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(54) **DIESEL INTERNAL COMBUSTION ENGINE**

(57) A Diesel combustion engine includes at least one cylinder (C) with a respective piston (P) and a respective fire ring (FR) inserted in a stepped housing (FRH) defined in a cylinder liner (CL) so as to surround a respective combustion chamber (CC); an outer surface (OS) of the fire ring (FR), intended to contact the stepped housing (FRH), is shaped so as to include at least one protruding portion shaped as a tip or a ridge and to reduce a thermal exchange between the fire ring and the cylinder liner; an upper edge of the fire ring consists of a cutting edge, in contact with a cylinder head (H) and defining a sealing effect between the fire ring (FR) and the cylinder head (H).

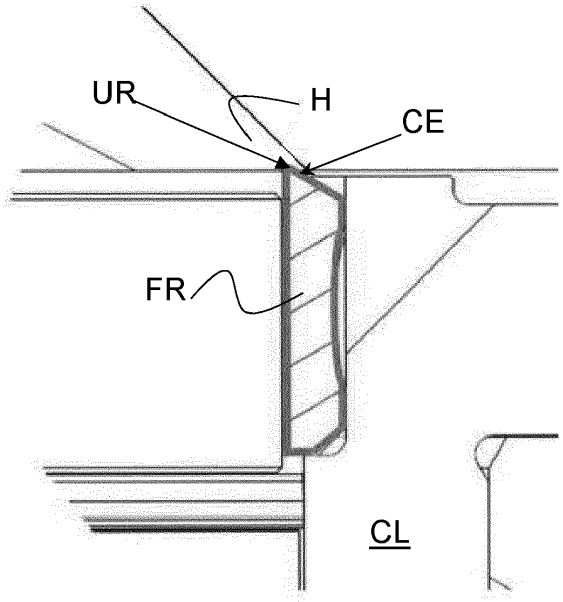

Fig. 5

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Description

Cross-reference to related applications

[0001] This patent application claims priority from Italian patent application no. 102018000020110 filed on 18/12/2018.

Field of the invention

[0002] The present invention relates to a diesel internal combustion engine.

Description of the prior art

[0003] Diesel combustion engines develop a high particulate amount during fuel combustion.

[0004] This particulate lead to solid deposits that must be removed from the cylinder liner though the piston rings and oil scraper.

[0005] To extend the service life of commercial vehicle engines and cut harmful exhaust emissions, some engine manufacturers are increasingly using cylinder sleeves with a fire ring, usually made of steel.

[0006] A fire ring, also called oil scraper ring, in a fixed ring stuck in the cylinder liner in order to surround the combustion chamber.

[0007] The fire ring protrudes within the combustion chamber, but without any impact with the piston crown when it reaches the top dead center. Thus, at the inner diameter of the fire ring is smaller than inner diameter of the cylinder bore.

[0008] Figure 1 discloses an example internal combustion engine implementing a fire ring according to what applicant considers to be state of the art. The piston P is represented in its TDC position.

[0009] Figure 2 discloses a magnified portion of figure 1.

[0010] Here, the fire ring protrudes for about 0.15 mm within the combustion chamber CC.

[0011] The piston P has the top surface usually called crown PCR. According to figure 2, the clearance between the lateral surface of the piston and the cylinder liner CL is about 0.18 mm, therefore, there is no collision risk.

[0012] The fire ring defines a sort of seal between the combustion chamber and the annular clearance between the piston and the cylinder liner, preventing carbon from depositing on the cylinder liner and thus on the piston rings and piston oil scrape PR.

[0013] The fire ring, in addition, reduces the production of particulate and thus its deposition on the cylinder head.

[0014] This aspect is particularly relevant because the carbon deposits reduce engines maintenance.

[0015] The features disclosed in the prior art background are introduced only in order to better understand the invention and not as a declaration about the existence of known prior art. In addition, said features define the context of the present invention, thus such features shall be considered in common with the detailed description.

Summary of the invention

[0016] The main object of the present invention to improve the effectiveness of the fire ring by modification of its shape.

