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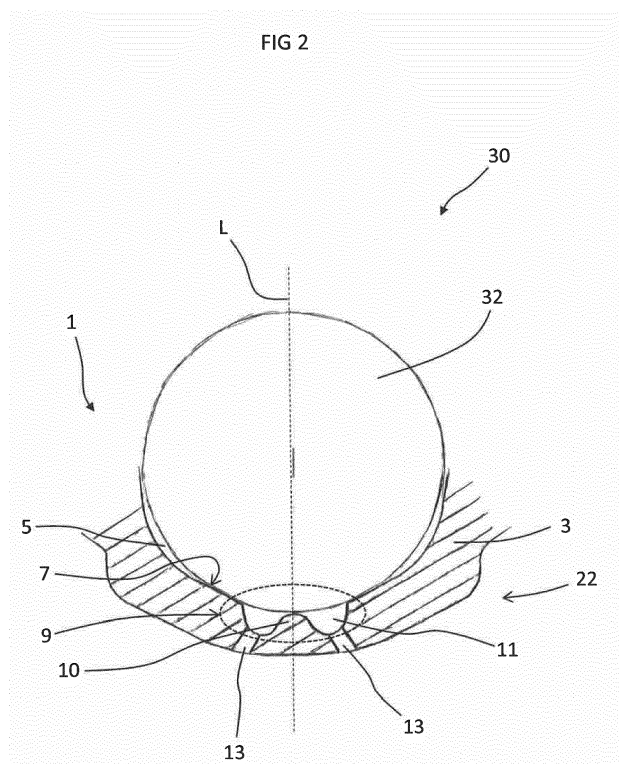
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(54) **NOZZLE BODY FOR A FLUID INJECTOR AND FLUID INJECTOR**

(57) A nozzle body (1) for a fluid injector (30) comprises a nozzle wall (3) which limits an opening (5) of the nozzle body (1) along a longitudinal axis (L) from a fluid inlet end (21) to a fluid outlet end (22). The nozzle body (1) further comprises a needle seat (7) formed as a portion of the nozzle wall (3) to interact with a needle (32) to prevent a fluid flow through a flow hole (13) in a closed position and otherwise to enable it. The flow hole (13) penetrates the nozzle wall (3) in the region of the fluid

outlet end (22) from the opening (5) to outside of the nozzle body (1). The nozzle body (1) further comprises a sac volume portion (9) of the nozzle wall (3) formed in the region of the fluid outlet end (22) such as to limit a sac volume (11) wherein the sac volume portion (9) comprises a protrusion (10) inside the sac volume (11) formed in one piece with the nozzle wall (3) extending along the longitudinal axis (L).



Description

[0001] The invention relates to a nozzle body for a fluid injector and a fluid injector.

[0002] Injectors are in widespread use, in particular for internal combustion engines where they may be arranged in order to dose a fluid into an intake manifold of the internal combustion engine or directly into a combustion chamber of a cylinder of the internal combustion engine.

[0003] In order to enable a beneficial combustion process, it is necessary to provide good spray quality and fluid penetration of a fluid into the combustion chamber, amongst others. In this context generating a low particulate number of pollutant emissions is an ongoing task. To achieve this there is a possibility to influence on the spray behaviour of fluid escaping the fluid injector.

[0004] One object of the invention is to create a nozzle body for a fluid injector and a corresponding fluid injector which facilitate a reliable dosing of fluid with enhanced spray quality and characteristics.

[0005] The object is achieved by the features of the independent claims. Advantageous embodiments of the invention are given in the sub claims.

