(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 905 453 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.08.2015 Bulletin 2015/33

(51) Int Cl.:
F02F 1/00 *(2006.01)*

(21) Application number: **14000471.4**

(22) Date of filing: **11.02.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **10.02.2014 EP 14154562**

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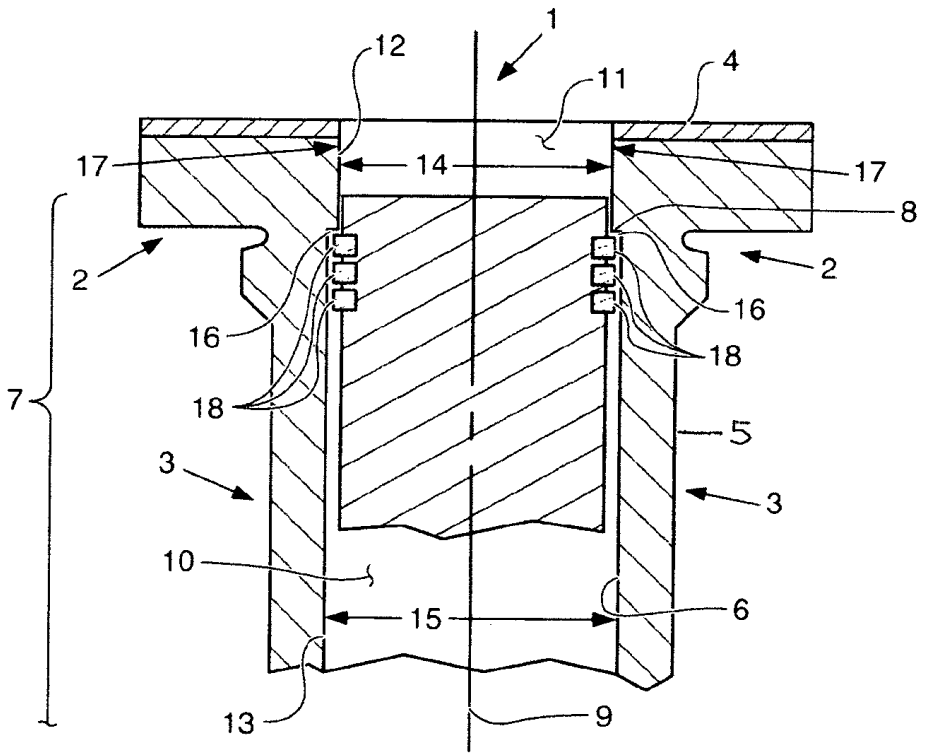
(54) **Cylinder liner with striking-off edge**

(57) Cylinder liner (1) comprising an inner surface (6), an outer surface (5) and a protrusion (17) at the inner surface (6) whereby the protrusion (17) forms one part with the cylinder liner (1).

FIG. 1



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Description

Technical Field

[0001] The present disclosure generally relates to a cylinder liner for an internal combustion engine.

Background

[0002] Cylinder liners are part of an internal combustion engine and are placed in the cylinder bore to form the inner surface of the cylinder, particularly the surface along which a piston moves during normal operation.

[0003] During normal operation of the piston, waste products from the explosion process, such as soot, may stick to the top part of the piston. The waste products may also attach to the side of the piston and therefore be located between the piston and the cylinder liner. In that situation the waste products may build up over time and may touch the inner surface of the cylinder liner during the movement of the piston. This may damage the surface.

[0004] To remove the waste products from the upper part of the piston it is known to place a ring in a recess at the upper part of the cylinder liner. The ring forms an edge at the inner surface of the cylinder liner. During operation the piston will move across this ring and if there is any waste product attached to the piston it will be swept off by the ring.

[0005] The present disclosure is directed, at least in part, to provide an alternative cylinder liner, to improve and/or to overcome one or more aspects of the prior cylinder liners.

Summary of the Invention

[0006] According to one aspect of the disclosure a cylinder liner comprises an inner surface, an outer surface and a protrusion at the inner surface. The cylinder liner and the protrusion may be one single part.

[0007] A further aspect of the disclosure is related to an internal combustion engine, particular to a stationary internal combustion engine, comprising at least the above mentioned cylinder liner or the use of such a cylinder liner in a stationary combustion engine, particular in a stationary gas engine.

