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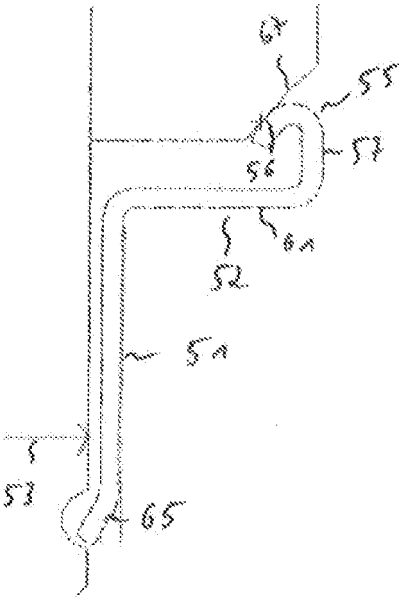
(54) Fuel injector and fuel-injection system

(57) A fuel injector (18) of a combustion engine (22) being operable to be arranged in a cylinder head (14) of a combustion engine (22) comprises an injector housing (26) and an adjustment device (50) being arranged in a recess (15) of the cylinder head (14) between the injector housing (26) and the cylinder head (14). The adjustment device (50) comprises a cylindrical portion (51) comprising a first diameter (53) being in the range of a diameter of the injector housing (26) in an area the injector housing (26) is arranged in the cylindrical portion (51). Furthermore the adjustment device (50) comprises a discoidal portion (52) with a central opening with an inner diameter and an outer diameter, the outer diameter being larger than the inner diameter and the inner diameter being in the range of the first diameter (53) of the cylindrical portion (51). The discoidal portion (52) is rigidly coupled to the cylindrical portion (51) along the central opening. The discoidal portion (52) comprises a bottom planar surface (61) being in contact with the cylinder head (14), if the fuel injector (18) is mounted in the cylinder head (14). The discoidal portion (52) comprises a mainly toroidal bended up flange (55) to align the fuel injector relative to the recess in radial and axial direction.

Fig 2B



EP 2 518 304 A1

Description

[0001] The invention relates to a fuel injector and a fuel-injection system of a combustion engine.

[0002] Fuel injectors are in wide spread use, in particular for internal combustion engines where they may be arranged in order to dose fuel into an intake manifold of the internal combustion engine or directly into the combustion chamber of a cylinder of the internal combustion engine. Fuel can be supplied to the internal combustion engine by the fuel injector. The fuel injectors can be coupled to the cylinder head of the internal combustion engine in different manners.

[0003] The coupling of the fuel injectors to the cylinder heads needs to be very precise to get a correct injection angle.

[0004] The object of the invention is to create a fuel injector for a cylinder head of a combustion engine which is simply to be manufactured and which facilitates a reliable and precise coupling between the fuel injector and the cylinder head of the combustion engine.

[0005] It is furthermore the object of the invention to create a fuel-injection system that ensures a precise dosing of fuel.

[0006] The objects are achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub-claims.

[0007] According to a first aspect the invention is distinguished by a fuel injector of a combustion engine including a central longitudinal axis and being operable to be arranged in a cylinder head of a combustion engine. The fuel injector comprises an injector housing and an adjustment device being arranged in a recess of the cylinder head between the injector housing and the cylinder head. The adjustment device comprises a cylindrical portion comprising a first diameter being in the range of a diameter of the injector housing in an area the injector housing is arranged in the cylindrical portion. Furthermore the adjustment device comprises a discoidal portion with a central opening with an inner diameter and an outer diameter, the outer diameter being larger than the inner diameter and the inner diameter being in the range of the first diameter of the cylindrical portion. The discoidal portion is rigidly coupled to the cylindrical portion along the central opening. The discoidal portion comprises a bottom planar surface being in contact with the cylinder head, if the fuel injector is mounted in the cylinder head. The discoidal portion comprises a mainly toroidal bended up flange to align the fuel injector relative to the recess in radial and axial direction.

[0008] The mainly toroidal bended up flange is coupled with injector housing, when the fuel injector is mounted in the cylinder head of the combustion engine. This has the advantage that the flange in correlation with the discoidal and cylindrical portion offers a simple and reliable coupling of the injector housing of the fuel injector with the cylinder head, in particular by allowing planar and rotational movements of the fuel injector. By this the fuel injector can compensate tolerances of parts coupled to it. Additional the mainly toroidal bended up flange being designed elastically allows shock absorption and noise reduction. A levelling of the fuel injector relative to the cylinder head can be carried out by discoidal portions with different axial extensions, or different radiuses of the mainly toroidal bended up flanges.

