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(54) **High-pressure fuel accumulator for common-rail injection systems**

(57) A high-pressure fuel accumulator for common-rail injection systems, comprising a tubular body (24) elongated in a longitudinal direction (A), having a longitudinal cylindrical hole (26) and a plurality of connection holes (28), each connection hole (28) having an internal end (30) open in said longitudinal cylindrical hole (26) and an external end (32) open onto an outer surface (34) of the tubular body (24). The tubular body (24) comprises at least one recess for reduction of the stresses (36) formed in the immediate vicinity of the internal end (30) of each of said connection holes (28), said recess for reduction of the stresses having an extension (L) limited in a longitudinal direction (A).

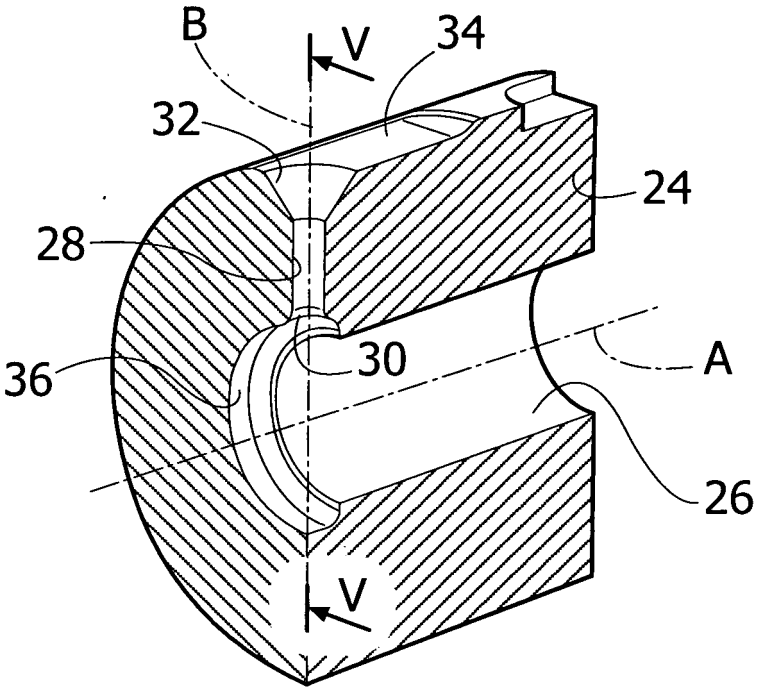

FIG. 3

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Description

Field of the invention

[0001] The present invention relates to a high-pressure fuel accumulator for common-rail injection systems.

[0002] Typically, a high-pressure fuel accumulator comprises a tubular body elongated in a longitudinal direction, having a longitudinal cylindrical hole and a plurality of connection holes perpendicular to the axis of the longitudinal cylindrical hole. Each connection hole has an internal end open in the longitudinal cylindrical hole and an external end open onto an outer surface of the tubular body.

[0003] To prevent stress peaks due to the internal pressure of the fuel it is necessary to avoid sharp edges in the area of intersection between the longitudinal cylindrical hole and each of the connection holes.

Description of the known art

[0004] The document No. EP-B1-1413744 describes a high-pressure accumulator for a common-rail injection system having a longitudinal cylindrical hole for accumulation of fuel and at least one radial hole for discharge of the fuel. To prevent accumulation of stress in the area of intersection, provided between the radial hole and the longitudinal hole is an arched wall with a curvature that is opposite to that of the wall of the longitudinal hole and extends throughout the length of the tubular body. The radial connection holes have the internal end open onto said arched wall.

[0005] Another solution is described in the document No. EP-B1-1423601. This document describes a high-pressure fuel accumulator having a tubular body with a longitudinal hole and branching from which is a plurality of connection holes. At least one section shaped like a ribbing is formed on the inner surface of the longitudinal hole. The connection holes extend through the section shaped like a ribbing.

[0006] The main drawback of the known solutions is that they involve costly machining processes to prevent any sharp edges in the area of intersection between the connection holes and the longitudinal hole, as a special profiling of the entire longitudinal hole. This drawback is particularly burdensome in the case of injection systems for large ships' engines, where the accumulator has a length of several metres.

Object and summary of the invention

[0007] The object of the present invention is to provide a high-pressure fuel accumulator that does not involve costly manufacturing processes for obtaining the profile for reduction of stress in the area of intersection between the radial connection holes and the longitudinal hole.

[0008] According to the present invention, said object is achieved by a high-pressure accumulator having the characteristics forming the subject of Claim 1.

Brief description of the drawings

[0009] The present invention will now be described in detail with reference to the attached drawings, which are provided purely by way of non-limiting example and in which:

- Figure 1 is a schematic view of a common-rail injection system for internal-combustion engines;
- Figure 2 is a longitudinal section of the fuel accumulator indicated by the arrow II in Figure 1;
- Figure 3 is a cross-sectional perspective view according to the line III-III of Figure 2;
- Figure 4 is a variant of Figure 3;
- Figure 5 is a cross section according to the line V-V of Figure 3;
- Figure 6 is a variant of Figure 5;
- Figures 7 and 8 are diagrams illustrating the percentage of reduction of the maximum stress as a function of dimensional parameters of the accumulator;
- Figure 9 is a cross section illustrating a second embodiment of the invention;
- Figure 10 is an enlarged cross section of the part indicated by the arrow X in Figure 9;
- Figure 11 is a longitudinal section according to the arrow XI-XI of Figure 10;
- Figure 12 is a cross-sectional perspective view according to the arrow XII of Figure 11;
- Figure 13 is a cross-sectional view illustrating a third embodiment of the present invention;
- Figure 14 is a longitudinal section according to the arrow XIV - XIV of Figure 13; and
- Figure 15 is a cross-sectional perspective view of the part indicated by the arrow XV in Figure 14.

