



(11)

EP 3 043 054 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
01.05.2019 Bulletin 2019/18

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

(21) Application number: **15150637.5**

(22) Date of filing: **09.01.2015**

(54) **CUFF-RING FOR A CYLINDER LINER**

RING FÜR EINE ZYLINDERLAUFBUCHSE

INSERT ANNULAIRE POUR CHEMISE DE CYLINDRE

(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**

(43) Date of publication of application:
13.07.2016 Bulletin 2016/28

(73) Proprietor: **Caterpillar Motoren GmbH & Co. KG**
24159 Kiel (DE)

(72) Inventors:
• **BURKHARD, Sascha**
24119 Kronhagen (DE)
• **SIXEL, Eike Joachim**
24109 Kiel (DE)
• **LANGE, Hendrik Johannes**
24116 Kiel (DE)
• **RUSCHMEYER, Kai**
27389 Fintel (DE)

- **WOLFGRAMM, Marius**
24116 Kiel (DE)
- **BANCK, Andreas**
24161 Altenholz (DE)
- **MOOSER, Dirk**
24223 Raisdorf (DE)
- **ABRAHAM, Volker**
24159 Kiel (DE)

(74) Representative: **BRP Renaud & Partner mbB**
Rechtsanwälte Patentanwälte
Steuerberater
Königstraße 28
70173 Stuttgart (DE)

(56) References cited:
DE-A1- 10 121 852 DE-C- 886 545
US-A- 4 474 147 US-A- 4 770 133
US-A1- 2012 240 883

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

Technical Field

[0001] The present disclosure relates to a cuff-ring for a cylinder liner of an internal combustion engine, and more particularly, to a cuff-ring with an uneven top end. Cuff-rings are also known as fire rings, flame rings, carbon scraping rings, scraping rings or anti-polishing rings

Background

[0002] Internal combustion engines, such as diesel, gasoline and/or gaseous fuel engines, typically include a cylinder liner for guiding a piston disposed in an engine block. The piston is designed with a small distance from the cylinder liner. A lubricating film disposed on an inner surface of the cylinder liner reduces friction between the piston, associated piston rings and the cylinder liner. During operation of the internal combustion engine, however, soot and other particulates may accumulate on the piston, scavenge the inner surface of the cylinder liner, thereby reduce the lubricating film, which, in turn, may cause the engine to malfunction or break down.

[0003] Accumulation of particulates on the piston is usually avoided using a carbon scraping ring positioned in a top part of the cylinder liner. The carbon scraping ring typically is positioned at a small distance away from a cylinder head of the internal combustion engine to avoid contact between the cylinder head and the carbon scraping ring due to thermal expansion and tolerances of other related engine parts.

[0004] For example, US 6,164,260 of Caterpillar Inc. discloses a carbon scraping ring installed in a recess of a cylinder liner. When installed in the recess, the carbon scraping ring is positioned slightly away from the cylinder head such that during operation of the internal combustion engine no contact between the cylinder head and the carbon scraping ring occurs.

[0005] US 4 74 147 A discloses a ring having an L-shaped cross section for performing the functions of a fire ring and a carbon scraping cylinder insert. The ring has a first leg positioned in a recess of a cylinder to scrape carbon from the walls of a piston, and a second leg positioned between the cylinder head and the engine block to form a seal therebetween.

[0006] US 4 770 133 A discloses a cylinder liner with a ring-shaped insert to ensure that the carbon deposited on the fire land of the piston cannot contact the cylinder surfaces below the insert.

[0007] Further scraping rings are disclosed in US 2012/240883 A1 and DE 101 21 852 A1.

[0008] A heat insulation ring for preventing high thermal stress on walls of the combustion chamber is disclosed in DE 886 545 C.

[0009] The present disclosure is directed, at least in part, to improving or overcoming one or more aspects of prior systems.

Summary of the Disclosure

[0010] The above object is solved by a cuff-ring according to claim 1 and an internal combustion engine according to claim 6. Further developments are given in the dependent claims.

[0011] In one example of the present disclosure, a cuff-ring for a cylinder liner of an internal combustion engine is disclosed. The cuff-ring may comprise a cuff-ring axis, a circumferential outer side extending about the cuff-ring axis and being configured to contact the cylinder liner, a circumferential inner side extending about the cuff-ring axis and being configured to scrape off deposits accumulated on a piston of the internal combustion engine.

[0012] The cuff-ring may further comprise a top end extending in radial direction between the circumferential inner side and the circumferential outer side, and a bottom end opposite the top end. The top end may include at least one of a protrusion or a recess.

[0013] In another example of the present disclosure, an internal combustion engine is disclosed. The internal combustion engine comprises a piston, a cylinder liner for guiding the piston, a cylinder head, and a cuff-ring. The cuff-ring may be configured to be positioned in the cylinder liner and may include a cuff-ring axis, a circumferential outer side extending about the cuff-ring axis and being configured to contact the cylinder liner, a circumferential inner side extending about the cuff-ring axis and being configured to scrape off deposits accumulated on the piston, a top end, and a bottom end opposite the top end, wherein the top end of the cuff-ring may include at least one of a protrusion or a recess.

