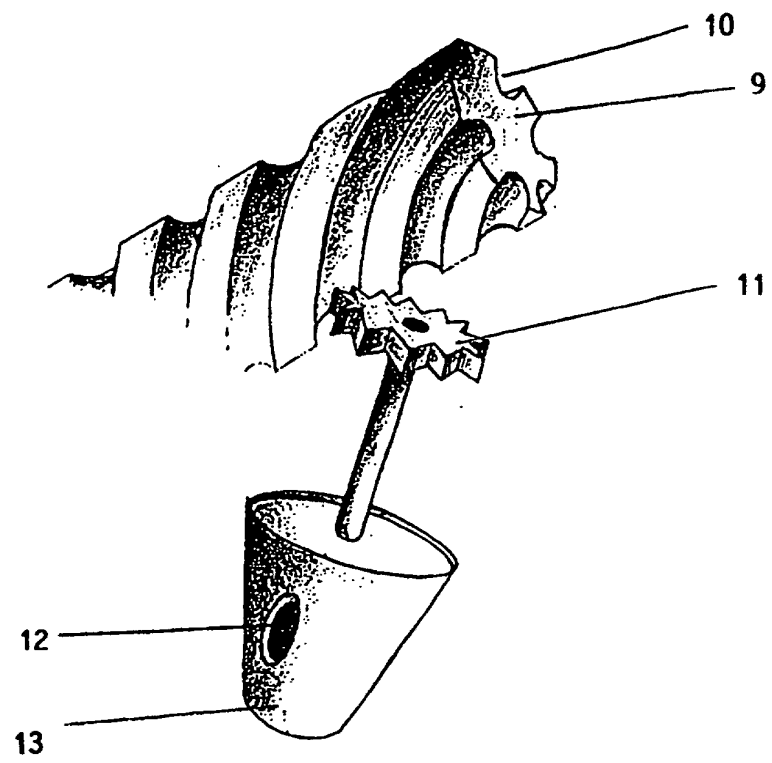


Fig. 2

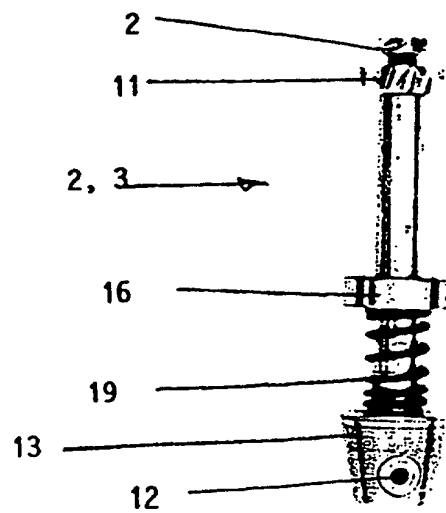


Fig. 3