[0006] According to a first aspect of the invention, a nozzle body for a fluid injector comprises a nozzle wall which limits a penetrating opening of the nozzle body along a longitudinal axis from a fluid inlet end to a fluid outlet end of the nozzle body. The nozzle body further comprises a needle seat formed as a portion of the nozzle wall to interact with a needle to prevent a fluid flow through a flow hole in a closed position and otherwise to enable it. The flow hole penetrates the nozzle wall in the region of the fluid outlet end from the opening to outside of the nozzle body. The nozzle body further comprises a sac volume portion of the nozzle wall formed in the region of the fluid outlet end such as to limit a sac volume wherein the sac volume portion comprises a protrusion inside the sac volume formed in one piece with the nozzle wall extending along the longitudinal axis.

[0007] Such a configuration of a nozzle body for a fluid injector enables beneficial streaming conditions for a streaming fluid and contributes to enhanced spray quality of the fluid and a profitable combustion process. Due to the protrusion which acts as a wall or a barrier for streaming fluid inside the sac volume streaming conditions inside the nozzle body and the one or more flow holes are advantageously affected. This implies a reduction of undesirable flow mixture inside the sac volume and a reduction of shot-to-shot deviations as well as an improvement of spray stability due to reduction of flow fluctuations or oscillations inside the area of the sac volume portion and the flow holes.

[0008] The described nozzle body simply enables to influence the spray targeting without the need of further geometrical changes of the nozzle body. The protrusion inside the sac volume separates the flow holes from each other with respect to streaming interactions and benefi-

cially affects the spray characteristics of the fluid escaping the nozzle body. In this context amongst others the invention is based on the knowledge that one flow hole has influence on the flow and spray behaviour inside the other flow holes and vice versa. Therefore, modifications of penetration of fluid escaping out of the nozzle body by changing a length, a diameter and/or angle of the respective flow hole, for example, will strongly affect the streaming and spray conditions of the other flow holes.

[0009] By using a nozzle body as described above with a protrusion inside the sac volume the geometry of one flow hole will have less influence to the flow and spray behaviour inside the other flow holes. Due to this it is possible to change the design of a respective flow hole in order to optimize one jet plume separately from the others. This means changing of a length, a diameter and/or an angle of the flow hole with respect to the longitudinal axis will have a reduced influence on the flow characteristics of the others.

[0010] The protrusion realizes a step or a pin, for example formed in the middle of the sac volume, as one piece of the nozzle wall. The dimension and the shape of the protrusion should be big enough to separate the flow holes from each other in terms of flow characteristics inside the nozzle body. Advantageously the protrusion is adapted to given application requirements as predetermined spray targeting and hole drilling configuration of the at least one flow hole.

[0011] According to one embodiment of the nozzle body, the protrusion comprises a rounded shape.

[0012] According to a further embodiment of the nozzle body, the protrusion comprises an angular shape.

[0013] The protrusion may be formed as a hemisphere such that the resulting sac volume comprises a shape of a ring surrounding the protrusion. With respect to a top view or a projection along the longitudinal axis, the protrusion is arranged, for example centred, inside the sac volume between different inlets of respective flow holes. The protrusion may alternatively comprise an angular, for example a rectangular shape, such that the resulting sac volume comprises a rectangular frame shape surrounding the protrusion. But necessarily the protrusion is formed with a height with respect to the longitudinal axis that is small enough to not contact the needle to enable reliable functioning of a corresponding fluid injector.

[0014] The protrusion beneficially influences flow and spray behaviour of the nozzle body and additionally reduces the sac volume in comparison with a nozzle body which does not comprise a protrusion inside the sac volume. Hence, the described nozzle body further contributes to a reduction of fluid remaining in the sac volume after the needle has returned to closing position again. Due to this the described nozzle body enhances flow purging during an injector closure phase and as a consequence reduces tip sooting of the nozzle tip of a nozzle body. This further contributes to a low particulate number of pollutant emissions.

[0015] According to a further embodiment of the nozzle body, the protrusion is formed symmetrically inside the sac volume with respect to the longitudinal axis.