[0014] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Brief Description of the Drawings

[0015]

Fig. 1 is a schematic drawing of a sectional cut through a section of an internal combustion engine;

Fig. 2 is a schematic drawing of a cut through a cuff-ring;

Fig. 3 is a detailed view of a top part of the cuff-ring according to one example not being part of the invention;

Fig. 4 is a detailed view of a top part of the cuff-ring according to another example not being part of the invention;

Fig. 5 is a detailed view of a top part of the cuff-ring according to one aspect of the present disclosure;

Fig. 6 is a detailed view of a top part of the cuff-ring

according to another example not being part of the invention;

Fig. 7 is a detailed view of a top part of the cuff-ring according to another example not being part of the invention;

Fig. 8 is a detailed view of a bottom part of the cuff-ring according to another example not being part of the invention;

Detailed Description

[0016] The following is a detailed description of exemplary embodiments of the present disclosure. The exemplary embodiments described therein and illustrated in the drawings 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 be considered as, a limiting description of the scope of patent protection. Rather, the scope of patent protection shall be defined by the appended claims.

[0017] The present disclosure is based in part on the realization that a clearance distance between the carbon scraping ring and the cylinder head constitutes a crevice volume which may result in an incomplete combustion and increased emissions such as unburned hydrocarbons.

[0018] The present disclosure may, therefore, further be based in part on the realization that a cuff-ring may be positioned closer to the cylinder head to reduce the crevice volume between the cylinder head and the cuff-ring. However, by reducing the crevice volume, the cuff-ring and the cylinder head may contact each other during operation of the internal combustion engine, thereby potentially causing the cuff-ring to deform or misalign. The present disclosure may, therefore, further be based in part on the realization that deformation or misalignment between the cylinder head and the cuff-ring may be reduced by reducing a contact surface between the cylinder head and the cuff-ring. By reducing the contact surface between the cylinder head and the cuff-ring, a compression force between the cylinder head and the cuff-ring may be reduced, which, in turn, may reduce material deformation of the cuff-ring, and therefore a risk of potential misalignment of the cuff-ring during operation of the internal combustion engine.

[0019] The present disclosure may further be based in part on the realization that a contact surface between the cylinder head and the cuff-ring may be reduced by forming a top end of the cuff-ring with protrusions and/or recesses. Preferably, the protrusions and/or recesses define a distal end having an area smaller than a top end area of the cuff-ring without protrusions and/or recesses. The present disclosure may further be based in part on

the realization that a contact surface between the cylinder head and the cuff-ring may be minimized by providing a line contact between the cylinder head and the cuff-ring.

[0020] Referring now to Fig. 1, a sectional view of an internal combustion engine 1 is shown. Internal combustion engine 1 may be any known type of internal combustion engine, having any shape and any number of cylinders. Internal combustion engine 1 comprises a piston 2 and a cylinder liner 3. Piston 2 and cylinder liner 3 are installed in a cylinder (not shown) of internal combustion engine 1. A cylinder head 4 closes off the cylinder from on top. Cylinder head 4 is in sealing contact with cylinder liner 3 using a cylinder head sealing 5. Cylinder head sealing 5 seals off a sealing gap 51 between cylinder head 4 and cylinder liner 3. Cylinder head sealing 5 may be any type of sealing known to a person skilled in the art.

[0021] Piston 2 may be provided with annular grooves 8. In annular grooves 8, piston rings 9 may be installed to seal the cylinder and regulate a flow of lubricant within the cylinder.

[0022] Cylinder liner 3 is designed with a small distance 6 away from piston 2 and seized to securely guide piston 2 during its reciprocating movement from top dead center (TDC) to bottom dead center (BDC), and vice versa. Cylinder liner 3 further comprises an inner surface 7. Inner surface 7 may comprise a micro-structure adapted to facilitate adhesion of a lubricating film, such as an oil film. Cylinder liner 3 may be manufactured from gray cast iron or other cast irons.

[0023] At an upper section of cylinder liner 3, a liner recess 10 is formed. Liner recess 10 may comprise a fillet 11, preferably an arcuate fillet having at least one radius, more preferably two radii for reducing tension and crevice volume in liner recess 10. In liner recess 10, a cuff-ring 12 is positioned. In some embodiments, cuff-ring 12 may also be integrally formed with cylinder liner 3.

[0024] Cuff-ring 12 comprises a cuff-ring axis (shown in Fig. 2), a circumferential outer side 13 and a circumferential inner side 14. Circumferential outer side 13 contacts cylinder liner 3 when positioned in liner recess 10, whereas circumferential inner side 14 faces piston 2. Moreover, circumferential inner side 14 is arranged closer to piston 2 than inner surface 7 of cylinder liner 3. Circumferential inner side 14 may therefore constitute a scraping face configured to scrape off deposits accumulated on a side surface 15 of piston 2 during upward movement of piston 2 from BDC to TDC. In Fig. 1, piston 2 is shown to be in TDC. To facilitate the scraping process, piston 2 may comprise a top part 16 formed with a taper. By forming top part 16 with a taper, upon upward movement of piston 2, particulates accumulated on side surface 15 may be scraped off more easily. Cuff-ring 12 may be manufactured from the same or different materials as cylinder liner 3, such as gray cast iron or other cast irons. Moreover, cuff-ring 12 may be designed such that during operation of internal combustion engine 1 cuff-ring 12 is press-fitted in liner recess 10.

