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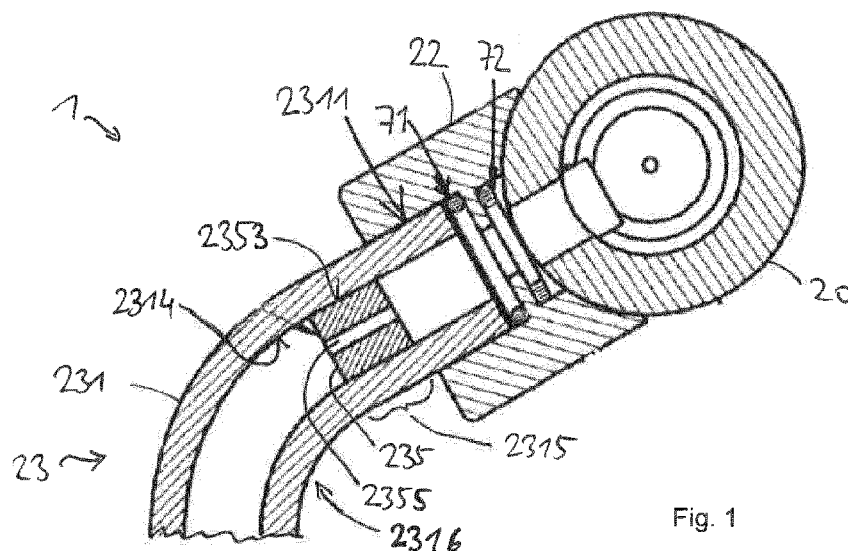


Fig. 1

(57) Abstract: A fuel rail assembly (1) and a fuel delivery assembly with the fuel rail assembly (1) are disclosed. The fuel rail assembly (1) comprises a tubular fuel reservoir (20) with a plurality of outlet ports (22) and a fuel delivery line (23) connected to each of the outlet ports (22), each fuel delivery line (23) comprising a pipe (231) and an injector cup (233). Each fuel delivery line (23) further comprises a constrictor element (235) which has an orifice (2355) extending through the constrictor element (235). The constrictor element (235) is inserted into the pipe (231) so that an external surface (2353) of the constrictor element (235) is in form-fit and/or force-fit connection with an internal surface (2314) of the pipe (231).



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DESCRIPTION

TITLE

5 Fuel rail assembly with a constrictor element and fuel delivery assembly

TECHNICAL FIELD

10 The present disclosure relates to a fuel rail assembly with the constrictor element and to a fuel delivery assembly comprising the fuel rail assembly.

BACKGROUND

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Fuel rail assemblies usually comprise a tubular fuel reservoir and a plurality of fuel delivery lines which branch off from the fuel reservoir to connect the fuel rail assembly hydraulically and mechanically to fuel injectors of an internal
20 combustion engine.

It is desirable to have an orifice in the fuel rail assembly between the fuel reservoir and the fuel injectors. By means of such an orifice, pressure pulsations can be dampened so as
25 to decrease pressure peaks. In this way, a better functionality of the injector and lower mechanical stress to the fuel rail assembly is achievable.

It is an object of the present disclosure to specify a fuel
30 rail assembly which is particularly reliable and/or producible with particularly small scrap costs. This object is achieved by a fuel rail assembly having the features of the independent claim. Advantageous embodiments and developments of the fuel rail assembly and a fuel delivery assembly com-

prising the fuel rail assembly are specified in the dependent claims, in the following description and in the drawings.

SUMMARY AND EMBODIMENTS

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A fuel rail assembly is specified according to one aspect. The fuel rail assembly is configured for delivering fuel to a plurality of fuel injectors. A fuel delivery assembly comprising the fuel rail assembly and the fuel injectors is
10 specified according to another aspect. The fuel delivery assembly is preferably configured for delivering fuel to an internal combustion engine.

The fuel rail assembly comprises a tubular fuel reservoir.
15 The tubular fuel reservoir can also be denoted as a main gallery. A plurality of outlet ports branch off from the fuel reservoir. The fuel rail assembly further comprises a plurality of fuel delivery lines. Each fuel delivery line is connected to a respective one of the outlet ports, and is in
20 particular configured for receiving a respective one of the fuel injectors.

Each fuel delivery line comprises a pipe and an injector cup. The pipe has a first end which is hydraulically and mechanically
25 cally connected to the respective outlet port and a second end, remote from the first end, hydraulically and mechanically connected to an inlet end of the injector cup. The injector cup has an outlet end, remote from the inlet end, for receiving a respective one of the fuel injectors.

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Each fuel injector may expediently have an inlet portion which is shifted into the outlet end of the respective injector cup. In this way, the fuel injector is hydraulically connected to the fuel reservoir so that fuel can be fed from the

fuel reservoir through the outlet port, the pipe and the injector cup to the injector.

Each fuel delivery line further comprises a constrictor element which has an orifice extending through the constrictor element. The constrictor element is inserted into the pipe so that an external surface of the constrictor element is in form-fit and/or force-fit connection with an internal surface of the pipe. By means of the form-fit and/or force-fit connection, in particular the displaceability of the constrictor element in direction along the pipe from the first towards the second end and/or vice versa is limited.

In the present context, that "an external surface of the constrictor element is in form-fit and/or force-fit connection with an internal surface of the pipe" is understood to include embodiments in which the constrictor element is movable relative to the pipe so that it can engage into an disengage from the form fit and/or force fit connection with the pipe. The constrictor element, however, may expediently be shaped, sized and positioned in such fashion that it is in the form-fit and/or force-fit connection with the pipe at least during producing connections between the outlet port and the pipe and/or between the pipe and the injector cup during manufacturing of the fuel rail assembly, the connections being in particular brazed connections.

With advantage, the constrictor element can be used for different fuel rail assembly configurations by adapting its position. In addition, the size and/or the position of the orifice of the constrictor element as well as other dimensions such as the shape and the length of the constrictor element can be changed for different fuel rail configurations by replacing the constrictor element without any further changes

to other components of the fuel rail assembly. The constrictor element is easily connectable to the pipe. Due to the form fit and/or force fit connection, the position of the constrictor element relative to the pipe can be easily adjusted during manufacturing of the fuel rail assembly.

