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

(11) **EP 2 861 856 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
10.06.2020 Bulletin 2020/24

(21) Application number: **13732206.1**

(22) Date of filing: **31.05.2013**

(51) Int Cl.:
F02F 1/16 *(2006.01)*

(86) International application number:
PCT/FI2013/050594

(87) International publication number:
WO 2013/190175 (27.12.2013 Gazette 2013/52)

(54) CYLINDER LINER AND PISTON ENGINE

ZYLINDERROHR UND KOLBENMOTOR

CHEMISE DE CYLINDRE ET MOTEUR À PISTON

(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

(30) Priority: **19.06.2012 FI 20125679**

(43) Date of publication of application:
22.04.2015 Bulletin 2015/17

(73) Proprietor: **Wärtsilä Finland Oy**
65100 Vaasa (FI)

(72) Inventors:
- **BRIGHI, Federico**
  IT-34018 Trieste (IT)
- **LOLLIS, Davide**
  IT-34018 Trieste (IT)
- **LATTANZIO, Vincenzo**
  IT-34018 Trieste (IT)
- **CATTARINUSSI, Massimo**
  IT-34018 Trieste (IT)

(74) Representative: **Berggren Oy, Helsinki & Oulu**
P.O. Box 16
Eteläinen Rautatiekatu 10A
00101 Helsinki (FI)

(56) References cited:
EP-A2- 1 087 124
DD-A1- 133 985
US-A- 4 440 118

EP 2 861 856 B1

Description

Technical field of the invention

[0001] The present invention relates to a cylinder liner according to claim 1. The invention also concerns a piston engine.

Background of the invention

[0002] Because of the high temperature in the combustion chambers of piston engines, the cylinder liners need to be provided with cooling arrangements. Except for very small engines, the cooling arrangements involve the use of cooling liquid that is circulated in cooling channels around the cylinder liners. In many engine constructions, the cooling channels are located at least partly inside the engine block. This makes the construction of the engine block more complicated and expensive. In some cases, the cooling channels are located partly in the cylinder heads. Also the cylinder heads are expensive components, and if the cylinder heads need to be provided with cooling channels for cooling the cylinder liners, the costs of the cylinder heads are increased even more. Another problem with many existing cylinder liner cooling arrangements is that in case of the failure of the cylinder head gasket, the combustion gases from the cylinder can mix with the cooling water.

[0003] DD 133985 A1 discloses a cylinder liner and a piston engine. A cooling jacket is arranged around the cylinder liner and limits together with the cylinder liner a cooling channel.

[0004] EP 1087124 A2 discloses a cylinder liner for a piston engine. The cylinder liner is provided with a recess encircling the outer circumference of the cylinder liner. US 4440118 A discloses a cylinder liner for a piston engine. The cylinder liner is provided with a recess encircling the outer circumference of the cylinder liner and forming part of a cooling channel.

Summary of the invention

[0005] An object of the present invention is to provide an improved cylinder liner, in which the above mentioned problems are reduced or avoided. The present invention relates to a cylinder liner according to claim 1. Another object of the invention is to provide an improved piston engine.

[0006] A cylinder liner according to the invention comprises a first support surface that can be arranged against an upper surface of an engine block for carrying forces in the axial direction of the cylinder liner, a second support surface that is located below the first support surface in the axial direction of the cylinder liner for supporting the cylinder liner in the radial direction, and a third support surface that is arranged below the second support surface in the axial direction of the cylinder liner for supporting the cylinder liner in the radial direction. The cylinder liner is provided with a single cooling recess encircling the outer circumference of the cylinder liner, and the cooling recess is located above the first support surface in the axial direction of the cylinder liner. The outer circumference of the cylinder liner is provided with an annular recess below the cooling channel for reducing thermal stresses. The cross-section of the recess comprises a first portion that is a sector of a circle, the radius of the circle is 30-60 % of the thickness of the wall of the cylinder liner outside of the support surfaces or other reinforced areas of the cylinder liner, and the recess comprises a portion that is a sector of a circle and has a smaller radius than the first portion of the recess.

[0007] An engine according to the invention comprises an engine block, at least one cylinder liner that is arranged partly inside the engine block, a cylinder head for closing the upper end of the cylinder liner, and a cooling jacket that is arranged around the cylinder liner and delimits together with the cylinder liner a cooling channel. Each cylinder of the engine is provided with only one cooling channel for cooling the cylinder liner, and the whole cooling channel is arranged above the engine block. The cylinder liner is a cylinder liner defined above.

[0008] Since each of the cylinders of the engine is provided with only one cooling channel, the cooling channel can be located exclusively around the upper end of the cylinder liner outside the engine block and the cylinder liner. The complexity of the engine block and the cylinder liner can thus be reduced. Also, the risk of mixing of the combustion gases and the cooling water in case of a cylinder head gasket failure can be eliminated. The risk of cooling liquid leakages inside the engine block is also eliminated. The invention enables increased modularization, which makes the assembling and servicing of the engine easier. An engine according to the invention has lower production and operating costs and better reliability. The cooling channel can be located so that it is around the uppermost piston ring when the piston is at top dead center. Effective cooling of this point is critical for ensuring reliable functioning of the piston rings. When a single cooling channel is used, thermal stresses in the cylinder liner increase. With the recess below the cooling channel, the thermal stresses can be reduced.

