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(71) Applicant: **INNIO JENBACHER GMBH & CO OG** [AT/AT]; Achenseestraße 1-3, 6200 Jenbach (AT).

(72) Inventors: **FIMML, Wolfgang**; Ebener Strasse 69, 6212 Maurach in Tirol (AT). **WALDNER, Guenther**; Seewinklstrasse 25, 6215 Achenkirch (AT).

(74) Agent: **TORGGLER & HOFMANN PATENTANWÄLTE GMBH & CO KG**; Wilhelm-Greil-Straße 16, 6020 Innsbruck (AT).

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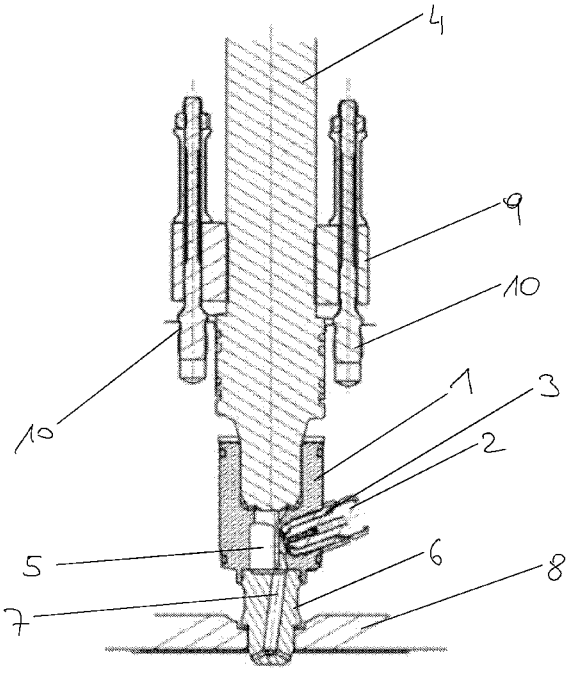
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(54) Title: PRECHAMBER ASSEMBLY

Fig. 1



(57) Abstract: A prechamber assembly for an internal combustion engine in which a sealing seat is formed between at least one first sleeve seat surface (12) of a prechamber sleeve (1) and at least one injector seat surface (11) of at least one fuel injector (4).

Prechamber assembly

[0001] The invention is in the field of a prechamber assembly for an internal combustion engine.

[0002] WO 2020 158 263 A1 shows a prechamber used to ignite an air-fuel mixture in a main combustion chamber. In order to reduce the emissions of the internal combustion engine during engine start a prechamber heating operations is performed by injecting a predetermined amount of fuel into the prechamber by way of a fuel injector and igniting an air-fuel-mixture therein using a spark plug, while a main fuel injector is deactivated during at least a first engine cycle after engine start request.

[0003] It is problematic to achieve sufficient sealing of the prechamber arrangement, especially if there are concerns with space requirement, in particular, if it is intended to provide all the fuel necessary for the working of the internal combustion engine via the prechamber assembly.

[0004] It is an object of the invention to provide a prechamber assembly for an internal combustion engine with improved sealing such that the prechamber assembly has reduced space requirement.

[0005] Still other objects and advantages of the invention will in part be obvious and will in part be apparent from the specification and drawings.

[0006] One object of the disclosure relates to a prechamber assembly for an internal combustion engine, comprising:

- an elongated prechamber sleeve having
  - an axis of elongation
  - at least one first opening for partially inserting at least one fuel injector, for injection of hydrogen, the at least

one first opening being surrounded by at least one first sleeve seat surface

- at least one second opening for at least one ignition device
- preferably, a third opening for contacting a riser channel
- at least one prechamber volume connected to the aforementioned openings

- at least one fuel injector for injecting fuel into the at least one prechamber volume, the at least one fuel injector being arranged at least substantially parallel (preferably parallel) to the axis of elongation and having at least one injector seat surface
- at least one ignition device for igniting a fuel-air-mixture inside the at least one prechamber volume, the at least one ignition device protruding into the at least one second opening and having an elongated shape and a device axis which forms an acute angle with the axis of elongation (preferably in a range of 30° to 90° measured from the device axis)

wherein a sealing seat is formed between the at least one first sleeve seat surface and the at least one injector seat surface.