[0025] Cuff-ring 12 further comprises a top end 17 indicated by a dashed line. Exemplarily shown in Fig. 1, cuff-ring 12 may further comprise a protrusion 18 with a distal end 19. Protrusion 18 extends in axial direction from top end 17 towards cylinder head 4. Various other embodiments of top end 17 are explained in more detail when referring to Fig. 3 to 7.

[0026] Top end 17 may have a first clearance distance 20 from cylinder head 4. Protrusion 18 at its distal end 19 may have a second clearance distance 21 from cylinder head 4. According to one aspect of the present disclosure, second clearance distance 21 may be significantly smaller, preferably about 50 % - 70 % or more, than first clearance distance 20. Although, first clearance distance is shown in Fig. 1 to have the same size as sealing gap 51, this may not necessarily be the case. For example, in some embodiments, first clearance distance may be smaller than sealing gap 51 and, therefore, top end 17 may extend in axial direction beyond cylinder liner 3.

[0027] Generally, if a clearance distance between cuff-ring 12 and cylinder head 4 is significantly reduced, as shown in Fig. 1, a contact between top end 17 of cuff-ring 12 and cylinder head 4 may occur more likely during operation of internal combustion engine 1. The contact may be caused, for example, due to thermal expansion of cuff-ring 12. For example, during normal operation of internal combustion engine 1, cuff-ring 12 may expand in axial direction by about 0.5 mm or more, which is about the same size as current manufacturing tolerances. As a consequence, a compression force between cuff-ring 12 and cylinder head 4 may build up - transmitted via top end 17. The compression force may cause cuff-ring 12 to deform, which, in turn, may lead to a contact between circumferential inner side 14 and side surface 15, causing increased material wear and piston seizure, which may lead to a malfunction or break down of internal combustion engine 1. It was, however, realized that the compression force between cuff-ring 12 and cylinder head 4 may be reduced, when top end 17 is adapted such that the resulting contact surface between cylinder head 4 and cuff-ring 12 is smaller than an area of top end 17. In the exemplary embodiment of Fig. 1, the contact surface is reduced by forming top end 17 with protrusion 18. Thus, in the exemplary embodiment, a potential contact surface between cylinder head 4 and top end 17 is reduced compared to an area defined by distal end 19. Various embodiments of top end 17 configured to reduce the contact surface are explained in more detail when referring to Fig. 3 to 7.

[0028] First in Fig. 2, a schematic drawing of a cut through cuff-ring 12 is shown. Elements already explained in connection with Fig. 1 have the same reference numerals.

[0029] As mentioned, cuff-ring 12 comprises cuff-ring axis A, circumferential outer side 13 and circumferential inner side 14. Circumferential outer side 13 contacts cylinder liner 3 when positioned in liner recess 10, and cir-

cumferential inner side 14 faces side surface 15 of piston 2. Moreover, circumferential inner side 14 and circumferential outer side 13 extend in radial direction about cuff-ring axis A, forming a closed ring. Cuff-ring 12 further comprises top end 17 and a bottom end 23 opposite top end 17.

[0030] In the following and with reference to Fig. 3 to 8, various embodiments of top end 17 (indicated by circle Y) and bottom end 23 (indicated by circle Z) are explained in more detail. Again, elements already explained have the same reference numerals. Fig. 3 to 8 are schematic views of cross-sectional cuts through cuff-ring 12 in a radial plane about cuff-ring axis A.

[0031] In the example not being part of the invention shown in Fig. 3, top end 17 includes protrusion 18. Protrusion 18 may have a trapezoidal shape when viewed in a radial plane of cuff-ring axis A, but may, not according to the invention, have a different shape when viewed in a different radial plane. However, this may not necessarily be the case. The trapezoidal shape may, not according to the invention, be a right trapezoid, as shown in Fig. 3, having a first leg 181 extending in radial direction between circumferential inner side 14 and circumferential outer side 13, and a second leg 182 extending in axial direction from top end 17 in parallel to cuff-ring axis A. First leg 181 may be formed, for example, by a chamfer or a bevel.

[0032] The trapezoidal shape may, not according to the invention, further comprise a distal end 19. Distal end 19 has the largest distance from top end 17, when viewed in axial direction. During a potential contact between cuff-ring 12 and cylinder head 4, distal end 19, therefore, defines the contact surface. As can be easily seen, distal end 19 defines an area that is significantly smaller than an area defined by top end 17 during a potential contact with cylinder head 4. Thus, for a potential contact between cylinder head 4 and cuff-ring 12, the contact surface between the cylinder head 4 and distal end 19 is significantly smaller than the contact surface between the cylinder head 4 and top end 17, for example about 70 % to 85 % smaller. In Fig. 3, distal end 19 is running horizontally between first leg 181 and second leg 182. However, in another example not being part of the invention, distal end 19 may run at an angle between first leg 181 and second leg 182, thereby reducing the contact surface further. Protrusion 18 may, not according to the invention, have an axial extension from top end 17 that is about 5 % - 10 %, or less, of the radial extension between circumferential inner side 14 and circumferential outer side 13 and/or about 2 % - 5 %, or less, of the axial extension between top end 17 and bottom end 23 of cuff-ring 12.

