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(54) **Fuel tank for a vehicle, especially a railway vehicle**

(57) Fuel tank for a vehicle, in particular for under-floor arrangement in a rail vehicle, comprising a first fuel compartment (2.1) and a fuel outlet device (2.41) for drawing fuel from said fuel tank (2), further comprising a second fuel compartment (2.2) being spatially associated to said first fuel compartment (2.1) and having a

smaller volume than said first fuel compartment (2.1), and a first fuel supply arrangement (2.3) for supplying fuel from said first compartment (2.1) to said second compartment (2.2), wherein said fuel outlet device (2.41) is located within said second fuel compartment (2.2).

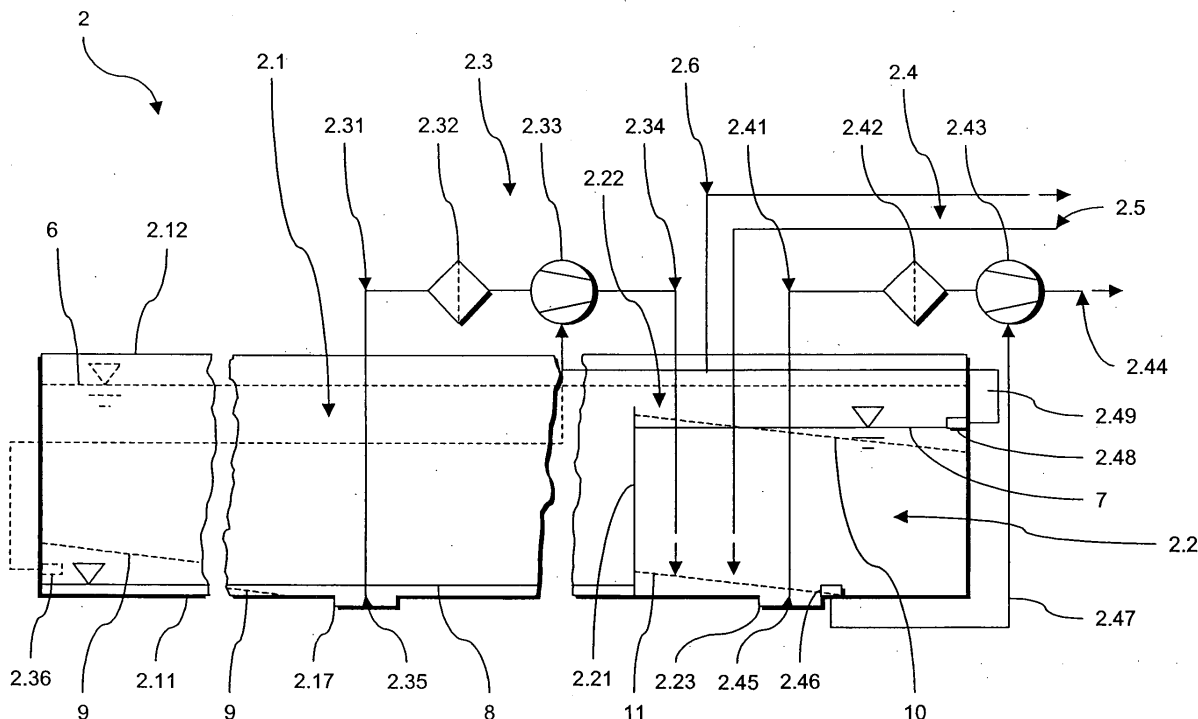


Fig. 2

Description

[0001] The present invention relates to a fuel tank for a vehicle, in particular for underfloor arrangement in a rail vehicle, comprising a first fuel compartment and an fuel outlet device for drawing fuel from said fuel tank.

[0002] In particular in the context of diesel or diesel-electric low floor rail vehicles it is known to arrange the fuel tank for the diesel motor underneath the floor of the vehicle. To keep the floor level as low as possible while providing a sufficient fuel storage capacity and, thus, a sufficiently large action radius of the vehicle, very long and generally flat fuel tank designs have been developed. Usually, a fuel outlet line is located in the central bottom region of the tank to draw fuel from the tank.

[0003] Those flat tanks suffer from the disadvantage of considerable "dead" volume. This is due to the fact that even considerable amounts of fuel only produce a very low fuel level within the tank. Thus, even small inclinations of the tank with respect to a horizontal plane cause accumulation of the fuel in regions remote from the central fuel outlet. This may lead to an interruption of the fuel supply to the motor even though there is still a considerable amount of fuel present within the tank. Since such situations with interrupted fuel supply are to be avoided during operation of a rail vehicle, counter-measures are to be taken to avoid such situations.

[0004] One known possibility to solve this problem is to provide several fuel outlets at different locations of the tank such as it is disclosed in the document DE 201 13 898 U1. Anyway, this solution adds to the overall cost of the arrangement. This is due to the fact that a rather complicated mechanism has to be implemented for preventing intake of air into the fuel supply system via non immersed fuel outlets.

[0005] It is thus an object of the present invention to provide a fuel tank that, at least to some extent, overcomes the above disadvantages. It is a further object of the present invention to provide a fuel tank that ensures, at a low overall cost, enhanced usage of the volume of fuel available within the tank.

[0006] The above objects are achieved starting from a fuel tank according to the preamble of claim 1 by the features of the characterizing part of claim 1.

[0007] The present invention is based on the technical teaching that enhanced usage of the volume of fuel available within the tank may be achieved by providing a fuel tank comprising a first fuel compartment and a fuel outlet device for drawing fuel from said fuel tank. According to the invention there is provided a second fuel compartment being spatially associated to said first fuel compartment and having a smaller volume than said first fuel compartment and a first fuel supply arrangement for supplying fuel from said first compartment to said second compartment. Said fuel outlet device is then located within said second fuel compartment.