In one embodiment, the constrictor element is arranged adjacent to the first end of the pipe and the pipe is connected to the outlet port by means of a brazed connection. In an alternative embodiment, the constrictor element is arranged adjacent to the second end of the pipe and the pipe is connected to the injector cup by means of a brazed connection.

With advantage, due to the force-fit and/or form-fit connection of the external surface of the constrictor element with the internal surface of the pipe, the constrictor element or at least the inflow and outflow openings of the orifice may be positioned at a distance from the respective brazed connection.

For example, the constrictor element is inserted into the pipe through the first end and is offset, in its entirety, from the brazed connection of the pipe with the outlet port in direction towards the injector cup along the pipe or the constrictor element is inserted into the pipes from the second end and is offset, in its entirety, from the brazed connection of the pipe with the injector cup in direction towards the outlet port along the pipe. In another example, the inflow and outflow openings of the orifice are offset in opposite directions along the pipe with respect to the respective brazed connection. With advantage, the positioning may be reproducible and particularly reliable in this way. The risk that brazing material obstructs the orifice is particu-

larly small. Therefore, scrap costs may be particularly small when producing the fuel rail.

In one embodiment, the constrictor element is in the shape of a plug, in particular in the shape of a cylindrical plug. In this case, the orifice preferably extends through the constrictor element along the cylinder axis of the cylindrical plug. In another embodiment, the constrictor element is in the shape of a cap having a circumferential sidewall, in particular a cylindrical sidewall, and a cover portion which closes the cap at one end of the circumferential sidewall. In this case, the orifice preferably extends through the cover portion, in particular along a center axis of the circumferential sidewall. With advantage, such constrictor elements are easily and cost efficiently producible.

Expediently, a portion of the pipe may extend circumferentially around the constrictor element and the constrictor element and its orifice are dimensioned such that the constrictor element reduces the hydraulic diameter of said portion of the pipe by 25% or more, preferably by 50 % or more, and in particular by 90 % or less. In this way, a particularly advantageous reduction of pressure peaks is achievable.

In one embodiment, in which the constrictor element is in force fit connection with the pipe, the constrictor element is arranged in the pipe such that a portion of the pipe extends circumferentially around the constrictor element, the internal surface of said portion being in press-fit connection, i.e. in a force-fit connection, with the external surface of the constrictor element. In this way, the position of the constrictor element along the length of the pipe is particularly easily adjustable.

Preferably, surface portions of the constrictor element and of the pipe which are in press-fit connection extend completely circumferentially around the constrictor element at least in places so as to fluid tightly seal the interface between the internal surface of the pipe and the constrictor element. In this way, particularly precise adjustment of the hydraulic diameter of the fuel delivery line in the region of the constrictor element is achievable.

In another embodiment, the pipe has a bend or kink which is operable to engage into form-fit and/or force-fit connection with the constrictor element. In particular, the pipe has a straight section comprising the first or second end, respectively, of the pipe through which the constrictor element is inserted into the pipe. The bend or kink may expediently delimit the straight section on the side remote from said first or second end. In particular, the shape and size of the constrictor element is adapted to the shape and size of the internal cross section of the straight section and the bend in such fashion that the constrictor element is displaceable along the straight portion to the bend, the bend limiting the displaceability of the constrictor element along the pipe by form fit and/or force fit engagement.

In a preferred development of this embodiment, the constrictor element is in loose fit engagement with the straight portion of the pipe. Thus, it can easily slide along the straight portion of the pipe until it is stopped by the bend or kink.

For example in this embodiment, the constrictor element may be configured to move along the pipe driven by gravity until it comes in contact with the bend or kink. The bend or kink is in particular positioned such that the constrictor ele-

ment, in its entirety, is spaced apart from any brazed joints between the pipe and the outlet port and the pipe and the injector cup when the constrictor element is in form-fit and/or force-fit engagement with the bend or kink. In this way, a
5 reproducible position of the constrictor element during production of the brazed connections of the fuel rail assembly is easily achievable.

In a further embodiment, the internal surface of the pipe and
10 the external surface of the constrictor element have corresponding threaded portions for establishing a threaded connection between the constrictor element and the pipe. In this way, the position of the constrictor element is easily and precisely adjustable.

15 In another embodiment, the internal surface of the pipe has a step which is operable to engage in form-fit connection with the external surface of the constrictor element. In particular, the step represents an interface between a larger cross-
20 section portion and a smaller cross-section portion of the pipe, the constrictor element being inserted into the larger cross-section portion. The larger cross-section portion is in particular a straight section of the pipe comprising the first or the second end, respectively, through which the con-
25 strictor element is inserted into the pipe. By means of the step, the displaceability of the constrictor element along the pipe can be easily and/or precisely limited.

30 In yet another embodiment, the constrictor element is shifted into the first end of the pipe and projects from the first end into the outlet port. For example in this embodiment, the inflow opening of the orifice may be positioned inside the tubular fuel reservoir and the outflow opening may be positioned inside the pipe and spaced apart from the brazed con-

nection between the pipe and the outlet port on the side of the brazed connection facing away from the fuel reservoir and towards the injector cup. In this way, a particularly good damping function of the constrictor element and/or a particularly small risk that brazing material obstructs the orifice are achievable.

In an alternative embodiment, the constrictor element is shifted into the first end of the pipe such that it is arranged completely inside the pipe and spaced apart from the first end and in particular spaced apart from a brazed connection between the respective outlet port and the pipe in direction towards the injector cup. Such a fuel rail assembly is particularly easily manufacturable and/or cost-efficient.

In another alternative embodiment, the constrictor element is shifted into the second end of the pipe so that it is arranged subsequent to the inlet end of the injector cup in direction towards the respective outlet port of the fuel reservoir. In this way, the dampening function of the orifice may be achieved particularly close to the fuel injector. Further, the inlet end of the injector cup may limit displacability of the constrictor element. In this way, accidental removal of the constrictor element through the second end of the pipe may be reliably prevented even if the constrictor element is only in loose-fit connection with the pipe.