[0009] In an advantageous embodiment of the invention the discoidal portion with the toroidal bended up flange is formed in one piece with the cylindrical portion. This has the advantage that the adjustment device can be simply and cost-efficiently manufactured, for instance by deep drawing, with a small amount of material. Furthermore, a compact construction is possible.

[0010] In a further advantageous embodiment of the invention the fuel injector comprises a snap-ring, which is arranged underneath the adjustment device, with the first diameter of the cylindrical portion of the adjustment device being smaller than an outer diameter of the snap-ring to keep the adjustment device packaged to the injector housing. By this the adjustment device can be packaged to the fuel injector. This has the advantage that an assembly of the fuel injector into the cylinder head of the combustion engine can be processed in a single step, saving assembly time and reducing manufacturing costs for assembly in the combustion engine. The snap ring may be coupled to the injector housing by an interference fit.

[0011] In a further advantageous embodiment of the invention the cylindrical portion comprises at least one indentation in its end area facing away from the discoidal portion, extending at least partly along a circumferential line of the cylindrical portion, to keep the adjustment device packaged to the injector housing. This has the advantage that the adjustment device, with the functions of a washer and a misalignment recovery and a packaging of the adjustment device to the injector housing, can be formed in one piece. The adjustment device can be simply manufactured, for instance by deep drawing, with a small amount of material. An assembly of the fuel injector into the cylinder head of the combustion engine can be processed in a single step, saving assembly time and reducing manufacturing costs for assembly in the combustion engine.

[0012] In a further advantageous embodiment of the invention the discoidal portion with the mainly toroidal bended up flange and the cylindrical portion comprise stainless steel or are made of stainless steel. Preferably the injector housing, the mainly toroidal bended up flange, the discoidal portion and the cylindrical portion are made of the same material. This has the advantage that a reliable coupling between the adjustment device and the injector housing of the fuel injector can be ensured.

[0013] According to a second aspect the invention is distinguished by a fuel-injection system with a cylinder head of an internal combustion engine and a fuel injector according to the first aspect of the invention. The fuel injector is arranged

in a recess of the cylinder head.

[0014] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings. These are as follows:

Figure 1	an internal combustion engine in a schematic view,
Figure 2A	a fuel injector with a first embodiment of an adjustment device in a cylinder head of the combustion engine in a side view,
Figure 2B	the fuel injector with the first embodiment of the adjustment device in the cylinder head of the combustion engine in an enhanced view,
Figure 2C	the fuel injector with a second embodiment of the adjustment device in the cylinder head of the combustion engine in an enhanced view,
Figure 3	the fuel injector with different degrees of freedom and
Figure 4	an adjustment device with a discoidal portion and a cylindrical portion in a spatial view.

[0015] Elements of the same design and function that occur in different illustrations are identified by the same reference character.

[0016] Figure 1 shows an internal combustion engine 22, with an intake manifold 10, a motor block 12, a cylinder head 14 and an exhaust manifold 16. A combustion chamber 20 is arranged within the motor block 12.

[0017] The cylinder head 14 comprises a fuel injector 18 and a sparking plug 19. A spring and/or a clamp 30 enable the adjustment of the fuel injector 18 to the cylinder head 14 of the combustion engine 22.

[0018] The fuel injector 18 (in figure 2A) comprises an injector coupling portion 24 and a valve assembly 27. The injector coupling portion 24 is designed to be coupled to a high-pressure fuel rail of the internal combustion engine 22, the fuel is stored under high pressure, for example, under the pressure of about 200 bar in the case of a gasoline engine or of about 2,000 bar in the case of a diesel engine.

[0019] Furthermore, the injector coupling portion 24 is designed to be coupled to an electrical supply to actuate a not shown actuator unit of the fuel injector 18.

[0020] The valve assembly 27 comprises an injector housing 26 with a central longitudinal axis L and a not shown cavity which is axially led through the injector housing 26. The valve assembly 27 further comprises a not shown valve needle taken in the cavity of the injector housing 26. On a free end of the valve assembly 27 an injection nozzle is formed which is closed or opened by an axial movement of the valve needle. In a closing position a fuel flow through the injection nozzle is prevented. In an opening position fuel can flow through the injection nozzle into the combustion chamber 20 of the internal combustion engine 22.