[0009] According to an embodiment of the invention, the recess is located at least partly below the first support surface. The recess can be merged with the first support surface. The recess can also be located above the second support surface and merged with it.

[0010] According to another embodiment of the invention, the recess comprises a second portion, where the wall of the recess is at an angle a relative to the longitudinal center line of the cylinder liner. The angle is preferably 15-50 degrees, more preferably 25-35 degrees. According to another embodiment, the third portion of the recess is arranged between the first support surface and the first portion of the recess.

Brief description of the drawings

[0011] Embodiments of the invention are described below in more detail with reference to the accompanying drawings, in which

Fig. 1 shows a cross-sectional view of one cylinder of a piston engine according to an embodiment of the invention,

Fig. 2 shows a cross-sectional view of the cylinder liner of figure 1,

Fig. 3 shows a detail of figure 2,

Fig. 4 shows a cross-sectional view of the upper part of the cylinder together with a cooling jacket,

Fig. 5 shows a cooling jacket of the engine, and

Fig. 6 shows a cross-sectional view of the cooling jacket of figure 5.

Description of embodiments of the invention

[0012] In figure 1 is shown one cylinder 1 of a piston engine according to an embodiment of the invention. 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 can comprise any reasonable number of cylinders 1, which can be arranged, for instance, in line or in a V-configuration. Each cylinder 1 is provided with a cylinder liner 2 (best seen in Fig. 2), which is arranged partly inside an engine block 3. The upper end of the cylinder liner 2 is above the engine block 3. The term 'upper' means here the cylinder head end of the cylinder 1. Each cylinder 1 of the engine is provided with an own cylinder head 4, which is provided with gas exchange valves and ducts. The gas exchange ducts 5, 6 and the gas exchange valves (not shown) can be of conventional design and are therefore not described in more detail here. There is a reciprocating piston 9 inside the cylinder 1. The piston 9 is provided with a plurality of piston rings 9a. Also the piston 9 can be of conventional design.

[0013] For cooling the cylinder liner 2, the engine is provided with a cooling jacket 10. The cooling jacket 10 is arranged around the upper end of the cylinder liner 2. The cooling jacket 10 is completely above the engine block 3 and below the cylinder head 4. Together with an annular cooling recess 11 on the outer circumference of the cylinder liner 2, the cooling jacket 10 defines a cooling channel 12 between the cylinder liner 2 and the cooling jacket 10. The cooling channel 12 extends in the axial direction of the cylinder liner 2 over the area where the piston rings 9a are located when the piston 9 is at top dead center. This is the most critical point in regard to the cooling of the cylinder liner 2. The cross-section of the cooling recess 11 comprises a flat middle portion 11a and edge portions 11b, 11c. The depth of the upper edge portion 11b decreases towards the upper end of the recess 11 and the depth of the lower edge portion 11c decreases towards the lower end of the recess 11. The cooling recess 11 is thus substantially U-shaped. The shape of the cooling channel 12 enables effective cooling of the cylinder liner 2 but keeps the thermal stresses in the cylinder liner 2 low. Seals 13, 14 are provided at the upper and the lower ends of the cooling jacket 10 between the cylinder liner 2 and the cooling jacket 10 for preventing leakages from the cooling channel 12. Since the cooling channel 12 is completely above the engine block 3 and below the cylinder head 4, expensive cooling channels in the engine block 3 are not needed. The risk of cooling liquid leakages inside the engine block 3 is also eliminated and pressure testing of the engine block 3 is not needed.

[0014] The cylinder liner 2 is provided with three support surfaces 15, 16, 17 for supporting the cylinder liner 2 against the engine block 3. A first support surface 15 is arranged in the upper part of the cylinder liner 2 and it supports the cylinder liner 2 against the engine block 3 in the axial direction, i.e. in the direction of the longitudinal axis 18 of the cylinder liner 2. The first support surface 15 is an elbow that can be arranged against the upper surface of the engine block 3. A second support surface 16 is arranged in the upper part of the cylinder liner 2 below the first support surface 15. The second support surface 16 supports the cylinder liner 2 against the engine block 3 in the radial direction of the cylinder liner 2. The second support surface 16 is a portion of the cylinder liner 2 having a greater outer diameter than the basic outer diameter of the cylinder liner 2. A third support surface 17 is located in the lower part of the cylinder liner 2. Also the third support surface 17 carries radial forces.

[0015] Because the engine is provided with a single cooling channel 12 around the upper end of the cylinder liner 2, the thermal stresses of the cylinder liner 2 are larger than in conventional designs, where there are several cooling channels around the cylinder liner. To reduce the thermal stresses, the cylinder liner 2 is provided with an annular recess 19 that is arranged below the cooling recess 11 of the cylinder liner 2. Figure 3 shows an enlarged view of the recess 19. In the embodiment of the figures, the recess 19 is located above the second support surface 16. The recess 11 is also partly below the first support surface 15. The recess 19 encircles the whole cylinder liner 2. The recess 19 is formed of a first portion 19a, a second portion 19b, and a third portion 19c. When seeing the cross-section of the recess 19, the first portion 19a of the recess 19 is a sector of a circle. The radius of the first portion 19a of the recess is preferably 30-60 % of the thickness of the wall of the cylinder liner 2, more preferably 35-50 % of the thickness of the wall of the cylinder liner 2. In the embodiment of the figures, the radius is approximately 40 % of the thickness of the wall of the cylinder liner 2. The thickness of the

