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(54) METHOD FOR PRODUCING A FUEL OUTLET OPENING IN A TUBULAR FUEL RAIL AND TUBULAR FUEL RAIL

(57) A method for producing a fuel outlet opening (100) in a circumferential wall (10) of a tubular fuel rail (1) is disclosed which comprises perforating the circumferential wall (10) of the fuel rail (1) with a first through hole (101) having a first radius r1, with a second through hole (102) having a second radius r2 and with a third through hole (103) having a radius r3 which is greater than the first radius r1 and the second radius r2 and positioned such between the first through hole (101) and the second through hole (102) in direction along the longitudinal axis (L) that it partially overlaps the first and second through holes (101, 102) at the external surface (11) of the circumferential wall (10). A tubular fuel rail (1) is also disclosed.

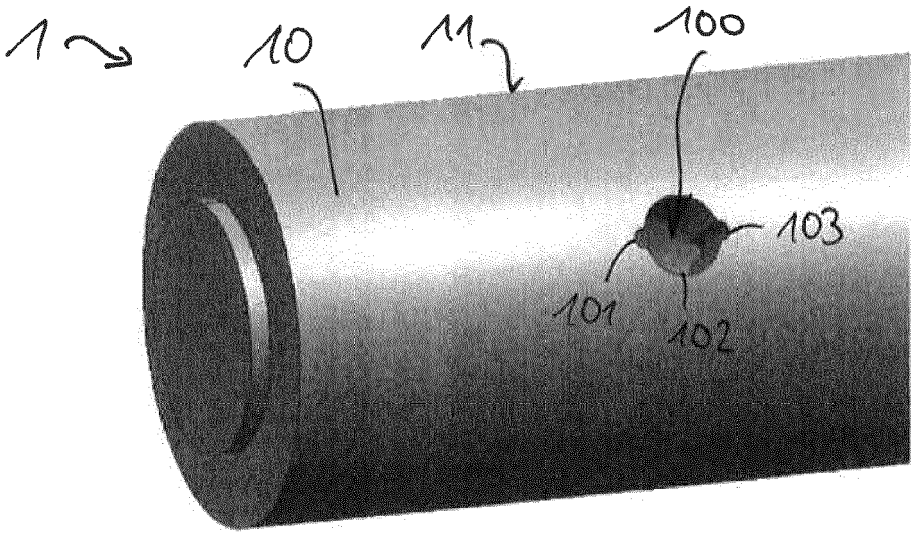

Fig. 4

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a method for producing a fuel outlet opening in a tubular fuel rail. It further relates to a tubular fuel rail with a fuel outlet opening.

BACKGROUND

[0002] A fuel rail is, for example, disclosed in EP 2071175 A1.

[0003] It is an object of the present disclosure to specify a fuel rail which has a particular small risk of failure due to fatigue stress. It is a further object of the present disclosure to specify a method for producing a fuel outlet opening in a tubular fuel rail which leads to a particularly small reduction of the mechanical stability of the fuel rail.

[0004] These objects are achieved by a fuel rail and a method having the features of the independent claims. Advantageous embodiments and developments of the fuel rail and the method are specified in the dependent claims, in the following description and in the drawings.

SUMMARY AND EMBODIMENTS

[0005] A method for producing a fuel outlet opening in a circumferential wall of a tubular fuel rail is disclosed according to one aspect of the present disclosure. A tubular fuel rail comprising a circumferential wall with a fuel outlet opening is disclosed according to a second aspect of the present disclosure.

[0006] The fuel rail is elongated along a longitudinal axis. The circumferential wall may expediently have an internal surface facing towards the longitudinal axis. The internal surface delimits the fuel reservoir which is represented by the fuel rail. The circumferential wall has an external surface, facing in particular away from the longitudinal axis. The each of the internal and external surfaces may, for example, have a circular, oval or polygonal cross-sectional shape.

[0007] According to one step of the method, the tubular fuel rail, including the circumferential wall, is provided. According to another, in particular subsequent, method step, the circumferential wall is perforated with a first through hole having a first radius r1 and a second through hole having a second radius r2. Perforating is carried out such that the first and second through holes are spaced apart in direction along the longitudinal axis.