Detailed description of the preferred embodiments

[0010] With reference to Figure 1, designated by 10 is a common-rail injection system for internal-combustion engines. The injection system 10 comprises a fuel accumulator 12 that is supplied with fuel at high pressure by a pump 14 equipped with a valve for regulating the flow rate 16. The fuel accumulator 12 supplies a plurality of injectors 18. An electronic control unit 20 governs opening of the injectors 18 and the valve for regulating the flow rate 16 in order to keep the pressure in the accumulator 12 at the desired level. The electronic control unit 20 detects the pressure within the fuel accumulator 12 by means of a sensor 22.

[0011] With reference to Figure 2, the fuel accumulator 12 comprises a tubular body 24 elongated in a longitudinal direction A. A longitudinal cylindrical hole 26 with circular cross section is formed in the tubular body.

[0012] With reference to Figures 2 and 3, the tubular body 24 has a plurality of connection holes 28 that extend in a radial direction with respect to the longitudinal axis

A. Each connection hole 28 has an internal end 30 open in the cylindrical hole 26 and an external end 32 open onto an outer surface 34 of the tubular body 24. Each connection hole 28 has a central stretch with cylindrical section, preferably with circular cross section, with a radial axis B orthogonal to the longitudinal axis A. The external end 32 of each connection hole 28 can have the shape of a truncated cone with major diameter open towards the outside, which forms a sealing seat for the end of a connection tube.

[0013] At the internal end of each connection hole 28 a recess is formed for reduction of the stresses 36, which has a limited extension in a longitudinal direction A.

[0014] In the embodiment illustrated in Figure 3, the recess for reduction of the stresses 36 has the form of a groove centred with respect to the longitudinal axis A, preferably of an annular shape. With reference to Figures 5 and 6, the groove 36 has a length L in the direction of the longitudinal axis A. The length L is preferably not greater than three times the diameter d of the connection hole 28. Designated by P in Figures 5 and 6 is the depth in a radial direction of the recess for reduction of the stresses 36.

[0015] In the variant illustrated in Figure 4, the recess for reduction of the stresses 36 has the form of a groove, preferably of annular shape, with longitudinal axis parallel and eccentric with respect to the longitudinal axis A, the axis of the groove being displaced with respect to the longitudinal axis A towards the connection hole 28.

[0016] In the embodiment illustrated in Figure 5, in a section lying in a plane passing through the longitudinal axis A, the groove 36 has a central cylindrical portion 36a and two small radiusing end portions 36b of radius R1.

[0017] In the variant illustrated in Figure 6, the groove 36 has a wall 36c having a continuous circular shape with a radius R2 that radiuses to one another the areas of intersection between the groove 36 and the cylindrical hole 26.

[0018] Any configuration with a radius of radiusing of amplitude intermediate between the radiuses R1 and R2 falls within the scope of the present invention. The configuration illustrated in Figure 6 is more advantageous than the one illustrated in Figure 5 in so far as it enables a greater reduction of the maximum stress.

[0019] The diagram of Figure 7 illustrates the percentage of reduction of the maximum stress as a function of the ratio L/d, where L is the extension of the recess for reduction of the stresses 36 in a longitudinal direction and d is the diameter of the connection hole 28. The percentage of reduction of the maximum stress is calculated on the geometry illustrated in Figure 3 with reference to a reference configuration in which only a radius of radiusing between the internal end of the connection hole 28 and the longitudinal cylindrical hole 26 is present. In the diagram of Figure 7 it may be noted that the benefits as regards the reduction of the maximum stress are limited with ratios L/d higher than three. The benefits increase considerably as the axial extension L of the recess for reduction of the stresses 36 decreases.

[0020] The diagram of Figure 8 illustrates the percentage of reduction of the maximum stress for the geometry illustrated in Figure 3 as a function of the ratio P/d, where P indicates the radial depth of the groove 36 and d the diameter of the connection hole 28.

[0021] Figures 9 to 12 illustrate a second embodiment of the present invention. The details corresponding to the ones previously described are designated by the same reference numbers. In this embodiment, each recess for reduction of the stresses 36 has the form of an annular groove centred with respect to the axis B of the respective connection hole 28. Also in this case the dimension in a longitudinal direction L (Figure 11) of the recess for reduction of the stresses 36 has a limited extension, preferably not greater than three times the diameter d of the connection hole 28.