In one development of this embodiment, the internal surface of the pipe and the external surface of the constrictor element have corresponding threaded portions for establishing a threaded connection between the constrictor element and the pipe and the fuel delivery line further comprises a brazed connection connecting the pipe and the injector cup. The brazed connection may preferably be located in a region sub-

sequent to the threaded portions in direction towards the inlet end of the injector cup. In this way, the risk for brazing material flowing into the threaded portions during manufacturing of the fuel rail assembly is particularly small.

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In another development of this embodiment, the internal surface of the pipe has a step, herein also denoted as a first step, which is operable to engage in form-fit connection with the external surface of the constrictor element. In addition, 10 the internal surface of the pipe has a further step positioned between said first step and the inlet end of the injector cup. The fuel delivery line may further comprise a brazed connection connecting the pipe and the injector cup in a region subsequent to the further step in direction away 15 from said first step. Preferably, the cross-section of the pipe increases at the step and at the further step in direction towards the second end of the pipe. In this way, the constrictor element can be inserted through the second end into the pipe and its displaceability is limited by the first 20 step. At the same time, for example a ring of brazing material, having a larger cross-section than the constrictor element, can also be inserted through the second end into the pipe and is stopped by the further step preceding the first step in direction from the second end towards the first end 25 of the pipe. In this way, the constrictor element and the brazing material can be reliably kept at a distance during production of the fuel rail assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

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Further advantages, advantageous embodiments and developments of the fuel rail assembly and the fuel delivery assembly will become apparent from the exemplary embodiments which are described below in association with the figures.

In the figures:

Figure 1 shows a sectional view of a portion of a fuel rail
assembly according to a first exemplary embodiment,

Figure 2 shows a sectional view of a portion of a fuel rail
assembly according to a second exemplary embodiment,

Figure 3 shows a sectional view of a portion of a fuel de-
livery assembly according to a third exemplary em-
bodiment,

Figure 4 shows a sectional view of a portion of the fuel de-
livery assembly according to a fourth exemplary em-
bodiment, and

Figure 5 shows a schematic exploded view of a portion of a
fuel delivery assembly comprising the fuel rail as-
sembly according to the first embodiment and a fuel
injector.

DETAILED DESCRIPTION OF EMBODIMENTS

In the exemplary embodiments and figures, similar, identical
or similarly acting elements are provided with the same ref-
erence symbols. In some figures, individual reference symbols
may be omitted to improve the clarity of the figures.

Figure 1 shows a sectional view of a portion of the fuel rail
assembly 1 according to a first exemplary embodiment. The
fuel rail assembly 1 makes part of a fuel delivery assembly,

a portion of which is schematically shown in the exploded view of figure 5.

The fuel rail assembly 1 comprises a tubular fuel reservoir
5 20 and a plurality of fuel delivery lines 23 which branch off at outlet ports 22 on the fuel reservoir 20. Each fuel delivery line has a pipe 231 and an injector cup 233. A first end 2311 of the pipe 231 is shifted into the outlet port 22. A second end 2312 of the pipe 231, remote from the outlet port
10 22, is hydraulically and mechanically connected to the injector cup 233.

The fuel delivery assembly comprises a plurality of fuel injectors 2, each fuel injector 2 being shifted into an outlet
15 end 2332 of the injector cup 233 of a respective fuel delivery line 23 of the fuel rail assembly 1 for hydraulically connecting the fuel injector 2 to the fuel rail assembly 1. In the exploded view of figure 5, the inlet portion 11 of the fuel injector 2 is visible outside the injector cup 233.

20 The fuel injector 2 and the injector cup 233 may have corresponding indexing features for setting a predetermined angular position of the fuel injector 2 with respect to the injector cup 233. In the present embodiment the indexing features are a tab projecting from the outlet end 2332 of the
25 injector cup 233 and a corresponding pocket in a housing of the fuel injector 2.

The fuel delivery assembly of this and other embodiments is
30 preferably configured for delivering fuel to an internal combustion engine, in particular for injecting fuel directly into individual cylinders of the internal combustion engine (not shown in the figures). The fuel delivery assembly is preferably configured for being fixed to a cylinder head (not

shown in the figures) of the internal combustion engine. For fixing to the cylinder head, the fuel rail assembly 1 has one or more brackets 24 which is/are, for example, configured for receiving a bolt that may be screwed into or otherwise fixed to the cylinder head.

Only one fuel delivery line 23 is shown in figures 1 and 5. However, the fuel rail assembly 1 preferably has a fuel delivery line 23 associated to each of the cylinders of the internal combustion engine. Preferably, the fuel delivery lines 23 follow one another along an elongation direction of the tubular fuel reservoir 20.

In the present embodiment, the outlet ports 22 are fixed to an outer surface of a circumferential wall of the tubular fuel reservoir 20 and connected to the interior of the fuel reservoir 20 by means of respective bores through the circumferential wall. Each bore is expediently laterally enclosed by their respective outlet port 22.

The first end 2311 of the pipe 231 of each fuel delivery line 23 is shifted into the corresponding outlet port 22 from the side of the outlet port 22 remote from the fuel reservoir 20. The second end 2312 of the pipe 231 receives an inlet end 2331 of the injector cup 233.

The first ends 2311 of the pipes 231 are hydraulically and mechanically connected to the outlet ports 22 by means of brazed connections 71. The outlet ports 22 are hydraulically and mechanically connected to the fuel reservoir 20 by brazed connections 72. Further, the second ends 2312 of the pipes 231 are hydraulically and mechanically connected to the inlet ends 2331 of the injector cups 233 by means of brazed connections 73 (see also the third exemplary embodiments discussed

below in connection with Fig. 3). In the fuel rail assembly 1 according to the present embodiment, the brackets 24 are fixed to the respective pipes 231 also by brazed connections 74.

