

(19)



(11)

EP 2 138 679 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

30.12.2009 Bulletin 2009/53

(51) Int Cl.:

F01L 3/22 (2006.01)

F01L 3/02 (2006.01)

(21) Application number: **08159248.7**

(22) Date of filing: **27.06.2008**

(84) Designated Contracting States:

**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT
RO SE SI SK TR**

Designated Extension States:

AL BA MK RS

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Remarks:

Amended claims in accordance with Rule 137(2)
EPC.

(54) **Valve seat**

(57) The invention relates to a valve arrangement and a valve seat insert in a cylinder head in an internal combustion engine comprising at least one combustion chamber provided with at least one intake valve cooperating with a valve seat insert, said valve seat insert being

arranged in a cavity in the cylinder head and having a first surface facing the combustion chamber and a second surface facing a corresponding surface in the cylinder head. The valve seat arrangement is provided with means for conveying pressure from the combustion chamber to the outer periphery of the valve seat insert.

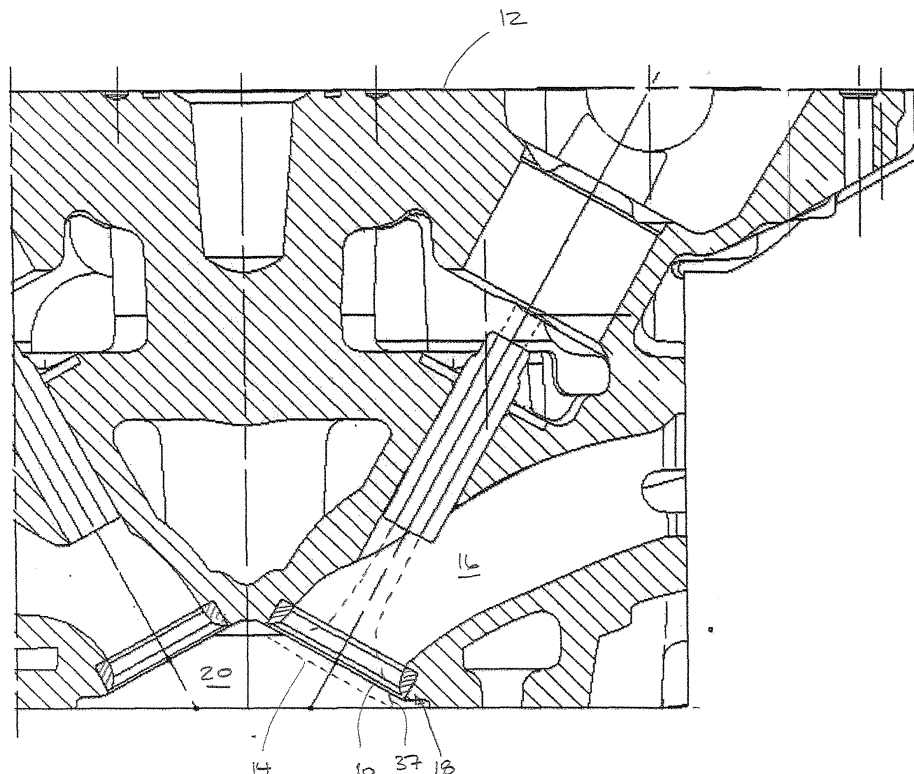


FIG. 1

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Description

TECHNICAL FIELD

[0001] This invention relates to a valve arrangement and a valve seat insert which substantially prevents corrosion within an engine cylinder head.

BACKGROUND ART

[0002] Valve seat inserts are used in automotive vehicles and are typically and operatively disposed within the cylinder head of a vehicle engine. Particularly, valve seat inserts are selectively forced or press-fitted into a "pocket" or cavity within the cylinder head and are typically manufactured from a relatively hard, wear-resistant and heat-resistant material, such as a cast or sintered metal material. When operatively installed, the valve seat inserts are effective to provide a seating surface for the engine's valves, thereby allowing the valves to selectively open and close. While these valve seats or valve seat inserts provide a strong and durable seating surface for the engine's valves, they suffer from some drawbacks.

[0003] For example and without limitation, one such drawback arises from the press-fit engagement or mating of the valve seat insert within the cavity or pocket of the cylinder head. Particularly, the press-fit mating of the valve seat insert results in the formation of a minute gap or crevice between the "top" or back surface of the cavity and the "top" surface of the valve seat insert, which abuts against the "top" or back surface of the cavity. During operation, liquid or fuel passes into this gap and becomes "trapped" or held within the gap. While this "trapped" or held fuel is relatively benign in traditional or conventional engines which burn fuel containing a relatively low percentage of ethanol, it can cause severe damage to engines which burn fuel containing a relatively high percentage of ethanol or a similar fuel.

[0004] That is, in engines which burn fuel containing a relatively high percentage of ethanol (e.g., greater than 50% ethanol), the trapped or held fuel may form and/or promote the formation of corrosive acids or by-products which corrode the cylinder head. Over time, this corrosion may become extremely severe, especially in cylinder heads which are manufactured from an aluminium material or alloy, and will oftentimes break or wear through to the engine's water jacket, thereby causing engine failure.

[0005] US 6 260 531 shows a solution where a plurality of notches are formed on the top surface of a valve seat insert, to form a plurality of passages between an intake conduit and an annular cavity around the outer periphery of the top surface. The plurality of passages is intended to substantially prevent fuel from becoming trapped between the top surface and the cylinder head, thereby preventing corrosion of the cylinder head. A problem with this solution is that, in spite of the passages provided, fuel may accumulate in the annular space and cause

corrosion of the cylinder head.

[0006] There is therefore a need for a valve seat insert which overcomes some if not all of the drawbacks of prior valve seat inserts.

DISCLOSURE OF INVENTION

[0007] The above problems have been solved by a valve arrangement and a valve seat insert according to the appended claims.

[0008] In the subsequent text, terms such as upper and lower are defined in relation to the relative positions of an intake valve and a combustion chamber in a longitudinal or transverse internal combustion engine with a crankcase located below the combustion chamber and its associated cylinder head. According to this definition of upper and lower, a lower surface in the valve arrangement is facing the cylinder or combustion chamber while an upper surface is located remote from the cylinder or combustion chamber. These definitions are used for clarity only and the invention is therefore also applicable to engines with other cylinder configurations, such as boxer engines.

