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Title: PRECHAMBER ARRANGEMENT, CYLINDER HEAD AND PISTON ENGINE

Abstract: The prechamber arrangement for a piston engine comprises a body part (1) forming the first end (4A) of the prechamber (4) and a separate nozzle part (2) for discharging fluids from the prechamber (4) into the main combustion chamber (7) of the cylinder. The nozzle part (2) is arranged to protrude into the body part (1) and comprises at least one nozzle opening (5) and a conduit (6) for establishing fluid communication between the nozzle opening (5) and the prechamber (4), and the body part (1) comprises a support surface (9) for supporting the body part (1) against a contact surface (10) of the cylinder head (8) in the longitudinal direction of the cylinder.
Prechamber arrangement, cylinder head and piston engine

Technical field of the invention

The present invention relates to a prechamber arrangement for a piston engine in accordance with the preamble of claim 1. The invention also concerns a cylinder head and a piston engine.

Background of the invention

Internal combustion engines can be provided with prechambers, also called as precombustion chambers. In prechamber engines, each cylinder is provided with a prechamber, and part or all of the fuel is introduced into the prechamber. Depending on the engine, the fuel can be self-ignited, or a spark plug or some other device can be used for igniting the fuel. The combustion thus starts in the prechamber, but main part of the combustion takes place in the cylinder outside the prechamber. The prechamber construction is beneficial especially in lean burn engines, where part of the fuel is introduced into the prechamber and part of the fuel is mixed with the air before the intake valves. This kind of arrangement can be used, for instance, in spark ignited gas engines. The gas-air mixture in the prechamber is rich compared to the mixture in the cylinder. The rich mixture in the prechamber is ignited by a spark plug and the flames from the prechamber ignite the mixture in the cylinder.

A disadvantage of prechamber engines is the high temperature in the prechamber, which causes, for instance, high temperature corrosion. Especially in gas engines, the prechamber is subject to extreme high-pressure gradients and maximum pressures. This sets very high standards for the materials and construction of the prechamber.

Summary of the invention

An object of the present invention is to provide an improved prechamber arrangement for a piston engine, which comprises at least one cylinder and a cylinder head closing one end of the cylinder. The characterizing features of
the prechamber arrangement according to the invention are given in the characterizing part of claim 1. Other objects of the invention are to provide an improved cylinder head and a piston engine.

The prechamber arrangement according to the invention forms a prechamber having a first end and a second end, and can be arranged into the cylinder head so that the second end of the prechamber is closer to the cylinder than the first end. The arrangement comprises a body part forming the first end of the prechamber and a separate nozzle part for discharging fluids from the prechamber into the main combustion chamber of the cylinder. The nozzle part is arranged to protrude into the body part and comprises at least one nozzle opening and a conduit for establishing fluid communication between the nozzle opening and the prechamber. The body part comprises a support surface for supporting the body part against a contact surface of the cylinder head in the longitudinal direction of the cylinder.

Since the body part, which is supported against the cylinder head, forms the upper end of the prechamber, a gasket is not needed in the upper part of the prechamber. Consequently, risk of leakages can be reduced. A smaller wall thickness in the upper part of the prechamber is needed, which improves the cooling of a spark plug, in case the prechamber is used in a spark ignition engine. The nozzle part, which needs to withstand higher temperatures than the body part, can be made of a different material than the body part. A smaller amount of special steel or other expensive material is thus needed. The construction removes the need for a large diameter gasket, and a smaller pretightening force is thus needed to attach the prechamber arrangement to a cylinder head. The loading in the center area of the cylinder head is thus reduced. The prechamber is also easier to align with the cylinder head.

**Brief description of the drawings**

Embodiments of the invention are described below in more detail with reference to the accompanying drawings, where

Fig. 1 shows a cross-sectional view of a prechamber arrangement in connection with a cylinder head,
Fig. 2 shows a cross-sectional view of the prechamber arrangement from another direction.

Fig. 3 shows detail A of Fig. 1, and

Fig. 4 shows detail B of Fig. 1.

Description of embodiments of the invention

In figure 1 is shown a prechamber arrangement for a piston engine in connection with a cylinder head 8. Figure 2 shows the same prechamber arrangement from another direction. The engine is a large internal combustion engine, such as a main or an auxiliary engine of a ship or an engine that is used at a power plant for producing electricity. The engine is provided with a number of cylinders, and each cylinder of the engine is provided with a prechamber arrangement. Each cylinder of the engine is provided with a cylinder head 8, which closes the upper end of the cylinder. The term "upper" refers here to that end of the cylinder, which is farther from the crankshaft. The cylinders do not need to be arranged vertically, but they can be in some other angle in relation to the base of the engine. A main combustion chamber 7 is formed inside the cylinder between the cylinder head 8 and the piston. In the embodiment of the figure, the engine is a spark ignition gas engine, where part of the gaseous fuel is introduced into the intake duct to form a lean air/fuel mixture, and part of the fuel is introduced into a prechamber 4 to form a rich mixture, which is ignited by a spark plug. The leaner mixture in the main combustion chamber 7 is ignited by the combustion of the richer mixture formed in the prechamber 4.