wall refers to the thickness outside of the support surfaces 15, 16, 17 or other reinforced areas of the cylinder liner 2. It is thus the thickness of the main part of the cylinder liner 2 between the second support surface 16 and the third support surface 17. The width of the sector that forms the first portion 19a is preferably in the range of 90 to 130 degrees. In the embodiment of the figures, the sector is approximately 110 degrees. The center 25 of the radius of the first, circular portion 19a of the recess 19 is located in the axial direction of the cylinder liner 2 at such a distance from the first support surface 15, which is less than the radius of the first portion 19a. Therefore, part of the first portion 19a of the recess 19 is located above the first support surface 15. In the radial direction of the cylinder liner 2, the center 25 of the radius is located inwards from the second support surface 16. The second portion 19b of the recess 19 is a straight cut that is merged with the first portion 19a of the recess 19. The second portion 19b is also merged with the second support surface 16 of the cylinder liner 2. The second portion 19b of the recess is at an angle a relative to the longitudinal axis 18 of the cylinder liner 2. Angle a is preferably 15 to 50 degrees, more preferably 25-35 degrees. In the embodiment of the figures, the angle is approximately 30 degrees. Also the third portion 19c of the recess 19 is a sector of a circle. The radius of the third portion 19c is smaller than the radius of the first portion 19a. The radius of the third portion 19c is preferably 5-15 % of the thickness of the wall of the cylinder liner 2. The width of the sector that forms the third portion 19c is preferably in the range of 30 to 60 degrees. The third portion 19c of the recess 19 is merged with the first support surface 15 of the cylinder liner 2 and with the first portion 19a of the recess 19. In the axial direction of the cylinder liner 2, the third portion 19c is above the first support surface 15. In the radial direction of the cylinder liner 2, the center 26 of the radius of the third portion 19c of the recess 19 is located outwards from the center 25 of the radius of the first portion 19a and inwards from the first support surface 15.

[0016] The construction of the cooling jacket 10 is best seen in figures 5 and 6. The cooling jacket 10 can be manufactured, for instance, by casting. The cooling jacket 10 is provided with a plurality of brackets 20, which can be used for attaching the cooling jacket 10 to the engine block 3. Since the cooling jacket 10 is fastened directly to the engine block 3, the cylinder liner 2 can be removed without removing the cooling jacket 10. This makes servicing of the cylinder liner 2 easier. The cooling jacket 10 is provided with an inlet 21 for introducing the cooling liquid into the cooling channel 12 and for draining the cooling channel 12 when needed. An outlet 22 is provided for discharging the cooling liquid from the cooling channel 12. From the outlet 22 the cooling liquid can be introduced into the cooling channels of the cylinder head 4. Also an inlet pipe 23 for the cooling liquid is integrated into the cooling jacket 10. In figure 4, the cooling jacket 10 can be seen in connection with the cylinder liner 2 and the cylinder head 4. Figure 4 also shows a gasket 24 between the cylinder liner 2 and the cylinder head 4. As it can be seen, the construction of the engine prevents mixing of the combustion gases and the cooling liquid even in case some of the seals 13, 14, 24 is leaking.

[0017] 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 cylinder liner (2) for a piston engine, which cylinder liner (2) comprises a first support surface (15) that can be arranged against an upper surface of an engine block (3) for carrying forces in the axial direction of the cylinder liner (2), a second support surface (16) that is located below the first support surface (16) in the axial direction of the cylinder liner (2) for supporting the cylinder liner (2) in the radial direction, and a third support surface (17) that is arranged below the second support surface (16) in the axial direction of the cylinder liner (2) for supporting the cylinder liner (2) in the radial direction, wherein the cylinder liner (2) is provided with a single cooling recess (11) encircling the outer circumference of the cylinder liner (2), the cooling recess (11) is located above the first support surface (15) in the axial direction of the cylinder liner (2), and the outer circumference of the cylinder liner (2) is provided with an annular recess (19) below the cooling recess (11) for reducing thermal stresses, wherein the cross-section of the recess (19) comprises a first portion (19a) that is a sector of a circle, and the radius of the circle is 30-60 % of the thickness of the wall of the cylinder liner (2) outside of the support surfaces (15, 16, 17) or other reinforced areas of the cylinder liner (2), and that the recess (19) comprises a portion (19c) that is a sector of a circle and has a smaller radius than the first portion (19a) of the recess (19).

2. A cylinder liner (2) according to claim 1, **characterized in that** the recess (19) is located at least partly below the first support surface (15).

3. A cylinder liner (2) according to claim 2, **characterized in that** the recess (19) is merged with the first support surface (15).

4. A cylinder liner (2) according to any of claims 1-3, **characterized in that** the recess (19) is located above the second support surface (16).

5. A cylinder liner (2) according to claim 4, **characterized in that** the recess (19) is merged with the second support surface (16).

6. A cylinder liner (2) according to any of the preceding claims, **characterized in that** the recess (19) comprises a second portion (19b), where the wall of the recess (19) is at an angle a relative to the longitudinal center line (18) of the cylinder liner (2), a being 15-50 degrees.