[0016] The protrusion might be formed rotationally symmetric inside the middle of the sac volume with respect to the longitudinal axis. But alternatively the protrusion might be formed non symmetric and/or arranged asymmetrically inside the sac volume. Such a configuration may beneficially affect the flow and spray behaviour of the one or more flow holes, for example to fulfil given application requirements.

[0017] According to a further embodiment the nozzle body comprises two or more flow holes and the protrusion is formed between the flow holes with respect to a projection along the longitudinal axis. A further advantageous effect resulting from the protrusion is an improvement of separation of respective spray jets of a corresponding flow hole from the others. Each spray jet is generated by fluid which escapes out of the nozzle body through the respective flow hole into the combustion chamber, for example. Using an embodiment of the described nozzle body enables adaption and optimization of a spray jet separately, for instances in order to optimize the spray jet plume angle with respect to customer requirements.

[0018] Furthermore, given by the separation of the respective spray jets generated by the protrusion the nozzle body enables a reduction of shot-to-shot deviation in steady state conditions due to reduced possibility of unsteady string cavitation between the flow holes.

[0019] According to a further embodiment of the nozzle body, the protrusion is formed such that it contacts opposite sides of the nozzle wall in the region of the sac volume portion with respect to the longitudinal axis.

[0020] Such an embodiment of the nozzle body describes a further possibility to form the protrusion inside the sac volume as one piece with the nozzle wall. In such a configuration the protrusion represents a continuous wall which divides the sac volume into two separated parts, for example. Thus, the resulting sac volume would comprise the shape of two separated half-rings or half-disc segments, for example. In this context, opposite sides of the nozzle wall represents side portions of the nozzle wall which substantially faces each other with respect to a top view of the nozzle body along the longitudinal axis, for instance. According to further embodiments of the nozzle body the protrusion may comprise two or more continuous walls which contact different side portions of the nozzle wall with respect to the longitudinal axis.

[0021] According to a second aspect of the invention, a fluid injector comprises a nozzle body in accordance with one of the embodiments described above and a needle which is arranged axially movable in the opening of the nozzle body with respect to the longitudinal axis to prevent a fluid flow through the flow hole in a closed position and otherwise to enable it.

[0022] Such a fluid injector enables enhanced perform-

ance, especially concerning improved streaming conditions and spray targeting of a streaming fluid with beneficial spray stability and controllability as well as penetrations characteristics. Because the fluid injector comprises one embodiment of the nozzle body, all characteristics and features corresponding to the nozzle body as described above also relates to the fluid injector and vice versa.

[0023] Exemplary embodiments of the invention are explained in the following with the aid of schematic drawings and reference numbers. Identical reference numbers designate elements or components with identical functions. The figures show:

- 5 Figure 1 an exemplary embodiment of a fluid injector;
- Figure 2 an exemplary embodiment of a nozzle body for the fluid injector; and
- 10 Figure 3 a further exemplary embodiment of a nozzle body for the fluid injector.

[0024] Figure 1 illustrates a cross-section of an exemplary embodiment of a fluid injector 30 which comprises a nozzle body 1 and a needle 32. The needle 32 is arranged axially movable inside an opening 5 of the nozzle body 1 with respect to a longitudinal axis L to prevent a fluid flow through a flow hole 13 in a closed position and otherwise to enable it.

25 **[0025]** The nozzle body 1 comprises a nozzle wall 3 (in figure 1 just illustrated as a line) which limits the penetrating opening 5 of the nozzle body 1. The nozzle wall 3 comprises a needle seat 7 and a sac volume portion 9 adjacent to the needle seat 7 with respect to the longitudinal axis L. The needle seat 7 and the sac volume portion 9 are formed at a fluid outlet end 22 of the nozzle body 1 whereas a fluid inlet end 21 is located at an opposite side of the nozzle body 1 with respect to the longitudinal axis L. The nozzle body 1 is configured rotationally symmetric with respect to the longitudinal axis L, for example.