Each cylinder of the engine is provided with a prechamber 4 having a first end 4A, i.e. an upper end, and a second end 4B, i.e. a lower end. The first end 4A is thus located farther from the cylinder and the main combustion chamber 7 than the second end 4B. In the embodiment of the figures, the prechamber 4 is almost spherical, but the prechamber 4 can alternatively have a different shape, such as an ellipsoidal shape. The cylinder head 8 is provided with a space 11 for accommodating the prechamber 4.

The prechamber arrangement comprises a body part 1 and a nozzle part 2. The body part 1 and the nozzle part 2 are separate parts. The body part 1 de-
limits a major part of the prechamber 4, including the first end 4A of the pre-
chamber 4. The upper part of the prechamber 4 is thus defined by the body
part 1. The body part 1 defines at least the upper half of the prechamber 4.
The nozzle part 2 delimits the second end 4B of the prechamber 4, and the
lower part of the prechamber 4 is thus defined by the nozzle part 2. Together
the body part 1 and the nozzle part 2 define the whole prechamber 4. The pre-
chamber 4 could also be defined solely by the body part 1. Since the body part
2 forms the first end 4A of the prechamber 4, no gaskets are needed in the up-
per part of the prechamber 4. The risk of cooling water leakage is thus re-
duced. The nozzle part 2 is made of a special steel or some other suitable ma-
terial, which endures the high temperatures and pressures in the prechamber
4. Because more effective cooling can be arranged for the upper part of the
prechamber 4, the body part 1 can be made of a less expensive material, such
as steel. Since the nozzle part 2 delimits only a small part of the prechamber 4,
only a minor portion of the prechamber arrangement needs to be made of an
expensive material, and major part of the prechamber arrangement can be
made of a less expensive material. The nozzle part 2 and/or the body part 1
can be coated. Since the nozzle part 2 needs to withstand higher temperatures
than the body part 1, the coating of the nozzle part 2 can be made of a differ-
ent material than the material of the body part 1 or the coating of the body part
1.

The nozzle part 2 protrudes into the body part 1 and extends from the body
part 1 towards the combustion chamber 7. The portion of the nozzle part 2 in-
side the body part 1 is conical, tapering slightly towards the main combustion
chamber 7. The cylinder head 8 is provided with an opening 12, through which
the nozzle part 2 protrudes into the combustion chamber 7. The opening 12 of
the cylinder head 8 is slightly conical, corresponding thus the form of the noz-
kle part 2. The nozzle part 2 is introduced into the opening 12 from above. The
diameter of the nozzle part 2 is slightly smaller than the diameter of the open-
ing 12. The diameters are selected so that when the cylinder head 8 and the
nozzle part 2 are at the ambient temperature, i.e. when the engine is not run-
ing, there is a clearance 19, i.e. a small gap, between the nozzle part 2 and
the cylinder head 8. When the engine is running, the temperature of the cylin-
der head 8 rises less than the temperature of the nozzle part 2 due to the more
effective cooling of the cylinder head 8. When the cylinder head 8 and the noz-
zele part 2 are at the operating temperature, the nozzle part 2 is in contact with
the cylinder head 8. There may be even a shrink fit between the nozzle part 2 and the cylinder head 8 at the operating temperature. The nozzle part 2 is attached to the body part 1 with a shrink fit. The nozzle part 2 is provided with a conduit 6, through which fluids are discharged from the prechamber 4 into the combustion chamber 7. The conduit 6 is divided into several branches 6A, which end to nozzle openings 5 opening to the outer surface of the nozzle part 2 in the combustion chamber 7. Instead of a branching conduit 6, the nozzle part 2 could be provided with several conduits, each of which is connected to a nozzle opening. Instead of several nozzle openings 5, the nozzle part 2 could be provided with a circular slot, to which one or more conduits are connected and through which the fluids are discharged into the combustion chamber 7. Due to the simple shape of the nozzle part 2, it is easy and inexpensive to manufacture.