[0022] Illustrated in Figures 13 to 15 is a third embodiment of the present invention. In this case, for each connection hole 28 two recesses for reduction of the stresses 36 are provided arranged symmetrically with respect to a plane passing through the longitudinal axis A and through the axis B of the connection hole 28. The recesses 36 have a limited extension in a longitudinal direction, preferably not greater than three times the diameter of the connection hole 28.

[0023] In all the embodiments described above, the recesses for reduction of the stresses 36 are preferably formed by means of electrochemical machining (ECM) or electrical-discharge machining (EDM). The longitudinal cylindrical hole 26 can be formed using any machining technique of a conventional type, for example drilling.

[0024] The fact of providing the recesses for reduction of the stresses 36 only in the immediate vicinity of the connection holes 28 enables a considerable reduction in the cost of the machining operations as compared to the solutions according to the known art, especially in the case of accumulators for large ships' engines in which the length of the accumulators is in the region of some metres.

Claims

1. A high-pressure fuel accumulator for common-rail injection systems, comprising a tubular body (24) elongated in a longitudinal direction (A), having a longitudinal cylindrical hole (26) and a plurality of connection holes (28), each connection hole (28) having an internal end (30) open in said longitudinal cylindrical hole (26) and an external end (32) open onto an outer surface (34) of the tubular body (24), said fuel accumulator being **characterized in that** the tubular body (24) comprises at least one recess for reduction of the stresses (36) formed in the immediate vicinity of the internal end (30) of each of said connection holes (28), said recess for reduction of the stresses having a limited extension (L) in a

longitudinal direction (A).

2. The high-pressure fuel accumulator according to Claim 1, **characterized in that** said recess for reduction of the stresses (36) has the shape of a groove.

3. The high-pressure fuel accumulator according to Claim 2, **characterized in that** said groove is centred with respect to the longitudinal axis (A) of said cylindrical hole (26).

4. The high-pressure fuel accumulator according to Claim 2, **characterized in that** said groove has a longitudinal axis parallel and eccentric with respect to the longitudinal axis A of said longitudinal cylindrical hole (26).

5. The high-pressure fuel accumulator according to Claim 2, **characterized in that** said groove is centred with respect to the radial axis (B) of the respective connection hole (28).

6. The high-pressure fuel accumulator according to Claim 2, **characterized in that** in a section lying in a plane passing through said longitudinal axis (A), said groove has a cylindrical central portion (36a) and two end radiusing portions (36b).

7. The high-pressure fuel accumulator according to Claim 2, **characterized in that**, in a section lying in a plane passing through said longitudinal axis (A), said groove has a wall (36c) of continuous circular shape with a radius (R2) that radiuses to one another opposite areas of intersection between the groove and the cylindrical hole (26).

8. The high-pressure fuel accumulator according to Claim 1, **characterized in that** it comprises two recesses for reduction of the stresses (36) for each of said connection holes (28), said recesses (36) being arranged symmetrically with respect to a plane passing through the longitudinal axis (A) of the longitudinal cylindrical hole (26) and through the radial axis (B) of the connection hole (28).

9. The high-pressure fuel accumulator according to any one of the preceding claims, **characterized in that** the longitudinal extension (L) of said recess for reduction of the stresses (36) is less than three times the diameter (d) of the connection hole (28).