[0008] That the first and second through holes are spaced apart in direction along the longitudinal axis means in particular, the first and second through holes do not overlap and follow one another in direction along the longitudinal axis. Expediently, the first and second through holes each may have a straight, cylindrical shape extending along a center line. The distance between the first through hole and the second through hole, as measured between their center lines, is in particular larger than the sum of the first radius and second radius r1 + r2.

[0009] According to a further method step, the circumferential wall is perforated with a third through hole. The third through hole has a radius r3 which is greater than each of the first radius r1 and the second radius r2. It is positioned such between the first through hole and the second through hole in direction along the longitudinal axis that it partially overlaps the first and second through holes at the external surface of the circumferential wall.

[0010] In particular, the third through hole may have a straight, cylindrical shape extending along a center line. In an expedient embodiment, the third radius r3 and the position of the center line of the third through hole are selected such that the distance D31 between the center lines of the first and third through holes is smaller than the sum of the first radius and the third radius r1 + r3 and larger than the difference of the third radius and the first radius r3 - r1 and such that the distance D32 between the center lines of the second and third through holes is smaller than the sum of the second radius and the third radius r2 + r3 and larger than the difference of the third radius and the second radius r3 - r2.

[0011] In one embodiment, the first through hole, the second through hole and the third through hole are produced by means of drilling. In an expedient development, the third hole is drilled subsequently to drilling the first and second through holes. In the present context, "drilling" shall also encompass laser drilling and electro-eroding.

[0012] The tubular fuel rail comprises the circumferential wall with the fuel outlet opening. The fuel outlet opening - in particular produced by an embodiment or development of the method described above - is the set union of the first, second and third through holes perforating the circumferential wall.

[0013] More specifically, the first through hole has the first radius r1 and the second through hole has the second radius r2. The first and second through holes are spaced apart in direction along the longitudinal axis. Expediently, their distance D12 may be larger than larger than the sum of the first radius and second radius r1 + r2.

[0014] The third through hole has the third radius r3 which is greater than the first radius r1 and the second radius r2. The third through hole is positioned such between the first through hole and the second through hole in direction along the longitudinal axis that it partially overlaps the first and second through holes at an external surface of the circumferential wall.

[0015] The set union of the first, second and third through holes corresponds in particular represented by a bi-lobated cross-sectional shape of the fuel outlet opening. For example, the fuel outlet opening has a cylindrical basic shape, the center line of the cylinder in particular extending perpendicular to the longitudinal axis. The basic shape is in particular provided with two protrusions on opposite sides in direction along the longitudinal axis. The protrusions are preferably shaped as partial cylin-

dars, the center lines of the partial cylinders being preferably parallel to the center line of the cylinder forming the basic shape. The radii r1, r2 of the partial cylinders may expediently be smaller, for example half as large or less than half as large, than the radius r3 of the cylinder which forms the basic shape.

[0016] In this way, mechanical stress of the circumferential wall may be particularly small in the region of the fuel outlet opening. Therefore, particular high operating pressures are possible at a given wall thickness. In this way, the fuel rail can have particular small dimensions and particular small weight and may be produced particularly cost-effective.

[0017] In one embodiment, the first through hole, the second through hole and the third through hole perforate the circumferential wall in a direction perpendicular to the longitudinal axis. This may contribute to achieve advantageous flow conditions in the region of the outlet opening.

[0018] In one embodiment, the third radius r3 is at least for times as large as the first radius r1 and the second radius r2. In this way, the first and second through holes may only generate a comparatively small deviation from the shape of the third through hole, e.g. from a circular opening at the external surface of the circumferential wall. This may be advantageous when for the fluidic connecting of a fuel cup or pipe adapter to the fuel outlet opening.

[0019] In one embodiment, the distance between the first through hole and the second through, measured between the center lines of the first and second through holes, is twice the third radius. This may effect a substantial right angle at the interface of the third though hole with each of the first and second through holes. A particularly advantageous distribution of mechanical stress may be achievable in this way.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Further advantages, advantageous embodiments and developments of the method and the fuel rail will become apparent from the exemplary embodiments which are described below in association with schematic figures.

[0021] In the figures:

Fig. 1 shows a longitudinal section view of a fuel rail during a first stage of a manufacturing method according to an embodiment of the invention,

Fig. 2 shows a longitudinal section view of the finished fuel rail,

Fig. 3 shows the fuel rail in a top view and

Fig. 4 shows the fuel rail in a perspective view.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] In the exemplary embodiments and figures, similar, identical or similarly acting elements are provided with the same reference symbols. In some figures, individual reference symbols may be omitted to improve the clarity of the figures. Figures 1 an 2 are not regarded to be true to scale. Rather, individual elements in the figures may be exaggerated in size for better represent-ability and/or better understanding.