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Each fuel delivery line 23 has a constrictor element 235 which, in the present embodiment, is shifted into the pipe 231 through the first end 2311 and arranged adjacent to the first end 2311. In the present embodiment, the constrictor element 235 is in the shape of a cylindrical plug having an orifice 2355 which extends centrally through the plug along its cylinder axis. The diameter of the orifice 2355 has a value of, for example, 15% to 25% - e.g. of 20% - of an external diameter of the constrictor element 235, the limits being included. The external diameter of the constrictor element 235 is identical - or at least almost identical - to the internal diameter of the portion 2315 of the pipe 231 which extends circumferentially around the constrictor elements 235. Therefore, the constrictor element 235 reduces the hydraulic diameter of said portion 2315 of the pipe 231 by 75% to 85%, the limits being included; e.g. it reduces the hydraulic diameter by 80%.

The constrictor element 235 is dimensioned such that it can slide along a straight end section which comprises the first end 2311 of the pipe 231. A circumferential portion of the external surface 2353 of the constrictor element 235 is in loose-fit connection with an internal surface 2314 of the pipe 231. In particular, the external diameter of the constrictor element 235 corresponds almost to the internal diameter of the straight section of the pipe 231, but being a little smaller so that the internal surface 2314 of the pipe 231 and the external surface 2353 of the constrictor element 235 are in sliding contact.

In the present embodiment, the pipe 231 has a bend 2316. Due to the respective sizes and shapes, the bend 2316 limits the displaceability of the constrictor element 235 along the pipe 231 in direction away from the first end 2311 by form-fit and/or force-fit engagement. Typically, the bend 2316 limits the movement of the plug-shaped constrictor element 235 by a combination of force-fit and form-fit engagement.

For producing the fuel rail assembly 1, rings of a brazing material, e.g. copper, are inserted into the outlet port 22 for producing the brazed connections 71 and 72. For example, a ring of brazing material is positioned between the first end 2311 of the pipe 231 and a surface portion of the outlet port 22 in a recess of the outlet port 22 which receives the pipe 231 and the ring of brazing material. For example, the first end 2311 of the pipe 1231 locks the ring of brazing material in the recess during manufacturing of the fuel rail assembly 1. In this and other embodiments, the brazing material can have other shapes instead of a ring shape. For example, the brazing material can be in the shape of a washer or the like.

The constrictor element 235 is spaced apart from the first end 2311 of the pipe 231 and from the ring of brazing material and is arranged subsequent to the outlet port 22 in direction towards the injector cup 233 along the pipe 231 when it is in form-fit and/or force-fit connection with the bend 2316 of the pipe 231. During production of the brazed connections 71, 72, the pipe 231 is preferably positioned such that gravity forces the constrictor element 235 into the form-fit and/or force-fit connection with the bend 2316. Therefore, when the brazing material rings melt, there is only a small risk that brazing material flows into the orifice 2355. Braz-

ing material flowing into the orifice 2355 could lead to obstruction of the orifice 2355 by the brazing material and to a malfunction of the fuel rail assembly 1.

5 Figure 2 shows a portion of a fuel rail assembly 1 according to a second exemplary embodiment in a sectional view. The fuel rail assembly 1 according to the second embodiment corresponds in general to the fuel rail assembly according to the first embodiment.

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However, in the present embodiment, the constrictor element 235 is not in loose-fit connection with the pipe 231. Rather, the constrictor element 235 is press-fitted into the straight end section of the pipe 231 so that the circumferential portion of its external surface 2353 and the internal surface 15 2314 of the straight portion 2315 of the pipe 231 which extends circumferentially around the constrictor element 235 are in force-fit engagement with one another.

20 In the present embodiment, the constrictor element 235 projects beyond the first end 2311 of the pipe 231 into the outlet port 22 and further through the outlet port 22 and through the bore in the circumferential sidewall into the interior of the tubular fuel reservoir 20. In this way, the inflow opening of the orifice 2355 is positioned in the interior of the fuel reservoir 20. The outflow opening of the orifice 2355 is positioned inside the pipe 231, offset in direction from the first end 2311 towards the second end 2312 25 along the pipe 231 with respect to the brazed connections 71, 72, the outlet port 22 and the first end 2311 of the pipe 30 231.

Figure 3 shows a portion of a fuel delivery assembly according to a third exemplary embodiment in a sectional view. The

fuel delivery assembly corresponds in general to the fuel delivery assembly described in connection with figures 1 and 5. The portion shown in figure 3 comprises the second end 2312 of the pipe 231, the injector cup 233 and the inlet end 11 of the fuel injector 2. The inlet end 11 of the fuel injector 2 is shifted into the injector cup 233 through the outlet end 2332 of the injector cup 233.

The injector cup 233 has a nipple 2335 at its inlet end 2331 which is shifted into the pipe 231 through the second end 2312 thereof and connected to the pipe 231 by means of a brazed connection 73. Such a configuration may also be useful for other embodiments of the fuel rail assembly 1, and may, for example, be realized in the first and second embodiments described above.

In contrast to the first and second embodiments, the constrictor element 235 is not arranged adjacent to the first end 2311 of the pipe 231, but adjacent to the second end 2312 of the pipe 231. It is inserted into the pipe 231 through the second end 2312. A form-fit and force-fit connection between the external surface 2353 of the constrictor element 235 and the internal surface 2314 of the pipe 231 is established by a threaded connection between threaded portions 2317, 2357 of the pipe 231 and of the constrictor element 235, respectively.

In the present embodiment, the constrictor element 235 is also not shaped as a cylindrical plug, but it has the shape of a cap screw with a circumferential sidewall having a hollow cylindrical basic shape and with a cover portion closing the sidewall at one axial end thereof. The sidewall expediently comprises the threaded portion 2357 of the constrictor element 235 at its external surface. Preferably, the sidewall

has a hexagonal internal cross-section so that the constrictor element 235 represents a hexagon socket head cap screw. The cover portion may expediently comprise the orifice 2355 in the present embodiment of the constrictor element 235.