[0009] According to a preferred embodiment, the invention relates to a valve arrangement in a cylinder head in an internal combustion engine comprising at least one combustion chamber provided with at least one intake valve cooperating with a valve seat insert. The valve seat insert may be arranged in a cavity in the cylinder head and has a first surface facing the combustion chamber and a second surface facing a corresponding surface in the cylinder head. During operation of the engine, the valve seat insert is arranged to cooperate with an intake valve as the valve opens to admit an air/fuel mixture into the combustion chamber and closes to allow the air/fuel mixture to be compressed and ignited. As the invention is directed to a valve arrangement and a valve seat insert adapted for substantially preventing corrosion of the cylinder head caused by corrosive fuels, only the intake valve arrangement will be discussed. In order to prevent fuel from passing from an intake channel to the outer periphery of the valve seat insert, the valve seat arrangement is provided with means for conveying pressure from the combustion chamber to the outer periphery of the valve seat insert.

[0010] The valve seat arrangement preferably comprises an annular chamber in or around the outer periphery of the valve seat insert. The annular chamber may comprise a bevel at the upper edge of the valve seat insert or an annular groove in cylinder head adjacent the said second, or upper, surface of the valve seat insert. By providing such an annular chamber around the outer periphery of the valve seat insert, the pressure conveyed from the combustion chamber is equalized around the outer periphery of the entire valve seat insert.

[0011] According to one alternative embodiment, the valve seat arrangement may comprise at least one drilled hole extending through the cylinder head from the com-

bustion chamber to the outer periphery of the valve seat adjacent the second surface. In this embodiment, at least one hole is provided in the cylinder head, from a location radially remote from the outer periphery of the valve seat insert into the annular chamber around the outer periphery of the valve seat insert. The at least one hole can be achieved during the casting of the cylinder head or be drilled or otherwise machined in a subsequent process. The number and size of holes provided is dependent on a desired predetermined pressure gradient between the outer periphery of the insert and the intake port.

[0012] According to a further alternative embodiment, the valve seat arrangement may comprise a valve seat insert with means for conveying pressure through or past the valve seat insert itself towards the second surface.

[0013] For example, the valve seat insert may comprise means for conveying pressure past the insert. Such means may comprise at least one substantially axial groove in the outer periphery of the valve seat. Said at least one groove should preferably extend from the first to the second surface of the valve seat insert. Depending on their size, shape and/or cross-sectional area, up to between 3 and 6 grooves may be provided to give a predetermined pressure gradient between the outer periphery of the insert and the intake port. The at least one groove may be achieved during manufacture of the insert or by subsequent machining of the outer periphery.

[0014] Alternatively, the valve seat insert may comprise means for conveying pressure through the insert. Such means may comprise at least one hole extending substantially axially through the valve seat insert. The hole may extend from the first surface, between the outer peripheral surface of the valve seat insert and the circular contact surface for the associated intake valve, towards the annular chamber in or around the outer periphery of the valve seat insert. The hole may be provided by drilling or any other suitable machining method. The number and size of holes provided is dependent on a desired predetermined pressure gradient between the outer periphery of the insert and the intake port.

[0015] According to a further alternative, the valve seat insert may comprise a sintered body, wherein an outer cylindrical section of the sintered body has a lower density than an inner cylindrical section thereof. The radially inner cylindrical section may have a relatively high density and be substantially impermeable to fluids such as combusted exhaust gases. However, the outer cylindrical section of the sintered body, adjacent the outer peripheral surface of the valve seat insert is at least partially gas permeable. The thickness and/or density of the outer cylindrical section of the sintered body is determined by a desired predetermined pressure gradient between the outer periphery of the insert and the intake port.

[0016] Common for all the above embodiments is that the means for conveying pressure is in fluid communication with an annular chamber adjacent the second surface of the valve seat insert. The annular chamber may comprise a bevelled surface around the outer periphery

of an edge of the insert remote from the combustion chamber. Alternatively, the annular chamber can be provided as a groove in the cylinder head adjacent the outer peripheral surface and/or the second surface of the valve seat insert.

[0017] During operation, the pressure conveyed from the combustion chamber, into the annular chamber and towards the intake conduit will vary over time. However, during a working cycle (intake, compression, expansion and exhaust) the net pressure gradient will be in the direction from the combustion chamber towards the intake conduit. Also, the periods during the working cycle when there is a risk of fuel or an air/fuel mixture entering the space between the valve seat insert and the cavity in the cylinder head coincides with the compression and expansion phases of the working cycle. During these phases the pressure in the combustion chamber will be significantly larger than that of the intake conduit, which ensures a net pressure gradient towards the intake conduit. Consequently, the arrangement according to the invention is effective to substantially prevent fuel from becoming trapped between the first surface and the second surface, thereby substantially preventing corrosion of the cylinder head.

[0018] The annular chamber provided around the outer periphery of the valve seat insert ensures an even pressure distribution and an equal pressure gradient between the outer periphery of the insert and the intake port across the entire second surface of the insert. For instance, if a single relatively large hole is used, then the annular chamber is required to distribute the pressure around the insert. Alternatively, if multiple relatively small holes are used, the annular chamber may assist in distributing the pressure around the insert if one or more holes should become clogged.

[0019] Particles and other substances carried by the gas will be passed into the relatively small space between the cavity in the cylinder head and the second or upper surface of the valve seat insert. Over time, said particles and other substances will clog this space and assist in preventing fuel from reaching the outer periphery of the valve seat insert.

[0020] These and other features, aspects, and advantages of the invention will become apparent by reading the following specification and by reference to the following drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0021] The invention will be described in detail with reference to the attached figures. It is to be understood that the drawings are designed solely for the purpose of illustration and are not intended as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to schematically illustrate the structures and procedures

described herein.

- Figure 1 shows a schematic illustration of a valve arrangement according to the invention;
- Figure 2 shows an enlarged view of the intake port in Figure 1;
- Figure 3 shows a partial cross-section through a valve seat insert according to a preferred embodiment of the invention;
- Figure 4 shows a plan view of the valve seat insert in Figure 3;
- Figure 5 shows a cross-section through a valve seat insert according to an alternative embodiment of the invention;
- Figure 6 shows a cross-section through a valve seat insert according to a further alternative embodiment of the invention; and
- Figure 7 shows a cross-section through a valve seat insert 70 according to a further alternative embodiment of the invention.