[0023] Fig. 1 shows a fuel rail 1 during a stage of a method according to an embodiment of the invention.

[0024] In the stage shown in fig. 1, the fuel rail 1 has been provided. It is elongated along a longitudinal axis L and has a circumferential wall 10 which represents a tube enclosing the longitudinal axis L.

[0025] In a further method step preceding the stage shown in fig. 1, a first through hole 101 and a second trough hole 102 have been drilled through the circumferential wall 10. Drilling of the first and second through holes 101, 102 has been carried out in such fashion that the first and second through holes 101, 102 follow one another in direction along the longitudinal axis L and perforate the circumferential wall 10 in a direction perpendicular to the longitudinal axis L. Specifically, the first through hole has a center line c1 which is perpendicular to the longitudinal axis L and to a second through hole has a center line c2 which is perpendicular to the longitudinal axis L. The center lines c1, c2 are parallel and define a plane which includes the longitudinal axis L in the present embodiment. The first and second through hole 101, 102 may each have a circular cylindrical shape, the center lines c1 and c2, respectively, in particular representing the respective cylinder axis.

[0026] Further, drilling of the first and second through holes 101, 102 is carried out such that the distance D between the center lines c1, c2 of the first and second through holes 101, 102 is larger than the sum of the radius r1 of the first through hole 101 and the radius r2 of the second through hole 102.

[0027] The method further comprises a step of drilling a third through hole 103 through the circumferential wall 10 of the fuel rail 1. This step is performed subsequent to the stage shown in fig. 1 and described above.

[0028] The finished fuel rail 1, after drilling of the third through hole 103 is shown in the longitudinal section view of fig. 2, in the top view of fig. 3 and in the perspective view of fig. 4.

[0029] The third through hole 103 is positioned centrally between the first through hole 101 and the second through hole 102. The center line c3 of the third through hole 103 is in the same plane as the center lines c1, c2 of the first and second through holes 101, 102.

[0030] The distance between the center line c1 of the first through hole and the center line c3 of the third through hole 103 and the distance between the center line c3 of the third through hole 103 and the center line c2 of the second through hole 102 in each case corresponds to

the radius r3 of the third through hole. In this way, the distance D between the first through hole 101 and the second through hole 102, measured between the center lines c1, c2 is twice the radius r3 of the third through hole 103.

[0031] By means of the first, second and third through holes 101, 102, 103, a fuel outlet opening 100 is produced in the circumferential wall 10 of the fuel rail. The fuel outlet opening 100 has a bi-lobated shape in top view along the center lines c1, c2, c3 (see e.g. fig. 3) . It has a circular cylindrical basic shape which is defined by the third through hole 103 and two protrusions which protrude from the cylindrical basic shape in each of the two opposite longitudinal directions and which form the lopes of the bi-lobated shape. The protrusions are formed by the first and second through holes 101, 102 which partially overlap the third through hole 103, so that the protrusions are in the shape of partial circular cylinders.

[0032] The invention is not limited to specific embodiments by the description on basis of these exemplary embodiments. Rather, it comprises any combination of elements of different embodiments. Moreover, the invention comprises any combination of claims and any combination of features disclosed by the claims.

Claims

1. Method for producing a fuel outlet opening (100) in a circumferential wall (10) of a tubular fuel rail (1), the fuel rail (1) being elongated along a longitudinal axis (L), comprising the following steps:

   - providing the fuel rail (1);
   - perforating the circumferential wall (10) of the fuel rail (1) with a first through hole (101) having a first radius r1 and a second through hole (102) having a second radius r2 such that the first and second through holes (101, 102) are spaced apart in direction along the longitudinal axis (L);
   - perforating the circumferential wall (10) with a third through hole (103) having a radius r3 which is greater than the first radius r1 and the second radius r2 and positioned such between the first through hole (101) and the second through hole (102) in direction along the longitudinal axis (L) that it partially overlaps the first and second through holes (101, 102) at the external surface (11) of the circumferential wall (10).