FIG. 1

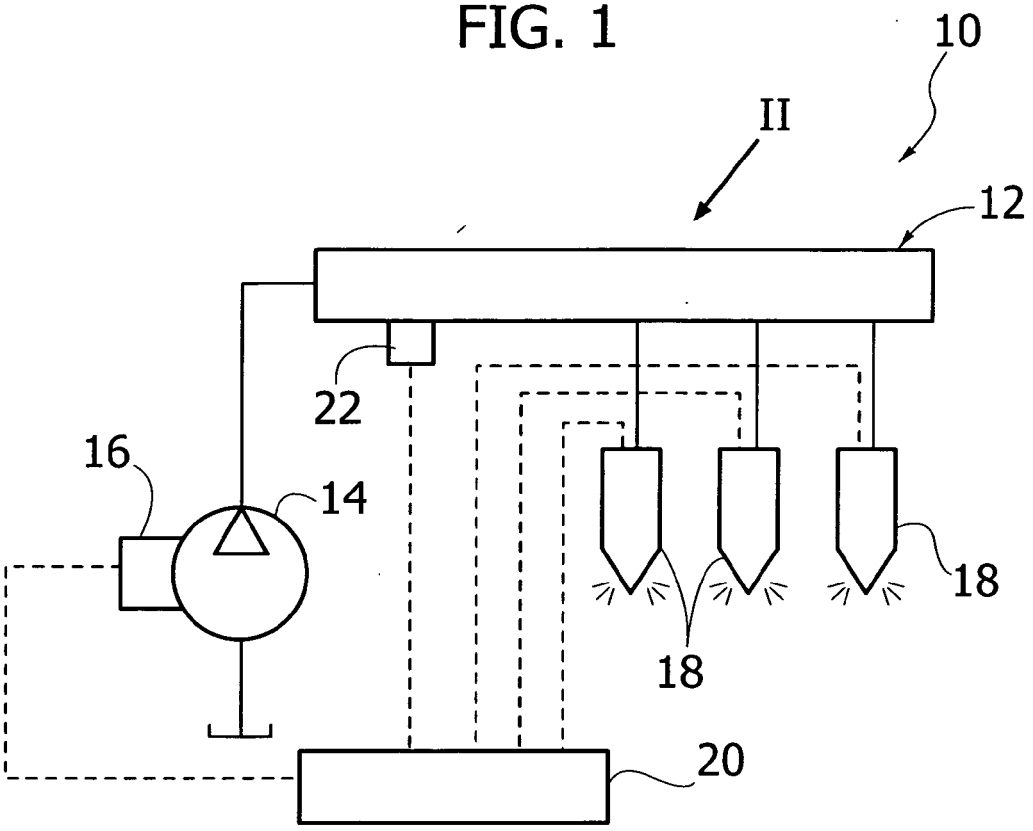
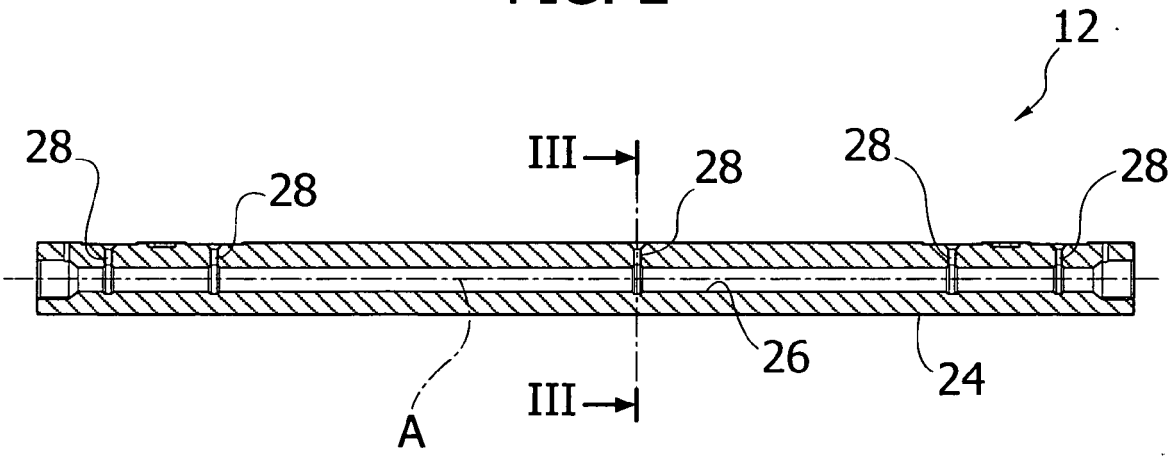