EMBODIMENTS OF THE INVENTION

[0022] Referring now to Figure 1, there is shown partial cross-section of a cylinder head provided with a valve seat insert or member 10 which according to a preferred embodiment of the invention and which is adapted for use within an internal combustion engine. The cylinder head 12 includes an air intake port or conduit 16 into which a liquid spray and/or vaporized fuel is injected. The air/fuel mixture is intended for combustion within one of the cylinders 20 of the engine. A conventional valve 14 is movably disposed within an intake port 16 in the cylinder head 12 and controls the transfer of air and fuel into the cylinder 20. Particularly, the valve 14 is selectively movable from a first position (not shown) in which the valve 14 engages the valve seat 10, thereby preventing fuel from entering the cylinder 20, and a second position (shown in dashed lines in FIG. 1) in which the valve 14 is removed from the valve seat 10, thereby allowing fuel to enter the cylinder 20.

[0023] As indicated in Figure 2, showing an enlarged view of the intake port in Figure 1, the cylinder head 12 further includes an integrally formed pocket or cavity 18 in which insert 10 is operatively disposed. The pocket or cavity 18 is formed around or circumscribes the intake port 16 and is defined or formed by a lower surface 24 facing the cylinder and an outer cylindrical surface or perimeter 26.

[0024] Figure 3 shows a partial cross-section through a valve seat insert 10 according to a preferred embodiment of the invention. The valve seat insert 10 is generally

circular or ring shaped and has an outer cylindrical surface 28 and an upper annular surface 30. The valve seat insert 10 has an outer diameter which is slightly greater than the diameter of the outer perimeter 26 of the cavity 18, thereby allowing for a "press-fit" mating between surfaces 26 and 28. Particularly, in the preferred embodiment, the insert 10 is press-fitted into the cavity 18, effective to cause the outer annular surface 30 to abuttingly engage the lower surface 24 of the cavity 18, thereby securing the insert 10 within the cavity 18. The outer cylindrical surface 28 includes an angled or bevelled portion 32 which assists in centering and/or guiding the insert 10 into the cavity 18 during the press-fitting procedure. When the insert 10 is fitted in the cavity, an annular chamber 40 is formed, delimited by the bevelled portion 32 of the insert and by the lower surface 24 and the outer cylindrical surface 28 of the cavity 18. The insert 10 further includes an inner annular surface 36 having an angled or bevelled portion or surface 34. The portion or surface 34 is adapted to conformingly and sealingly receive and engage an outer surface 37 of the valve 14 (see Fig. 1), thereby allowing valve 14 to selectively seal the intake port 16. The insert 10 is preferably manufactured from a relatively durable, wear-resistant, and heat-resistant metal material, such as hardened or cast steel or iron.

[0025] Figure 3 further shows an axial notch or groove 38 provided in the outer cylindrical surface 28, which groove extends from the cylinder 20 to the annular chamber 40. By providing such an annular chamber 40 around the outer periphery of the valve seat insert 10, the pressure conveyed from the combustion chamber is equalized around the entire valve seat insert 10. The pressure gradient between the annular chamber 40, between the facing surfaces 24 and 30 and the intake port 16 is schematically indicated by a diagram in Figure 3. This diagram illustrates a pressure gradient, where the equalized pressure in the annular chamber 40 gradually drops with the distance from said chamber, that is, with a reduced radius as measured from the centre of the insert 10. The aim of this arrangement is not to induce a flow of gas past the insert, but to prevent a flow of gas and/or fuel to accumulate between the facing surfaces 24 and 30 and thereby reach the annular chamber 40. Although the facing surfaces 24 and 30 are in relatively close contact, the press fitted components are not in gas-tight contact. Consequently, the pressure gradient provided by the invention prevents small volumes of gas and/or fuel from entering in-between the facing surfaces 24 and 30.

[0026] Figure 4 shows a plan view of the valve seat insert 10 in Figure 3. The insert 10 in Figure 4 is provided with three equidistant notches 38 each separated by an angle of 120° around the outer cylindrical surface 28. As can be seen from the partial enlargement of one of the notches 38, each notch is shaped as a part circular groove with a radius r with a depth d into the outer cylindrical surface 28. The radius and depth of the grooves may be selected to achieve a desired pressure gradient between the annular chamber 40 and the intake port 16

(see Figure 1). Figure 3 is a cross-section through the plane X-X in Figure 4.

[0027] Although Figure 4 shows a valve seat insert 10 with three grooves 38, the number of grooves may be selected greater or larger to achieve a desired pressure gradient between the annular chamber 40 and the intake port 16.

[0028] Figure 5 shows a cross-section through a valve seat insert 50 according to an alternative embodiment of the invention. In this case, the groove or notch indicated in the insert in Figure 3 has been replaced by a hole 52. The hole 52 is arranged to extend between the annular chamber 40 and a bevelled, lower surface 54 located radially outside the bevelled surface 34 adapted to engage the outer surface of an intake valve (see Figure 1). The number and size of the hole or holes may be selected to achieve a desired pressure gradient between the annular chamber 40 and the intake port 16.

[0029] Figure 6 shows a cross-section through a valve seat insert 60 according to a further alternative embodiment of the invention. In this case, the valve seat insert 60 comprises a sintered body, wherein an outer cylindrical section 62 of the sintered body has a lower density than an inner cylindrical section 64. The radially inner cylindrical section 64 has a relatively high density and is substantially impermeable to fluids such as combusted exhaust gases. However, the outer cylindrical section 62 of the sintered body, adjacent the outer peripheral surface 66 of the valve seat insert 60 is at least partially gas permeable. The thickness and/or density of the outer cylindrical section 62 of the sintered body is determined by a desired predetermined pressure gradient between the annular chamber 40 and the intake port 16.