[0033] Fig. 4 shows another example not being part of the invention of protrusion 18, where second leg 182 does not extend in axial direction from top end 17, but runs, with respect to top end 17, at an angle α towards distal end 19. Moreover, in the example not being part of the invention shown in Fig. 4, first and second legs 181, 182

run at the same angle α towards each other, thereby defining a protrusion which, when viewed in a radial plane of the cuff-ring axis A, corresponds to an isosceles trapezoid. By forming a protrusion 18 with an isosceles trapezoidal cross-sectional area, the compression force exerted onto cuff-ring 12 via distal end 19, is transmitted homogeneously, thereby preventing deformation of cuff-ring 12 more effectively. In some example not being part of the invention, first and second legs 181, 182 may run at different angles towards each other.

[0034] In Fig. 5 a first embodiment of protrusion 18 is shown where, when viewed in a radial plane of cuff-ring axis A, protrusion 18 has a triangular shape with a distal end 19 formed as a tip. Thus, during a potential contact between cuff-ring 12 and cylinder head 4, the contact surface reduces to a contact line, thereby minimizing the compression force further. In the embodiment shown in Fig. 5, the triangular shape is an isosceles triangle and protrusion 18 may have an axial extension from top end 17 that is about 1 % - 2.5 %, or less, of the axial extension between top end 17 and bottom end 23 of cuff-ring 12.

[0035] In some embodiments, the triangular shape may be an equilateral triangle, a right triangle, an acute triangle, or any other suitable triangle. Thus, in some embodiments, distal end 19 may not be centered between circumferential outer and inner sides 13, 14, as shown in Fig. 5, but biased to either circumferential inner side 14 or circumferential outer side 13. Preferably, distal end 19 may be biased towards circumferential inner side 14 or, ideally, may be radially in-line with circumferential inner side 14, thereby arriving at a right triangle with first leg 181 running in axial direction from top end 17 in parallel with cuff-ring axis A.

[0036] In another example not being part of the invention shown in Fig. 6, protrusion 18 has, when viewed in a radial plane of cuff-ring axis A, the shape of a rectangle with at least one rounded edge 183 and a distal end 19. Rounded edge 183 connects circumferential inner side 14 and distal end 19 in an arcuate shape. The arcuate shape, preferably, is formed by at least one convex radius, such as two or three convex radii, each being the same or different. In other examples not being part of the invention, the arcuate shape may further include a concave radius, or a plurality of concave radii alternating with the plurality of convex radii. By forming protrusion 18 with an arcuate shape extending from circumferential inner side 14 to distal end 19, a crevice volume between cylinder head 4 and cuff-ring 12 is avoided and a flushing of this region within the cylinder is improved.

[0037] In Fig. 7, an example not being part of the invention is shown where, when viewed in a radial plane of cuff-ring axis A, top end 17 comprises a recess 25. In the embodiment shown in Fig. 7, recess 25 has an arcuate shape. The arcuate shape may, not according to the invention, be formed by at least one concave radius, such as one or two concave radii. The arcuate shape may further comprise a convex radius interspaced between two adjacent concave radii, thereby arriving at a wave-

like shape. In other embodiments, recess 25 may be formed by a plurality of grooves spaced apart in radial direction between circumferential outer and inner sides 13, 14.

[0038] Recess 25 discontinues top end 17 in that, when recess 25 is formed on top end 17, top end 17 no longer is entirely planar. Recess 25, therefore, defines a plurality of distal ends 19 between circumferential outer side 13 and circumferential inner side 14. Thus, by forming top end 17 with recess 25, distal ends 19 define a contact surface that is smaller than an area of top end 17 without recess 25 formed thereon. As a consequence, during a potential contact between cylinder head 4 and cuff-ring 12, a contact surface between cylinder head 4 and cuff-ring 12 is reduced. Generally, when formed with recess 25 or a plurality of recesses 25, top end 17 may extend in axial direction further towards cylinder head 4 than it would extend without recess 25 formed thereon, thereby reducing a crevice volume and a potential contact surface at the same time.

[0039] Finally, Fig. 8 shows an example not being part of the invention, where alternatively or in addition to modifications of top end 17, bottom end 23 is connected to circumferential outer side 13 by an arcuate fillet 26. Arcuate fillet 26 includes a first radius 27 and a second radius 28, wherein, preferably, first radius 27 is smaller than second radius 28. Moreover, arcuate fillet 26, as well as first and second radii 27, 28, may be formed to fit in liner recess 10, such that, when cuff-ring 12 is positioned in liner recess 10, circumferential outer side 13 contacts cylinder liner 3 with a minimized crevice volume between cuff-ring 12 and cylinder liner 3.

Industrial Applicability

[0040] The cuff-ring as generally disclosed herein is applicable in any internal combustion engine using a cylinder liner. If cuff-ring comprises an arcuate fillet connecting a bottom side with a circumferential outer side of the cuff-ring, the cuff-ring may be adjusted such that it fits into a corresponding recess formed on the cylinder liner. Cuff-rings explained in connection with Fig. 3 to 8 are applicable, but not limited to diesel internal combustion engines of the series M20, M25, M32 and M43, to gaseous fuel engines of the series GCM34 and/or Dual fuel engines of the series M34DF and M46DF manufactured by Caterpillar Motoren GmbH & Co KG. However, other internal combustion engines may be used as well.

[0041] In the following, operation of internal combustion engine 1 comprising cuff-ring 12 as exemplary disclosed herein is described in connection with Fig. 1 to 8.