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A constrictor element 235 having such a shape may also be useful for other embodiments of the fuel rail assembly 1. It is also conceivable to use a plug shaped constrictor element 235 in the present embodiment, such as described in detail above. However, the constrictor element 235 in the shape of a hexagon socket head cap screw is particularly advantageous for establishing the threaded connection between the threaded portions 2317, 2357.

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In the present embodiment, the constrictor element 235 is shifted into the second end 2312 of the pipe 231 so that it is arranged subsequent to the inlet end 2331 of the injector cup 233 in direction towards the outlet port 22 of the fuel reservoir 20 along the pipe 231, i.e. in upstream direction along the pipe 231. Further, the constrictor element 235 is offset from the brazed connection 73 between the pipe 231 and the injector cup 233 in direction towards the first end 2311 of the pipe 231. In other words, the brazed connection 73 is arranged in a region subsequent to the threaded portions

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2317, 2357 in direction towards the inlet end 2331 of the injector cup 233 and towards the second end 2312 of the pipe 231, i.e. in downstream direction along the pipe 231. Therefore, also in this embodiment, the risk for brazing material to obstruct the orifice 2355 is particularly small.

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Figure 4 shows a sectional view of a portion of a fuel delivery assembly according to a fourth exemplary embodiment. The fuel delivery assembly according to the fourth embodiment

corresponds in general to the fuel delivery assembly according to the third embodiment.

In contrast thereto, the constrictor element 235 is shaped as a cylindrical plug like in the first embodiment, not as a hexagonal socket head cap screw as in the third embodiment. Correspondingly, the pipe 231 and the constrictor element 235 do not have threaded portions 2317, 2357 as in the third embodiment.

Rather, the internal surface 2314 of the pipe 231 has a first step 2318 which is shaped and arranged to limit axial displaceability of the constrictor element 235 in direction towards the first end 2311 of the pipe 231 by means of a form-fit connection with the external surface 2353 of the constrictor element 235, in particular with a front surface of the constrictor element 235. In addition, a circumferential portion of the external surface 2353 of the constrictor element 235 may be in a force-fit connection with the internal surface 2314 of a portion 2315 of the pipe 231 which extends circumferentially around the constrictor element 235. In this way, a predetermined position of the constrictor element 235 relative to the pipe 231 may be reliably set by means of the form fit connection with the first step 2318 and the position may be reliably retained against vibrations and gravity due to the force-fit connection with the internal surface 2314 of the pipe 231.

In addition to the above-mentioned first step 2318, the pipe 231 comprises a further step 2319 which is positioned between the first step 2318 and the second end 2312 of the pipe 231. The internal diameter of the pipe 231 decreases in stepwise fashion in direction from the second end 2312 towards the first end 2311 of the pipe 231 at the second step 2319 from a

first to a second diameter and subsequently at the first step 2318 from the second to a third diameter. The external diameter of the constrictor element is larger than the third diameter, smaller than the first diameter and preferably has almost the same value as the second diameter so as to allow press fitting of the constrictor element 235 into the pipe 231 through the second end 2312 thereof until it is stopped at the first step 2318.

For producing the fuel rail assembly 1 of the fuel delivery assembly according to the fourth embodiment, a ring of brazing material, e.g. a copper ring, may be inserted through the second end 2312 of the pipe 231 to engage in form fit connection with the further step 2319. During production of the brazed connection 73 between the pipe 231 and the injector cup 233, displaceability of the ring of brazing material is expediently limited by the further step 2319 and by the nipple 2335 of the injector cup 233 in opposite directions along the pipe 231.

Analogously to the third embodiment, the constrictor element 235 may in this way be offset along the pipe 231 in direction towards the first end 2311 of the pipe 231 with respect to the inlet end 2331 of the injector cup 233 and to the brazed connection 73.

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. Fuel rail assembly (1) for delivering fuel to a plurality of fuel injectors (2) comprising a tubular fuel reservoir (20) with a plurality of outlet ports (22) and a fuel delivery line (23) connected to each of the outlet ports (22), wherein each fuel delivery line (23) comprises a pipe (231) and an injector cup (233), the injector cup (233) having an outlet end (2332) for receiving a respective one of the fuel injectors (2), the pipe (231) has a first end (2311) which is hydraulically and mechanically connected to the respective outlet port (22) and a second end (2312), remote from the first end (2313), hydraulically and mechanically connected to an inlet end (2331) of the injector cup (233), remote from the outlet end (2332), each fuel delivery line (23) further comprises a constrictor element (235) which has an orifice (2355) extending through the constrictor element (235), the constrictor element (235) is inserted into the pipe (231) so that an external surface (2353) of the constrictor element (235) is in form-fit and/or force-fit connection with an internal surface (2314) of the pipe (231).
2. Fuel rail assembly (1) according to the preceding claim, wherein the constrictor element (235) is arranged adjacent to the first end (2311) of the pipe (231) and the pipe (231) is connected to the outlet port (22) by means of a brazed connection (71) or wherein the constrictor element (235) is arranged adjacent to the second end (2312) of the pipe (231) and the

pipe (231) is connected to the injector cup (233) by means of a brazed connection (72).

3. Fuel rail assembly (1) according to one of the preceding
5 ing claims, wherein the constrictor element (235) is arranged in the pipe (231) such that a portion (2315) of the pipe (231) extends circumferentially around the constrictor element (235), the internal surface (2314) of said portion (2315) being in press-fit connection
10 with the external surface (2353) of the constrictor element (235).
4. Fuel rail assembly (1) according to one of the preceding
15 ing claims, wherein the pipe (231) has a bend (2316) or kink which is operable to engage into form-fit and/or force-fit connection with the constrictor element (235).
5. Fuel rail assembly (1) according to one of the preceding
20 ing claims, wherein the internal surface (2314) of the pipe (231) and the external surface (2353) of the constrictor element (235) have corresponding threaded portions (2317, 2357) for establishing a threaded connection between the constrictor element (235) and the pipe
25 (231).
6. Fuel rail assembly (1) according to one of the preceding
30 ing claims, wherein the internal surface (2314) of the pipe (231) has a step (2318) which is operable to engage in form-fit connection with the external surface (2353) of the constrictor element (235).
7. Fuel rail assembly (1) according to one of the preceding
ing claims, wherein the constrictor element (235) is

shifted into the first end (2311) of the pipe (231) and projects from the first end (2311) into the outlet port (22).