[0017] According to the present invention, a method for improving the combustion of a diesel combustion engine is provided as defined in claim 1, and a diesel combustion engine is provided as defined in claim 8.

[0018] The main principle of the invention is to reduce the thermal exchange between the fire ring and the cylinder liner by reducing the contact surface between the outer face of the fire ring. This is preferably achieved by protruding portions shaped as tips or ridges fairly distributed along with the outer surface of the fire ring. Preferably, said ridges are shaped as annular protruding portions concentric on a cylinder symmetry axis.

[0019] Said protruding portions are formed in one piece with the fire ring.

[0020] Preferably, according to another embodiment, there is only one annular protruding portion shaped as a ring or rim.

[0021] In this way the fire ring has only two circumferential contact portions, one defined by the annular protruding ring or rim and the lower edge arranged to contact the stepped housing in the cylinder liner.

[0022] According to another embodiment, two protruding ring or rims are formed on the outer surface of the fire ring, respectively arranged close to the upper and lower edge of the fire ring in order to assure an optimal stability of the fire ring in the above stepped housing.

[0023] According to the invention, the upper edge is shaped as a cutting edge protruding towards the cylinder head. This cutting edge defines a sort of additional head gasket operating with a smaller diameter in comparison with the conventional cylinder/head gasket.

[0024] Advantageously, this cutting edge, not only results to be more effective as cylinder/head gasket, but also reduces the dead volume which reduces the engine efficiency.

[0025] These and further objects are achieved by means of the attached claims, which describe preferred embodiments of the invention, forming an integral part of the present description.

Brief description of the drawings

[0026] The invention will become fully clear from the following detailed description, given by way of a mere exemplifying and non limiting example, to be read with reference to the attached drawing figures, wherein:

- Fig. 1 shows a longitudinal sectional view of an internal combustion engine according to the state of the art, wherein the plane of the section perpendicular with the piston pin;

- Fig. 2 shows a zoomed portion of figure 1 centered on the fire ring;
- Fig.3 discloses a first example of a fire ring, which is not part of the present invention;
- Fig. 4 discloses a second example of a fire ring, which is not part of the present invention;
- Fig. 5 discloses an embodiment of a detail of the fire ring that can implemented both in the examples of figures 3 and 4 and is made according to the teachings of the present invention.

[0027] The same reference numerals and letters in the figures designate the same or functionally equivalent parts.

[0028] In order to render easier the understanding of the present invention, the same general reference numerals and letters are used with respect to figure 1 and 2 of the prior art. According to the present invention, the term "second element" does not imply the presence of a "first element", first, second, etc.. are used only for improving the clarity of the description and they should not be interpreted in a limiting way.

Detailed description of the preferred embodiments

[0029] Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art.

[0030] The main aim of the present invention is to reduce the contact surface between the fire ring FR and its housing FRH in the top portion of the cylinder liner CL.

[0031] This reduction leads to a substantial thermal insulation between the two components.

[0032] The top portion of the cylinder is close to the cylinder head H. The housing is conventionally obtained by enlarging the cylinder bore by achieving a stepped profile.

[0033] In such stepped profile, as usual, the fire ring FR is inserted.

[0034] The fire ring consist substantially in a ring with an inner surface IS, facing the combustion chamber, and an outer surface OS facing the housing FR.

[0035] An upper and lower edges conjoin the inner and outer surfaces. The outer surface usually has a cylindrical shape and lower edge has a shape such that to axially interfere with the stepped housing. The term "axially" is referred to the symmetry axis X of the cylinder, which coincides with the symmetry axis of the fire ring.

[0036] Thus, a first contact region C1 is flat and defined according to a plane perpendicular to the symmetry axis X of the cylinder between the stepped housing and the lower edge of the fire ring.

[0037] Such contact region C1 is flat because the lower edge of the fire ring is flat and perpendicular with respect to the inner surface IS of the fire ring.

[0038] Here, "lower" and "higher" are defined by considering the convention, namely the head is the higher portion and the crankshaft (not disclosed) is the lower portion of the engine. According to the same convention, TDC (top dead center) and BDC (bottom dead center) are defined in relation with the piston displacement.