[0008] The first fuel supply arrangement, even at low

fuel levels, allows for supplying fuel from said first fuel compartment to said second fuel compartment at periods where no adverse inclination or motion situation is prevailing during operation of the vehicle. Thus, during these periods - regularly occurring during operation of a vehicle - the fuel level within the second fuel compartment may be at least maintained at a certain value. Preferably, said fuel level within the second fuel compartment is even raised during such periods.

[0009] Thus, an inclination of the tank with respect to a horizontal plane or an acceleration acting on the fuel will not have the same adverse effect on continuous fuel supply as with the known single compartment designs.

[0010] On the one hand, this is due to the fact that, with such an arrangement, even at low fuel levels within said first fuel compartment, a certain fuel level within said second fuel compartment may be at least maintained, said fuel level being higher than the one in the first compartment and, thus, assuring continuous fuel supply via said outlet device even at low fuel volumes remaining within the tank.

[0011] Furthermore, although, at such adverse inclination or acceleration situations, the fuel within the second compartment will, as well, tend to accumulate at a location remote from the fuel outlet device, the smaller volume of the second fuel compartment leads to a shorter distance of this location of accumulation from the fuel outlet device. Thus, even at low fuel levels within the second fuel compartment, at a given inclination or acceleration situation the fuel level in the region of the fuel outlet device will not drop as far as it would be the case in a known single compartment tank. Consequently, continuous fuel supply from the tank will be guaranteed up to smaller fuel volumes remaining within the tank. This leads either to an elevated action radius of the vehicle at a given tank volume or to a reduced necessary tank volume at a given action radius of the vehicle.

[0012] The second fuel compartment may be located anywhere immediately adjacent to the first fuel compartment. Preferably, said second fuel compartment is located within said first fuel compartment. This allows for a very simple and cost effective design of the fuel compartments, in particular of the second fuel compartment. The second fuel compartment may be defined by one or more simple wall elements arranged within the first fuel compartment.

[0013] The second fuel compartment - apart from the connection via the first fuel supply arrangement - may be completely sealed versus the first fuel compartment. Preferably, the second fuel compartment comprises a first aperture located in an upper region of said second fuel compartment, said second fuel compartment being open towards said first fuel compartment via said first aperture. Thus, in a very simple manner, return of excess fuel fed to the second fuel compartment back to the first fuel compartment is assured.

[0014] Preferably, said first aperture is located at a first level which is lower than a predetermined first fuel

level within said first fuel compartment. Thus, upon filling the fuel tank in such a manner that the first fuel level within said first fuel compartment is exceeded, the second fuel compartment will automatically be filled via said first aperture. Thus, preferably, said first fuel level is located below the maximum filling level of the fuel tank.

[0015] The second fuel compartment may be designed in any suitable shape. It may, for example, have a substantially rectangular cross section in a horizontal plane. Preferably, it has a substantially elliptic cross section in a horizontal plane. Such a design in combination with an fuel outlet device located in the region of the center of the elliptic second fuel compartment leads to an optimized use of the fuel volume within the tank. This is due to the fact that such a design, thanks to the continuously reducing width of the compartment with increasing distance to the center of the compartment, even at elevated inclination angles of the tank leads to sufficiently high fuel levels reaching to the fuel outlet device for ensuring fuel supply from the fuel tank. Preferably, the long main axis of the elliptic cross section runs substantially parallel to the axis about which the most important, i.e. the most interfering inclinations of the tank are to be expected during operation of the vehicle. In particular for rail vehicles, these are usually the inclinations causing a nodding movement about a horizontal axis transverse to the longitudinal axis of the vehicle. If there is no such dominant inclination, the cross section in a horizontal plane may be substantially circular as a special case of the elliptic design.

[0016] The second compartment may be achieved in any suitable manner. For example, it may be a completely separate module. Preferably, to simplify the design of the tank, the first fuel compartment and the second fuel compartment share at least one component. Thus, with certain embodiments of the fuel tank according to the present invention, said first fuel compartment is defined by a plurality of first wall elements and said second fuel compartment is defined by at least one second wall element and at least one of said first wall elements. The components of the second fuel compartment may be arranged in any suitable manner. Preferably, said second wall element is arranged, in any suitable geometry, circumferentially with respect to said fuel outlet device and mounted to a first wall element forming a bottom wall of said first fuel compartment. To easily form the above aperture towards the first fuel compartment, said second wall element preferably does not reach to a first wall element forming an upper wall of said first fuel compartment.

[0017] Anyway, it may also be provided that said second wall element partly, e.g. in at least one connection region, reaches up and is connected to said first wall element forming an upper wall of said first fuel compartment. With such a configuration, on the one hand, one or several inlets of fuel from the first fuel compartment to the second fuel compartment may be obtained. On the other hand, due to the connection between the sec-

ond wall element and the upper wall of said first fuel compartment, enhanced rigidity and stability of the fuel tank may be obtained.

[0018] With advantageous embodiments of the fuel tank according to the present invention said first fuel supply arrangement is adapted to provide a first fuel stream towards said second compartment, wherein said first fuel stream is at least equal to a second fuel stream drawn from said second compartment during operation of said vehicle. Thus, during periods with uninterrupted fuel supply from said first fuel compartment to said second fuel compartment, it is at least possible to keep a certain fuel level within said second fuel compartment. If said second fuel stream is selected to be equal to a maximum fuel stream drawn from said second compartment during operation of said vehicle - with continuous fuel supply to said second fuel compartment - a rise in the fuel level within the second fuel compartment will result during periods where less than said maximum fuel stream is drawn from said second fuel compartment.