[0030] Figure 7 shows a cross-section through a valve seat insert 70 according to a further alternative embodiment of the invention. In this case, the groove or notch indicated in the insert in Figure 3 has been replaced by a hole 72 passing through the cylinder head 12. The hole 72 is arranged to extend between the annular chamber 40 and the cylinder 20 from a position located radially outside the outer periphery of the insert 70. As indicated in Figure 7, the annular chamber 40 has been supplemented with a radial groove 74 extending into the cylinder head 12 radially outside the annular chamber 40. The number and size of the hole or holes may be selected to achieve a desired pressure gradient between the annular chamber 40 and the intake port 16.

[0031] It is to be understood that the invention is not to be limited to the exact construction and/or method which has been illustrated and discussed above, but that various changes and/or modifications may be made without departing from the spirit and the scope of the invention.

Claims

1. Valve arrangement in a cylinder head in an internal

combustion engine comprising at least one combustion chamber provided with at least one intake valve cooperating with a valve seat insert, said valve seat insert being arranged in a cavity in the cylinder head and having a first surface facing the combustion chamber and a second surface facing a corresponding surface in the cylinder head, **characterized in that** the valve seat arrangement is provided with means for conveying pressure from the combustion chamber to the outer periphery of the valve seat insert.

2. Valve arrangement according to claim 1, **characterized in that** the valve seat arrangement comprises an annular chamber in or around the outer periphery of the valve seat insert.

3. Valve arrangement according to claim 1 or 2, **characterized in that** the valve seat arrangement comprises at least one hole extending through the cylinder head from the combustion chamber to the outer periphery of the valve seat adjacent the second surface.

4. Valve arrangement according to claim 1 or 2, **characterized in that** the valve seat arrangement comprises a valve seat insert with means for conveying pressure through or past the insert towards the second surface.

5. Valve seat insert in a valve seat arrangement according to claim 1, **characterized in that** the valve seat insert comprises means for conveying pressure through or past the insert.

6. Valve seat insert according to claim 5, **characterized in that** the valve seat insert comprises at least one axial groove in the outer periphery of the valve seat.

7. Valve seat insert according to claim 5, **characterized in that** the valve seat insert comprises at least one hole extending substantially axially through the valve seat insert.

8. Valve seat insert according to claim 5, **characterized in that** the valve seat insert comprises a sintered body, wherein an outer cylindrical section of the sintered body has a lower density than an inner cylindrical section.

9. Valve seat insert according to claim 8, **characterized in that** the outer cylindrical section of the sintered body is at least partially gas permeable.

10. Valve seat insert according to claim 1, **characterized in that** the means for conveying pressure is in fluid communication with a bevelled surface around

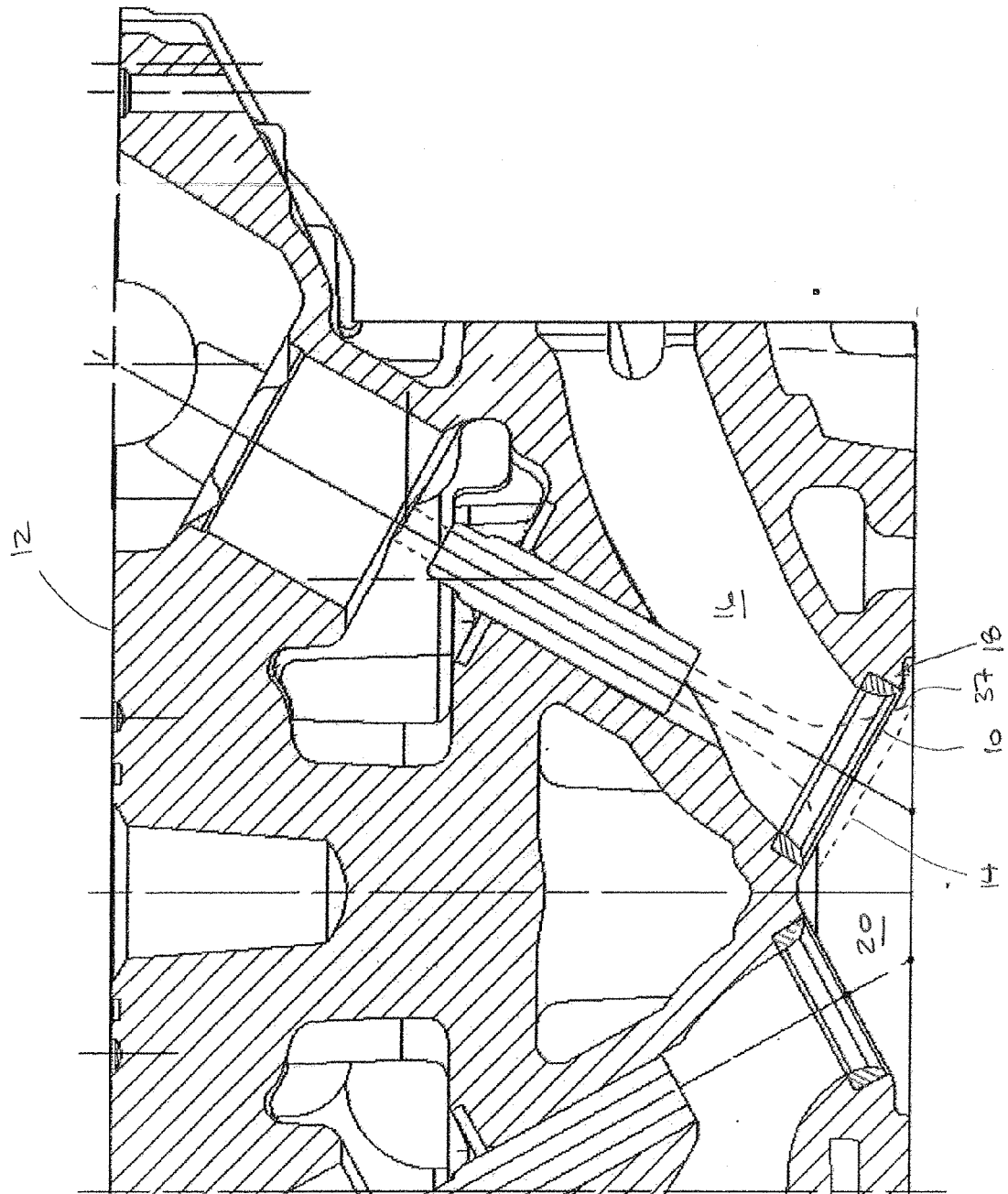
the outer periphery of an edge of the insert.