FIG. 2



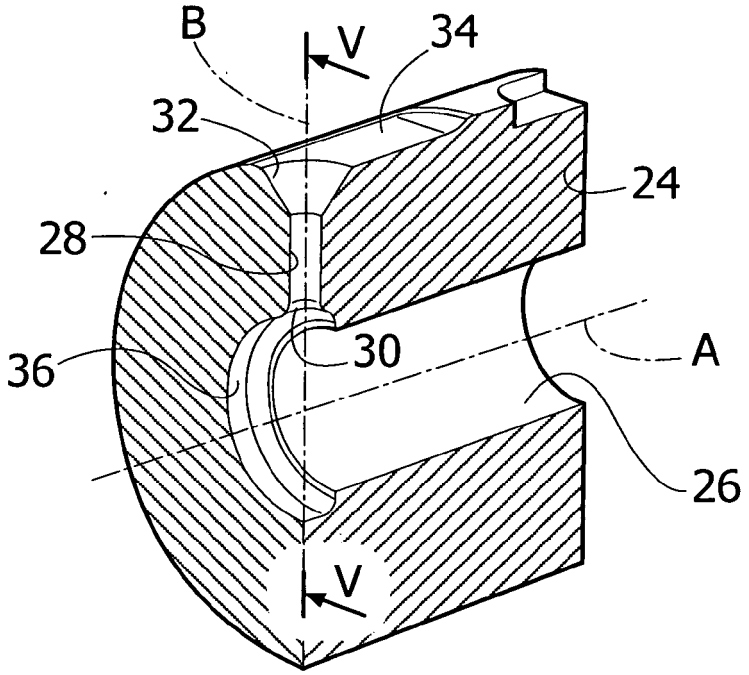


FIG. 3

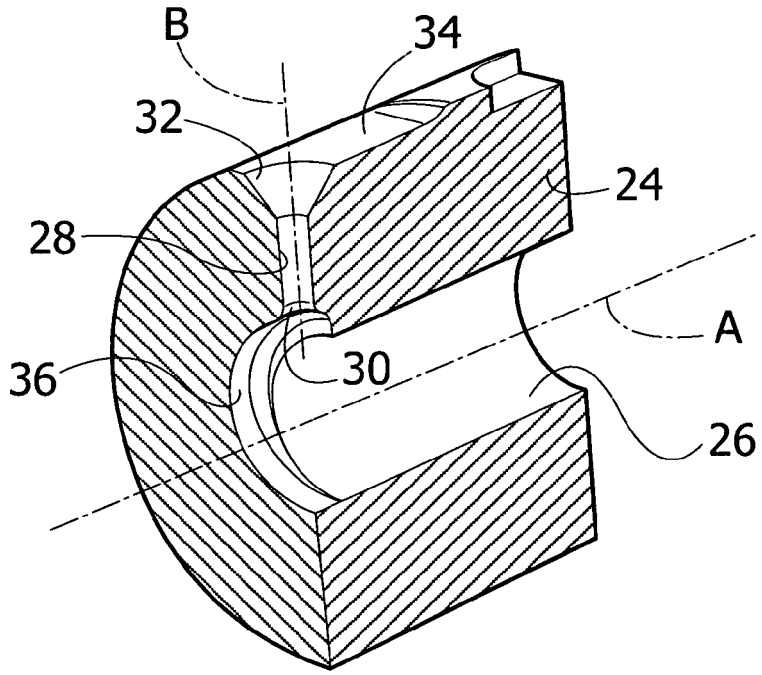


FIG. 4

FIG. 5

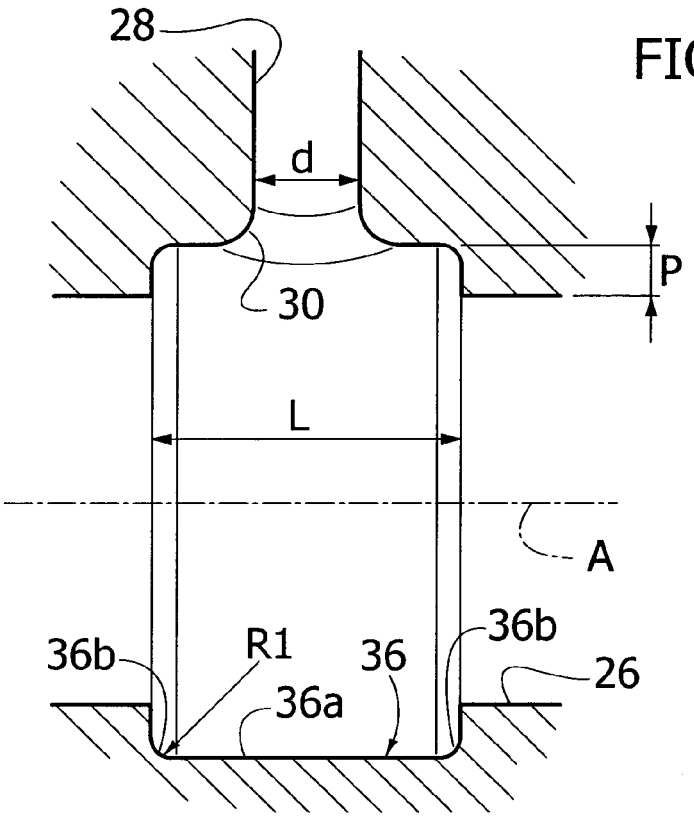


FIG. 6

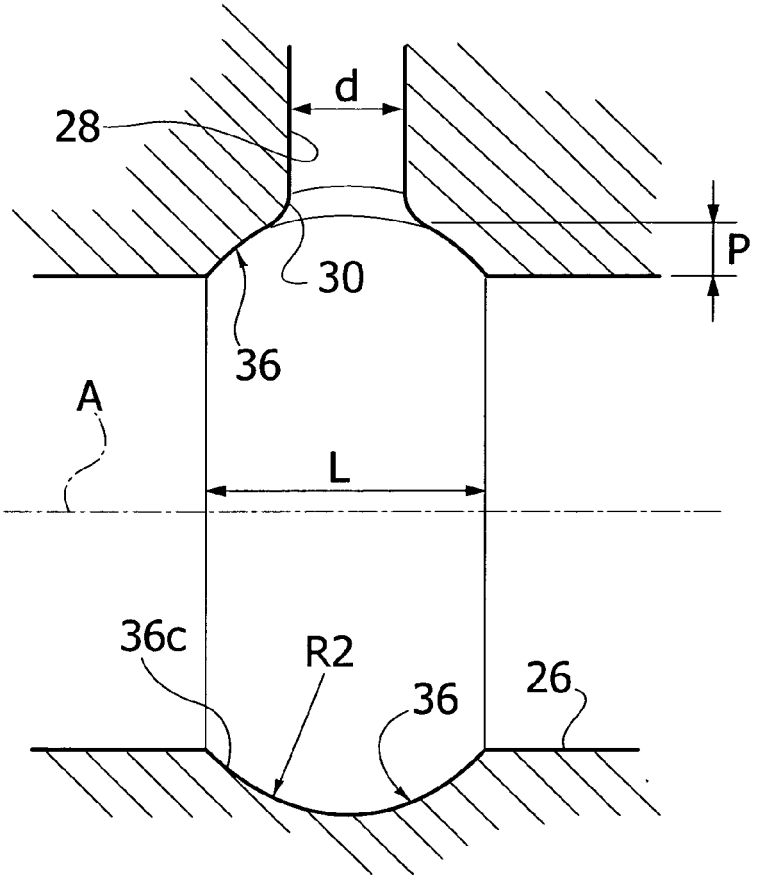