[0007] Because the at least one fuel injector is arranged at least substantially parallel to the axis of elongation and has at least one injector seat surface and the prechamber sleeve has at least one corresponding first sleeve seat surface it is possible to achieve sealing between the at least one fuel injector and the prechamber sleeve by applying pressure along the axis of elongation on the at least one fuel injector. This pressure can be applied when the at least one fuel injector is mounted to the cylinder head such that the at least one injector seat surface presses against the at least one first sleeve seat surface. In this way a metallic sealing edge is formed between the at least one fuel injector and the prechamber sleeve.

[0008] The arrangement of the at least one fuel injector at least substantially parallel and preferably parallel to the axis of elongation leaves more space compared to the prior art and allows the use of a fuel injector by which all the fuel necessary for the working of the internal combustion engine can be provided via the prechamber assembly.

[0009] In case the prechamber sleeve is of substantially cylindrical shape (with circular or elliptical cross-section) the axis of elongation is the cylinder axis.

[0010] It should be noted that the at least one second opening of the prechamber sleeve provides enough clearance for the at least one injection device not to hinder the slight movements of the parts in connection with the appliance of the pressure via the at least one fuel injector.

[0011] Preferred embodiments of the invention are described in dependent claims.

[0012] It is possible that the prechamber sleeve comprises a prechamber which also encompasses a riser channel.

[0013] It is possible that the at least one fuel injector and the prechamber sleeve are braced against each other.

[0014] In a preferred embodiment the prechamber assembly comprises a riser channel sleeve in which at least one riser channel is arranged, the riser channel sleeve having at least one first channel seat surface and the at least one third opening having at least one second sleeve seat surface, wherein a (metallic) sealing seat is formed between the at least one first channel seat surface and the at least one second sleeve seat surface. Due to the at least one fuel injector being mounted to

the cylinder head, the at least one second sleeve seat surface presses against the at least one first channel seat surface.

[0015] In a preferred embodiment the at least one second opening has at least one third sleeve seat surface and the at least one ignition device has at least one igniter seat surface, wherein a sealing seat is formed between the at least one igniter seat surface and the at least one third sleeve seat surface (front-sealed ignition device). This arrangement needs less space than the standard sealing arrangement using a seal arranged farther away from the prechamber sleeve (in case a spark plug is used, usually on the far side of the spark plug thread).

[0016] In these embodiments it is preferred that the at least one ignition device comprises a spark plug arranged in a spark plug sleeve and the at least one igniter seat surface is arranged on the spark plug sleeve.

[0017] Alternatively, or in addition, it can also be provided in these embodiments that the front-sealed ignition device can be fastened (preferably screwed) laterally into the prechamber sleeve. It might be advantageous to strengthen the prechamber in this region in direction towards the prechamber volume such that a wall strength of the prechamber sleeve is increased with respect to other regions.

[0018] It is preferred, that a middle of a front surface of the at least one ignition device is positioned in a distance of about 0 - 50 %, preferably of about 10 - 35 % of a diameter of the at least one ignition device in front of an axis of elongation of the at least one fuel injector (measured in a direction orthogonal to the axis of elongation of the at least one fuel injector).

[0019] In a preferred embodiment there is only one fuel injector present in the prechamber assembly.

[0020] In some embodiments fuel can be injected by the at least one fuel injector with a pressure between 30 bar and 50 bar.

[0021] In a preferred embodiment of the prechamber assembly the following sealing seats are formed when an axial force is exerted onto the at least one fuel injector during mounting of the at least one fuel injector to the at least one cylinder head surface:

- between the at least one fuel injector and the prechamber sleeve (between the at least one first sleeve seat surface and the at least one injector seat surface)
- between the riser channel sleeve and the prechamber sleeve (between the at least one first channel seat surface and the at least one second sleeve seat surface)
- between the at least one ignition device and the prechamber sleeve (between the at least one igniter seat surface and the at least one third sleeve seat surface)

[0022] In some embodiments it is provided that

- the at least one first opening is arranged on a front surface, and/or
- the at least one second opening is arranged on a lateral surface, and/or
- the at least one third opening is arranged on a front surface of the elongated prechamber sleeve

[0023] In some embodiments it is provided that the prechamber volume has, along the axis of elongation, a first cross section and a second cross section of different sizes, the cross section of larger size being arranged at the height of the at least one ignition device. The reason for this is to achieve a lower flow

velocity of the injected fuel in the region of th at least on ignition device.