Amended claims in accordance with Rule 137(2) EPC.

1. Valve arrangement in a cylinder head (12) in an internal combustion engine comprising at least one combustion chamber (20) provided with at least one intake valve (14) cooperating with a valve seat insert (10), said valve seat insert (10) being arranged in a cavity (18) in the cylinder head (12) and having a first surface (28) facing the combustion chamber (20) and a second surface (30) facing a corresponding surface in the cylinder head (12), **characterized in that** the valve seat arrangement is provided with means for conveying pressure from the combustion chamber (20) to the outer periphery of the valve seat insert (10). 5
2. Valve arrangement according to claim 1, **characterized in that** the valve seat arrangement comprises an annular chamber (40) in or around the outer periphery of the valve seat insert (10). 10
3. Valve arrangement according to claim 1 or 2, **characterized in that** the valve seat arrangement comprises at least one hole (72) extending through the cylinder head (12) from the combustion chamber (20) to the outer periphery of the valve seat adjacent the second surface (30). 15
4. Valve arrangement according to claim 1 or 2, **characterized in that** the valve seat arrangement comprises a valve seat insert (10) with means for conveying pressure through or past the insert (10) towards the second surface (30). 20
5. Valve seat insert (10) in a valve seat arrangement according to claim 1, **characterized in that** the valve seat insert (10) comprises means for conveying pressure through or past the insert (10). 25
6. Valve seat insert (10) according to claim 5, **characterized in that** the valve seat insert (10) comprises at least one axial groove (38) in the outer periphery of the valve seat. 30
7. Valve seat insert (10) according to claim 5, **characterized in that** the valve seat insert (10) comprises at least one hole (52) extending substantially axially through the valve seat insert (10). 35
8. Valve seat insert (10) according to claim 5, **characterized in that** the valve seat insert (60) comprises a sintered body, wherein an outer cylindrical section (62) of the sintered body has a lower density than an inner cylindrical section (64). 40

9. Valve seat insert (10) according to claim 8, **characterized in that** the outer cylindrical section (62) of the sintered body is at least partially gas permeable.

10. Valve seat insert (10) according to claim 1, **characterized in that** the means for conveying pressure is in fluid communication with a bevelled surface around the outer periphery of an edge of the insert (10). 45



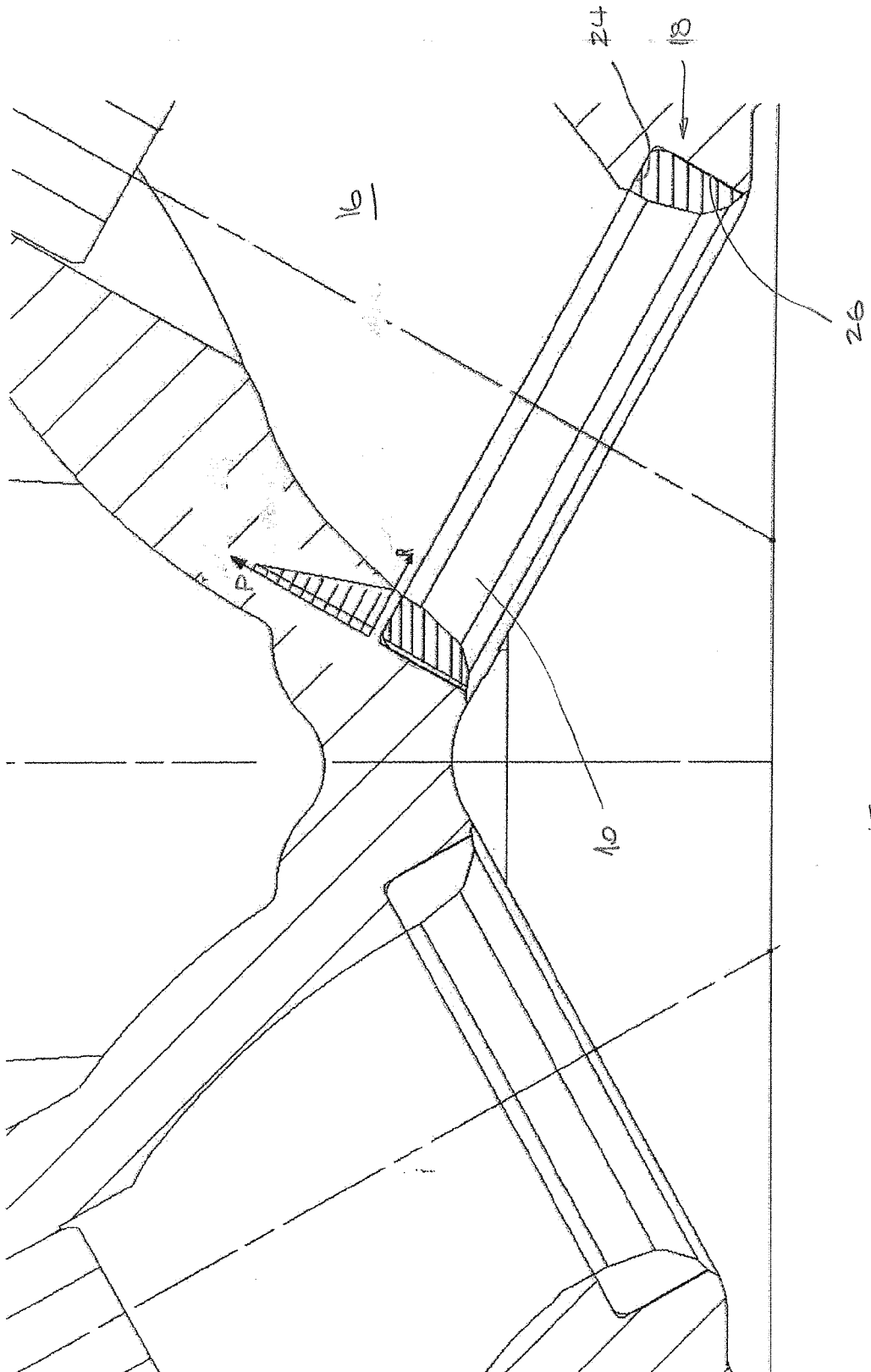
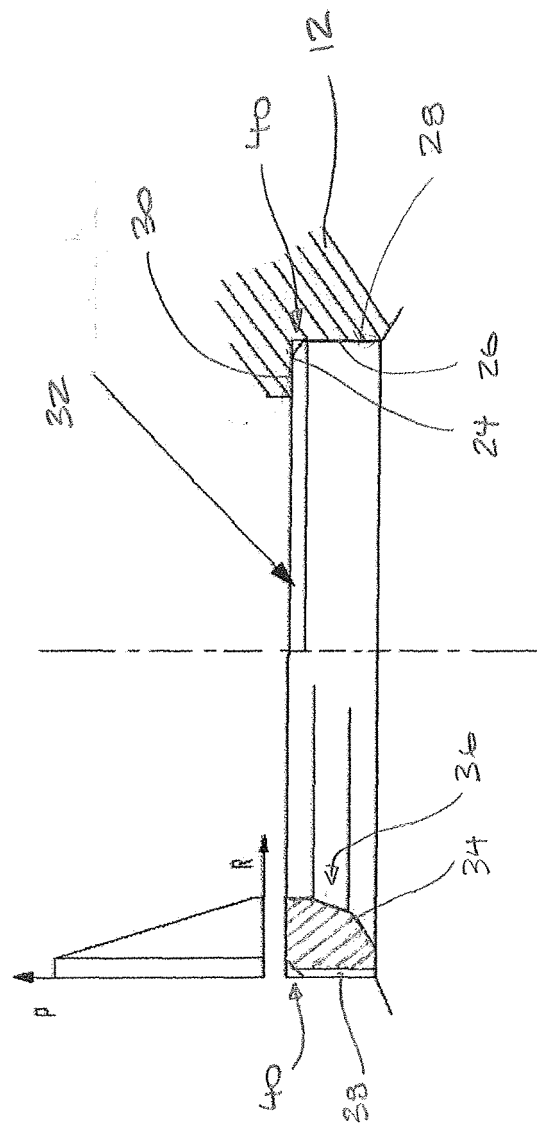