- 5 8. Fuel rail assembly (1) according to one of the preceding claims 1 to 6, wherein the constrictor element (235) is shifted into the first end (231) of the pipe (231) such that it is arranged completely inside the pipe (231) and spaced apart from the first end (2311) and in particular spaced apart from a brazed connection (71) between the respective outlet port (22) and the pipe (231) in direction towards the injector cup (233).
10
9. Fuel rail assembly according to one of the preceding claims 1 to 6, wherein the constrictor element (235) is shifted into the second end (2312) of the pipe so that it is arranged subsequent to the inlet end (2331) of the injector cup (233) in direction towards the respective outlet port (22) of the fuel reservoir (20).
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10. Fuel rail assembly (1) according to claims 9 and 5, wherein the fuel delivery line (23) further comprises a brazed connection (73) connecting the pipe (231) and the injector cup (233) in a region subsequent to the threaded portions (2317, 2357) in direction towards the inlet end (2331) of the injector cup (233).
25
11. Fuel rail assembly (1) according to claims 9 and 6, wherein the internal surface (2314) of the pipe (231) has a further step (2319) positioned between said step (2318) and the inlet end (2331) of the injector cup (233), the fuel delivery line (233) further comprising a brazed connection (73) connecting the pipe (231) and the injector cup (233) in a region subsequent to the
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further step (2319) in direction away from said step (2318) which is operable to engage in form-fit connection with the external surface (2353) of the constrictor element (235).

5

12. Fuel rail assembly (1) according to one of the preceding claims, wherein a portion (2315) of the pipe (231) extends circumferentially around the constrictor element (235) and the constrictor element (235) and its orifice (2355) are dimensioned such that the constrictor element (235) reduces the hydraulic diameter of said portion (2315) of the pipe (231) by 50 % or more and in particular by 90 % or less.

10

13. Fuel delivery assembly comprising a fuel rail assembly (1) according to one of the preceding claims and the fuel injectors (2), wherein each fuel injector (2) has an inlet portion (11) which is shifted into the outlet end (2332) of the respective injector cup (233).

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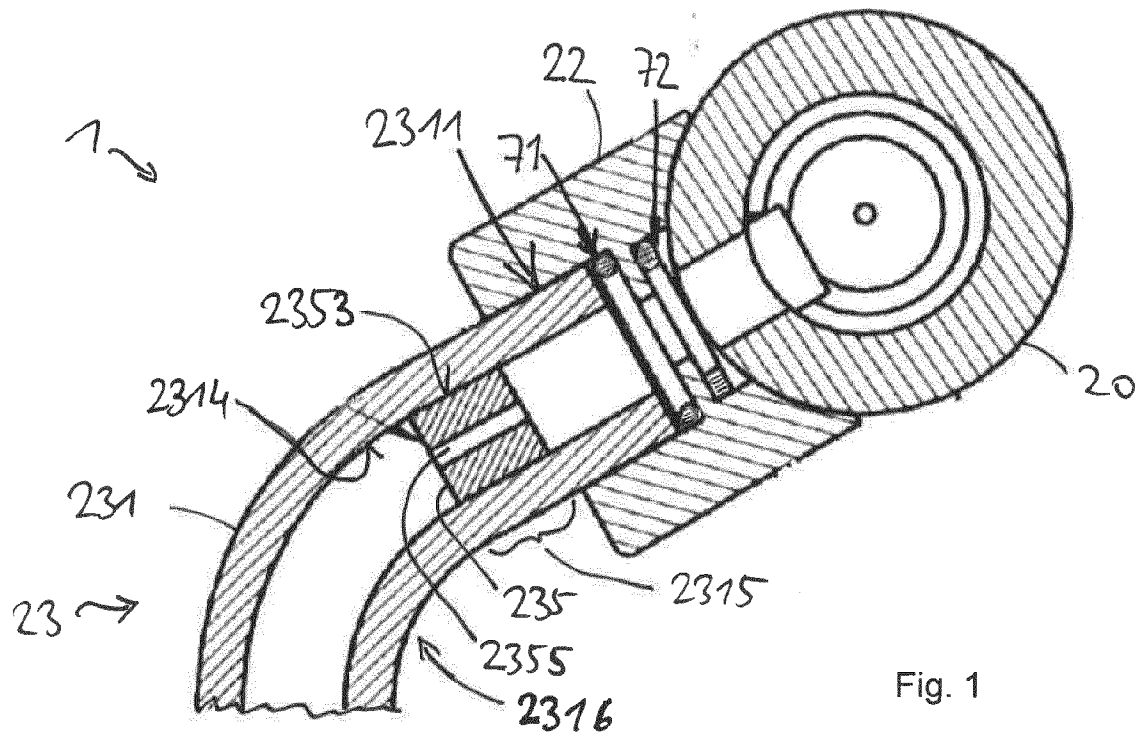