[0019] Preferably, said first fuel stream is selected to exceed said maximum fuel stream drawn from said second compartment during operation of said vehicle. Thus, a quick refill of the second fuel compartment after a longer period with interrupted fuel supply to said second fuel compartment may be achieved.

[0020] The first fuel supply arrangement may be designed in any suitable manner to feed fuel to the second fuel compartment. Preferably, said first fuel supply arrangement comprises a first fuel pump. With further preferred embodiments of the present invention, said first fuel supply arrangement comprises a first fuel filter. Thus, the second fuel compartment contains fuel that is at least pre-filtered to some extent. This reduces further fuel filtering effort prior to feeding the fuel to a motor.

[0021] The first fuel compartment may be of any suitable design and partition. It may comprise one single hollow space. With further embodiments of the present invention, said first fuel compartment comprises a plurality of sub-compartments, wherein for at least a part of said sub-compartments a separate first fuel supply arrangement is provided for supplying fuel from said sub-compartment to said second fuel compartment. Said separate first fuel supply arrangements may be arranged in series or in parallel.

[0022] Advantageous embodiments of the fuel tank according to the present invention comprise a first fuel level sensor, said first fuel level sensor being arranged for providing a low fuel signal when a fuel level within said second fuel compartment falls below a predetermined second fuel level. With such a first fuel level sensor it is possible to interrupt fuel supply to a motor. This prevents intake of air into the fuel stream supplied to the motor which otherwise might cause serious motor damage. Thus, preferably, said fuel outlet device comprises first fuel supply interrupt means for interrupting fuel supply from said second fuel compartment via said fuel outlet device. Said first fuel supply interrupt means is then

connected to said first fuel level sensor and adapted to interrupt fuel supply via said fuel outlet device upon receipt of said low fuel signal.

[0023] Such first fuel supply interrupt means may, for example, be a fuel valve or the like responding to said low fuel signal. Preferably, said fuel outlet device comprises a second fuel pump for drawing fuel from said second fuel compartment. Said second fuel pump is then connected to said first fuel level sensor and arranged for stopping operation upon receipt of said low fuel signal.

[0024] Further advantageous embodiments of the fuel tank according to the present invention comprise a second fuel level sensor, said second fuel level sensor being arranged for providing a high fuel signal when a fuel level within said second fuel compartment reaches a predetermined third fuel level. With such a second fuel level sensor it is possible to interrupt fuel supply to said second fuel compartment when a certain filling level has been reached. Thus, preferably, said first fuel supply arrangement comprises second fuel supply interrupt means for interrupting fuel supply to said second fuel compartment via said first fuel supply arrangement. Said second fuel supply interrupt means is then connected to said second fuel level sensor and adapted to interrupt fuel supply via said first fuel supply arrangement upon receipt of said high fuel signal.

[0025] Here as well, such second fuel supply interrupt means may, for example, be a fuel valve or the like responding to said high fuel signal. Preferably, said first fuel supply arrangement comprises a first fuel pump for pumping fuel to said second fuel compartment. Said first fuel pump is then connected to said second fuel level sensor and arranged for stopping operation upon receipt of said high fuel signal.

[0026] To assure appropriate filling of the second fuel compartment preferred embodiments of the fuel tank according to the present invention comprise a fuel return device for returning fuel from a motor to said second fuel compartment.

[0027] Venting of the first and second fuel compartment may be provided in any suitable way, e.g. by separate venting lines or the like. Preferably, one single venting device is provided for both fuel compartments. In order to achieve this in a very simple manner, said second fuel compartment is preferably open, at an upper side, towards said first fuel compartment. Then, preferably, said first fuel compartment and said second fuel compartment share a common venting device.

[0028] The present invention also relates to a vehicle, in particular a rail vehicle, comprising a transport compartment with a floor and a fuel tank according to the present invention arranged below said floor. With such a vehicle, the embodiments and advantages of the present invention as they have been described in the foregoing may be achieved to the same extent. Thus, it is simply referred here to the above.

[0029] Further embodiments of the present invention

will become apparent from the dependent claims and the following description of preferred embodiments which refers to the appended figures.

5 Figure 1 is a schematic sectional representation of a preferred embodiment of the vehicle according to the present invention comprising a preferred embodiment of the fuel tank according to the present invention;

10 Figure 2 is a schematic sectional representation of a detail of Figure 1;

15 Figure 3 is a schematic section top view of the fuel tank of Figure 1;

20 Figure 4 is a schematic sectional top view of a further preferred embodiment of the fuel tank according to the present invention.

[0030] With reference to Figures 1 to 3 a preferred embodiment of a low floor rail vehicle 1 according to the present invention with a fuel tank 2 according to the present invention will now be described in greater detail.

25 **[0031]** Figure 1 is a schematic sectional representation of the rail vehicle 1 which comprises a transport compartment 1.1 for transporting passengers. The transport compartment 1.1 has a floor 1.2. The fuel tank 2 is arranged under a low floor section of the floor 1.2. From the fuel tank 2 fuel is supplied to a diesel motor 3 driving, via a gearing unit 4, a wheel set 5 of the vehicle 1.

30 **[0032]** The fuel tank 2 comprises a first fuel compartment 2.1 and a second fuel compartment 2.2 arranged within said first fuel compartment 2.1 in a front section of the fuel tank 2. The first fuel compartment 2.1 is formed by a plurality of first walls 2.11 to 2.16.

35 **[0033]** The second fuel compartment 2.2 is considerably smaller than the first fuel compartment 2.1. The second fuel compartment 2.2 is formed by a second wall element 2.21 tightly fixed to the first wall element 2.11 forming the bottom wall of the first fuel compartment 2.1 and the two first wall elements 2.13 and 2.15 forming the left and right side walls of the first fuel compartment 2.1. This second wall element 2.21 does not reach up to the first wall element 2.12 forming the upper wall of the tank 2.