[0008] The disclosure is also directed to the use of a cylinder liner as mentioned before for a stationary internal combustion engine, in particular for a gas engine, especially for a stationary gas engine.

Brief Description of the Drawings

[0009] The present invention will now be described, by way of example, with reference to the accompanying drawing, in which:

[0010] Fig. 1 shows a cylinder liner with a protrusion according to the present disclosure.

Detailed Description

[0011] The following is a detailed description of exemplary embodiments of the present disclosure. The exemplary embodiments described therein and illustrated in the drawing are intended to teach the principles of the present disclosure, enabling those of ordinary skill in the art to implement and use the present disclosure in many different environments and for many different applications. Therefore, the exemplary embodiments are not intended to be, and should not considered as, a limiting description of the scope of patent protection. Rather, the scope of patent protection shall be defined by the appended claims.

[0012] Fig. 1 shows a cylinder liner 1 for an internal combustion engine, in particular for an gaseous fuel internal combustion engine. The cylinder liner 1 may be intended to be introduced in a bore of an engine block (not shown) The cylinder liner 1 comprises a top part 2 and a bottom part (not shown), where the top part 2 and the bottom part are connected by an intermediate part 3. The top part 2 of the cylinder liner may be defined throughout the disclosure as that part of the cylinder liner 1 which extends axially above the top dead center of the top piston ring. Top or above may be defined here as the direction towards to that end of the cylinder liner 1, where a cylinder head gasket 4 could be placed.

[0013] The cylinder liner 1 maybe constructed rotational symmetric in respect to main axis 9 and has an outer surface 5, which will in an operational state be next to the bore of the engine block. Further the cylinder liner 1 encompasses an inner volume 11, in which in operational state a piston 10 is placed. The piston 10 is arranged to move in the cylinder liner 1 in a reciprocating manner.

[0014] The inner volume 11 is to some extent defined by an inner surface 6, which is formed by the cylinder liner 1. The inner surface 6 has at least two sections, an upper section 12 and a lower section 13. A protrusion 17 defines the boundary between the upper section 12 and the lower section 13. In both sections 12,13 the inner surface 6 is substantially cylindrical. However the diameter 14 of the inner surface 6 of the upper section 12 is smaller than the diameter 15 of the inner surface 6 of the lower section 13. The difference between the diameter 14 of the inner surface 6 of the upper section 12 and the diameter 15 of the inner surface 6 of the lower section 13 is substantially between 0.1 and 0.3 mm. Because of this difference a substantially circular edge 16 is formed between the inner surface 6 of upper section 12 and the inner surface 6 of the lower section 13. The edge 16 is between 0.05 and 0.15 mm thick and circular around a center, which is positioned on the main axis 9 of the cylinder liner 1.

[0015] During operation the top part of the piston 10 reaches the edge 16 and moves further so at least a portion of an upper part of the outer surface of the piston 10 faces the protrusion 17. The upper part of the outer surface of the piston 10 may be defined as the part of

the outer surface that extends axially above the piston rings 18. After reaching the top dead center the piston 10 moves down, so at least when, but preferably before the piston 10 reaches the bottom dead center the outer surface of the piston 10 is no longer in contact with the protrusion 17.

[0016] By moving the upper part of the piston across the edge 16, the protrusion 17 strikes off the waste products from the piston 10. The waste products, which are removed, do not touch the lower section 13 of the inner surface of the cylinder liner 1. Thus the inner surface 6 of the cylinder liner 1 is protected from damage that may be caused by waste products.

[0017] The cylinder liner 1 can be manufactured by forming a steel tube with an inner diameter smaller than the desired diameter of the cylinder liner 1 at the position of the protrusion 17. In a next step the tube may be machines to form an upper section with a smaller diameter and a lower section with a larger diameter. Between both sections is the edge 16.

[0018] To harden the surfaces of the cylinder liner 1 the cylinder liner 1 may be nitrided and to round any sharp edges and to smoothen the surface, the cylinder liner 1 may be vibratory grinded.

[0019] Those skilled in the art will recognize that cylinder liner 2 may be manufactured and/or hardened by other methods known in the art.