FIG. 2



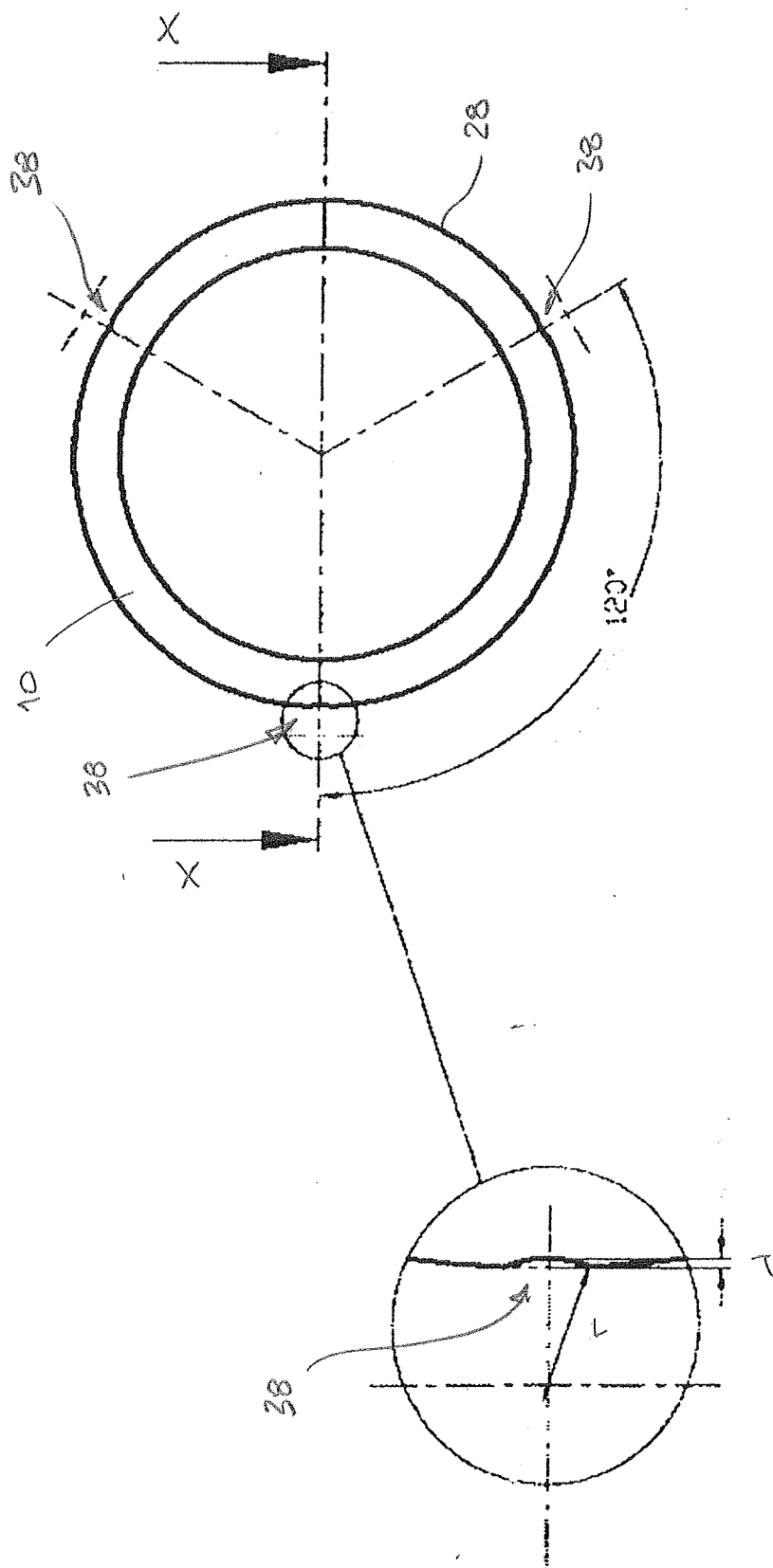