40 **[0034]** As can be seen in greater detail from Figure 2, the second fuel compartment 2.2 is open towards the first fuel compartment 2.1 in an upper region via a first aperture 2.22. Since the second fuel compartment 2.2 has no upper wall, said first aperture 2.22 is formed by the second fuel compartment 2.2 simply being open at its upper side. Anyway, it will be appreciated that, with other embodiments of the present invention, the first aperture may be achieved by any other suitable means. For example, a hole may be formed in a wall delimiting said second fuel compartment or the like.

[0035] The first aperture 2.22 is located at a first level above the bottom wall 2.11 of the tank 2. The first level is determined by the height of the upper edge of the second wall element 2.21. This height of the upper edge of the second wall element 2.21, i.e. the first level, is chosen to be inferior to the maximum fuel level reached when filling the tank 2 completely. This maximum fuel level is indicated by the dashed contour 6 in Figure 2.

[0036] Thus, when filling the tank 2 completely, the first aperture 2.22 assures that, both, the first fuel compartment 2.1 and the second fuel compartment 2.2 are filled with fuel. Thus, the filling device, e.g. a simple filling line, may be located at any position within the tank 2. In other words, this design advantageously does not impose any constraints with respect to the location of the filling device.

[0037] Anyway, it will be appreciated that, with other embodiments of the invention, the second wall element 2.21 partly, e.g. in at least one connection region 2.24, reaches up and is connected to the first wall element 2.12 forming the upper wall of the first fuel compartment 2.1. In aperture regions 2.25 located between said connection regions 2.24 the second wall element 2.21 does not reach up to the first wall element 2.12. Thus, on the one hand, one or several apertures allowing supply of fuel from the first fuel compartment 2.1 to the second fuel compartment 2.2 may be obtained. These apertures may be of any shape. For example, they may be substantially u-shaped. On the other hand, due to the connection between the second wall element 2.21 and the upper wall 2.12 of the first fuel compartment 2.1, enhanced rigidity and stability of the fuel tank 2 is obtained.

[0038] A first fuel supply arrangement 2.3 is provided to supply fuel from the first fuel compartment 2.1 to the second fuel compartment 2.2. This first fuel supply arrangement 2.3 comprises a first fuel line 2.31, a first fuel filter 2.32, a first fuel pump 2.33 and a second fuel line 2.34.

[0039] The fuel inlet 2.35 of the first fuel line 2.31 is located centrally within the first fuel compartment 2.1 approximately at the level of the bottom wall 2.11 of the tank 2. Below the fuel inlet 2.35 of the first fuel line 2.31 there is located a first sump 2.17 of the first fuel compartment 2.1. A removably mounted maintenance bottom plate of the first sump 2.17 allows for cleaning the sump 2.17 and performing maintenance operations on the first fuel line 2.31 and the first fuel compartment 2.1. A fast openable cleaning valve located in the side wall of the sump 2.17 may be used for drawing soilings and water etc. from the first fuel compartment 2.1.

[0040] A second fuel supply arrangement 2.4 is provided to supply fuel from the second fuel compartment 2.2 to the motor 3. This second fuel supply arrangement 2.4 comprises a fuel outlet device in the form of a third fuel line 2.41, a second fuel filter 2.42, a second fuel pump 2.43 and a fourth fuel line 2.44 leading towards the motor 3.

[0041] The fuel inlet 2.45 of the third fuel line 2.41 is

located centrally within the second fuel compartment 2.2 approximately at the level of the bottom wall 2.11 of the tank 2. Below the fuel inlet 2.45 of the third fuel line 2.41 there is located a second sump 2.23 of the second fuel compartment 2.2. A removably mounted maintenance bottom plate of the second sump 2.23 allows for cleaning the sump 2.23 and performing maintenance operations on the third fuel line 2.41 and the second fuel compartment 2.2. A fast openable cleaning valve located in the side wall of the sump 2.23 may be used for drawing soilings and water etc. from the second fuel compartment 2.2.

[0042] The second fuel supply arrangement 2.4 further comprises a first fuel level sensor 2.46 located slightly above the level of the fuel inlet 2.45 of the third fuel line 2.41. This first fuel level sensor 2.46 is adapted to provide a first fuel level signal, namely a low fuel signal, at times when it is not immersed in fuel, i.e. when the fuel within the second fuel compartment has reached a given second fuel level. This low fuel signal is forwarded to the second fuel pump 2.43 via a first signal line 2.47.

[0043] The second fuel pump 2.43, in response to said low fuel signal, stops operation in order to avoid intake of air into the fuel injection system of the motor 3 which otherwise might cause serious motor damage. If, due to immersion of the first fuel level sensor 2.46, there is no low fuel signal present at signal line 2.47, the second fuel pump 2.43 is adapted to operate, provided that it is not switched off by other means.

[0044] It will be appreciated that, with certain embodiments of the present invention, the first fuel pump 2.33 may run permanently to continuously supply fuel from the first fuel compartment 2.1 to the second fuel compartment 2.2. Excess fuel supplied to the second fuel compartment 2.2 will then return to the first fuel compartment via the first aperture 2.22. These embodiments have the advantage that, due to the pre-filtering via the first fuel filter 2.32, the fuel within the tank 2 is gradually purified during operation.

[0045] Anyway, in the present embodiment, there is provided a second fuel level sensor 2.48. This second fuel level sensor 2.48 is adapted to provide a second fuel level signal at times when it is not immersed in fuel, i.e. when the fuel within the second fuel compartment has fallen below a given third fuel level 7. This second fuel level signal is forwarded to the first fuel pump 2.33 via a second signal line 2.49.