Industrial Applicability

[0020] In the following the operation of the cylinder liner 1 will be described with reference to Fig. 1.

[0021] According to one aspect of the disclosure the cylinder liner 1 comprises an inner surface 6, an outer surface 7 and a protrusion 17 at the inner surface 6. The protrusion 17 forms one part with the cylinder liner 1 or with an major part of the top part 2 of the cylinder liner 1.

[0022] It was found, that a cylinder liner 1 can be formed with a protrusion 17 instead or in addition to a separate ring, which is placed at the inner surface 6 of the cylinder liner 1. As the protrusion 17 will be supported by the underlying rest of the cylinder liner 1 or a major part of the cylinder liner 1, it is possible to achieve a thin protrusion 17, which is resistant enough to withstand the mechanical impact of the piston 10 and/or the waste attached to the piston 10. A thin protrusion 17 minimizes the distance between the inner surface 6 of the cylinder liner 1 and the outer surface of the piston 7 for a better guidance of the piston 10 by the cylinder liner 1. Further a smaller gap between the piston 10 and the inner surface 6 of the cylinder liner 1 increases the effectiveness of the engine, as less unburned fuel will leave the combustion chamber through the gap.

[0023] Further it was found that by forming the protrusion 17 as an integral part of the cylinder liner 1, there is no need for a ring to strike off the waste products of the piston 10. Further there is no need for a recess in the cylinder liner 1 to house such a ring. Such a recess could weaken the stability of the cylinder liner 1 forming the cylinder liner 1 and the protrusion 17 as one part results in a more stable cylinder liner 1. So a thinner and therefore less expensive cylinder liner 1 will be possible.

[0024] The protrusion 17 may have an edge 16 facing the bottom part of the cylinder liner 1. This edge 16 can be formed by two or more planes or be curved to form a smoother gradient. The edge 16 may be formed rotational symmetric in respect to a main axis of the cylinder liner 1.

[0025] The protrusion 17 may be located, at least partially, where the piston 10 is moving along during normal operation. In other words, as the piston 10 moves in the cylinder liner 1 periodically between the top dead center and the bottom dead center, at least a top part of the side surface of the piston 10 is next to the protrusion 17 when the piston ring 18 of the piston 10 reaches the top dead center 8.

[0026] By reaching the protrusion 17 or moving along the protrusion 17 the waste elements that are attached to the piston 10 come into contact with the protrusion 17 and will be scraped off the piston 10.

[0027] The plane of the edge 16 facing the lower part of the cylinder liner 1 may be substantially perpendicular in respect to the main axis 9 of the cylinder liner 1.

[0028] The protrusion 17 may form at least a ring or a ring segment which center is on the main axis 9 of the cylinder liner 1. In particular the edge 16 formed by the protrusion 17 facing the bottom part of the cylinder liner 1 can form a ring or a ring segment with the center on the main axis of the cylinder liner 1. In particular, the plane in which the ring or the ring segment is placed is perpendicular to the cylinder liner 1. So the protrusion 17 and/or the edge 16 of the protrusion 17 will be reached by the top parts of the piston 10 at the same time and to the same extent, so, the waste elements will be removed from all sides of the piston.

[0029] The cylinder liner 1 may be formed of cast materials and/or steel. Making the cylinder liner 1 from steel, results in a cylinder liner 1 with a low tendency to distortion. As a result a cylinder-head gasket 4 may be no longer necessary, which may also result in less expensive or more robust engines.

[0030] The protrusion 17 may be disposed above the top dead center of a first piston ring 18. As the piston ring 18 seals the combustion chamber, the outer diameter of the piston ring 18 is often larger than the diameter of the part of the piston, which is above the piston ring 18. As the inner diameter of the protrusion 17 may be adapted to the outer diameter of the upper part of the piston 10, the inner diameter of the protrusion 17 is smaller or close to the outer diameter of the piston ring. So while moving along the protrusion 17 the piston ring 18 could touch the protrusion 17 and get damaged by the protrusion 17. Ro locate the protrusion 17 above the top end center of the piston ring prevents the piston ring 18 from reaching the protrusion 17 and getting damaged by the protrusion 17.