FIG. 7

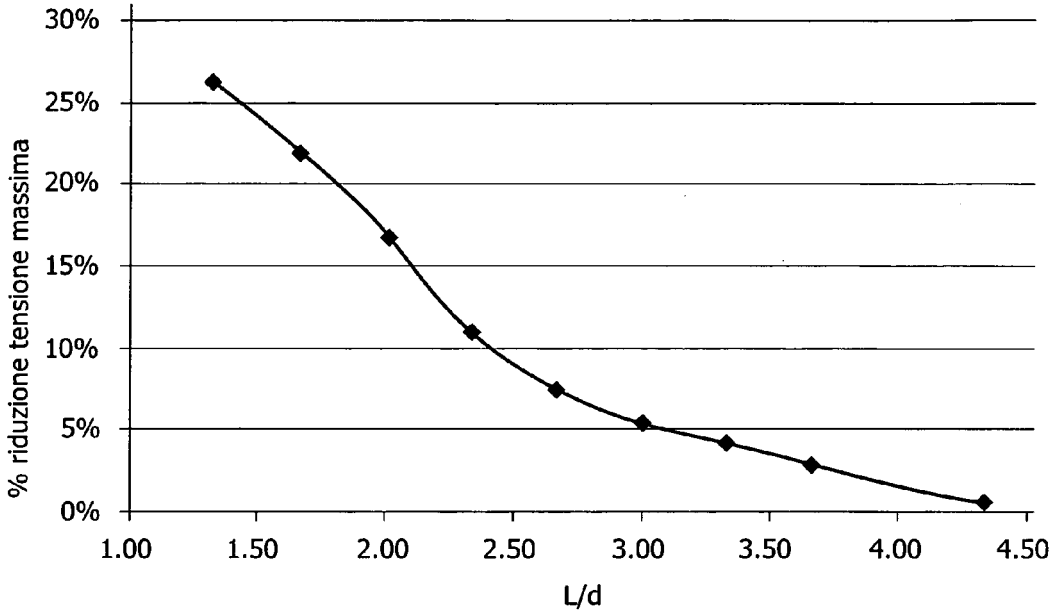

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FIG. 8

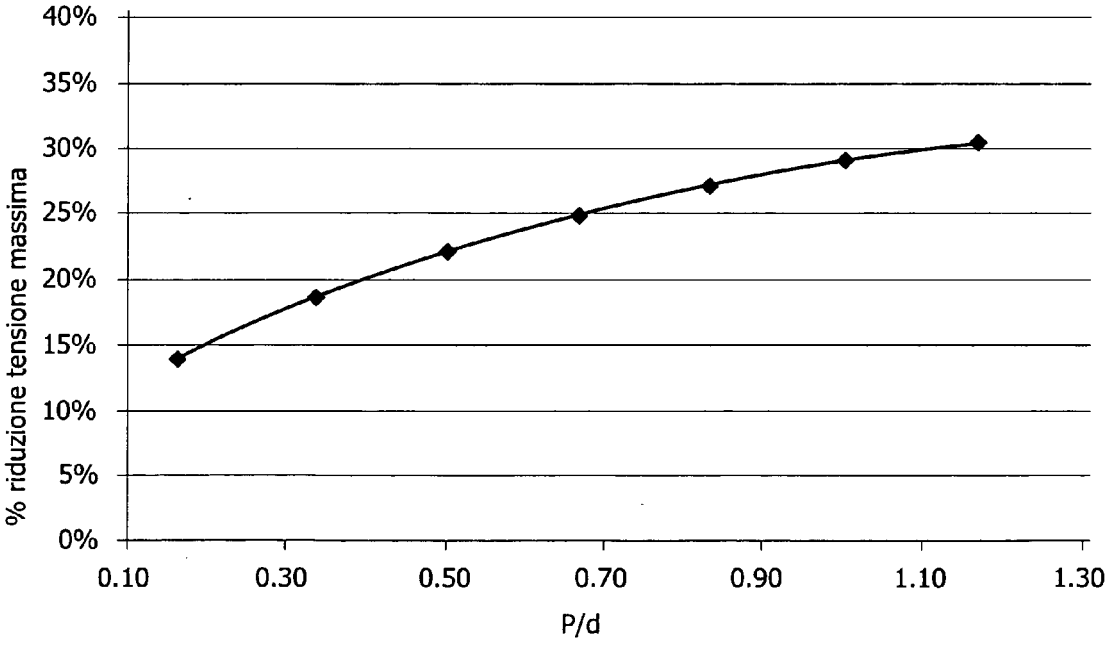
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FIG. 9