[0042] During operation of internal combustion engine 1, soot or other particulates may accumulate on side surface 15 of piston 2. Cuff-ring 12, which is positioned in liner recess 10 of cylinder liner 3, may prevent particulate accumulation. For this, cuff-ring 12 is positioned in liner recess 10 such that circumferential inner side 14 protrudes further towards piston 2, in particular towards side

surface 15 of piston 2, than inner surface 7 of cylinder liner 3. As a consequence, circumferential inner side 14 may constitute a scraping face configured to scrape off deposits accumulated on side surface 15. Scraping of deposits occurs during upward movement of piston 2 from BDC to TDC, when circumferential inner side 14 translates relative to side surface 15. Of course, scraping may also occur during a downward movement of piston 2 from TDC to BDC.

[0043] During movement of piston 2 and scraping off of particulates, cuff-ring 12 may heat up, for example, due to friction. Also, thermal heat produced during operation of internal combustion engine 1 may cause cuff-ring 12 to heat up over time. Thus, cuff-ring 12 may expand during operation of internal combustion engine 1. If, as disclosed herein, cuff-ring 12 is positioned with its top end 17 at only a small clearance distance away from cylinder head 4, thermal expansion of cuff-ring 12 within liner recess 10 may cause cuff-ring 12 to contact cylinder head 4 with its top end 17.

[0044] The contact surface between cuff-ring 12 and cylinder head 4 is mainly defined by an area of top end 17 contacting cylinder head 4. Due to the contact between cuff-ring 12 and cylinder head 4, via top end 17, a compression force is exerted onto cuff-ring 12, which may cause cuff-ring 12 to deform. This, in turn, may have an adverse effect on the upward and/or downward movement of piston 2, which is why deformation of cuff-ring 12 due to a contact of cuff-ring 12 with cylinder head 4 should be avoided or at least reduced.

[0045] As disclosed herein, the contact surface between cuff-ring 12 and cylinder head 4 may be reduced, by forming cuff-ring 12 with protrusions 18 and/or, not according to the invention, recesses 25, as exemplary shown in Fig. 1 to 7. By forming cuff-ring 12 with protrusions 18, a contact surface between cuff-ring 12 and cylinder head 4 is reduced to an area defined by distal end 19 of protrusion 18. Because the area defined by distal end 19 during a potential contact with cylinder head 4 is smaller than an area defined by top end 17 during a potential contact with cylinder head 4, the compression force exerted onto cuff-ring 12 by cylinder head 4 is reduced. Thus, also a potential deformation of cuff-ring 12 due to a contact with cylinder head 4 is reduced.

[0046] Likewise, by forming top end 17 with a recess 25 as shown in Fig. 7, top end 17 no longer is planar but defines a plurality of distal ends 19. During a potential contact between cuff-ring 12 and cylinder head 4, the plurality of distal ends 19 contacting cylinder head 4 define a contact surface that is smaller than a contact surface of top end 17 without a recess formed thereon. Consequently, a compression force exerted onto cuff-ring 12 is reduced and a material deformation is reduced as well.

[0047] Ideally, protrusion 18 and/or, not according to the invention, recess 25 are formed such that during a potential contact between cuff-ring 12 and cylinder head 4, the contact is reduced to a line contact, thereby minimizing the contact surface and thus the compression

force exerted onto cuff-ring 12. To achieve a line contact, as exemplary shown in Fig. 1 and 5, protrusion 18 may comprise distal end 19 formed as a tip. However, other embodiments to achieve a line contact between cuff-ring 12 and cylinder head 4 are possible as well, such as by forming recess 25 shown in Fig. 7 in a way that recess 25 extends in radial direction almost entirely towards circumferential inner and outer sides 14, 13, thereby reducing the plurality of distal ends 19 to tips.

[0048] Furthermore, it is also possible to combine protrusions 18 and recesses 25. For example, in the embodiments shown in Fig. 3 and 4, distal end 19 may comprise a recess similar to Fig. 7, thereby reducing the contact surface defined by distal end 19 during a potential contact with cylinder head 4 further. Various other embodiments of top end 17 with combinations of protrusions and/or recesses are also possible.

[0049] Moreover, as used herein, "convex" is used to indicate that material is extending outward when viewed in the direction of cuff-ring axis A from bottom end 23 to top end 17 of cuff-ring 12. Likewise, as used herein, "concave" is used to indicate that material is extending inward when viewed in the direction of cuff-ring axis A from bottom end 23 to top end 17 of cuff-ring 12.

Claims

1. A cuff-ring (12) for a cylinder liner (3) of an internal combustion engine (1), the cuff-ring (12) comprising:
 - a cuff-ring axis (A);
 - a circumferential outer side (13) extending about the cuff-ring axis (A) and being configured to contact the cylinder liner (3);
 - a circumferential inner side (14) extending about the cuff-ring axis (A) and being configured to scrape off deposits accumulated on a piston (2) of the internal combustion engine (1);
 - a top end (17) extending in radial direction between the circumferential inner side (14) and the circumferential outer side (13); and
 - a bottom end (23) opposite the top end (17), wherein
 - the top end (17) includes a protrusion (18) having in a radial plane of the cuff-ring axis (A) a triangular shape including a distal end (19) formed as a tip.
2. The cuff-ring (12) according to claim 1, wherein the protrusion (18) extends in circumferential direction about the cuff-ring axis (A) and have for any radial plane of the cuff-ring axis (A) the same cross-sectional area.
3. The cuff-ring (12) according to claim 1 or claim 2, wherein the distal end (19) defines an area that is smaller, preferably about 70 % to 85 % smaller, than

an area of the top end (17).