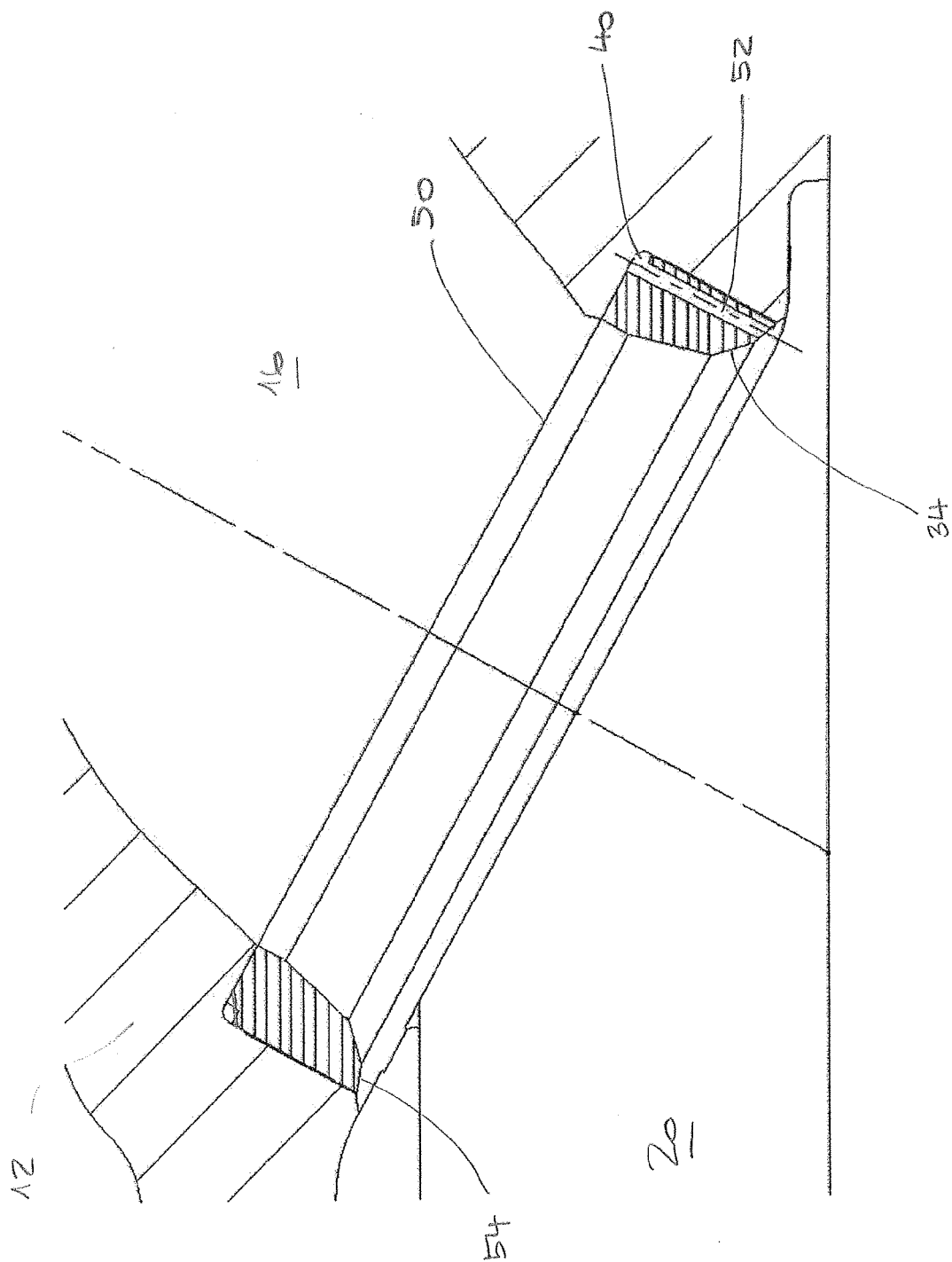
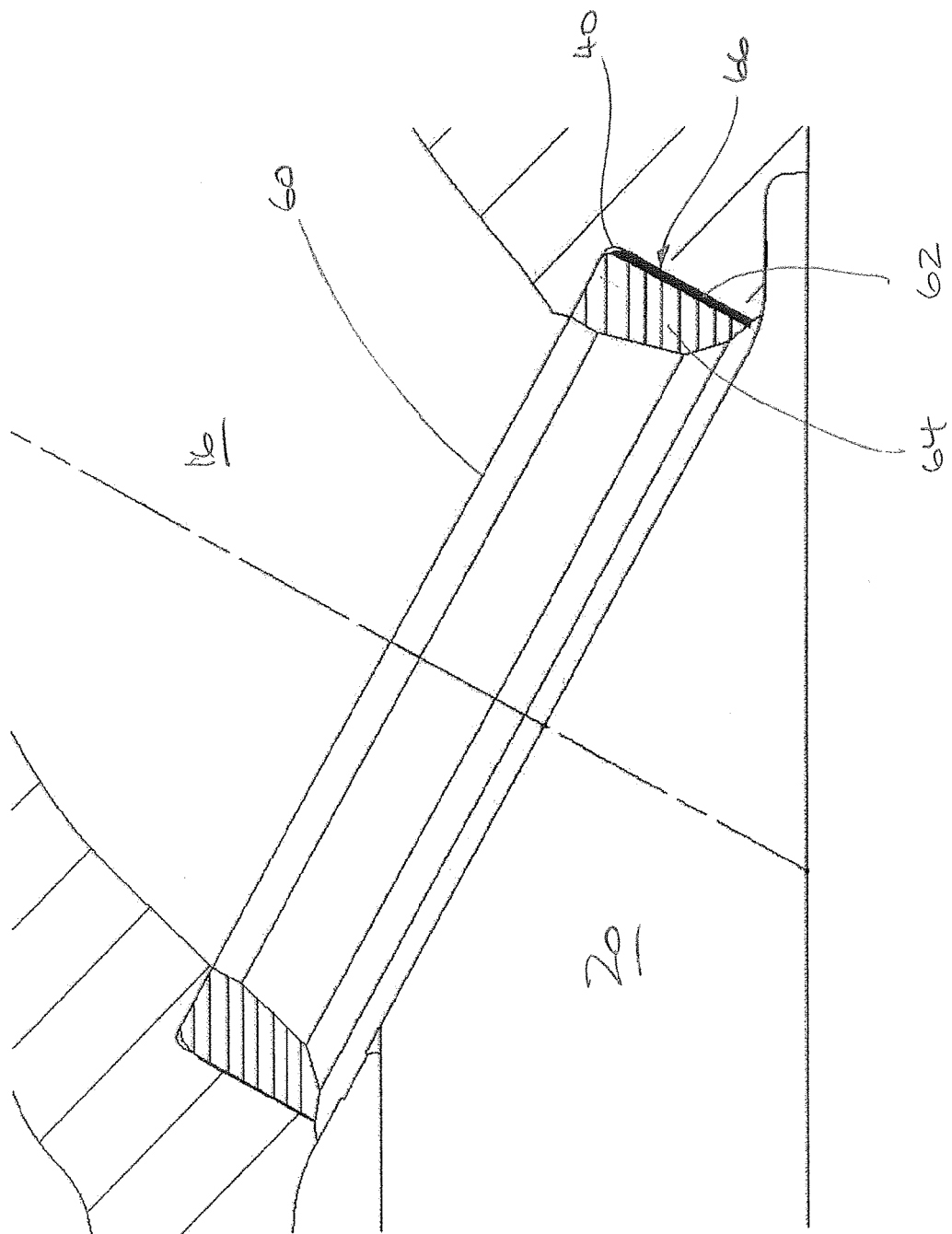