30 **[0026]** The flow hole 13 penetrates the nozzle wall 3 in the region of the fluid outlet end 22 from the opening 5 to outside of the nozzle body 1 for dosing fluid into a combustion chamber, for example. The nozzle body 1 may comprise one or more flow holes 13 for dosing a given amount of fluid.

35 **[0027]** Figure 2 shows an enlarged view of the sac volume portion 9 of the nozzle body 1 at the fluid outlet end 22 which realizes a nozzle tip of the nozzle body 1. From this Figure 2 it is apparent that the sac volume portion 9 is directly adjacent to the needle seat 7 and limits a sac volume 11 wherein a protrusion 10 is formed in one piece with the nozzle wall 3.

40 **[0028]** The protrusion 10 comprises a rounded shape and is formed or arranged symmetrically inside the sac volume 11. The protrusion 10 is formed as a pin extending along the longitudinal axis L and enables beneficial flow and spray conditions for a streaming fluid. The dimension

and the shape of the protrusion 10 is big enough to separate the flow holes 13 from each other in terms of flow characteristics inside the nozzle body 1. Advantageously the protrusion 10 is adapted to given application requirements as predetermined spray targeting and hole drilling configuration of the respective flow hole 13.

[0029] Such a configuration of the nozzle body 1 and a corresponding fluid injector 30 contributes to enhanced spray quality of the fluid and a profitable combustion process. Due to the protrusion 10 which acts as a wall or a barrier for streaming fluid inside the sac volume 11 streaming conditions inside the nozzle body 1 and the flow holes 13 are advantageously affected. This implies a reduction of undesirable flow mixture inside the sac volume 11 and a reduction of shot-to-shot deviations as well as an improvement of spray stability due to reduction of flow fluctuations or oscillations inside the area of the sac volume portion 9 and the flow holes 13. Hence, the protrusion 10 simply enables to influence the spray targeting without the need of further geometrical changes of the nozzle body 1.

[0030] Furthermore, it is a knowledge of the invention that every flow hole 13 has influence on the flow and spray behaviour inside the other flow holes 13 and vice versa. Therefore, modifications of the nozzle body 1 by changing a length, a diameter and/or angle of the respective flow hole 13, for example, will affect the streaming and spray conditions of the other flow holes 13. Using an embodiment of the nozzle body 1 with the protrusion 10 as illustrated the geometry of one flow hole 13 will have less influence to the flow and spray behaviour inside the other flow holes 13. Hence, the protrusion 10 separates the flow holes 13 from each other with respect of the streaming conditions of a streaming fluid.

[0031] The protrusion 10 is formed as a hemisphere such that the resulting sac volume 11 comprises a shape of a ring surrounding the protrusion 10. With respect to a top view or a projection along the longitudinal axis L, the protrusion 10 is centrally arranged inside the sac volume 11 between the inlets of two illustrated flow holes 13. The protrusion 10 necessarily comprises a height with respect to the longitudinal axis L that is small enough to not contact the needle 32 to enable reliable functioning of the fluid injector 30.

[0032] The protrusion 10 beneficially influences flow and spray behaviour of the nozzle body 1 and additionally reduces the sac volume 11 in comparison with a nozzle body which does not comprise a protrusion inside the respective sac volume. Hence, the nozzle body 1 further contributes to a reduction of fluid remaining in the sac volume 11 during an injection process after the needle 32 has returned to closing position again. Therefore, nozzle body 1 enhances flow purging during an injector closure phase and as a consequence reduces tip sooting of the nozzle tip of a nozzle body 1. This contributes to a low particulate number of pollutant emissions and a profitable combustion process.

[0033] The protrusion 10 further enables improvement

of separation of respective spray jets of a corresponding flow hole 13 from the others and allows for separately optimization of a spray jet, in order to optimize the spray jet plume angle with respect to application requirements, for instances. Due to the separation of the respective spray jets generated by the protrusion 10 the nozzle body 1 enables a reduction of shot-to-shot deviation in steady state conditions due to reduced possibility of unsteady string cavitation between the flow holes.