[0021] Figure 2A illustrates the fuel injector 18 mounted in the cylinder head 14 of the combustion engine 22. The recess 15 in the cylinder head 14, where the fuel injector 18 is mounted in, can be called a cylinder head pocket for the fuel injector 18. The fuel injector 18 comprises an adjustment device 50.

[0022] Figure 2B shows the fuel injector 18 with a first embodiment of the adjustment device 50 in the cylinder head of the combustion engine 22 in an enhanced view.

[0023] The adjustment device 50 comprises a cylindrical portion 51 comprising a first diameter 53 being in the range of a diameter of the injector housing 26 in an area the injector housing 26 is arranged in the cylindrical portion 51. Furthermore the adjustment device 50 comprises a discoidal portion 52 with a central opening with an inner diameter and an outer diameter, the outer diameter being larger than the inner diameter and the inner diameter being in the range of the first diameter 53 of the cylindrical portion. The discoidal portion 52 is rigidly coupled to the cylindrical portion 51 along the central opening. The discoidal portion 52 comprises a bottom planar surface 61 being in contact with a projection 68 of the cylinder head 14, if the fuel injector 18 is mounted in the cylinder head 14. The discoidal portion 52 comprises a mainly toroidal bended up flange 55 to align the fuel injector 18 relative to the recess 15 in radial and axial direction.

[0024] An upper surface 56 of the flange 55 is preferably mainly toroidal and in contact with a contact area 67 of the injector housing 26, whereas the contact area 67 is preferably conic. The contact area 67 of the injector housing 26 represents a transition area from a larger diameter of the injector housing 26 to a lower diameter.

[0025] The toroidal bended up flange 55 is applicable to allow predetermined movements of the fuel injector 18 within its cylinder head pocket in the combustion engine 22. As indicated in figure 3, the mainly toroidal bended up flange 55 preferably allows fuel injector 18 movements in up to five different degrees of freedom within its cylinder head pocket of the combustion engine 22. Three degrees of freedom represent typically rotational movements 40 of the fuel injector 18, while two remaining degrees of freedom represent planar movements 41 of the fuel injector 18 within its cylinder head pocket. The reason for allowing different degrees of freedom is, that the fuel injector 18 has to compensate tolerances of other parts coupled with it, as for example compensate the arrangement of the high-pressure fuel rail, which can vary in its arrangement by +/- 1 mm. Furthermore the fuel injector 18 has to compensate thermal changes of dimensions of the cylinder head 14 and/or the cylinder head pocket, while the combustion engine 22 is in operation. As

indicated in figure 2A, there is typically a predetermined clearance 69 between the inner vertical surface of the cylinder head pocket and the vertical surface of the injector housing 26. The clearance 69 is for example in the range between 0.5 mm to 1 mm. Beside the clearance 69 between the inner cylinder head surface and the surface of the injector housing 26, there is also a clearance between the vertical oriented surface 57 of the flange 55 and the inner vertical surface of the cylinder head 14, that means, the outer diameter of the mainly toroidal bended up flange 55 is preferable smaller than the diameter of the inner vertical cylinder head surface in the area, where the mainly toroidal bended up flange 55 is arranged.

[0026] For instance, the cylindrical portion 51 comprises at least one indentation 65 in its end area facing away from the discoidal portion 52, extending at least partly along a circumferential line of the cylindrical portion 51, to keep the adjustment device 50 packaged to the injector housing 26.

[0027] In a preferred embodiment of the adjustment device 50, the discoidal portion 52 with the mainly toroidal bended up flange 55 is formed in one piece with the cylindrical portion 51.

[0028] Figure 2C shows the fuel injector with a second embodiment of the adjustment device in the cylinder head of the combustion engine in an enhanced view. Additionally or alternatively the fuel injector 18 comprises for instance a snap-ring 64, which is associated to the adjustment device 50; more precisely the cylindrical portion 51 is associated to the snap-ring 64. The snap-ring 64 is arranged underneath the adjustment device 50. The first diameter 53 of the cylindrical portion 51 of the adjustment device 50 is smaller than an outer diameter of the snap-ring 64 to keep the adjustment device 50 packaged to the injector housing 26. As a result, the adjustment device 50 stays packaged to the fuel injector 18 through the snap-ring 64, even if the fuel injector 18 is pulled out of its cylinder head pocket. Furthermore the steps for mounting the fuel injector 18 into the cylinder head 14 of the combustion engine 22 can be reduced to a single step, because all necessary components are already packaged to the fuel injector 18.