FIG. 4





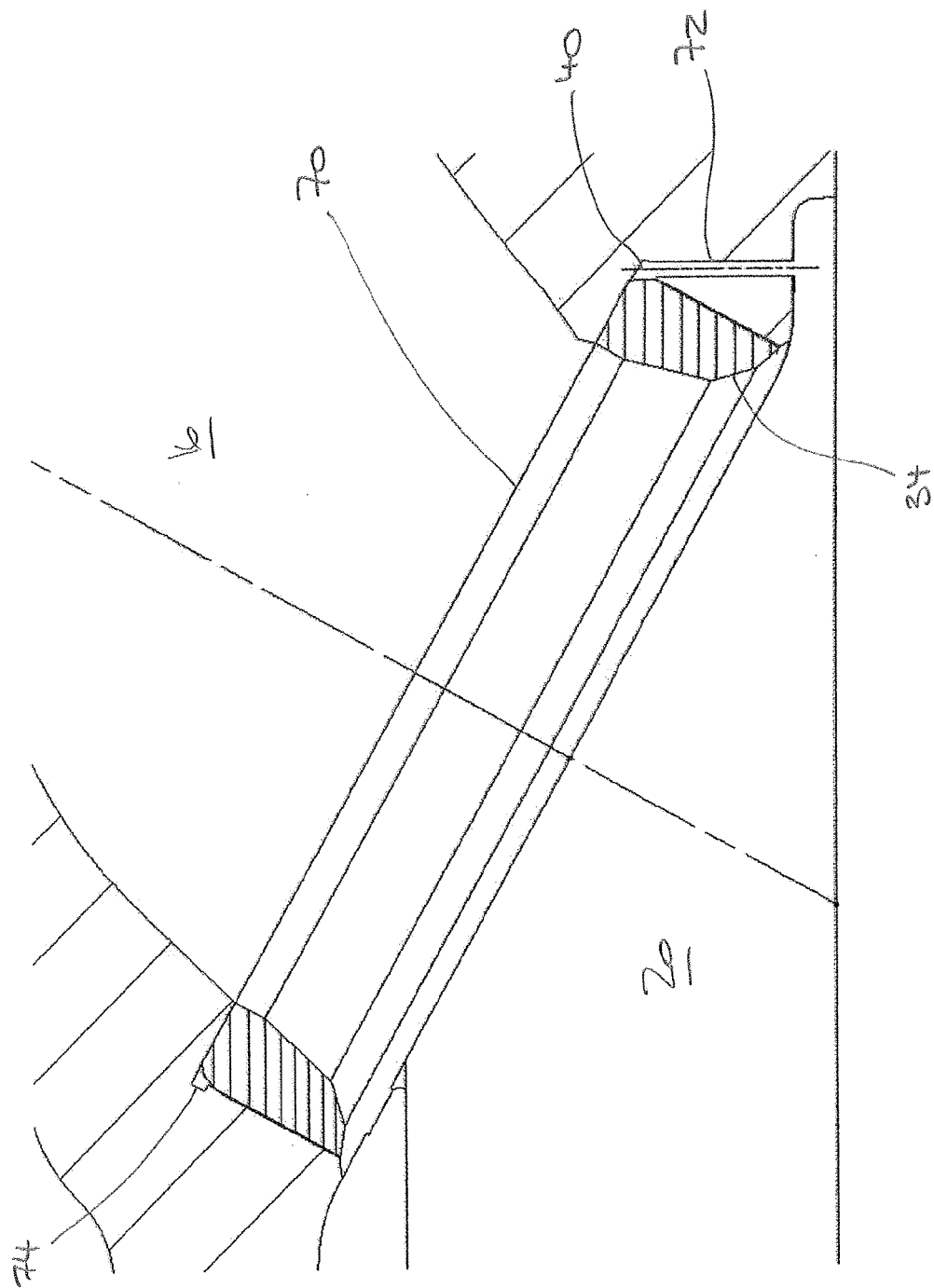


Fig. 7



EUROPEAN SEARCH REPORT

Application Number
EP 08 15 9248

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	US 6 260 531 B1 (HAAN DEBORAH MARTHA [US] ET AL) 17 July 2001 (2001-07-17) * the whole document *	1	INV. F01L3/22 F01L3/02
A	DE 37 14 229 A1 (KLOECKNER HUMBOLDT DEUTZ AG [DE]) 10 November 1988 (1988-11-10) * the whole document *	1	
A	US 4 108 132 A (HAYASHI YOSHIMASA) 22 August 1978 (1978-08-22) * the whole document *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			F01L
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		17 November 2008	Klinger, Thierry
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 15 9248

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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17-11-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6260531	B1	17-07-2001	NONE
DE 3714229	A1	10-11-1988	NONE
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6260531 B [0005]