Fig. 1

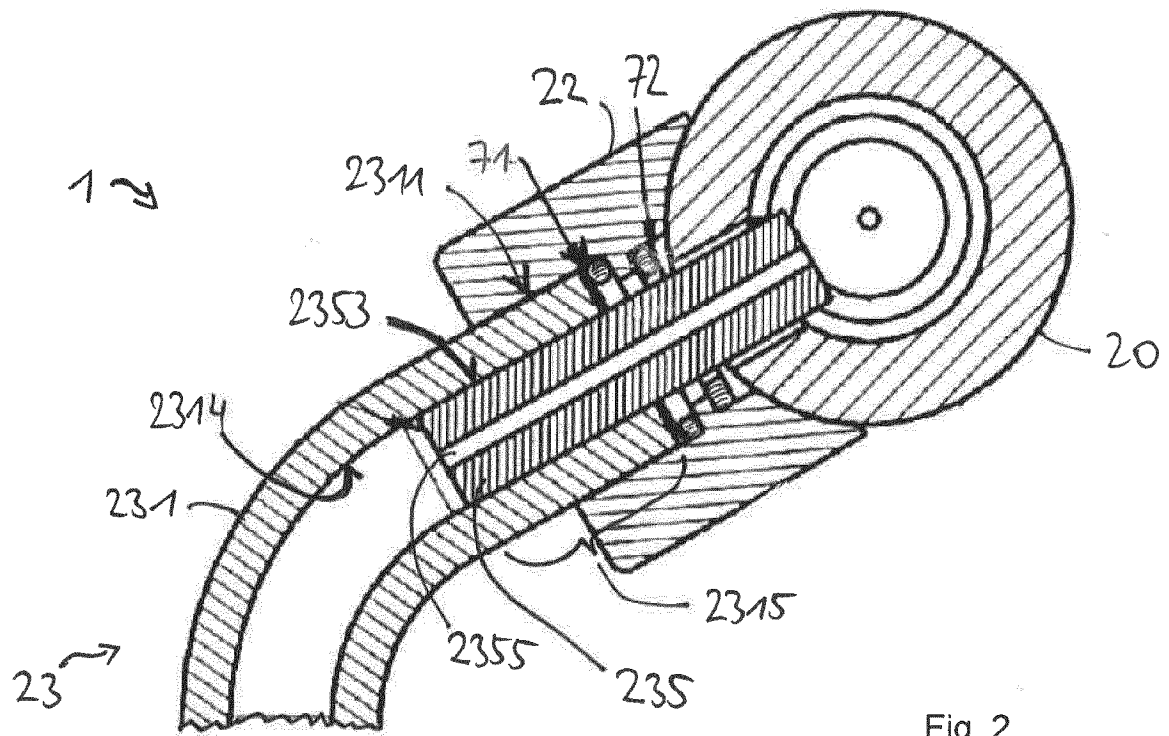


Fig. 2

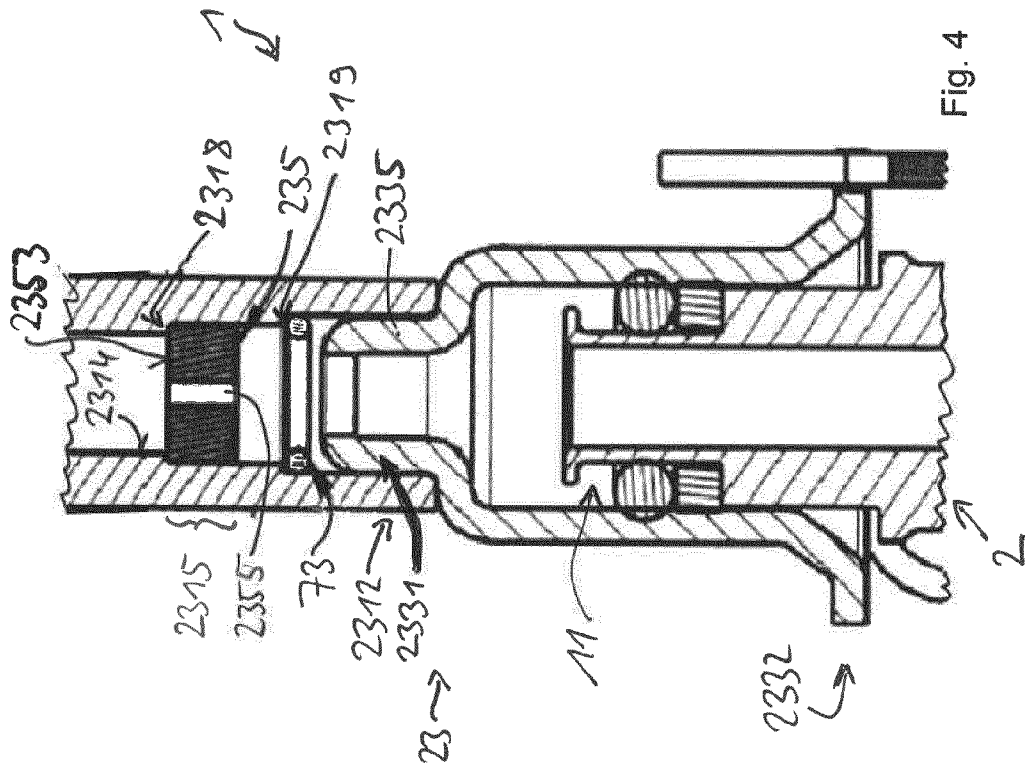


Fig. 4

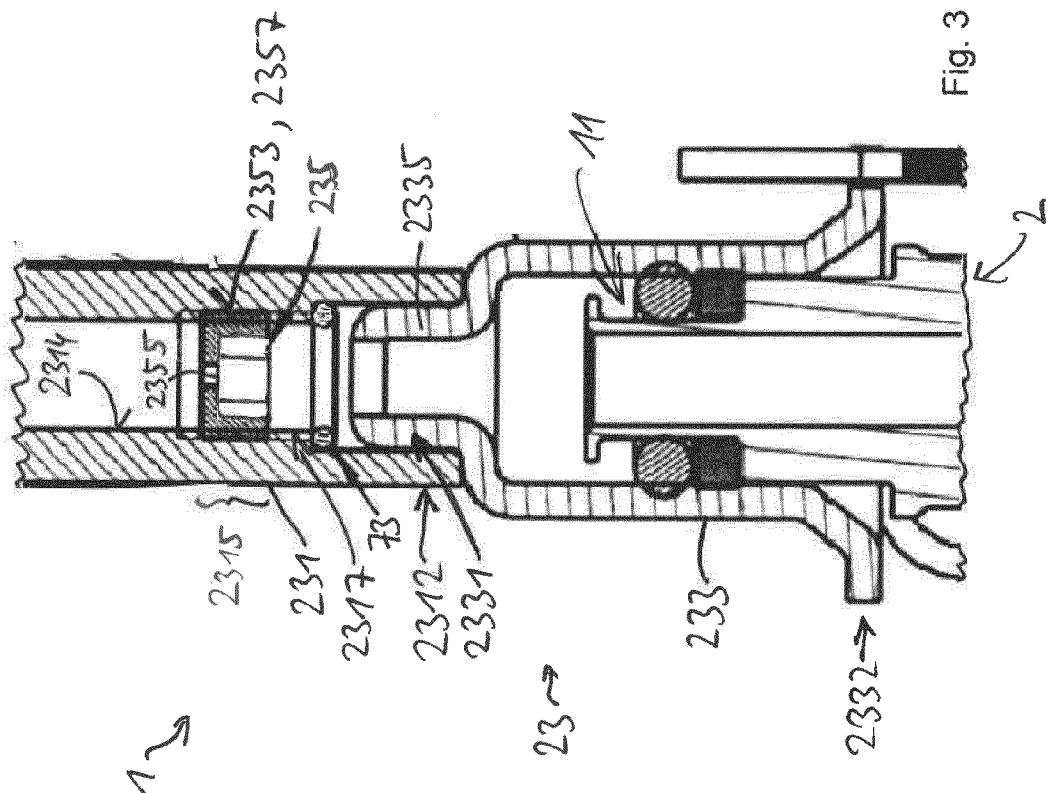


Fig. 3

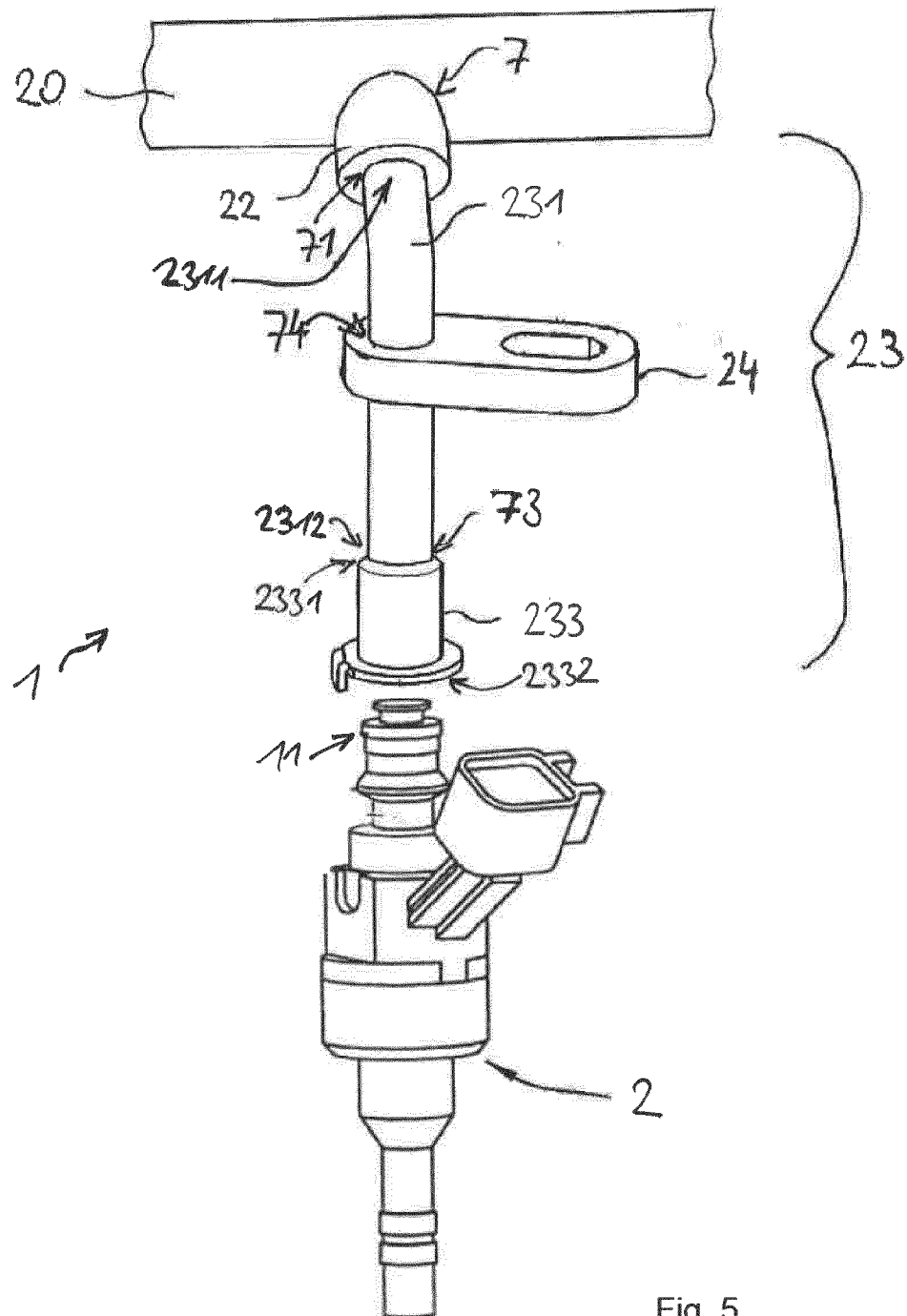


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/082516

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02M55/04 F02M37/00
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)
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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 2 910 768 A1 (CONTINENTAL AUTOMOTIVE GMBH [DE]) 26 August 2015 (2015-08-26) paragraph [0030] - paragraph [0059]; figure 2 abstract	1-13
Y	EP 1 707 793 A1 (DUALON INTERNAT HOLDING SA [LU]) 4 October 2006 (2006-10-04) paragraph [0009] - paragraph [0020] abstract	1-4,6,8,9,11-13
Y	US 5 937 909 A (CLAUSS HELMUT [DE] ET AL) 17 August 1999 (1999-08-17) the whole document	5,10
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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

28 March 2018

Date of mailing of the international search report

06/04/2018

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/082516

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	FR 2 845 129 A1 (DELPHI TECH INC [US]) 2 April 2004 (2004-04-02) page 12, line 24 - page 13, line 27; figure 7 abstract -----	1-13

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International application No

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