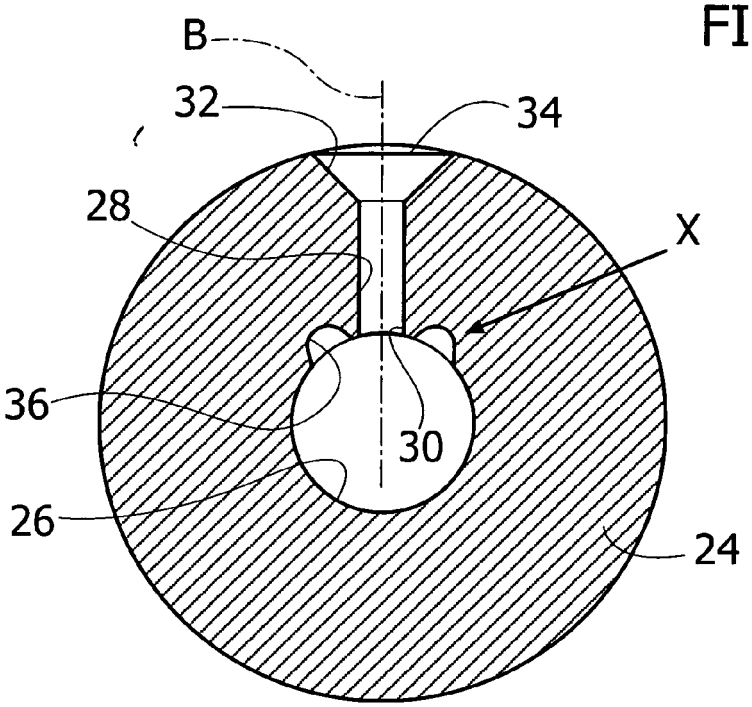


FIG. 10

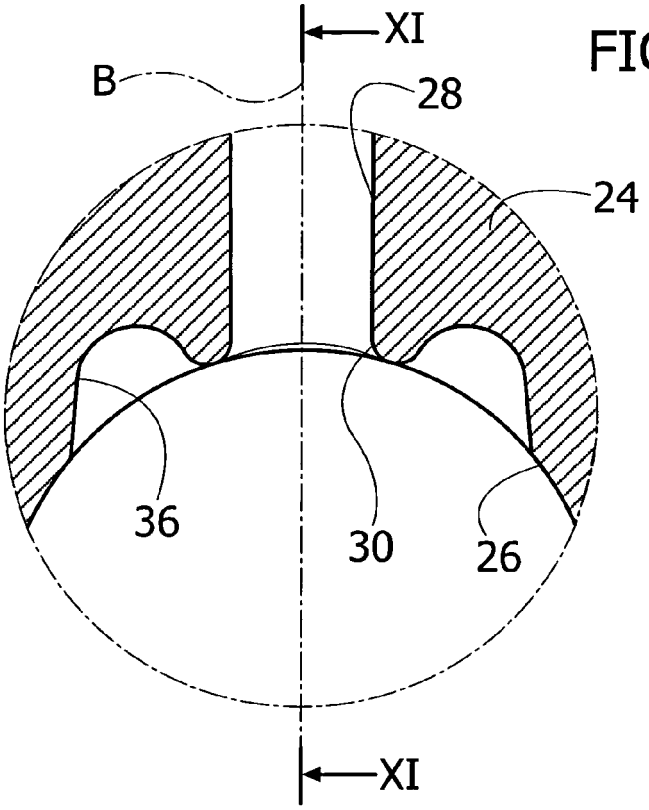


FIG. 11

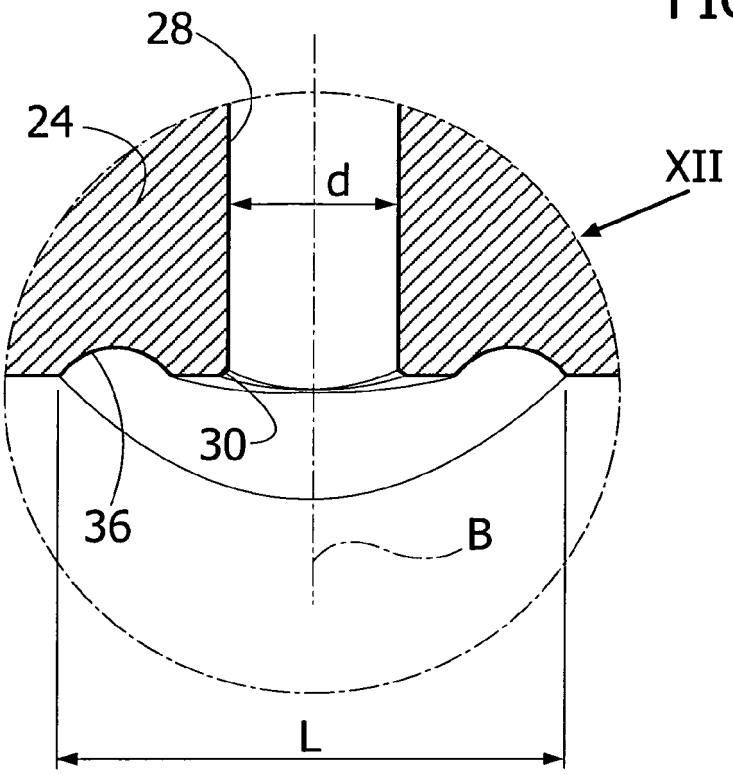
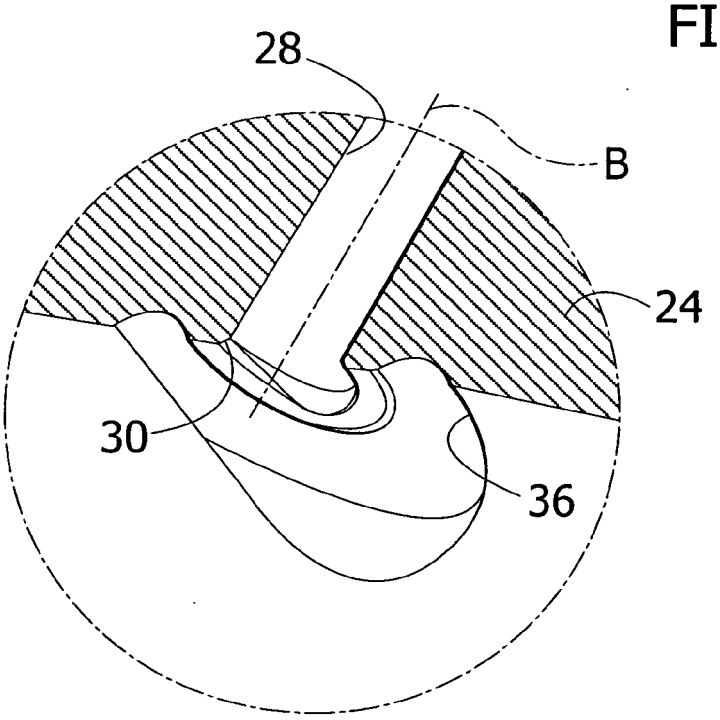