[0039] According to any of the figures 1 - 5, the stepped housing FRH has also a cylindrical surface LF, coaxial with the cylinder axis X, larger with respect to the cylinder bore. According to the embodiment of figure 3, the fire ring FR has an outer surface including an annular protruding ring CR, arranged between the upper and lower edges of the outer surface of the fire ring.

[0040] According to figure 3, it is clear that the annular protruding ring CR, which as a ridge defined on the annular outer surface of the fire ring, defines a mechanical and thermal interface with the cylindrical surface LF of the housing FRH. Also in this case, a second contact region C2 is defined. This contact region is substantially perpendicular to the first contact region C1.

[0041] The more the annular ring CR protrudes, the less is the first contact region C1.

[0042] The protrusion of inner surface of the fire ring in the combustion chamber is supposed to remain unchanged, therefore, single protruding ring CR defines two clearances in the stepped housing having triangular shape according to the longitudinal sections of figure 3.

[0043] According to figure 4, the central portion of the annular outer surface of the fire ring is machined such that two ridges R1, R2 are defined. Such ridges are arranged close to the opposite ends of the outer surface of the fire ring. The outer surface can be machined at the lower edge so as to reduce the first contact region C1. The outer surface can be machined at the upper end, close to the cylinder head, such that two triangular clearances are defined between the fire ring and the cylindrical surface when in operation, according to the above sectional view.

[0044] According to a preferred embodiment of the solution of figure 4, the central portion of the outer surface of the fire ring is machined such as to obtain hemispherical surface with radius 15 mm, by operatively defining a circular segment, according to the above sectional view. This solution result particularly advantageous during insertion of the fire ring within the stepped housing.

[0045] It should be understood that a similar effect can be achieved if the outer surface of the fire ring has high roughness, such as peaks, fairly distributed on the outer surface of the fire ring. However, it is more complicate to produce such peaks.

[0046] Preferably, the outer surface OS of the fire ring is provided with annular rings, substantially rims, coaxial with symmetry axis X of the cylinder.

[0047] Figure 5 discloses an embodiment of the invention that can be combined with the examples of figures 3 and 4.

[0048] It is known that the cylinder head receives a high thermal stress, however the cylinder head H is highly refreshed by the engine water. Therefore, to better insulate the fire ring from the cylinder head H, also the upper edge of the fire ring FR is machined so as to define a

cutting edge.

[0049] In other words, while the inner surface of the fire ring remains unchanged, e.g. it remains cylindrical, the outer surface is machined at the upper edge in order to define an upper ridge UR intended to contact the cylinder head H, so as to reduce thermal exchange with the latter. As shown in figure 5, the ridge UR is defined by an edge joining a first surface and a second surface, inclined one with respect of the other by means of an acute angle. Preferably, the first surface is the cylindrical inner surface of the fire ring, as it remains unchanged, as mentioned above, and the second surface is a frusto-conical surface CE, that joins the ridge UR to the contact region of an annular rim contacting the cylinder CL.

[0050] The fact of leaving unchanged the inner surface gives also further benefits. Indeed, this cutting edge defined by the ridge UR defines a sort of additional head gasket operating with a smaller diameter in comparison with the conventional cylinder/head gasket.

[0051] In addition, the cutting edge of the ridge UR defines a sort of shield for the cylinder head gasket and reduces the dead volume, which would otherwise reduce the engine efficiency.

[0052] Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well known processes, well-known device structures, and well known technologies are not described in detail.

[0053] Many changes, modifications, variations and other uses and applications of the subject invention will become apparent to those skilled in the art after considering the specification and the accompanying drawings which disclose preferred embodiments thereof as described in the appended claims.

[0054] Further implementation details will not be described, as the man skilled in the art is able to carry out the invention starting from the teaching of the above description.