[0046] The first fuel pump 2.33, in response to said second fuel level signal, starts operation. Due to immersion of the second fuel level sensor 2.48, a third fuel level signal, namely a high fuel signal, is present at the second signal line 2.49. The second fuel pump 2.43 is adapted to stop operation in response to said high fuel signal. Thus, the first fuel pump 2.33 is only running when the fuel level within the second compartment has fallen below said given third fuel level 7.

[0047] The first fuel pump 2.33 is adapted to provide

a first fuel stream towards the second compartment 2.1 that is higher than a second fuel stream drawn from the second fuel compartment 2.2 during operation of the vehicle 1. Thus, during periods with uninterrupted fuel supply from the first fuel compartment 2.1 to the second fuel compartment 2.2, it is possible to keep the fuel level within the second fuel compartment 2.2 above a certain fourth fuel level. If said second fuel stream is selected to be equal to a maximum fuel stream drawn from the second compartment 2.2 during operation of the vehicle 1 - after periods with interrupted fuel supply to the second fuel compartment 2.2 and during periods with continuous fuel supply to the second fuel compartment 2.2 - a rise in the fuel level within the second fuel compartment 2.2 towards the third fuel level will result during periods where less than said maximum fuel stream is drawn from the second fuel compartment 2.2 via the second fuel pump 2.43.

[0048] In the present embodiment, the second fuel stream is selected to be slightly higher than a maximum fuel stream drawn from the second compartment 2.2 during operation of the vehicle 1. Thus, with continuous fuel supply to the second fuel compartment 2.2, a rise in the fuel level within the second fuel compartment 2.2 towards the third fuel level will result in any case.

[0049] Such interrupted fuel supply to the second fuel compartment 2.2 may occur at low fuel levels within the first fuel compartment 2.1, i.e. when the fuel level within the first fuel compartment 2.1 - in a non-inclined, non-accelerated state of the vehicle 1 - has fallen below a fifth fuel level 8. Under these circumstances, due to the elongated flat design of the tank 2, an acceleration or inclination of the vehicle will result in an accumulation of the fuel within the first fuel compartment 2.1 remote from the inlet 2.35 of the first fuel line 2.31. This will result in a constellation where the fuel level within the first fuel compartment 2.1 - as it is indicated in Figure 2 by the dashed contour 9 - will not reach up to the inlet 2.35 of the first fuel line 2.31 anymore. Under these circumstances, the first fuel supply arrangement 2.3 sucks in air and, consequently, fuel supply to the second fuel compartment 2.2 is interrupted.

[0050] Anyway, due to the smaller size of the second fuel compartment 2.2 and the elevated fuel level maintained within the second fuel compartment 2.2 in accordance with the above explanations, at the occurrence of such adverse inclination or acceleration situations, the fuel level within the second fuel compartment 2.2 will be located well above the inlet 2.45 of the third fuel line 2.41 as it is indicated in Figure 2 by the dashed contour 10. Thus, continued fuel supply to the motor 3 via the second fuel supply arrangement 2.4 is assured.

[0051] Thanks to the present invention, this continued fuel supply to the motor 3 will also be maintained over an extended period of time with interrupted fuel supply to the second fuel compartment 2.2. Even in such a situation, due to the smaller size of the second fuel compartment 2.2, continued fuel supply to the motor 3 will

be maintained until the fuel level within the second fuel compartment 2.2 has dropped down to an inclined fuel level as it is indicated in Figure 2 by the dashed contour 11.

[0052] As soon as the inclination or acceleration situation improves such that the fuel level within the first fuel compartment 2.1 again reaches up to the fuel inlet 2.35 of the first fuel line 2.31, fuel is again supplied to the second fuel compartment 2.2. Due to the elevated size of the first fuel stream provided by the first fuel pump 2.33, the fuel level within the second fuel compartment 2.2 rises towards the third fuel level as it had been explained above. Thus, a quick recovery from such adverse inclination or acceleration situations may be achieved.

[0053] It will be appreciated that, with certain embodiments of the present invention, the first fuel pump 2.33 may be adapted to provide a variable first fuel stream. In these cases one or several third fuel level sensors may be provided within the first fuel compartment 2.1 and connected to the first fuel pump 2.33 as it is indicated by the dashed contour 2.36. Once the third fuel level sensor 2.36 indicates that the fuel level within the first fuel compartment 2.1 has fallen below a certain level, the first fuel stream is elevated to provide faster recovery from the above situations with interrupted fuel supply to the second fuel compartment 2.2.

[0054] To further improve the filling situation within the second fuel compartment 2.2, there is provided a fuel return line 2.5 returning unused fuel from the motor 3 back to the second fuel compartment 2.2.

[0055] Since, during normal operation of the vehicle 1, there is a permanent change between noncritical situations and critical situations with adverse inclination or acceleration, the present invention allows for an improved use of the volume of the tank 2. Thus, at a given volume of the tank 2, the action radius of the vehicle 1 increases. On the other hand, at a given action radius of the vehicle 1 the size of the tank 2 may be reduced.

[0056] As already mentioned above, the second compartment 2.2 is open towards the first compartment 2.1 at its upper side 2.22. This allows for implementing a common venting device in the form of a venting line 2.6 shared by the first fuel compartment 2.1 and the second compartment 2.2.

[0057] Figure 4 is a schematic sectional top view of a preferred embodiment of the fuel tank 2' according to the present invention. In its basic design and functionality, this embodiment does not differ from the embodiment shown in Figures 1 to 3. Thus, it will here mainly be referred to the differences. Furthermore, like parts are designated by like reference numerals.