4. The cuff-ring (12) according to any one of the preceding claims, wherein the triangular shape is an isosceles triangle.
5. The cuff-ring (12) according to any one of the preceding claims, wherein the cuff-ring (12) includes an arcuate fillet (26) connecting the circumferential outer side (13) and the bottom side (23), the arcuate fillet (26) having at least one convex radius (27, 28).
6. An internal combustion engine (1) comprising:
 - a piston (2);
 - a cylinder liner (3) for guiding the piston (2);
 - a cylinder head (4); and
 - a cuff-ring (12) according to any one of the preceding claims and being configured to be positioned in the cylinder liner (3).

Patentansprüche

1. Manschettenring (12) für eine Zylinderlaufbuchse (3) eines Verbrennungsmotors (1), wobei der Manschettenring (12) umfasst:

eine Manschettenringachse (A);
 eine umfängliche äußere Seite (13), die sich um die Manschettenringachse (A) erstreckt und eingerichtet ist, um die Zylinderlaufbuchse (3) zu kontaktieren;
 eine umfängliche innere Seite (14), die sich um die Manschettenringachse (A) erstreckt und eingerichtet ist, um auf einem Kolben (2) des Verbrennungsmotors (1) angesammelte Ablagerungen abzuschieben;
 ein oberes Ende (17), das sich in einer radialen Richtung zwischen der umfänglichen inneren Seite (14) und der umfänglichen äußeren Seite (13) erstreckt; und
 ein unteres Ende (23), gegenüberliegend dem oberen Ende (17), wobei
 das obere Ende (17) einen Vorsprung (18) einschließt, der in einer radialen Ebene der Manschettenringachse (A) eine dreieckige Gestalt hat, einschließend ein distales Ende (19), gebildet als eine Spitze.

2. Manschettenring (12) nach Anspruch 1, wobei der Vorsprung (18) sich in Umfangsrichtung um die Manschettenringachse (A) erstreckt und für jede radiale Ebene der Manschettenringachse (A) dieselbe Querschnittsfläche hat.
3. Manschettenring (12) nach Anspruch 1 oder Anspruch 2, wobei das distale Ende (19) eine Fläche

definiert, die kleiner, vorzugsweise ungefähr 70% bis 85% kleiner, ist als eine Fläche des oberen Endes (17).

4. Manschettenring (12) nach einem der vorstehenden Ansprüche, wobei die dreieckige Gestalt ein gleichschenkliges Dreieck ist.
5. Manschettenring (12) nach einer der vorstehenden Ansprüche, wobei der Manschettenring (12) eine bogenförmige Verrundung (26) einschließt, die die umfängliche äußere Seite (13) und die untere Seite (23) verbindet, wobei die bogenförmige Verrundung (26) mindestens einen konvexen Radius (27, 28) hat.
6. Verbrennungsmotor (1), umfassend:
 - einen Kolben (2);
 - eine Zylinderlaufbuchse (3) zum Führen des Zylinders (2);
 - einen Zylinderkopf (4); und
 - einen Manschettenring (12) nach einem der vorstehenden Ansprüche und eingerichtet, um in der Zylinderlaufbuchse (3) positioniert zu werden.

Revendications

1. Insert annulaire (12) pour une chemise de cylindre (3) d'un moteur à combustion interne (1), l'insert annulaire (12) comprenant :
 - un axe d'insert annulaire (A) ;
 - un côté extérieur circonferentiel (13) s'étendant autour de l'axe d'insert annulaire (A) et étant configuré pour être en contact avec la chemise de cylindre (3) ;
 - un côté intérieur circonferentiel (14) s'étendant autour de l'axe d'insert annulaire (A) et étant configuré pour enlever les dépôts accumulés sur un piston (2) du moteur à combustion interne (1) ;
 - une extrémité supérieure (17) s'étendant dans une direction radiale entre le côté intérieur circonferentiel (14) et le côté extérieur circonferentiel (13) ; et
 - une extrémité inférieure (23) opposée à l'extrémité supérieure (17), dans lequel l'extrémité supérieure (17) inclut une saillie (18) ayant dans un plan radial de l'axe d'insert annulaire (A) une forme triangulaire incluant une extrémité distale (19) formée en tant que pointe.
2. Insert annulaire (12) selon la revendication 1, dans lequel la saillie (18) s'étend dans une direction circonferentielle autour de l'axe d'insert annulaire (A) et a pour tout plan radial de l'axe d'insert annulaire

(A) la même superficie en coupe transversale.