[0029] The injector housing 26, the adjustment device 50 and the snap-ring 64 are preferably made of stainless steel, while the cylinder head 14 of the combustion engine 22 is preferably made of aluminium or magnesium.

[0030] Figure 4 shows an adjustment device 50 according to the first embodiment in a spatial view. The cylindrical portion 51 comprises, for instance, four indentations 65 extending partly along the circumferential line of the cylindrical portion 51, to keep the adjustment device 50 packaged to the injector housing 26.

Claims

1. Fuel injector (18) including a central longitudinal axis (L) and being operable to be arranged in a cylinder head (14) of a combustion engine (22), the fuel injector (18) comprising an injector housing (26) and an adjustment device (50) being arranged in a recess (15) of the cylinder head (14) between the injector housing (26) and the cylinder head (14), the adjustment device (50) comprising

   - a cylindrical portion (51) comprising a first diameter (53) being in the range of a diameter of the injector housing (26) in an area the injector housing (26) is arranged in the cylindrical portion (51),
   - a discoidal portion (52) with a central opening with an inner diameter and an outer diameter, the outer diameter being larger than the inner diameter and the inner diameter being in the range of the first diameter (53) of the cylindrical portion, the discoidal portion (52) being rigidly coupled to the cylindrical portion (51) along the central opening, the discoidal portion (52) comprising a bottom planar surface (61) being in contact with the cylinder head (14), if the fuel injector (18) is mounted in the cylinder head (14), the discoidal portion comprising a mainly toroidal bended up flange (55) to align the fuel injector (18) relative to the recess (15) in radial and axial direction.

2. Fuel injector (18) in accordance with claim 1, with the discoidal portion (52) and the toroidal bended up flange (55) being formed in one piece with the cylindrical portion (51).

3. Fuel injector (18) in accordance with one of the preceding claims, comprising a snap-ring (64), which is arranged underneath the adjustment device (50), with the first diameter (53) of the cylindrical portion (51) of the adjustment device (50) being smaller than an outer diameter of the snap-ring (64) to keep the adjustment device (50) packaged to the injector housing (26).

4. Fuel injector (18) in accordance with one of the preceding claims, with the cylindrical portion (51) comprising at least one indentation (65) in its end area facing away from the discoidal portion (52), extending at least partly along a circumferential line of the cylindrical portion (51), to keep the adjustment device (50) packaged to the injector housing (26).

5. Fuel injector (18) in accordance with one of the preceding claims, the discoidal portion (52) with the mainly toroidal

bended up flange (55) and the cylindrical portion (51) comprising stainless steel or being made of stainless steel.

6. Fuel-injection system with a cylinder head (14) of an internal combustion engine (22) and a fuel injector (18) according to one of the preceding claims, wherein the fuel injector (18) is arranged in a recess (15) of the cylinder head (14).