Claims

1. Method for improving the combustion of a diesel combustion engine comprising at least one cylinder (C) with a respective piston (P) and a respective fire ring (FR), which is inserted in a stepped housing (FRH) defined in a cylinder liner (CL) so as to surround a respective combustion chamber (CC), the method comprising the steps of:

   - shaping an outer surface (OS) of the fire ring (FR), intended to contact said stepped housing (FRH), so as to comprise at least one annular protruding portion shaped as a tip or a ridge so as to reduce a thermal exchange between the fire ring and the cylinder liner;
   - machining said outer surface at an upper edge of the fire ring (FR) in such a manner that said upper edge consists of a cutting edge intended to contact a cylinder head (H) of the combustion engine and to define a sealing effect between the fire ring (FR) and the cylinder head (H).

2. Method according to claim 1, **characterized in that** said at least one annular protruding portion is shaped as an annular rim coaxial with a symmetry axis (X) of said cylinder.

3. Method according to claim 2, wherein said outer surface is shaped so as to comprise a single one annular protruding portion defining a single annular rim (CR) arranged at an intermediate portion of said outer surface (OF), between said upper edge and a lower edge of the fire ring.

4. Method according to claim 2, wherein said outer surface is shaped so as to comprise two annular protruding portions defining respectively a first annular rim and a second annular rim (R1, R2), wherein the first annular rim is close to a lower edge of said fire ring and the second annular rim is close to said upper edge of said fire ring.

5. Method according to claim 4, wherein between said first and second annular rims an intermediate portion of the fire ring is machined so as to define a circular segment, according to a longitudinal sectional view traced so as to include the symmetry axis (X) of the fire ring, said symmetry axis of the fire ring coinciding with the symmetry axis of the cylinder.

6. Method according to any of previous claims 1 - 5, further comprising the step of machining said outer surface at a lower edge of the fire ring in such a manner that, according to a longitudinal sectional view, the lower edge is tapered and has a reduced first contact region (C1) in contact with said stepped housing, wherein said first contact region is flat and develops on a plane perpendicular to a cylinder symmetry axis (X).

7. Method according to anyone of the previous claims, wherein said cutting edge forms an acute angle.

8. Diesel combustion engine comprising at least one cylinder (C) with a respective piston (P) and a respective fire ring (FR), which is inserted in a stepped housing (FRH) defined in a cylinder liner (CL) so as to surround a respective combustion chamber (CC), the fire ring comprising:

- an outer surface (OS) which is in contact with said stepped housing (FRH) and is shaped so as to comprise at least one annular protruding portion shaped as a tip or a ridge so as to reduce a thermal exchange between the fire ring and the cylinder liner;
- an upper edge;

characterized in that said outer surface is recessed at said upper edge in such a manner that said upper edge consists of a cutting edge in contact with a cylinder head (H) of the combustion engine and defining a sealing effect between the fire ring (FR) and the cylinder head (H).

9. Engine according to claim 8, wherein said at least one protruding portion is shaped as an annular rim coaxial with a symmetry axis (X) of said cylinder.

10. Engine according to claim 9, wherein said outer surface is shaped so as to comprise a single one protruding portion defining a single annular ring (CR) arranged at an intermediate portion of said outer surface (OF) between said upper edge and a lower edge of the fire ring.

11. Engine according to claim 9, wherein said outer surface is shaped so as to include two annular protruding portions defining respectively a first annular rim and a second annular rim (R1, R2), wherein the first annular rim is close to a lower edge of said fire ring and the second annular rim is close to said upper edge of said.

12. Engine according to claim 11, wherein between said first and second annular rims an intermediate portion of the fire ring defines a circular segment, according to a longitudinal sectional view traced so as to include the symmetry axis (X) of the fire ring, the symmetry axis (X) of the fire ring coinciding with the symmetry axis of the cylinder.