[0058] One difference lies within the fact that the second fuel compartment 2.2' is formed by a second wall element 2.21' of circular cross section located centrally within the first fuel compartment 2.1' and tightly mounted to the bottom wall of the tank 2'. Thus, the second fuel compartment 2.2' is of cylindrical shape. As with the em-

bodiment of Figure 1 to 3, a second fuel supply arrangement 2.4' is provided to draw fuel from a region close to a second sump 2.23' of the second compartment 2.2'.

[0059] It will be appreciated that the cylindrical design of the second fuel compartment 2.2' does not only provide for a fuel level reaching to the first fuel line at an inclination of the tank 2' about the transverse axis 2.7' but also at inclinations of the tank 2' about the longitudinal axis 2.8 as well as at combinations of these inclinations. Such inclination situations may occur during traveling through superelevated curves of inclined rail sections etc.

[0060] A further difference lies within the fact that the first fuel compartment 2.1' is divided into four sub-compartments 2.18' via four third wall elements 2.9', 2.10' tightly connected to two of the first wall elements 2.11 and 2.13, 2.14, 2.15, 2.16, respectively and to the second wall element 2.21'. For each of the sub-compartments 2.18' there is provided a separate first fuel supply arrangement 2.3' drawing fuel from a region close to a first sump 2.17' of the respective sub-compartment 2.18'. The respective first fuel supply arrangement 2.3' is designed in the manner of the first fuel supply arrangement 2.3 of the embodiment of Figure 1 to 3.

[0061] The second compartment 2.2 is open towards each one of the sub-compartments 2.18' at its upper side 2.22. This allows for implementing a common venting device in the form of a venting line 2.6' shared by the first fuel compartment 2.1' and the second compartment 2.2'. This venting line 2.6 is located close to the center of the second compartment 2.2'.

[0062] The first fuel supply arrangements 2.3' may be operated in any suitable way. For example, they may all be operated at a time to continuously supply fuel to the second fuel compartment. Anyway, it may also be provided that the first fuel supply arrangements 2.3' are operated sequentially, e.g. when fuel supply is interrupted from one sub-compartment 2.18' it is switched to the next sub-compartment 2.18' and so on.

[0063] It will be appreciated that various modifications of the embodiment of Figure 4 may be made. For example, it is possible to divide the first fuel compartment into a different number of sub-compartments according to the needs of the respective vehicle. Furthermore, it is possible to provide one first fuel supply arrangement for a plurality of sub-compartments. In such a case it is e.g. possible to have one fuel pump and several first fuel lines from different sub-compartments connected thereto containing switchable valves for switching on fuel supply from the respective sub-compartment.

[0064] Although the present invention in the foregoing has only been described in the context of fuel tanks, it will be appreciated that it may also be applied to tanks for any other types of liquids in order to overcome similar problems with optimized use of the storage volume. Moreover, although the present invention in the foregoing has only been described in the context of rail vehicles, it will be appreciated that it may also be applied to

tanks for any other types of vehicles in order to overcome similar problems with optimized use of the storage volume.

Claims

1. Fuel tank for a vehicle, in particular for underfloor arrangement in a rail vehicle, comprising

- a first fuel compartment (2.1; 2.1') and
- a fuel outlet device (2.41) for drawing fuel from said fuel tank (2; 2'),

characterized by

- a second fuel compartment (2.2; 2.2') being spatially associated to said first fuel compartment (2.1; 2.1') and having a smaller volume than said first fuel compartment (2.1; 2.1'), and
- a first fuel supply arrangement (2.3; 2.3') for supplying fuel from said first compartment (2.1; 2.1') to said second compartment (2.2; 2.2'), wherein
- said fuel outlet device (2.41) is located within said second fuel compartment (2.2; 2.2').

2. Fuel tank according to claim 1, **characterized in that** said second fuel compartment (2.2; 2.2') is located within said first fuel compartment (2.1; 2.1').

3. Fuel tank according to claim 1 or 2, **characterized in that** said second fuel compartment (2.2; 2.2') comprises a first aperture (2.22) located in an upper region of said second fuel compartment (2.2; 2.2'), said second fuel compartment (2.2; 2.2') being open towards said first fuel compartment (2.1; 2.1') via said first aperture (2.22).

4. Fuel tank according to claim 3, **characterized in that** said first aperture (2.22) is located at a first level, said first level being lower than a predetermined first fuel level (6) within said first fuel compartment (2.1; 2.1').

5. Fuel tank according to any one of the preceding claims, **characterized in that** said first fuel compartment (2.1; 2.1') is defined by a plurality of first wall elements (2.11 to 2.16; 2.11' to 2.16') and said second fuel compartment (2.2; 2.2') is defined by at least one second wall element (2.21; 2.21') and at least one of said first wall elements (2.11 to 2.16; 2.11' to 2.16').

6. Fuel tank according to claim 5, **characterized in**

that said second wall element (2.21; 2.21') is arranged circumferentially with respect to said fuel outlet device (2.41) and mounted to a first wall element (2.11; 2.11') forming a bottom wall of said first fuel compartment (2.1; 2.1').