[0034] Figure 3 shows another embodiment of the nozzle body 1 wherein the protrusion 10 comprises an angular shape. The protrusion 10 may comprise a rectangular or square shape such that the resulting sac volume 11 comprises a rectangular frame shape surrounding the protrusion 10.

[0035] The described embodiments of the nozzle body 1 contribute to less pollutant emissions and enables reduces spray penetration even if a relatively big sac volume is required. This might be the case if the nozzle body 1 comprises a predetermined seat thickness and a predetermined seat durability such that the nozzle tip is formed with a given sac volume step and a required distance apart from the load source with respect to the longitudinal axis L. But the protrusion 10 reduces the sac volume 11 and therefore counteracts tip sooting due to reduced fluid purging and remaining fluid inside the sac volume 11 during an injector closing phase. Therefore, the described nozzle body 1 enables the combination of relatively high structure resistance and relatively small sac volume 11 as well as improvements of flow mixture and spray behaviour.

Reference signs

[0036]

- | | |
|----|--------------------------------------|
| 1 | nozzle body |
| 3 | nozzle wall |
| 5 | penetrating opening |
| 7 | needle seat |
| 9 | sac volume portion |
| 10 | protrusion |
| 11 | sac volume |
| 13 | flow hole |
| 21 | fluid inlet end of the nozzle body |
| 22 | fluid outlet end of the nozzle body |
| 30 | fluid injector |
| 32 | needle |
| L | longitudinal axis of the nozzle body |

Claims

1. Nozzle body (1) for a fluid injector, comprising
- a nozzle wall (3) limiting a penetrating opening (5) of the nozzle body (1) along a longitudinal

- axis (L) from a fluid inlet end (21) to a fluid outlet end (22) of the nozzle body (1),
- a needle seat (7) formed as a portion of the nozzle wall (3) to interact with a needle (32) to prevent a fluid flow through a flow hole (13) in a closed position and otherwise to enable it, wherein the flow hole (13) penetrates the nozzle wall (3) in the region of the fluid outlet end (22) from the opening (5) to outside of the nozzle body (1), and
 - a sac volume portion (9) of the nozzle wall (3) formed in the region of the fluid outlet end (22) such as to limit a sac volume (11), wherein the sac volume portion (9) comprises a protrusion (10) inside the sac volume (11) formed in one piece with the nozzle wall (3) extending along the longitudinal axis (L).
2. Nozzle body (1) in accordance with claim 1, wherein the protrusion (10) comprises a rounded shape.
 3. Nozzle body (1) in accordance with claim 1, wherein the protrusion (10) comprises an angular shape.
 4. Nozzle body (1) in accordance with one of the claims 1 to 3, wherein the protrusion (10) is formed symmetrically inside the sac volume (11) with respect to the longitudinal axis (L).
 5. Nozzle body (1) in accordance with one of the claims 1 to 4, wherein the nozzle body (1) comprises two or more flow holes (13) and the protrusion (10) is formed between the flow holes (13) with respect to a projection along the longitudinal axis (L).
 6. Nozzle body (1) in accordance with one of the claims 1 to 5, wherein the protrusion (10) is formed such that it contacts opposite sides of the nozzle wall (3) in the region of the sac volume portion (9).
 7. Fluid injector (30), comprising
 - a nozzle body (1) in accordance with one of the claims 1 to 6, and
 - a needle (32) which is arranged axially movable in the opening (5) of the nozzle body (1) with respect to the longitudinal axis (L) to prevent a fluid flow through the flow hole (13) in a closed position and otherwise to enable it.