FIG. 12



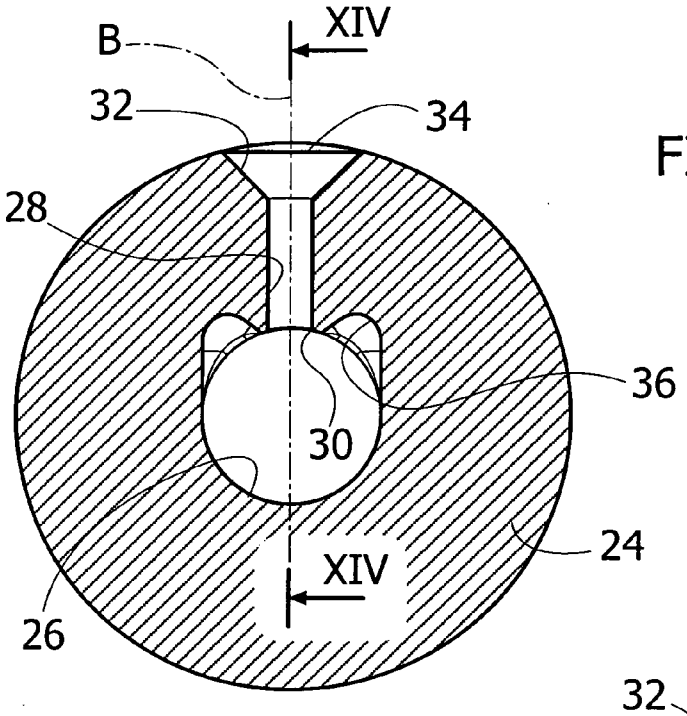


FIG. 13

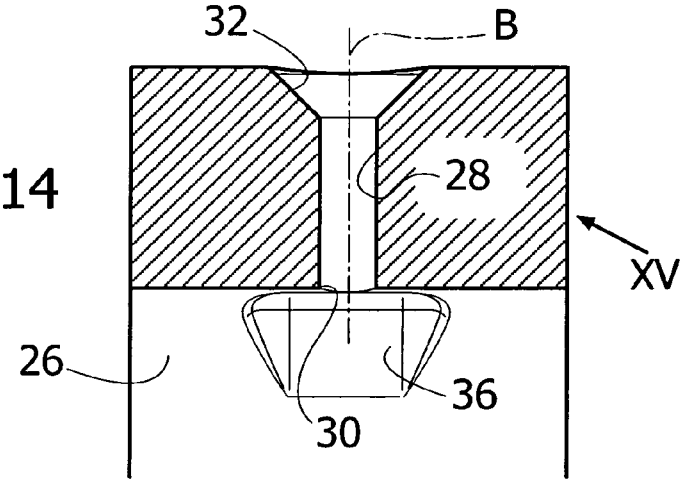


FIG. 14

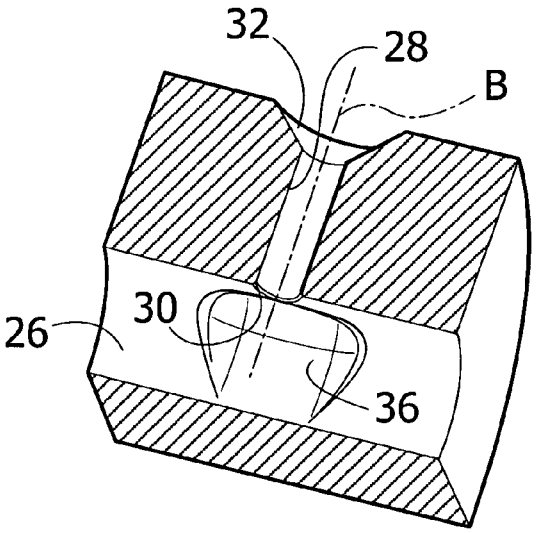


FIG. 15

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EUROPEAN SEARCH REPORT

Application Number
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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
Munich	18 February 2010	Landriscina, V

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