13. Engine according to anyone of the claims 8 to 12, wherein said cutting edge forms an acute angle.

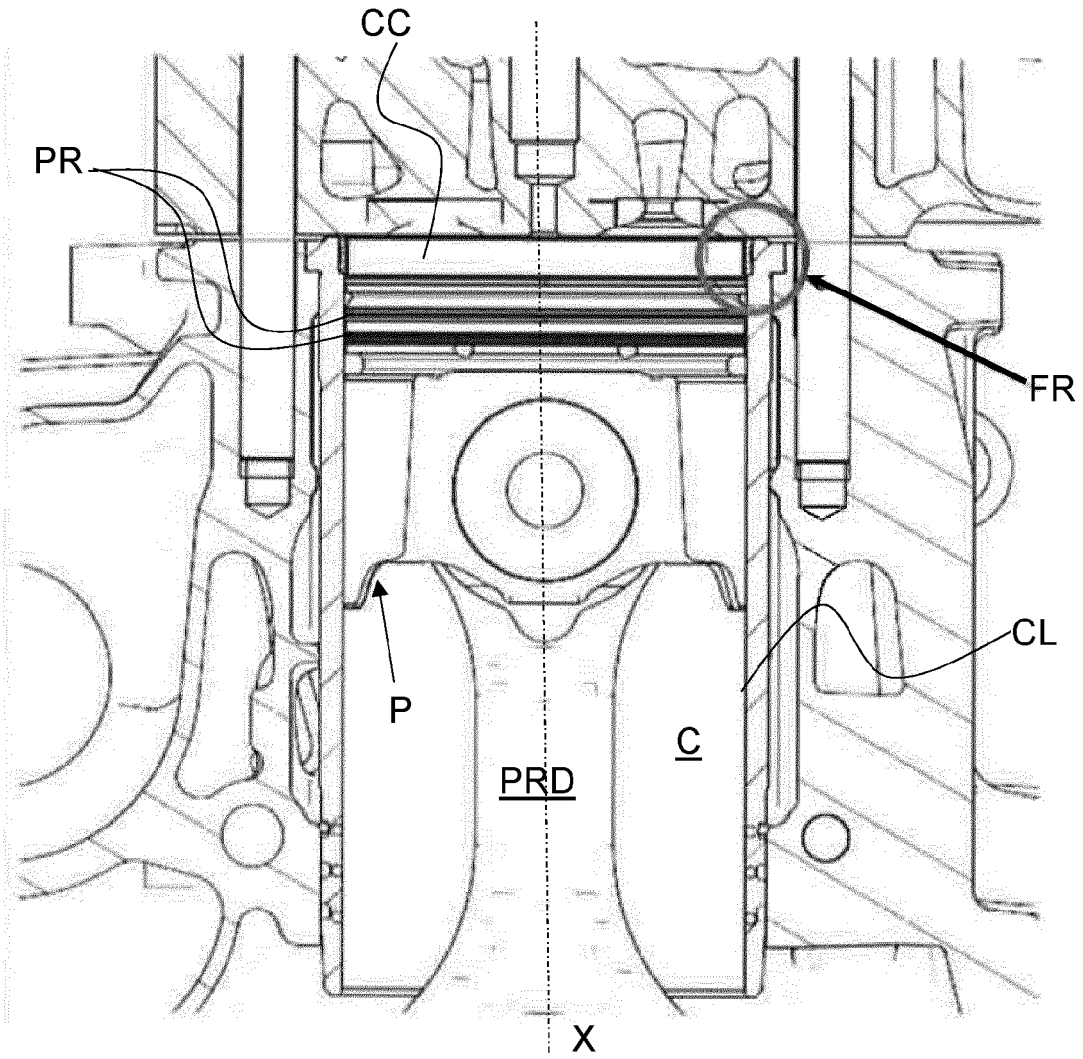

Fig. 1 (state of the Art)