[0024] In these embodiments it is preferred that a diameter of the prechamber volume is larger at an ignition gap (in particular, or electrode gap) of the at least one ignition device (in particular, a spark gap of a spark plug) than a diameter of the prechamber at the point of injection of the at least one fuel injector. In this way, the flow rate of the fuel injected by the at least one fuel injector is reduced at the ignition gap.

[0025] Although the prechamber assembly according to the invention can be used with any type of engine it is preferred that it is used in internal combustion engine having at least one piston-cylinder-units, preferably at least 10 piston-cylinder-units.

[0026] Although the prechamber assembly according to the invention can be used with any type of engine, it is preferred that it is used in an internal combustion engine that can be coupled with an electric generator to form a genset for production of electric energy.

[0027] Although the prechamber assembly according to the invention can be used with any type of engine, it is preferred that it is used in a stationary internal combustion engine.

[0028] It is to be understood that the features of the preceding paragraphs can be used in isolation or combined in any way.

[0029] Embodiments of the invention are discussed making use of the enclosed figures.

[0030] Figure 1 shows a cut section drawing along a medial plane of the prechamber assembly in a state mounted to a cylinder head of an internal combustion engine.

[0031] Figure 2 shows a detail of Figure 1 in enlarged presentation.

[0032] Figure 3 shows a prechamber sleeve of a prechamber assembly of Figure 1.

[0033] Figure 4 shows a view along the axis of elongation of the prechamber assembly of Figure 1 viewed from a main combustion chamber of the internal combustion engine.

[0034] In Figure 1 it is shown that the fuel injector 4 is mounted, in this example by way of bolts 10, to the cylinder head 8. It is important that the fuel injector 4 is pressed by the bolts 10 against the cylinder head 8. Due to this force a seal is achieved (cf. Figure 2):

- between the fuel injector 4 and the prechamber sleeve 1 (between the first sleeve seat surface 12 and the at least one injector seat surface 11)
- between the riser channel sleeve 6 and the prechamber sleeve 1 (between the at least one first channel seat surface 13 and the at least one second sleeve seat surface 14)
- between the at least one ignition device and the prechamber sleeve 1 (between the at least one igniter seat surface 17 and the at least one third sleeve seat surface 18)

[0035] It should be noted that the sealing ring visible on a lateral surface of the prechamber sleeve 1 is not necessary to achieve sealing but is used only to stabilize the prechamber sleeve 1 during assembly. The seal is achieved by metallic contact on the front surfaces of the parts.

[0036] Figure 3 shows the prechamber sleeve 1 in isolation.

[0037] In Figure 4 the openings of the riser channel 7 into a main combustion chamber can be seen.

List of References:

1	prechamber sleeve
2	spark plug
3	spark plug sleeve
4	fuel injector
5	prechamber volume
6	riser channel sleeve
7	riser channel
8	cylinder head
9	mounting sleeve
10	bolt
11	injector seat surface
12	first sleeve seat surface
13	first channel seat surface
14	second sleeve seat surface
15	second channel seat surface
16	cylinder head surface
17	igniter seat surface
18	third sleeve seat surface

Claims:

1. A prechamber assembly for an internal combustion engine, comprising:
   - an elongated prechamber sleeve (1) having
     - an axis of elongation
     - at least one first opening for partially inserting at least one fuel injector (4), in particular for injection of hydrogen, the at least one first opening being surrounded by at least one first sleeve seat surface (12)
     - at least one second opening for at least one ignition device
     - preferably, a third opening for contacting a riser channel (7)
     - at least one prechamber volume (5) connected to the aforementioned openings
   - at least one fuel injector (4) for injecting fuel into the at least one prechamber volume (5), the at least one fuel injector (4) being arranged at least substantially parallel to the axis of elongation and having at least one injector seat surface (11)
   - at least one ignition device for igniting a fuel-air-mixture inside the at least one prechamber volume (5), the at least one ignition device protruding into the at least one second opening and having a substantially cylindrical shape and a device axis which forms an acute angle with the axis of elongation

   wherein a sealing seat is formed between the at least one first sleeve seat surface (12) and the at least one injector seat surface (11).

2. The prechamber assembly according to the preceding claim wherein the prechamber assembly comprises a riser channel sleeve (6) in which at least one riser channel (7) is

arranged, the riser channel sleeve (6) having at least one first channel seat surface (13) and the at least one third opening having at least one second sleeve seat surface (14), wherein a sealing seat is formed between the at least one first channel seat surface (13) and the at least one second sleeve seat surface (14).