The body part 1 is provided with a support surface 9, which can be arranged against a contact surface 10 of the cylinder head 8. The contact surface 10 of the cylinder head 8 supports the body part 1 in the longitudinal direction of the cylinder. The support surface 9 of the body part 1 is circular. When the nozzle part 2 is inserted into the body part 1, the support surface 9 surrounds the nozzle part 2. The support surface 9 is located in an area surrounding the conduit 6 of the nozzle part 2, i.e. below the prechamber 4. A gasket 3 is arranged between the contact surface 10 of the cylinder head 8 and the support surface 9 of the body part 1. The body part 1 is attached to the cylinder head 8 with pretensioned bolts 18. The bolts 18 are not in a direct contact with the body part 1, but the body part 1 is clamped between the cylinder head 8 and parts 21, 22 that are arranged above the body part 1 for example for introducing fuel into the prechamber 4. A cooling jacket is formed in the space 11 between the body part 1 and the cylinder head 8. Cooling water can be introduced into the cooling jacket through an inlet conduit 13 and discharged from the cooling jacket through an outlet conduit 14. Since the gasket 3 is adjacent to the nozzle part 2 and not around the prechamber 4, it has a relatively small diameter. A smaller pretensioning force is thus needed for attaching the prechamber arrangement to the cylinder head 8 and for making the joint between the prechamber arrangement and the cylinder head 8 fluid-tight. The center area of the cylinder head 8 is thus less loaded. The contact surface 9 carries all the forces applied to the prechamber arrangement in the longitudinal direction of the cylinder.
The prechamber arrangement is provided with a gas admission valve 16 and a fuel conduit 15, which connects the gas admission valve 16 to the first end 4A of the prechamber 4. Through the fuel conduit 15, gaseous fuel can be introduced into the prechamber 4. The prechamber arrangement is also provided with a space 17 for a spark plug (not shown). The spark plug is used for igniting the air/fuel mixture in the prechamber 4. Since there are no gaskets in the upper part of the prechamber, the wall of the prechamber 4 can be relatively thin, and the cooling of the spark plug is effective.

It will be appreciated by a person skilled in the art that the invention is not limited to the embodiments described above, but may vary within the scope of the appended claims.
Claims

1. A prechamber arrangement for a piston engine, the engine comprising at least one cylinder and a cylinder head (8) closing one end of the cylinder, the prechamber arrangement forming a prechamber (4) having a first end (4A) and a second end (4B) and being arrangeable into the cylinder head (8) so that the second end (4B) of the prechamber (4) is closer to the cylinder than the first end (4A), wherein
   - the prechamber arrangement comprises a body part (1) forming the first end (4A) of the prechamber (4) and a separate a nozzle part (2) for discharging fluids from the prechamber (4) into the main combustion chamber (7) of the cylinder,
   - the nozzle part (2) is arranged to protrude into the body part (1) and comprises at least one nozzle opening (5) and a conduit (6) for establishing fluid communication between the nozzle opening (5) and the prechamber (4), and
   - the body part (1) comprises a support surface (9) for supporting the body part (1) against a contact surface (10) of the cylinder head (8) in the longitudinal direction of the cylinder.

2. An arrangement according to claim 1, wherein the body part (1) delimits a major part of the prechamber (4).

3. An arrangement according to claim 1 or 2, wherein the second end (4B) of the prechamber (4) is formed by the nozzle part (2).

4. An arrangement according to any of claims 1-3, wherein the nozzle part (2) is attached directly to the body part (1).

5. An arrangement according to any of the preceding claims, wherein the nozzle part (2) is attached to the body part (1) with a shrink fit.

6. An arrangement according to any of the preceding claims, wherein the nozzle part (2) is made of a different material than the body part (1).

7. An arrangement according to any of the preceding claims, wherein the nozzle part (2) is provided with a coating that is made of a different material than the material forming the surface of the body part (1).
8. An arrangement according to any of the preceding claims wherein the body part (1) and the nozzle part (2) together form the whole prechamber (4).

9. An arrangement according to any of the preceding claims, wherein the support surface (9) is located in an area surrounding the conduit (6) of the nozzle part (2).

10. An arrangement according to any of the preceding claims, wherein the arrangement comprises a gasket (3) which is arranged against the support surface (9) of the body part (1).

11. A cylinder head (8) comprising a prechamber arrangement according to any of the preceding claims.

12. A cylinder head (8) according to claim 11, wherein the prechamber arrangement is arranged in the cylinder head (8) so that a clearance (19) is formed between the outer surface of the nozzle part (2) and the cylinder head (8) when the cylinder head (8) and the nozzle part (2) are at the ambient temperature.

13. A cylinder head (8) according to claim 12, wherein the outer surface of the nozzle part (2) is configured to come into contact with the cylinder head (8) when the cylinder head (8) and the nozzle part (2) are at the operating temperature.

**INTERNATIONAL SEARCH REPORT**

**International application No**

PCT/FI2014/05Q186

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**A. CLASSIFICATION OF SUBJECT MATTER**

INV. F02B19/10 ... P.B. 5818 Patentlaan 2
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Fax: (+31-70) 340-3016 Martinez Cebol I ada

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**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
F02B

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**Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched**

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**Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)**

EPO-Internal , WPI Data

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**Further documents are listed in the continuation of Box C.**

**See patent family annex.**

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**Date of the actual completion of the international search**

24 October 2014

**Date of mailing of the international search report**

10/11/2014

**Name and mailing address of the ISA/Office**

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**Authorized officer**

Martinez Cebol I ada
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