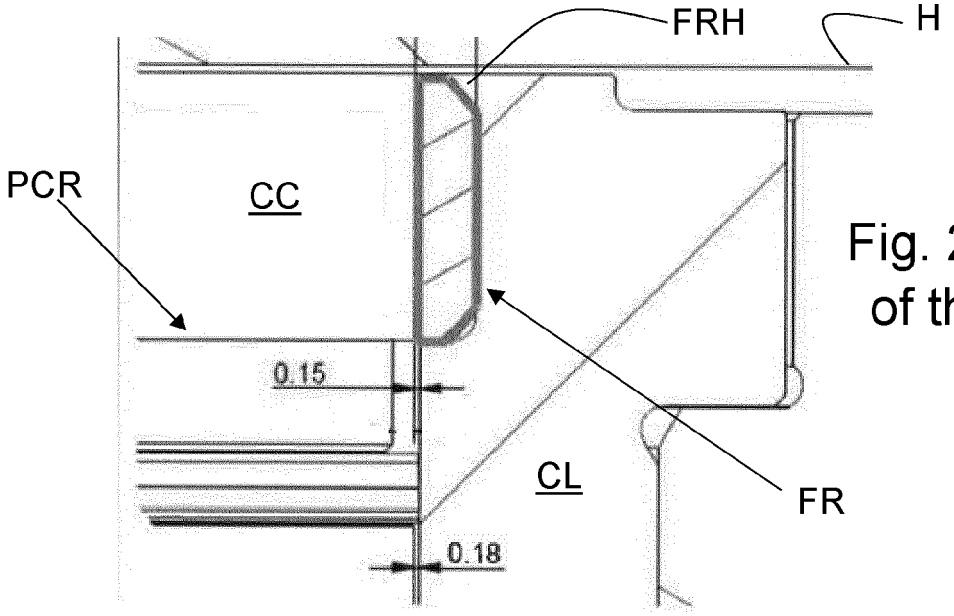

Fig. 2 (state of the Art)