7. A cylinder liner (2) according to claim 6, **characterized in that** a is 25-35 degrees.

8. A cylinder liner (2) according to any of the preceding claims, **characterized in that** the third portion (19c) of the recess (19) is arranged between the first support surface (15) and the first portion (19a) of the recess (19).

9. A piston engine comprising an engine block (3), at least one cylinder liner (2) that is arranged partly inside the engine block (3), a cylinder head (4) for closing the upper end of the cylinder liner (2), and a cooling jacket (10) that is arranged around the cylinder liner (2) and delimits together with the cylinder liner (2) a cooling channel (12), wherein each cylinder (1) of the engine is provided with only one cooling channel (12) for cooling the cylinder liner (2), and the whole cooling channel (12) is arranged above the engine block (3), **characterized in that** the cylinder liner (2) is a cylinder liner (2) according to any of the preceding claims.

Patentansprüche

1. Zylinderlaufbuchse (2) für einen Kolbenmotor, wobei die Zylinderlaufbuchse (2) eine erste Tragfläche (15), die an einer oberen Fläche eines Motorblocks (3) zum Tragen von Kräften in der axialen Richtung der Zylinderlaufbuchse (2) angeordnet werden kann, eine zweite Tragfläche (16), die sich unterhalb der ersten Tragfläche (16) in der axialen Richtung der Zylinderlaufbuchse (2) zum Stützen der Zylinderlaufbuchse (2) in der radialen Richtung befindet, und eine dritte Tragfläche (17), die unterhalb der zweiten Tragfläche (16) in der axialen Richtung der Zylinderlaufbuchse (2) zum Stützen der Zylinderlaufbuchse (2) in der radialen Richtung angeordnet ist, umfasst, wobei die Zylinderlaufbuchse (2) mit einer den Außenumfang der Zylinderlaufbuchse (2) umgebenden einzelnen Kühlvertiefung (11) versehen ist, wobei die Kühlvertiefung (11) sich oberhalb der ersten Tragfläche (15) in der axialen Richtung der Zylinderlaufbuchse (2) befindet und der Außenumfang der Zylinderlaufbuchse (2) mit einer ringförmigen Vertiefung (19) unterhalb der Kühlvertiefung (11) zum Reduzieren von thermischer Belastung versehen ist, wobei der Querschnitt der Vertiefung (19) einen ersten Abschnitt (19a) umfasst, der ein Teilabschnitt eines Kreises ist, und der Radius des Kreises 30-60 % der Wanddicke der Zylinderlaufbuchse (2) außerhalb der Tragflächen (15, 16, 17) oder anderer verstärkter Bereiche der Zylinderlaufbuchse (2) beträgt, und dass die Vertiefung (19) einen Abschnitt (19c) umfasst, der ein Teilabschnitt eines Kreises ist und einen kleineren Radius als der erste Abschnitt (19a) der Vertiefung (19) aufweist.

2. Zylinderlaufbuchse (2) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vertiefung (19) sich mindestens teilweise unterhalb der ersten Tragfläche (15) befindet.

3. Zylinderlaufbuchse (2) nach Anspruch 2, **dadurch gekennzeichnet, dass** die Vertiefung (19) mit der ersten Tragfläche (15) verbunden ist.

4. Zylinderlaufbuchse (2) nach einem der Ansprüche 1-3, **dadurch gekennzeichnet, dass** die Vertiefung (19) sich oberhalb der zweiten Tragfläche (16) befindet.

5. Zylinderlaufbuchse (2) nach Anspruch 4, **dadurch gekennzeichnet, dass** die Vertiefung (19) mit der zweiten Tragfläche (16) verbunden ist.

6. Zylinderlaufbuchse (2) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Vertiefung (19) einen zweiten Abschnitt (19b) umfasst, wobei die Wand der Vertiefung (19) in einem Winkel α bezüglich der longitudinalen Mittenlinie (18) der Zylinderlaufbuchse (2) ist, wobei α 15-50 Grad beträgt.

7. Zylinderlaufbuchse (2) nach Anspruch 6, **dadurch gekennzeichnet, dass** α 25-35 Grad beträgt.

8. Zylinderlaufbuchse (2) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der dritte Abschnitt (19c) der Vertiefung (19) zwischen der ersten Tragfläche (15) und dem ersten Abschnitt (19a) der Vertiefung (19) angeordnet ist.

9. Kolbenmotor, der einen Motorblock (3), mindestens eine Zylinderlaufbuchse (2), die teilweise in dem Motorblock (3) angeordnet ist, einen Zylinderkopf (4) zum Schließen des oberen Endes der Zylinderlaufbuchse (2) und einen Kühlmantel (10) umfasst, der um die Zylinderlaufbuchse (2) herum angeordnet ist und zusammen mit der Zylinderlaufbuchse (2) einen Kühlkanal (12) begrenzt, wobei jeder Zylinder (1) des Motors mit nur einem Kühlkanal (12) zum Kühlen der Zylinderlaufbuchse (2) versehen ist und der komplette Kühlkanal (12) über dem Motorblock (3) angeordnet ist, **dadurch gekennzeichnet, dass** die Zylinderlaufbuchse (2) eine Zylinderlaufbuchse (2) nach einem der vorhergehenden Ansprüche ist.