[0031] The protrusion 17 may substantially have a

height of 0.01 mm to 0.2 mm, in particular a height of 0.05 to 0.15 mm. By using a protrusion 17 of small height the difference of the inner diameter of the protrusion 17 and the inner diameter of the lower parts of the cylinder liner 1 will be less prominent. As there is just a small step from the outer surface of the protrusion 17 to the inner surface of the cylinder liner 1, less fuel will be located in axial direction behind the protrusion from the cylinder head and so less fuel will be prevented from being ignited because of the protrusion. By designing the protrusion 17 as an integral part of the cylinder liner 1 and not as a separate part, it is possible to use protrusions 17 with such a small height without resulting in a fragile component as it would, when a ring or another separate element of such a height would be implemented in the cylinder liner 1.

[0032] The protrusion 17 may start at the top end of the cylinder liner 1. The top end of the cylinder liner may be defined throughout the whole disclosure defined as the end of the cylinder liner which faces the cylinder head and /or the cylinder head gasket 4 in an operating position. In particular, the protrusion 17 starts in an axial direction at the top end of the cylinder liner 1 and ends below the top dead center of the top of piston 10. The beginning of the protrusion 17 at the top end of the cylinder liner 1 helps to avoid undesired edges in the upper part 2 of the cylinder liner 1, where waste could accumulate and change the geometry of the upper part 2 of the cylinder liner 1. Further as the protrusion 17 extends from the upper part 2 of the cylinder liner to an area below the top dead center of the movement of the top part of the piston, it forms an edge 16 facing the lower part of the cylinder liner, which is supported by the broad protrusion to reduce the risk of the protrusion breaking.

[0033] The protrusion 17 may have a uniform height. The height of the protrusion 17 can be uniform along the circumference at one defined point of the main axis 9. As the cylinder liner 1 is substantially symmetric in respect to the main axis 9 of the cylinder liner 1, the protrusion 17 with a uniform height along the circumference is also substantially symmetric in respect to the main axis 9 of the cylinder liner 1 and the cylinder liner 1 with the protrusion 17 has a substantially symmetric inner diameter.

[0034] Further the protrusion 17 may be produced by removing some material from the cylinder liner 1. By using a procedure to produce the protrusion which removes some material from the cylinder liner and not a procedure which just transfers some material from one point of the cylinder liner to the other, a more uniform thickness of the cylinder liner can be achieved, which results in a more defined cylinder liner 1.

[0035] The protrusion 17 may have a uniform height along the main axis 9 of the cylinder liner. This may be an advantage in manufacturing as a cylinder liner 1 with a uniform inner diameter can be produced with low cost.

[0036] The protrusion 17 may be substantially cylindrical, wherein the inner surface of the cylindrical protrusion 17 faces the inner opening of the cylinder liner 1. So the form of the protrusion 17 may be adapted to the form of the piston 10.

[0037] The inner diameter of a circle, which is on a plane normal to a main axis 9 of the cylinder liner 1 and which circle is on the surface of the protrusion 17 , may be larger than a diameter of the piston 10, in particular than the largest diameter of the piston 10. So it is possible to assembly the engine by putting the piston 10 in place through the cylinder liner 1 when the outer diameter of the piston 10 is smaller than the inner diameter of the cylinder liner 1.

[0038] The inner surface 6 of the cylinder liner 1 may be formed by turning. By manufacturing the cylinder liner by turning it is possible to get well defined inner surfaces of the cylinder liner 1 including a protrusion 17 with a well-defined height. Turning is also a common method of machining and easy to adopt to the surface treatment of the cylinder liner.

[0039] After turning the inner surface may be nitrided, to get a harder inner surface of the cylinder liner 1 to increase the life-time of the cylinder liner 1. It is also possible to treat the whole cylinder liner 1 or just a part of it.

[0040] Further the inner surface of the cylinder liner 1 or the whole cylinder liner 1 may be vibratory grinded to get a smooth surface to reduce the friction between the cylinder liner 1 and the piston 10.

[0041] Further the disclosure is related to an internal combustion engine, particular to a stationary internal combustion engine, comprising at least one of the above mentioned cylinder liners 1, the use of such a cylinder liner 1 in a stationary combustion engine, particular in a stationary gas engine.