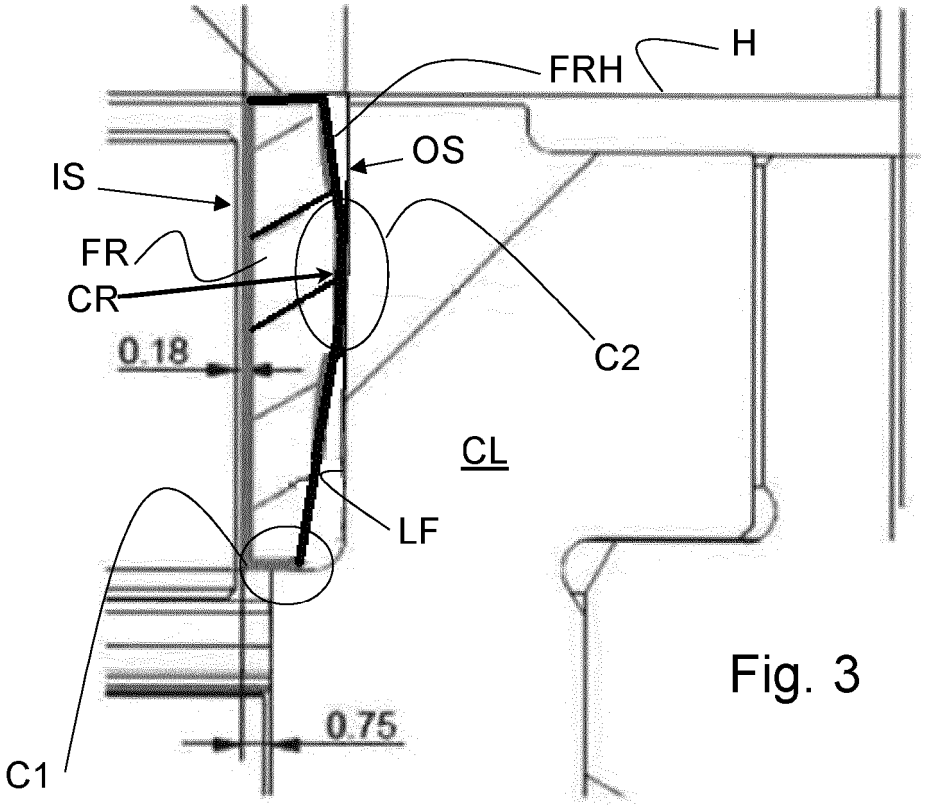
H
FRH
OS
IS
FR
CR
0.18
C2
CL
LF
C1
0.75

Fig. 3

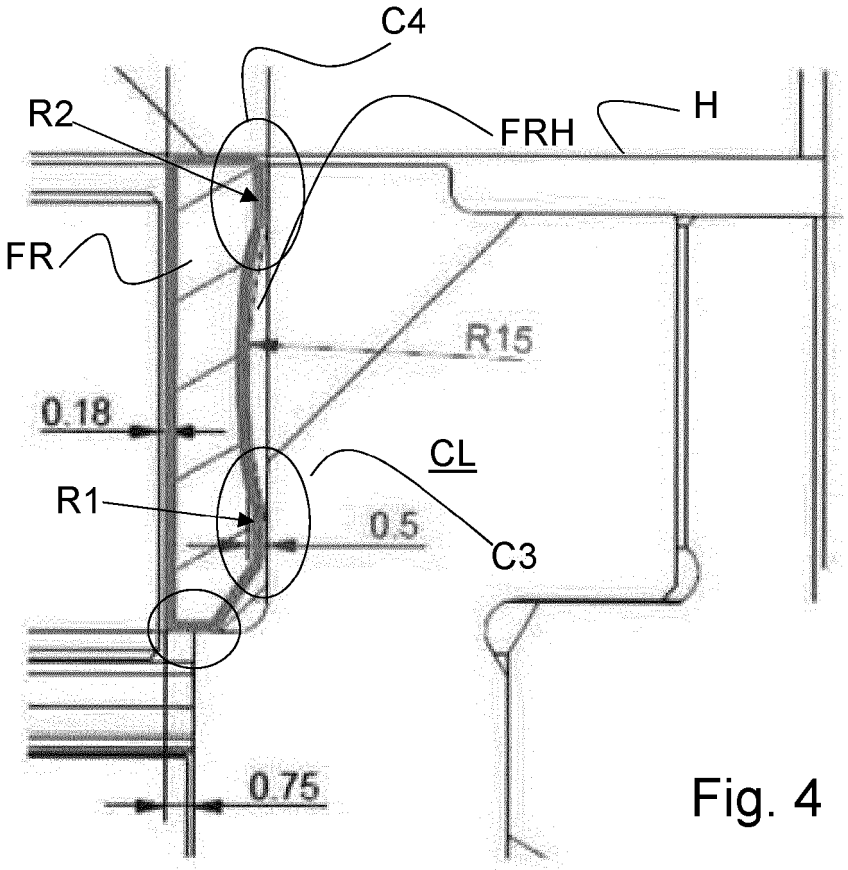
C4
R2
H
FRH
FR
R15
0.18
CL
R1
0.5
C3
0.75

Fig. 4

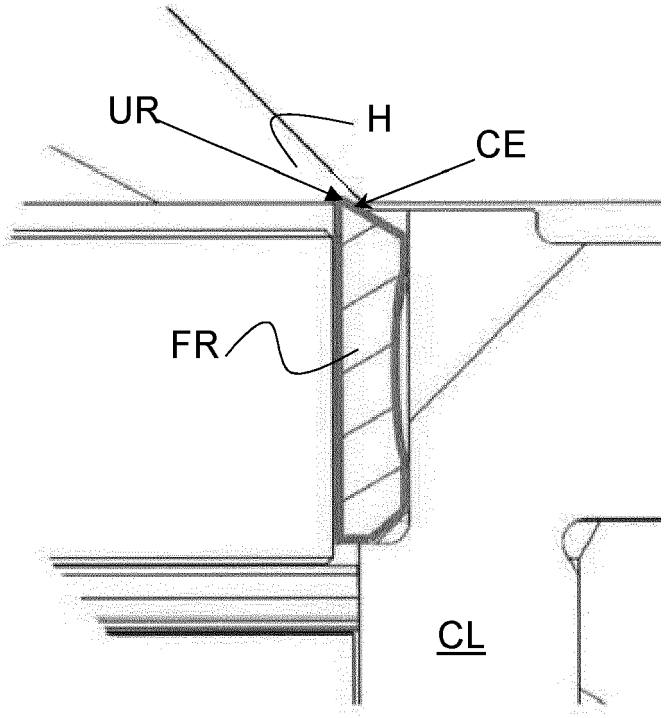

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 7077

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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	8 April 2020	Matray, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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