Revendications

1. Chemise de cylindre (2) pour un moteur à pistons, laquelle chemise de cylindre (2) comprend une première surface de support (15) qui peut être agencée contre une surface supérieure d'un bloc moteur (3) pour supporter des forces dans la direction axiale de la chemise de cylindre (2), une deuxième surface de support (16) qui est située en-dessous de la première surface de support (16) dans la direction axiale de la chemise de cylindre (2) pour supporter la chemise de cylindre (2) dans la direction radiale, et une troisième surface de support (17) qui est agencée en-dessous de la deuxième surface de support (16) dans la direction axiale de la chemise de cylindre (2) pour supporter la chemise de cylindre (2) dans la direction radiale, dans laquelle la chemise de cylindre (2) est dotée d'une cavité de refroidissement unique (11) encerclant la circonférence extérieure de la chemise de cylindre (2), la cavité de refroidissement (11) est située au-dessus de la première surface de support (15) dans la direction axiale de la chemise de cylindre (2), et la circonférence extérieure de la chemise de cylindre (2) est dotée d'une cavité annulaire (19) en-dessous de la cavité de refroidissement (11) pour réduire les contraintes thermiques, dans laquelle la section transversale de la cavité (19) comprend une première partie (19a) qui est un secteur d'un cercle, et la rayon du cercle est 30-60 % de l'épaisseur de la paroi de la chemise de cylindre (2) hors des surfaces de support (15, 16, 17) ou d'autres zones renforcées de la chemise de cylindre (2), et que la cavité (19) comprend une partie (19c) qui est un secteur d'un cercle et a un rayon plus petit que la première partie (19a) de la cavité (19).

2. Chemise de cylindre (2) selon la revendication 1, **caractérisée en ce que** la cavité (19) est située au moins partiellement en-dessous de la première surface de support (15).

3. Chemise de cylindre (2) selon la revendication 2, **caractérisée en ce que** la cavité (19) est fusionnée avec la première surface de support (15).

4. Chemise de cylindre (2) selon l'une quelconque des revendications 1-3, **caractérisée en ce que** la cavité (19) est située au-dessus de la deuxième surface de support (16).

5. Chemise de cylindre (2) selon la revendication 4, **caractérisée en ce que** la cavité (19) est fusionnée avec la deuxième surface de support (16).

6. Chemise de cylindre (2) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la cavité (19) comprend une seconde partie (19b), où la paroi de la cavité (19) est à un angle α par rapport à la ligne centrale longitudinale (18) de la chemise de cylindre (2), α étant de 15-50 degrés.

7. Chemise de cylindre (2) selon la revendication 6, **caractérisée en ce que** α est de 25-35 degrés.

8. Chemise de cylindre (2) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la troisième partie (19c) de la cavité (19) est agencée entre la première surface de support (15) et la première partie (19a) de la cavité (19).

9. Moteur à pistons comprenant un bloc moteur (3), au moins une chemise de cylindre (2) qui est agencée partiellement à l'intérieur du bloc moteur (3), une tête de cylindre (4) pour fermer l'extrémité supérieure de la chemise de cylindre (2), et une enveloppe de refroidissement (10) qui est agencée autour de la chemise de cylindre (2) et délimite conjointement avec la chemise de cylindre (2), un canal de refroidissement (12), dans laquelle chaque cylindre (1) du moteur est doté d'un seul canal de refroidissement (12) pour refroidir la chemise de cylindre (2), et la totalité du canal de refroidissement (12) est agencée au-dessus du bloc moteur (3), **caractérisée en ce que** la chemise de cylindre (2) est une chemise de cylindre (2) selon l'une quelconque des revendications précédentes.