2. Method according to the preceding claim, wherein the first through hole (101), the second through hole (102) and the third through hole (103) perforate the circumferential wall (10) in a direction perpendicular to the longitudinal axis.

3. Method according to one of the preceding claims, wherein the first through hole (101), the second through hole (102) and the third through hole (103) are produced by means of drilling and the third hole (103) is drilled subsequently to drilling the first and second through holes (101, 102) .

4. Tubular fuel rail (1) comprising a circumferential wall (10) with a fuel outlet opening (100), the fuel rail (1) being elongated along a longitudinal axis (L), wherein the fuel outlet opening (100) is the set union of first, second and third through holes (101, 102, 103) perforating the circumferential wall (10), wherein

   - the first through hole (101) has a first radius r1 and the second through hole (102) has a second radius r2;
   - the first and second through holes (101, 102) being spaced apart in direction along the longitudinal axis (L);
   - the third through hole (103) has a third radius r3 which is greater than the first radius r1 and the second radius r2 and positioned such between the first through hole (101) and the second through hole (102) in direction along the longitudinal axis (L) that it partially overlaps the first and second through holes (101, 102) at an external surface (11) of the circumferential wall (10).

5. Tubular fuel rail (1) according to the preceding claim, wherein the first through hole (101), the second through hole (102) and the third through hole (103) perforate the circumferential wall (10) in a direction perpendicular to the longitudinal axis (L).

6. Tubular fuel rail (1) according to one of the preceding claims 4 and 5, wherein the third radius r3 is at least four times as large as the first radius r1 and the second radius r2.

7. Tubular fuel rail (1) according to one of the preceding claims 4 to 6, wherein the distance D between the first through hole (101) and the second through hole (102), measured between the center lines (c1, c2) of the first and second through holes, is twice the third radius r3.