Claims

1. A cylinder liner (1) configured for use within an internal combustion engine, comprising an inner surface (6), an outer surface (5), wherein the inner surface 6 further defines a protrusion 17.

2. A cylinder liner (1) of claim 1, wherein the protrusion (17) located at an area of the inner surface 6 wherein a part of a piston 10 moves along during normal operation in the engine.

3. A cylinder liner (1) of claim 1 and 2, wherein the protrusion (17) forms at least a ring or a ring segment, which center is on a main axis (9) of the cylinder liner (1).

4. A cylinder liner (1) wherein the cylinder liner (1) is formed of cast materials and/or steel.

5. A cylinder liner (1) of claim 1 to 4, wherein during normal operation of the internal combustion engine the protrusion (17) is disposed above the top dead

center (8) of a piston ring (18).

6. A cylinder liner (1) of claim 1 to 5, wherein the protrusion (17) has a height of about 0.01 mm to 0.2 mm, particular a height of 0.05 to 0.15 mm

7. A cylinder liner (1) of claim 1 to 6, wherein the protrusion (17) starts at the top end of the cylinder liner (1).

8. A cylinder liner (1) of claim 1 to 7 wherein the protrusion (17) has a substantially uniform height.

9. A cylinder liner (1) of claim 1 to 8 wherein an inner diameter of a circle which is in a plane rectangular to a main axis (9) of the cylinder liner (1) and which circle is at the outer surface of the protrusion (17), is larger than a diameter of the piston, particular the largest diameter of the piston.

10. A method to manufacture a cylinder liner (1) of claim 1 to 9, wherein the inner surface (6) is at least partially formed by turning.

11. A method of claim 10 wherein after turning at least partially the inner surface (6) is nitrided.

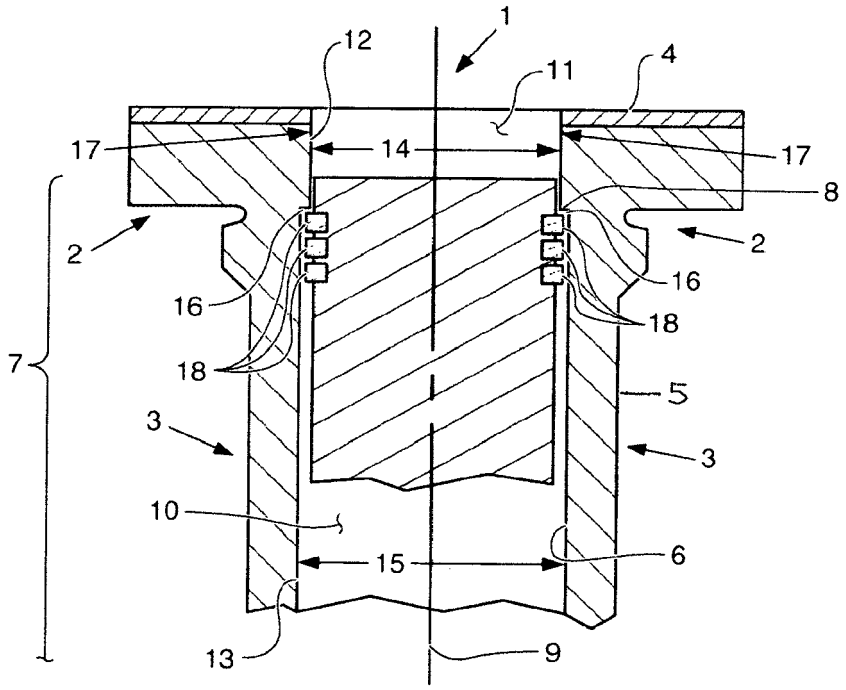
12. Method of claim 9 and 10 wherein at least a portion of the inner surface (6) is vibratory grinded.

13. Stationary internal combustion engine comprising a cylinder liner to claims 1 to 9.

14. Use of a cylinder liner (1) of claim 1 to 9 for a stationary internal combustion engine.

15. Use of a cylinder liner (1) of claim 1 to 9 for a gas engine, particular for a stationary gas engine.

FIG. 1



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EUROPEAN SEARCH REPORT

Application Number
EP 14 00 0471

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	13 June 2014	Matray, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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