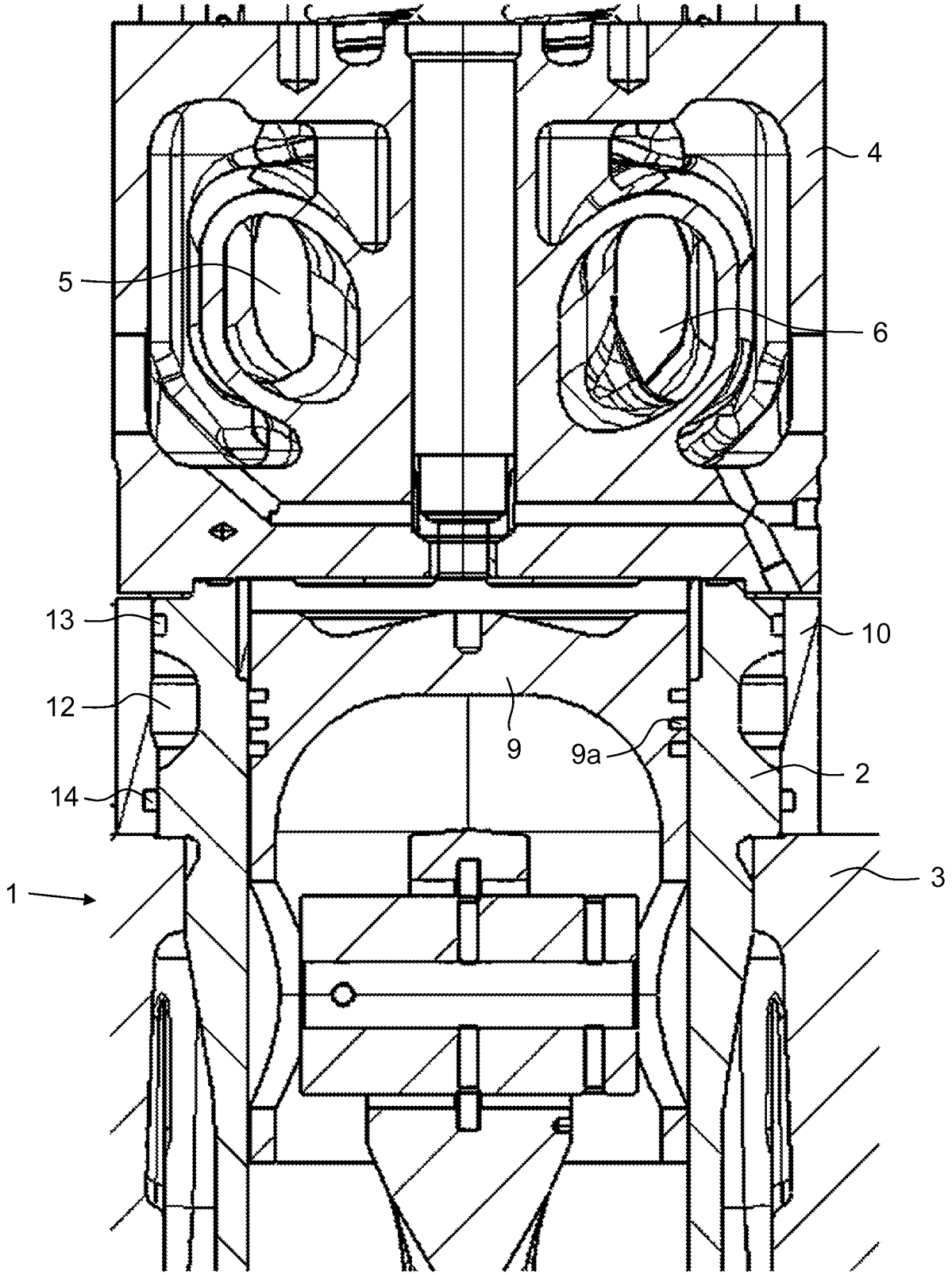

FIG. 1

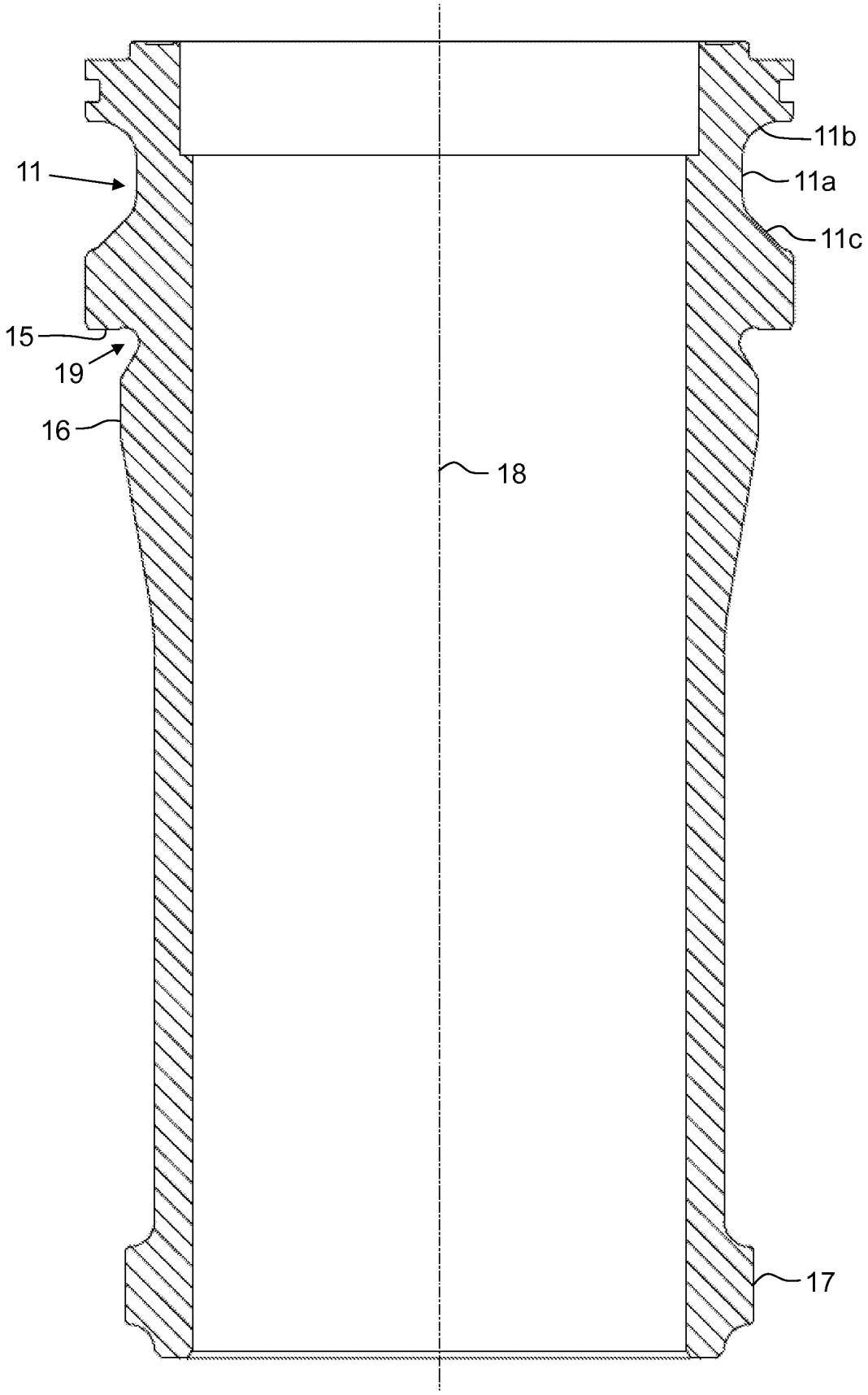

FIG. 2

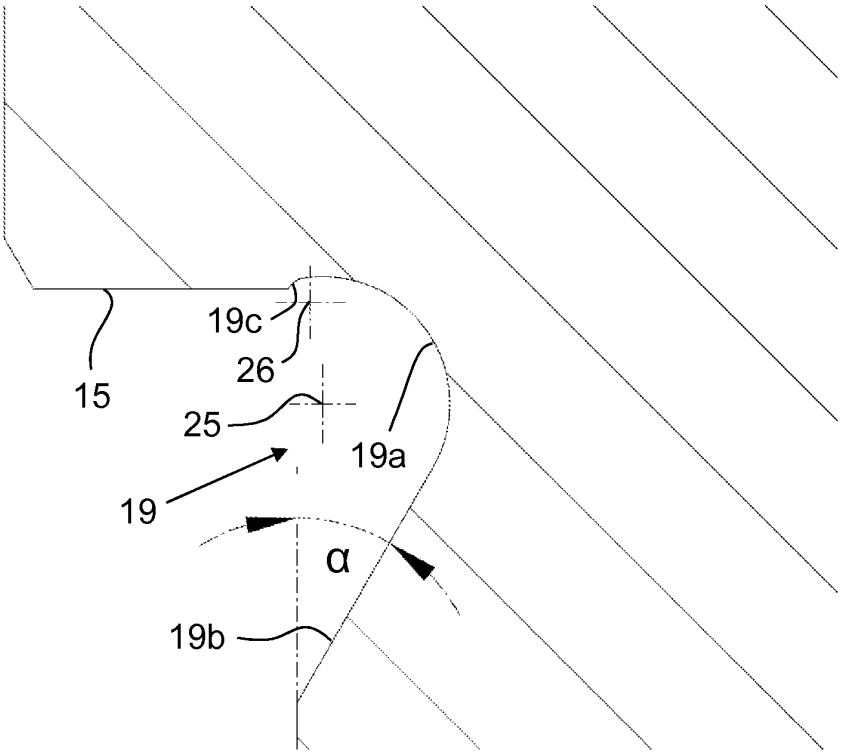