3. Insert annulaire (12) selon la revendication 1 ou la revendication 2, dans lequel l'extrémité distale (19) définit une superficie qui est plus petite, de préférence environ 70 % à 85 % plus petite, qu'une superficie de l'extrémité supérieure (17). 5
 4. Insert annulaire (12) selon l'une quelconque des revendications précédentes, dans lequel la forme triangulaire est un triangle isocèle. 10
 5. Insert annulaire (12) selon l'une quelconque des revendications précédentes, dans lequel l'insert annulaire (12) inclut un congé arqué (26) reliant le côté extérieur circonférentiel (13) et le côté inférieur (23), le congé arqué (26) ayant au moins un rayon convexe (27, 28). 15
 6. Moteur à combustion interne (1) comprenant : 20
 - un piston (2) ;
 - une chemise de cylindre (3) pour guider le piston (2) ;
 - une culasse (4) ; et 25
 - un insert annulaire (12) selon l'une quelconque des revendications précédentes et étant configuré pour être positionné dans la chemise de cylindre (3). 30
- 35
- 40
- 45
- 50
- 55

FIG 1

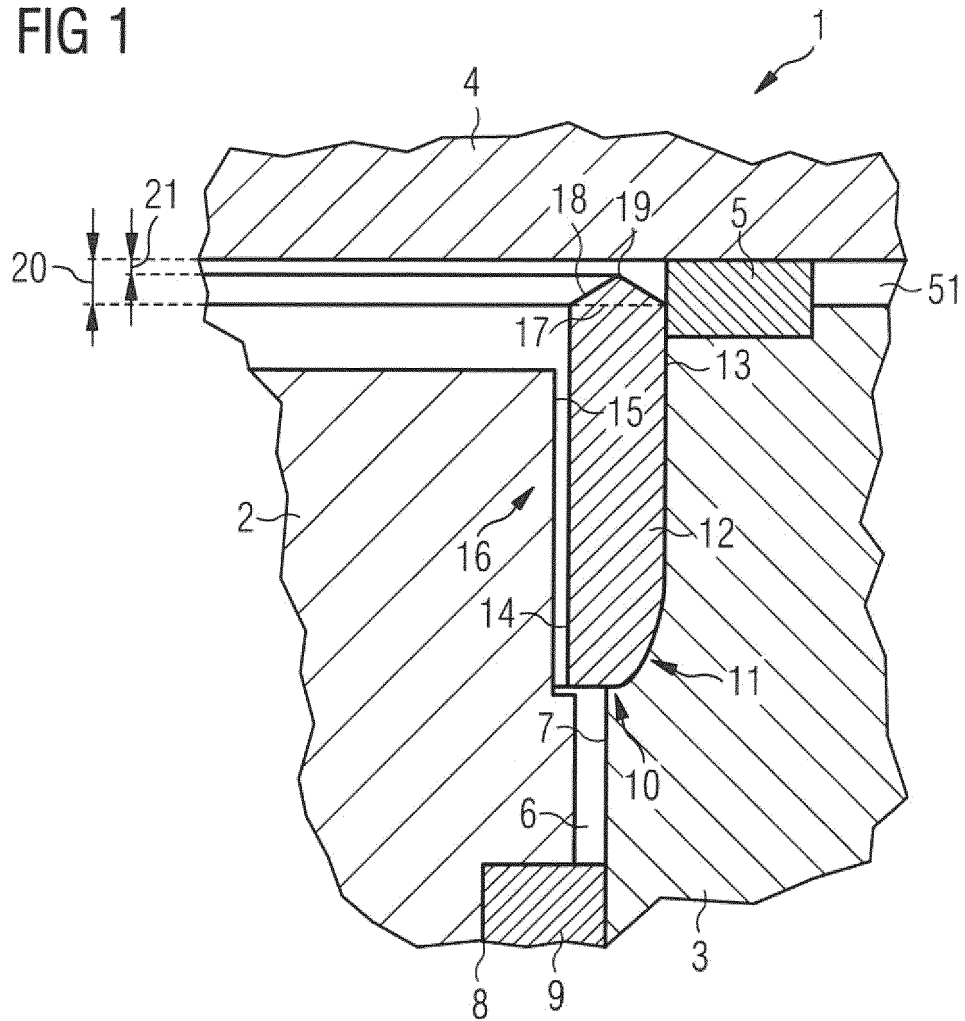


FIG 2

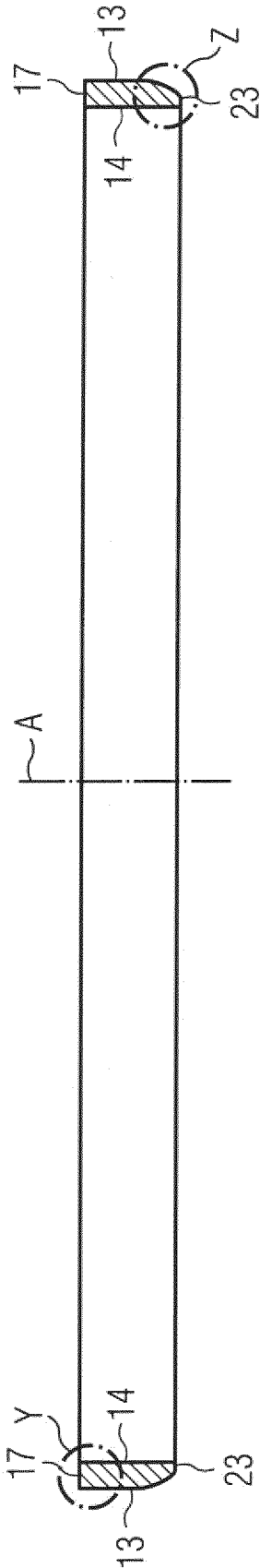


FIG 3

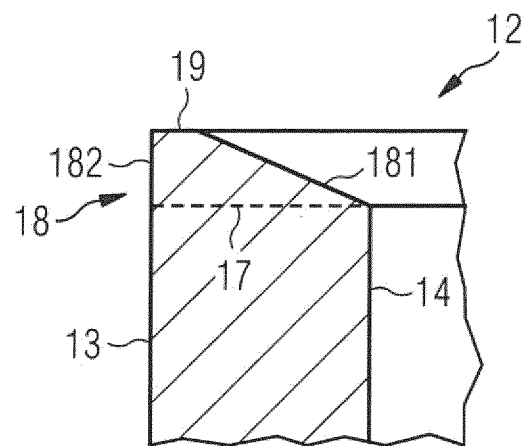


FIG 4

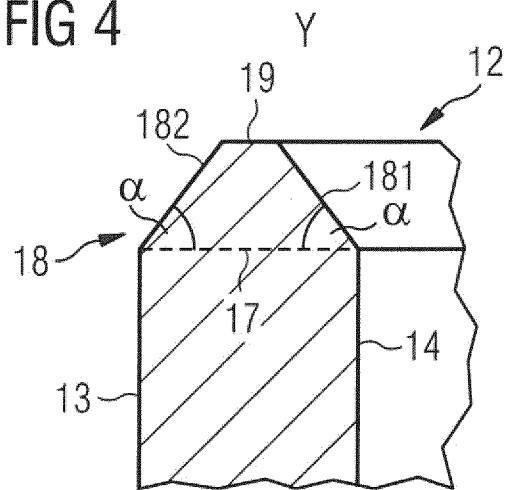


FIG 5

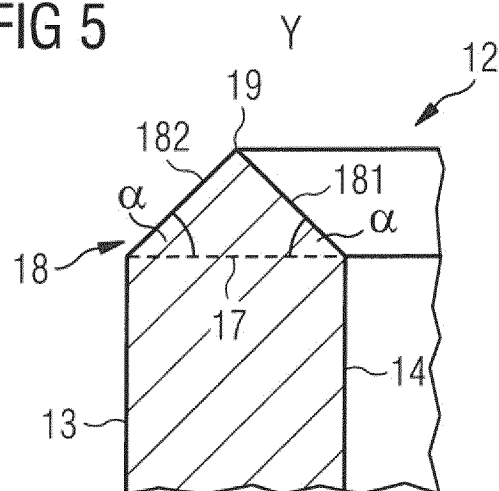


FIG 6

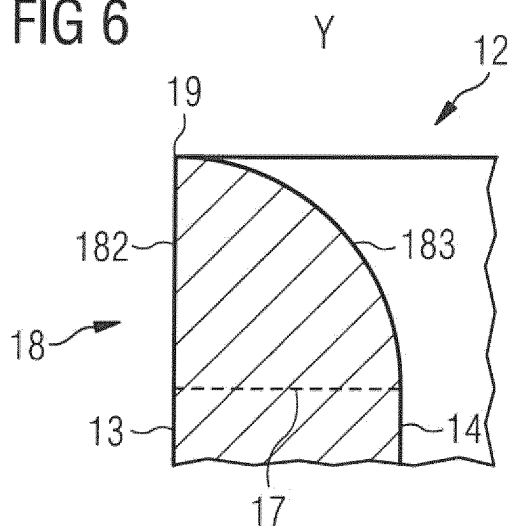


FIG 7

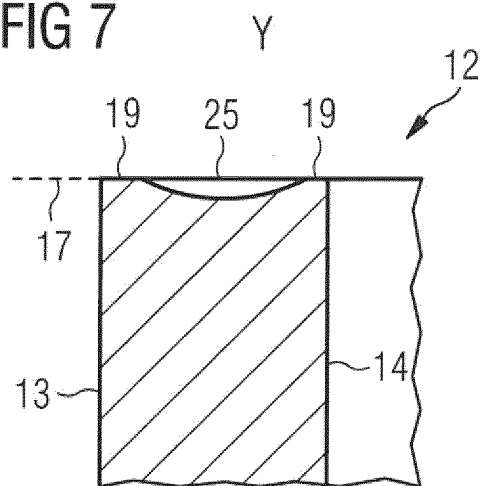
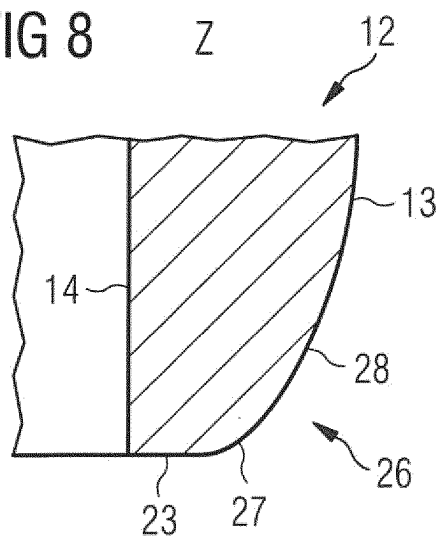


FIG 8



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6164260 A [0004]
- US 474147 A [0005]
- US 4770133 A [0006]
- US 2012240883 A1 [0007]
- DE 10121852 A1 [0007]
- DE 886545 C [0008]