3. The prechamber assembly according to at least one of the preceding claims wherein the at least one second opening has at least one third sleeve seat surface (18) and the at least one ignition device has at least one igniter seat surface (17), wherein a sealing seat is formed between the at least one igniter seat surface (17) and the at least one third sleeve seat surface (18) such that said at least one ignition device is front-sealed.

4. The prechamber assembly according to the preceding claim wherein the at least one ignition device comprises a spark plug (2) arranged in a spark plug sleeve (3) and the at least one igniter seat surface (17) is arranged on the spark plug sleeve (3).

5. The prechamber assembly according to at least one of the preceding claims wherein
   - the at least one first opening is arranged on a front surface, and/or
   - the at least one second opening is arranged on a lateral surface, and/or
   - the at least one third opening is arranged on a surface opposite the front surface

   of the elongated prechamber sleeve (1)

6. The prechamber assembly according to at least one of the preceding claims wherein the prechamber volume (5) has, along

the axis of elongation, a first cross section and a second cross section of different sizes, the cross section of larger size being arranged at the cylinder height of the at least one ignition device.

7. A cylinder head having at least one prechamber assembly according to at least one of the preceding claims wherein the at least one fuel injector (4) is mounted to the cylinder head such that the at least one injector seat surface (11) presses against the at least one first sleeve seat surface (12).

8. The cylinder head of the preceding claim wherein the prechamber assembly is formed according to claim 2 and wherein, due to the at least one fuel injector (4) being mounted to the cylinder head, the at least one second sleeve seat surface (14) presses against the at least one first channel seat surface (13).

9. The cylinder head of the preceding claim wherein the riser channel sleeve (6) has at least one second channel seat surface (15) and the cylinder head has at least one cylinder head surface (16) wherein, due to the at least one fuel injector (4) being mounted to the cylinder head, the at least one second channel seat surface (15) is pressed against the at least one cylinder head surface (16).

10. An internal combustion engine having at least one cylinder head according to at least one of claims 7 to 9.

11. The internal combustion engine of the preceding claim wherein the at least one fuel injector (4) of a piston-cylinder-unit is configured to inject 100 % of the fuel, preferably hydrogen, provided to that piston-cylinder-unit per combustion cycle.