FIG 1

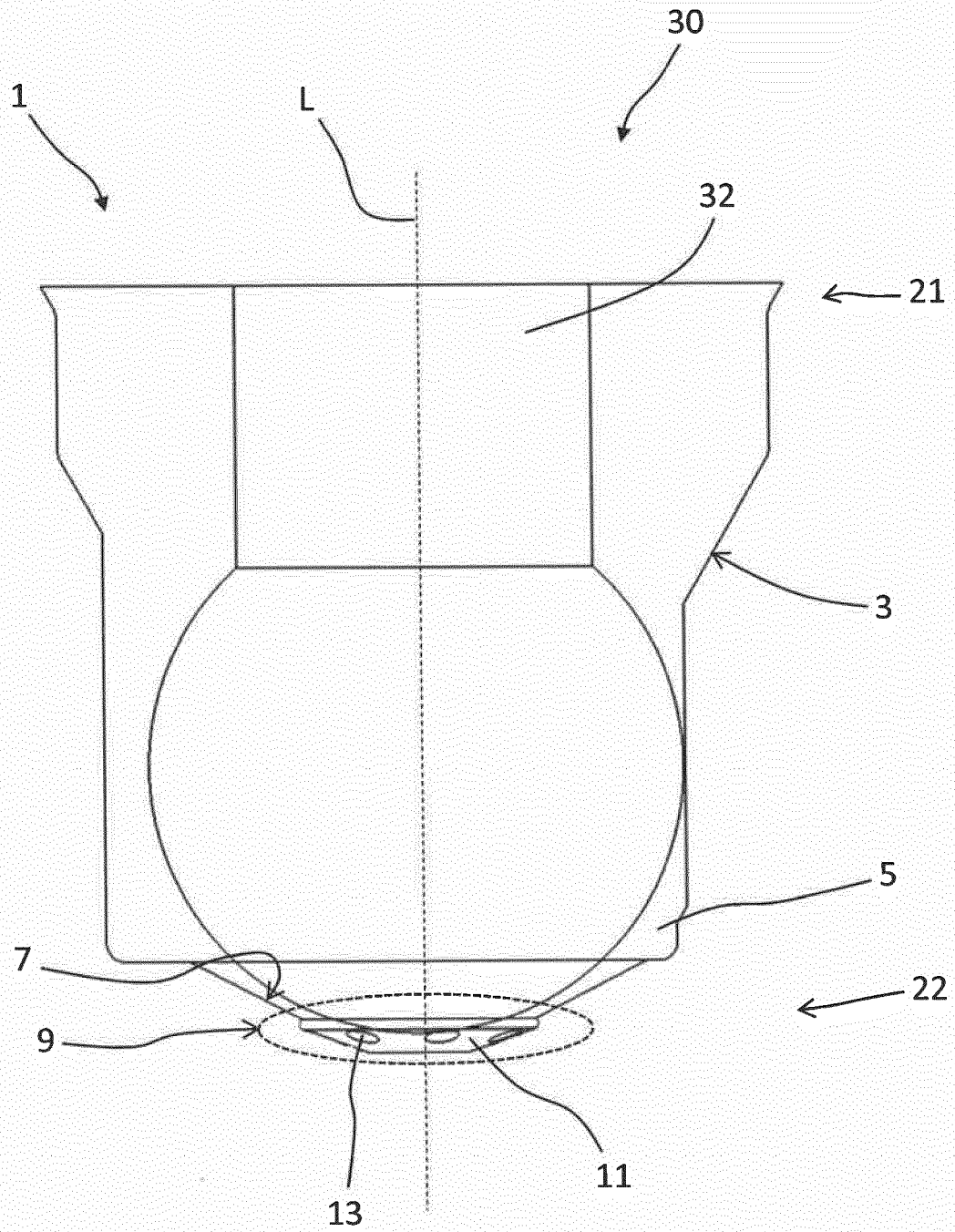


FIG 2

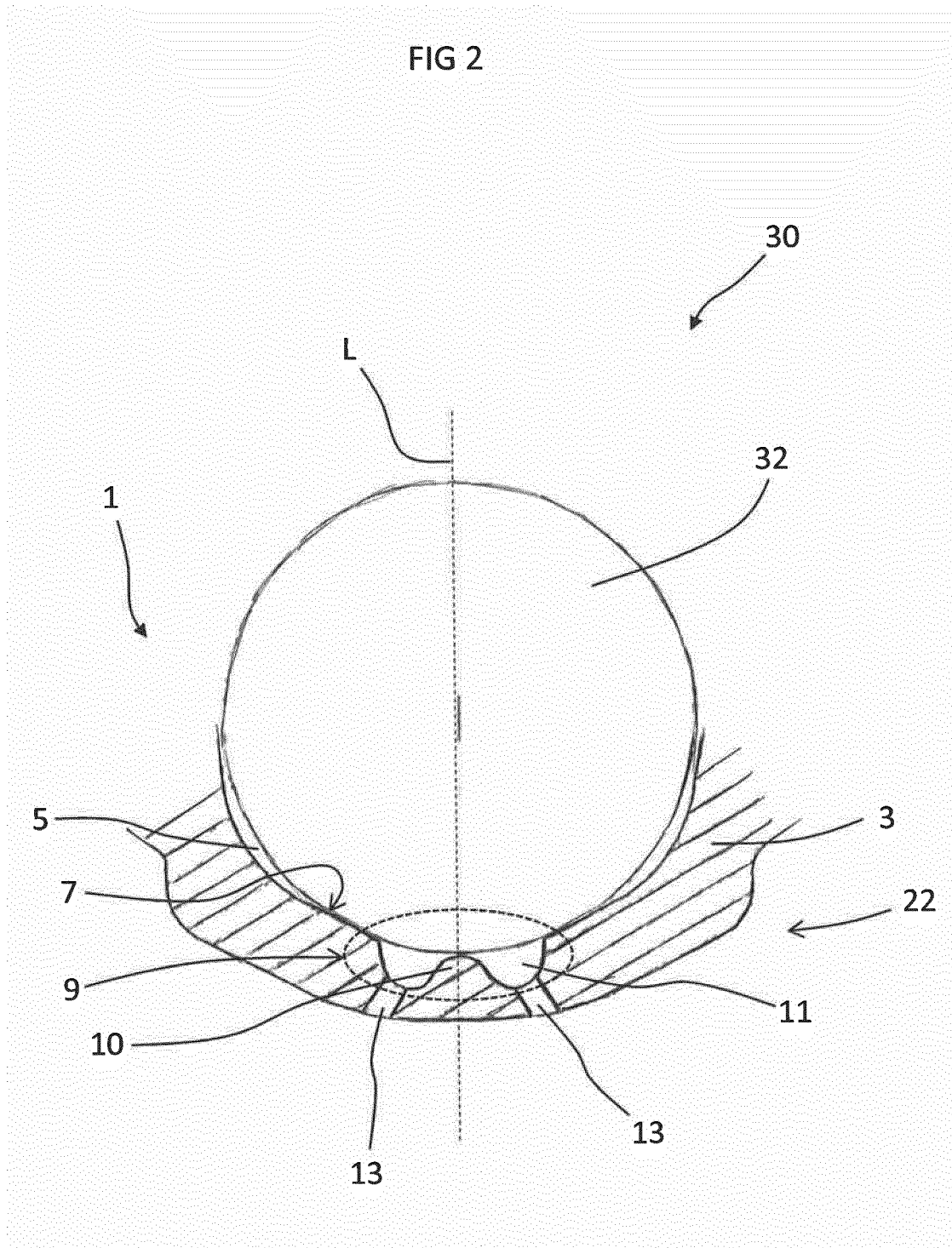
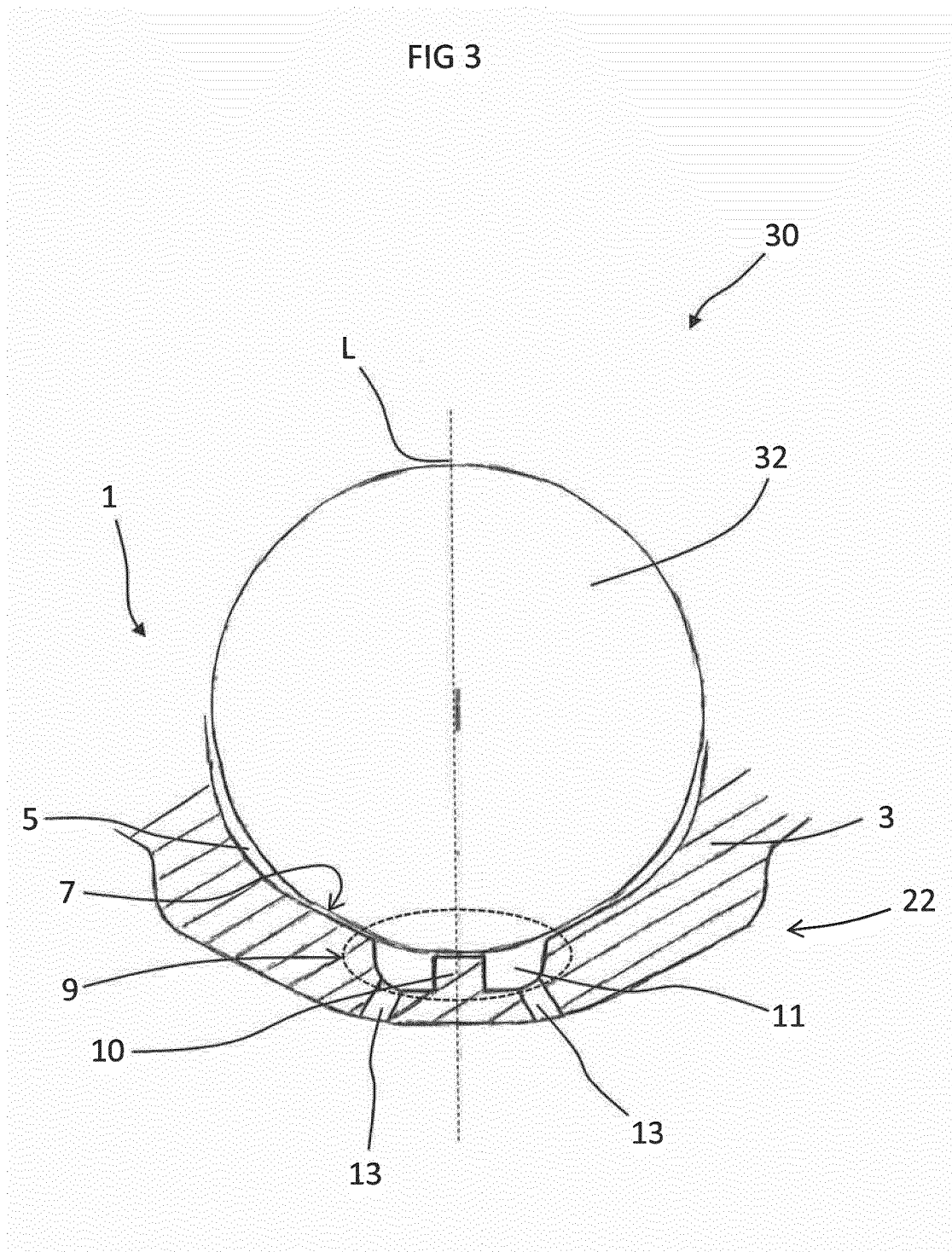


FIG 3





EUROPEAN SEARCH REPORT

Application Number
EP 15 20 1853

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 19 April 2016	Examiner Morales Gonzalez, M
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82