FIG 1

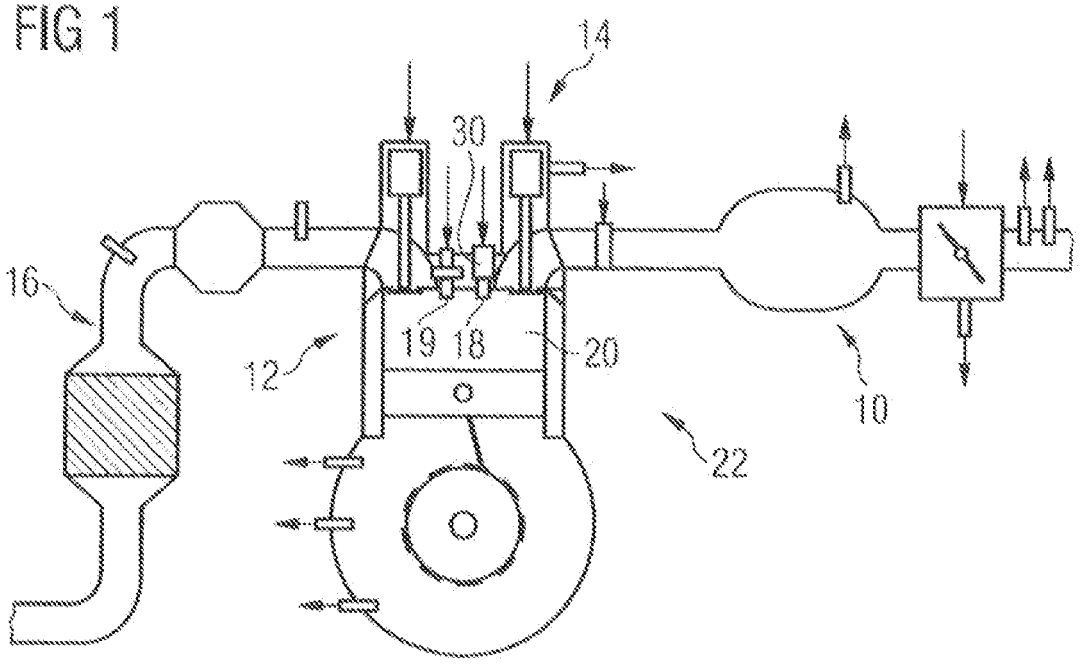


Fig 2A

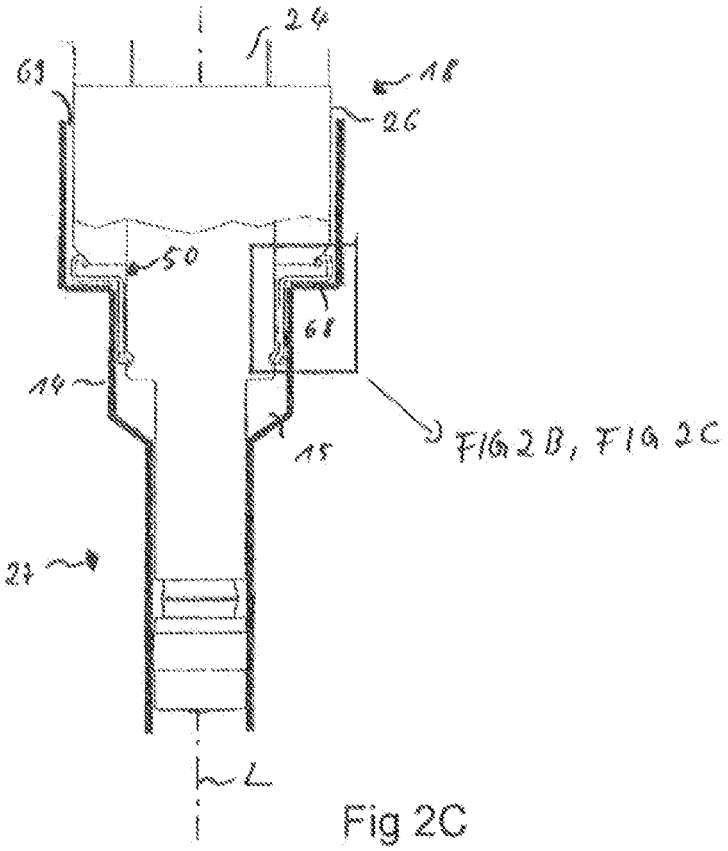


Fig 2B

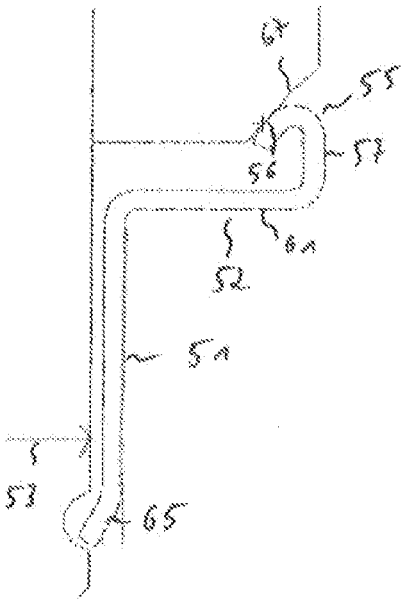


Fig 2C

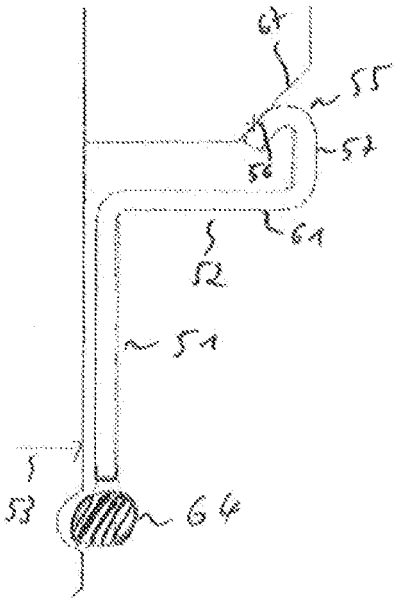


FIG 3

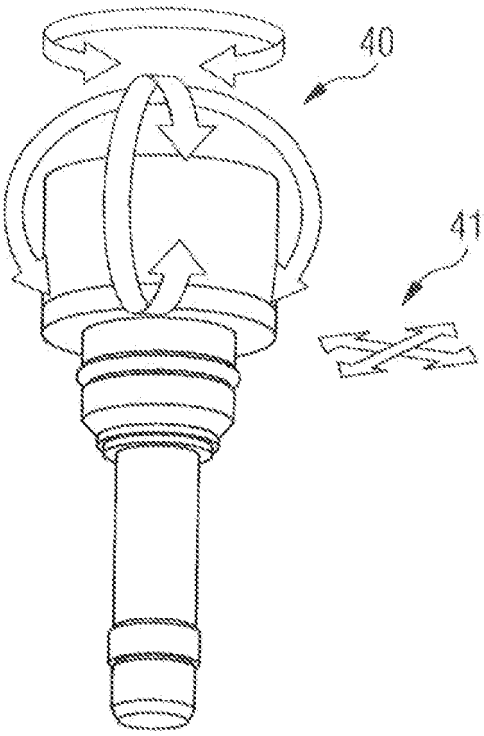
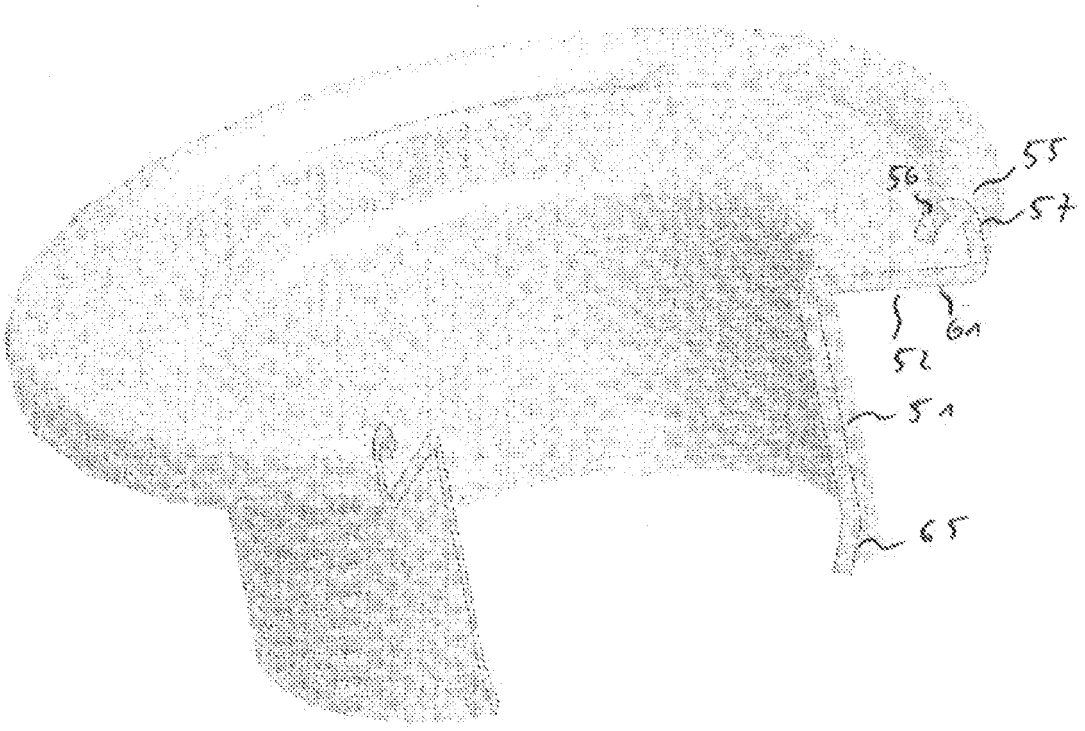


FIG 4



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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 4309

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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	7 July 2011	Hermens, Sjoerd

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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