FIG. 3

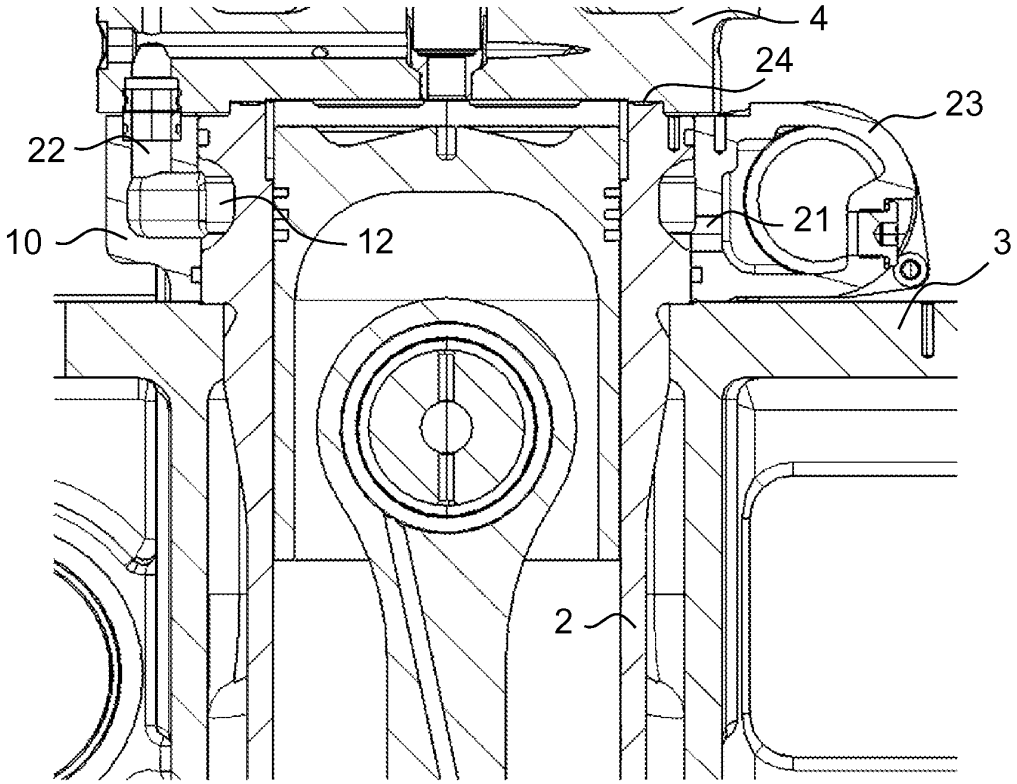

FIG. 4

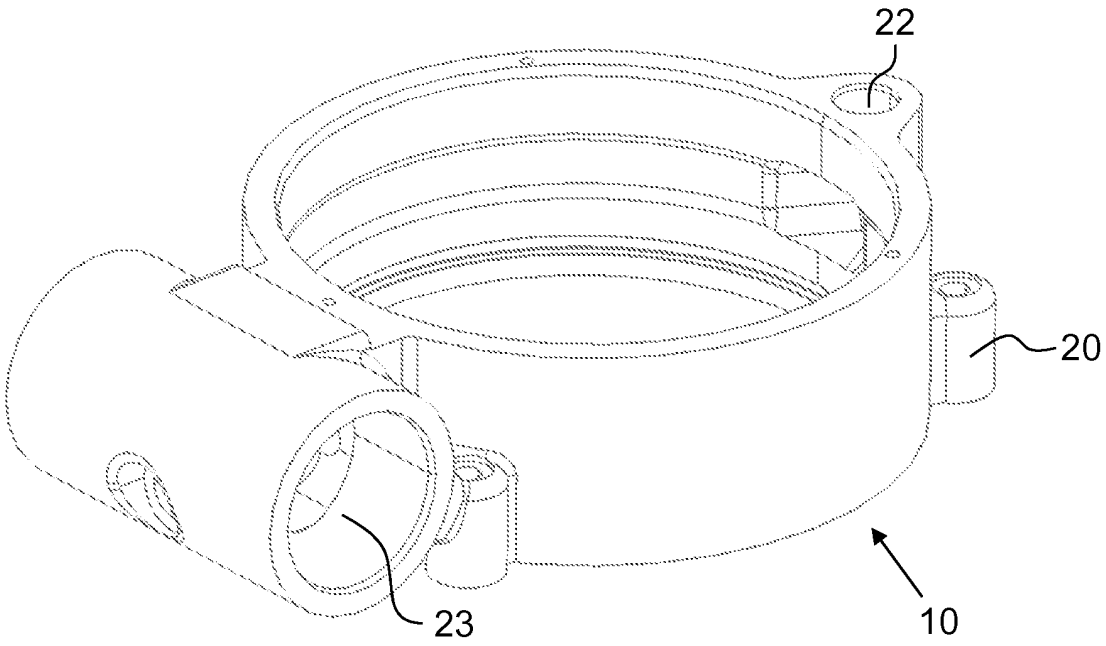

FIG. 5

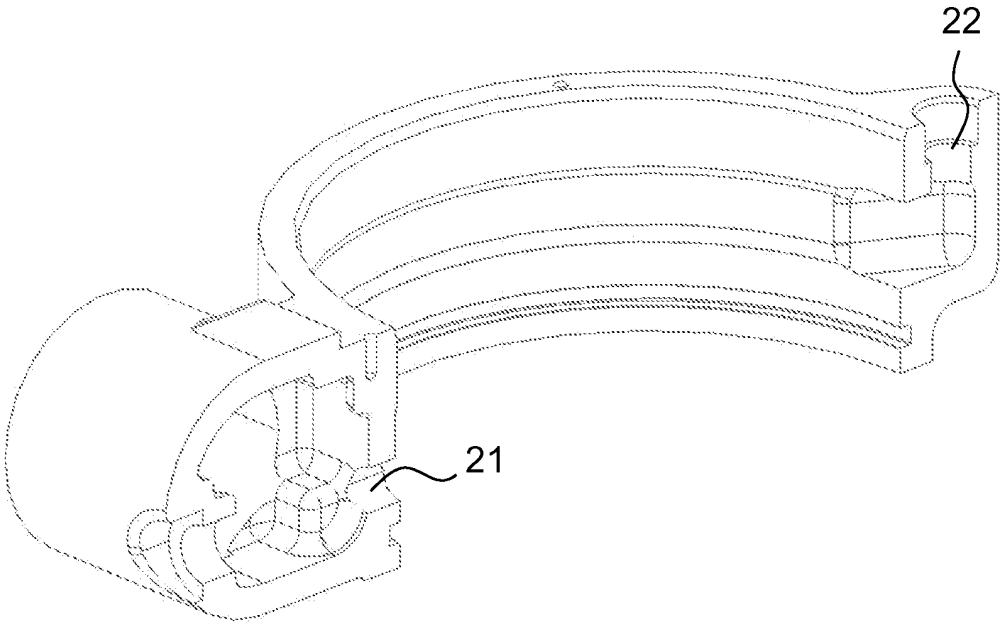

FIG. 6

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

- DD 133985 A1 **[0003]**
- EP 1087124 A2 **[0004]**
- US 4440118 A **[0004]**