7. Fuel tank according to claim 5 or 6, **characterized in that** said second wall element (2.21; 2.21') does not reach to a first wall element (2.12) forming an upper wall of said first fuel compartment (2.1; 2.1').
8. Fuel tank according to claim 5 or 6, **characterized in that** said second wall element (2.21) has at least one connection region (2.24) where it reaches up to a first wall element (2.12) forming an upper wall of said first fuel compartment (2.1).
9. Fuel tank according to any one of the preceding claims, **characterized in that** said first fuel supply arrangement (2.3; 2.3') is adapted to provide a first fuel stream towards said second fuel compartment (2.2; 2.2'), said first fuel stream being at least equal to a second fuel stream drawn from said second compartment (2.2; 2.2') during operation of said vehicle.
10. Fuel tank according to claim 9, **characterized in that** said second fuel stream is a maximum fuel stream drawn from said second fuel compartment (2.2; 2.2') during operation of said vehicle.
11. Fuel tank according to any one of the preceding claims, **characterized in that** said first fuel supply arrangement (2.3; 2.3') comprises a first fuel pump (2.33).
12. Fuel tank according to any one of the preceding claims, **characterized in that** said first fuel supply arrangement (2.3; 2.3') comprises a first fuel filter (2.32).
13. Fuel tank according to any one of the preceding claims, **characterized in that**
 - said first fuel compartment (2.1') comprises a plurality of sub-compartments (2.18'), wherein .
 - for at least a part of said sub-compartments (2.18') a separate first fuel supply arrangement (2.3') is provided for supplying fuel from said sub-compartment (2.18') to said second fuel compartment (2.2').
14. Fuel tank according to any one of the preceding claims, **characterized by** a first fuel level sensor (2.46), said first fuel level sensor (2.46) being arranged for providing a low fuel signal when a fuel level within said second fuel compartment (2.2) falls below a predetermined second fuel level.

15. Fuel tank according to claim 14, **characterized in that** said fuel outlet device (2.41) is connected to first fuel supply interrupt means (2.43) for interrupting fuel supply from said second fuel compartment (2.2) via said fuel outlet device (2.41), said first fuel supply interrupt means (2.43) being connected to said first fuel level sensor (2.46) and adapted to interrupt fuel supply via said fuel outlet device (2.41) upon receipt of said low fuel signal.
16. Fuel tank according to claim 15, **characterized in that** said fuel outlet device (2.41) is connected to a second fuel pump (2.43) for drawing fuel from said second fuel compartment (2.2), said second fuel pump (2.43) being connected to said first fuel level sensor (2.46) and arranged for stopping operation upon receipt of said low fuel signal.
17. Fuel tank according to any one of the preceding claims, **characterized by** a second fuel level sensor (2.48), said second fuel level sensor (2.48) being arranged for providing a high fuel signal when a fuel level within said second fuel compartment reaches a predetermined third fuel level (7).
18. Fuel tank according to claim 17, **characterized in that** said first fuel supply arrangement (2.3) comprises second fuel supply interrupt means (2.33) for interrupting fuel supply to said second fuel compartment (2.2) via said first fuel supply arrangement (2.3), said second fuel supply interrupt means (2.33) being connected to said second fuel level sensor (2.48) and adapted to interrupt fuel supply via said first fuel supply arrangement (2.3) upon receipt of said high fuel signal.
19. Fuel tank according to claim 18, **characterized in that** said first fuel supply arrangement (2.3) comprises a first fuel pump (2.33) for pumping fuel to said second fuel compartment (2.2), said first fuel pump (2.33) being connected to said second fuel level sensor (2.48) and arranged for stopping operation upon receipt of said high fuel signal.
20. Fuel tank according to any one of the preceding claims, **characterized by** a fuel return device (2.5) for returning fuel from a motor (3) to said second fuel compartment (2.2) and/or to said first fuel compartment (2.1; 2.1').
21. Fuel tank according to any one of the preceding claims, **characterized in that** said first fuel compartment (2.1; 2.1') and said second fuel compartment (2.2; 2.2') have a common venting device (2.6; 2.6').
22. Vehicle, in particular rail vehicle, comprising a transport compartment (1.1) with a floor (1.2) and a fuel

tank (2; 2') according to any on of the preceding claims arranged below said floor (1.2).

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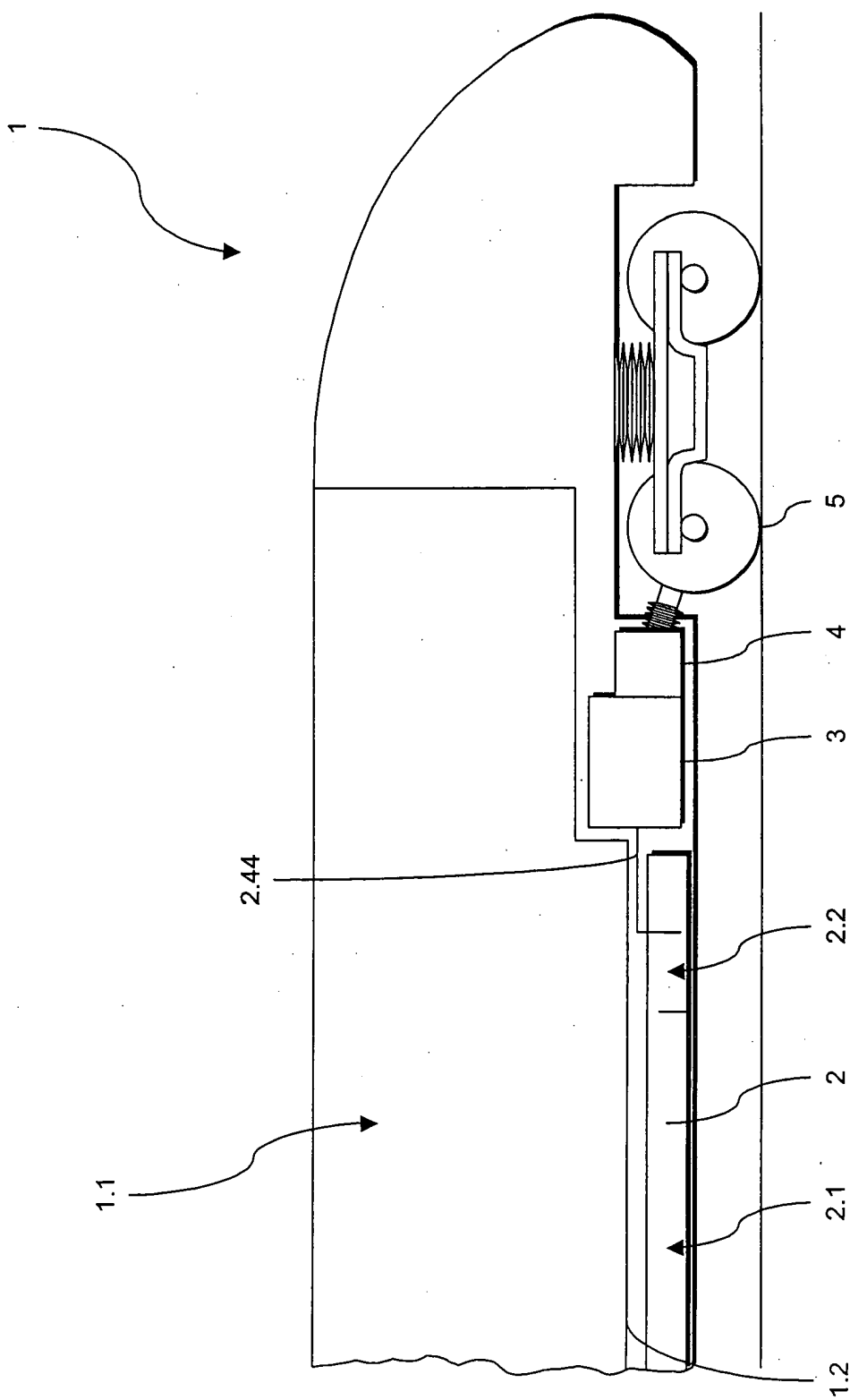