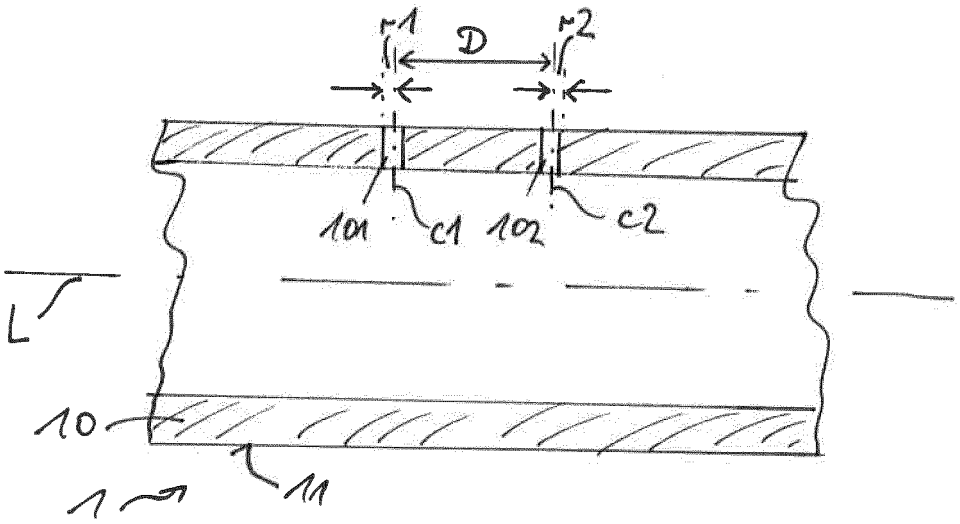

Fig. 1

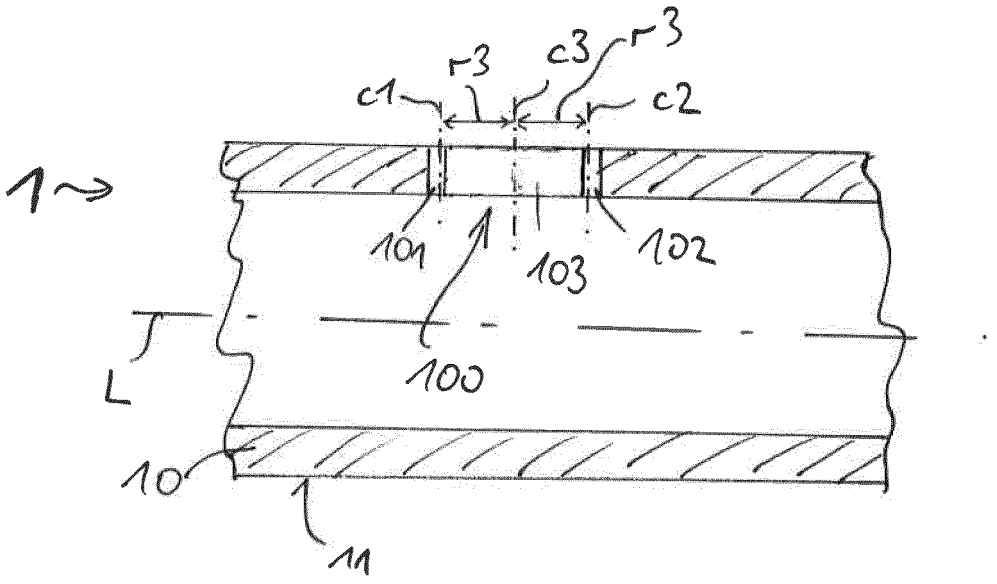

Fig. 2

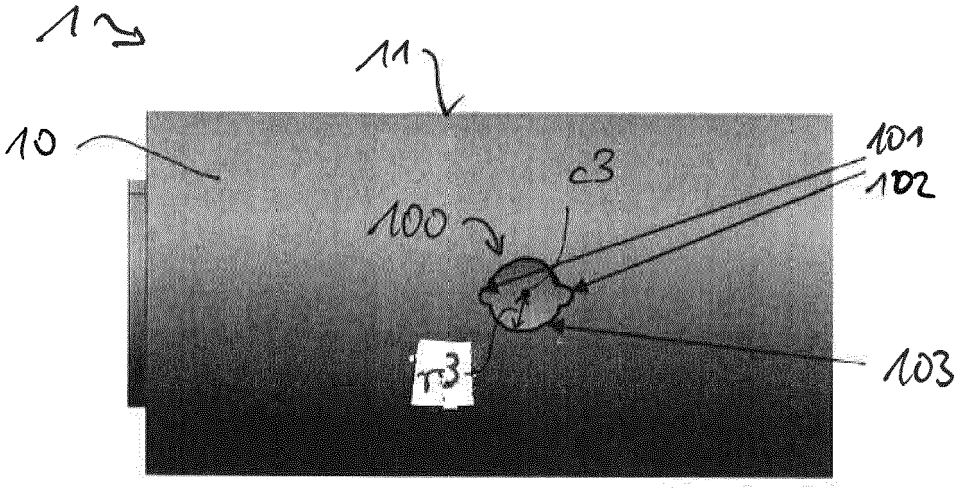

Fig. 3

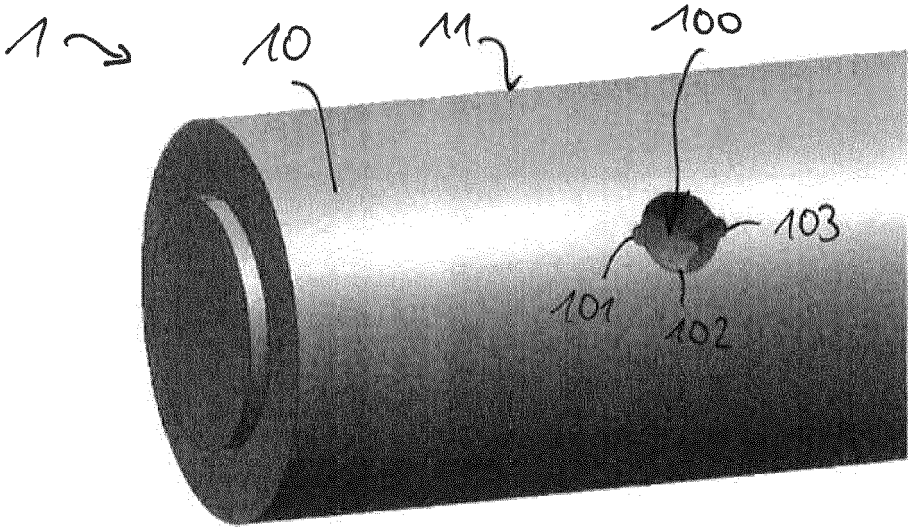

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 18 18 0291

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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	23 November 2018	Morales Gonzalez, M

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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