Fig. 1

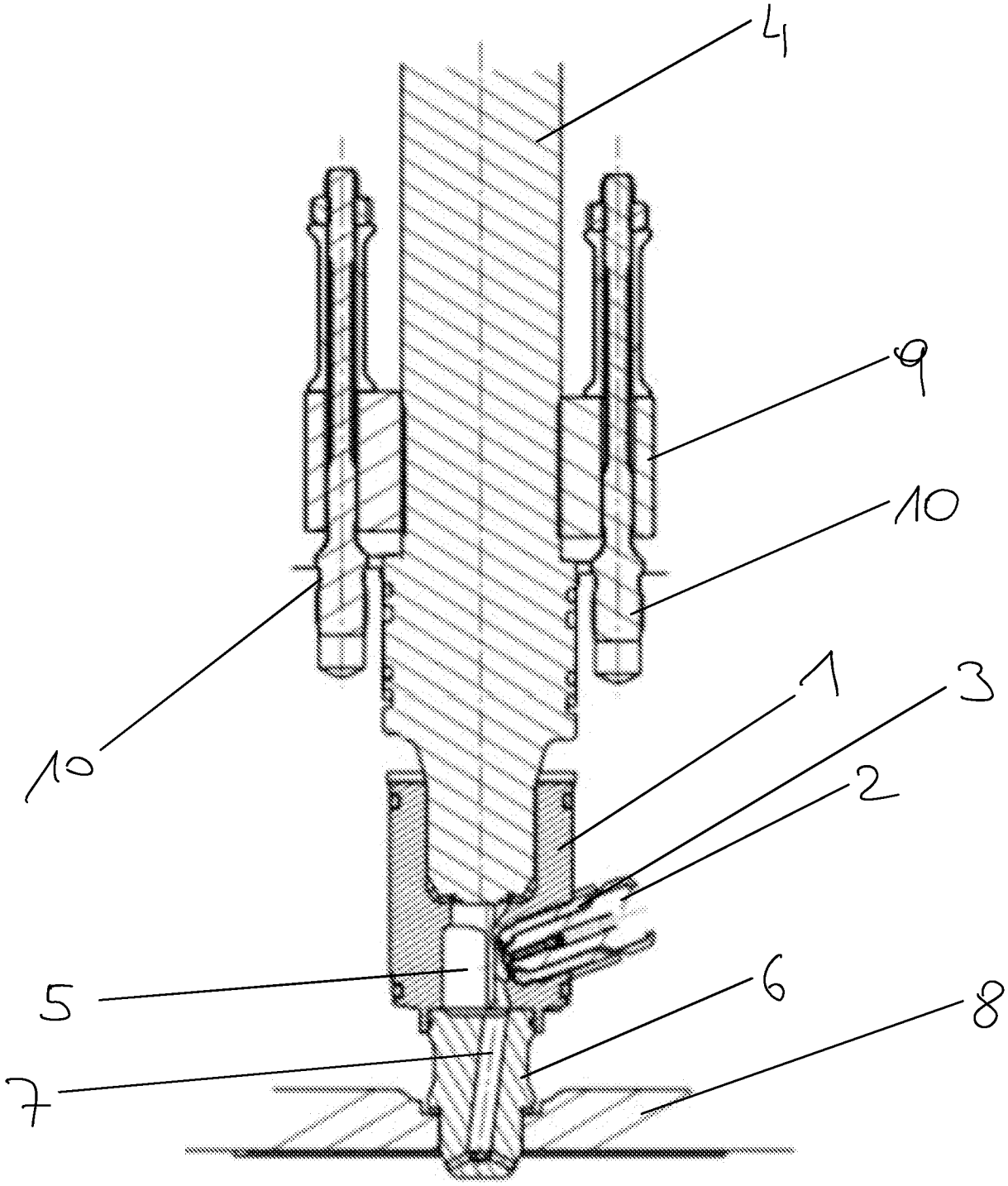


Fig. 2

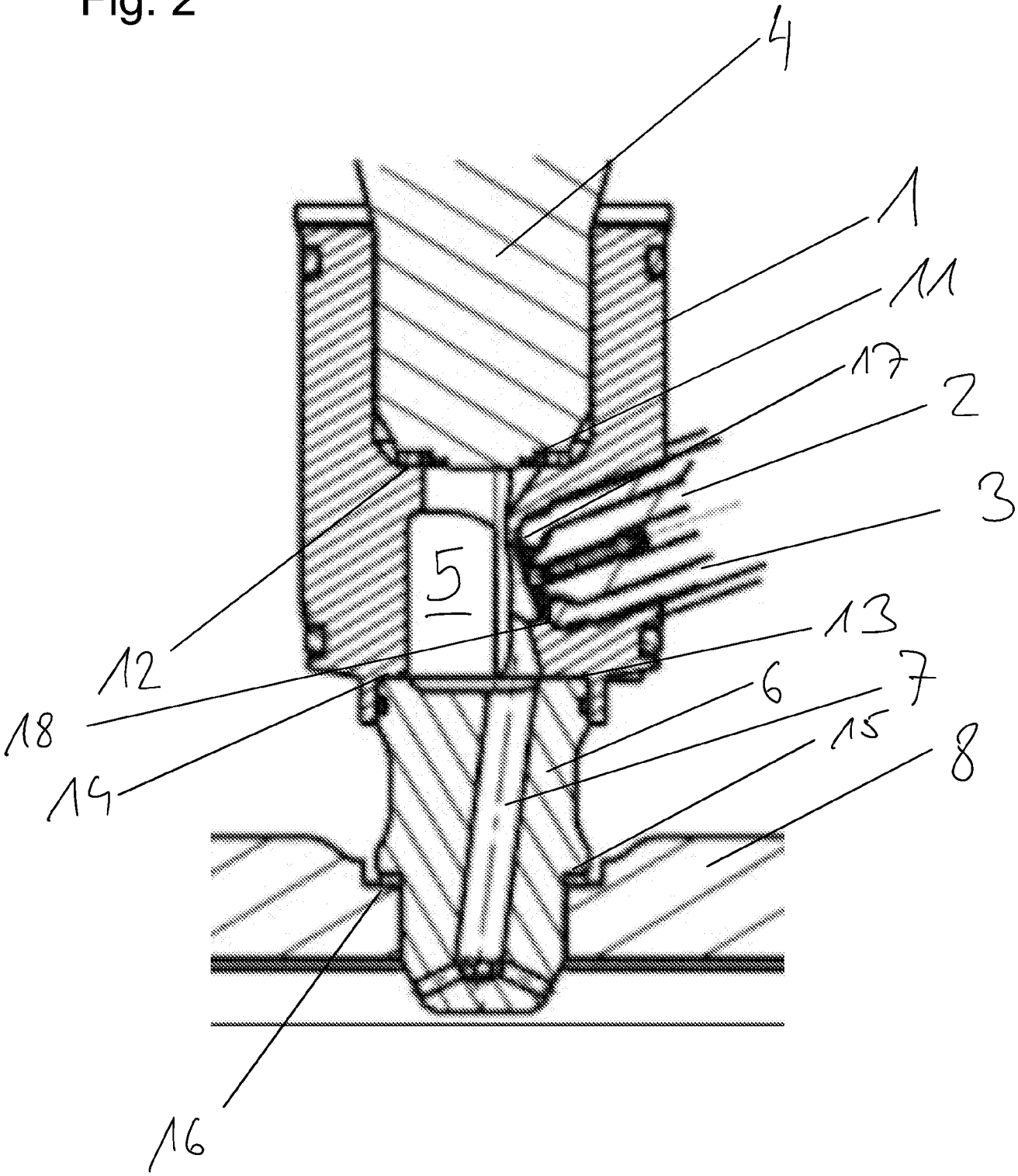


Fig. 3

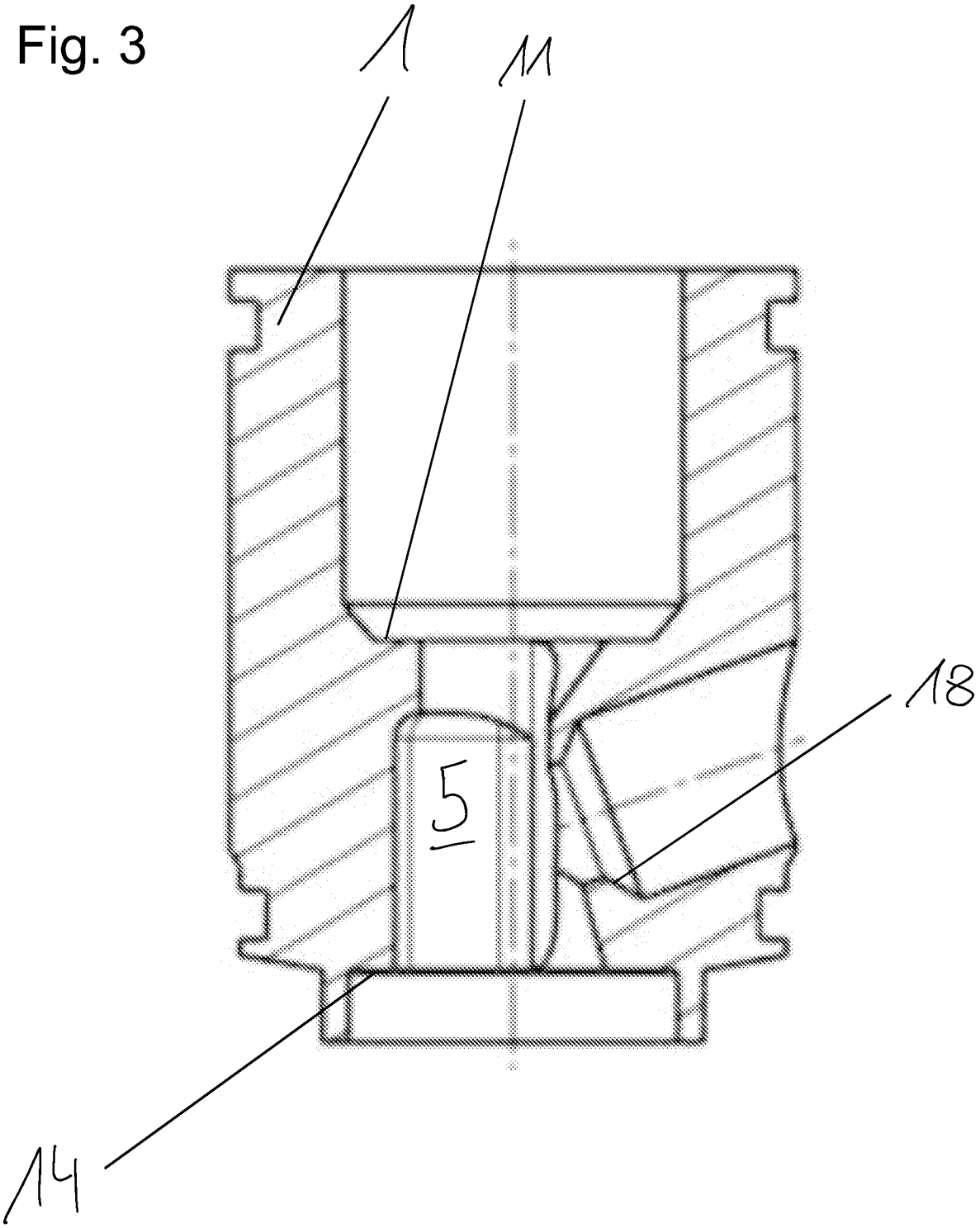
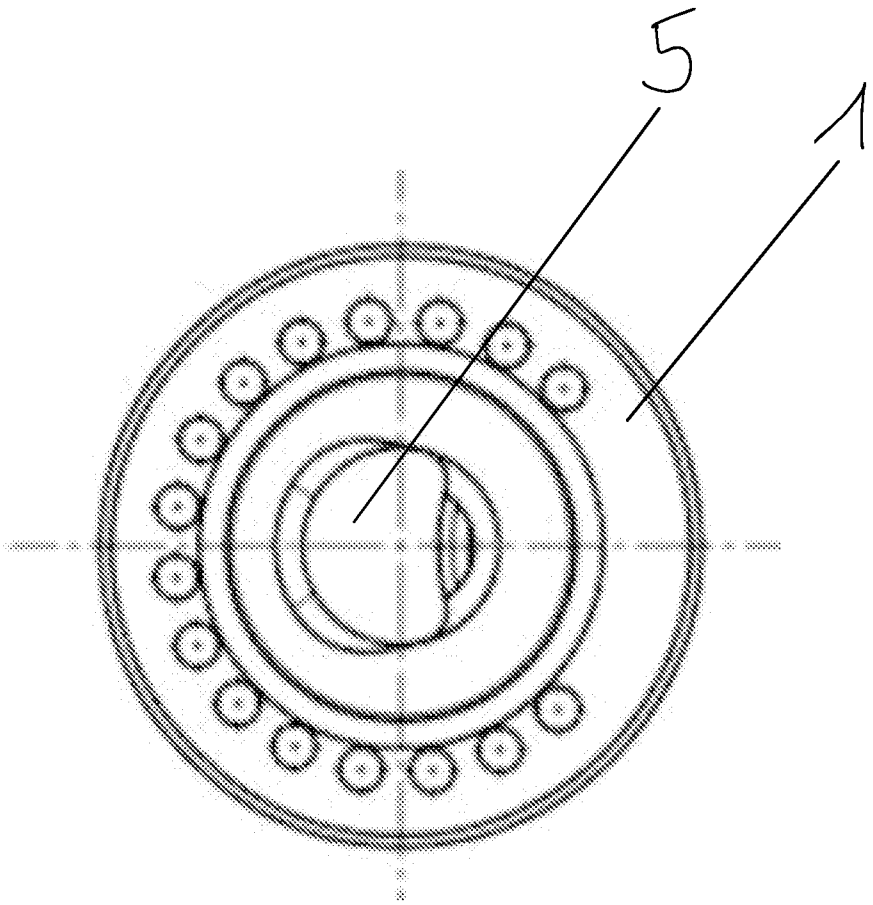


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. F02B19/12 F02M21/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F02B F02M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 26 06 014 A1 (PORSCHE AG) 25 August 1977 (1977-08-25) page 4, paragraph 3; figure 1	1-11
X	GB 1 535 762 A (HONDA MOTOR CO LTD) 13 December 1978 (1978-12-13) figures 1,3	1,2
A	DE 10 2020 003126 A1 (DAIMLER AG [DE]) 25 November 2021 (2021-11-25) paragraph [0012] - paragraph [0013]	1

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kolodziejczyk, Piotr

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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