Fig. 1

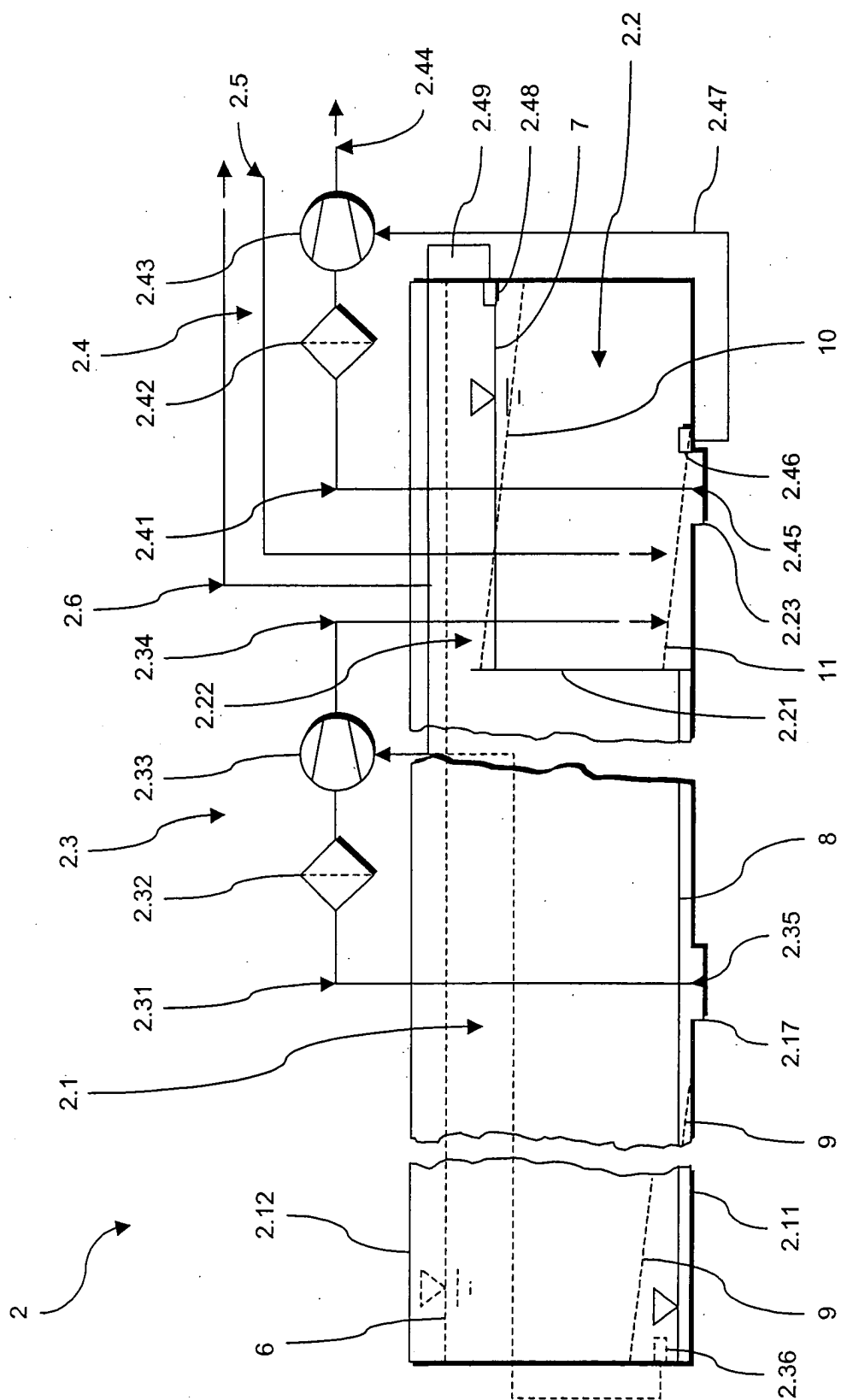


Fig. 2

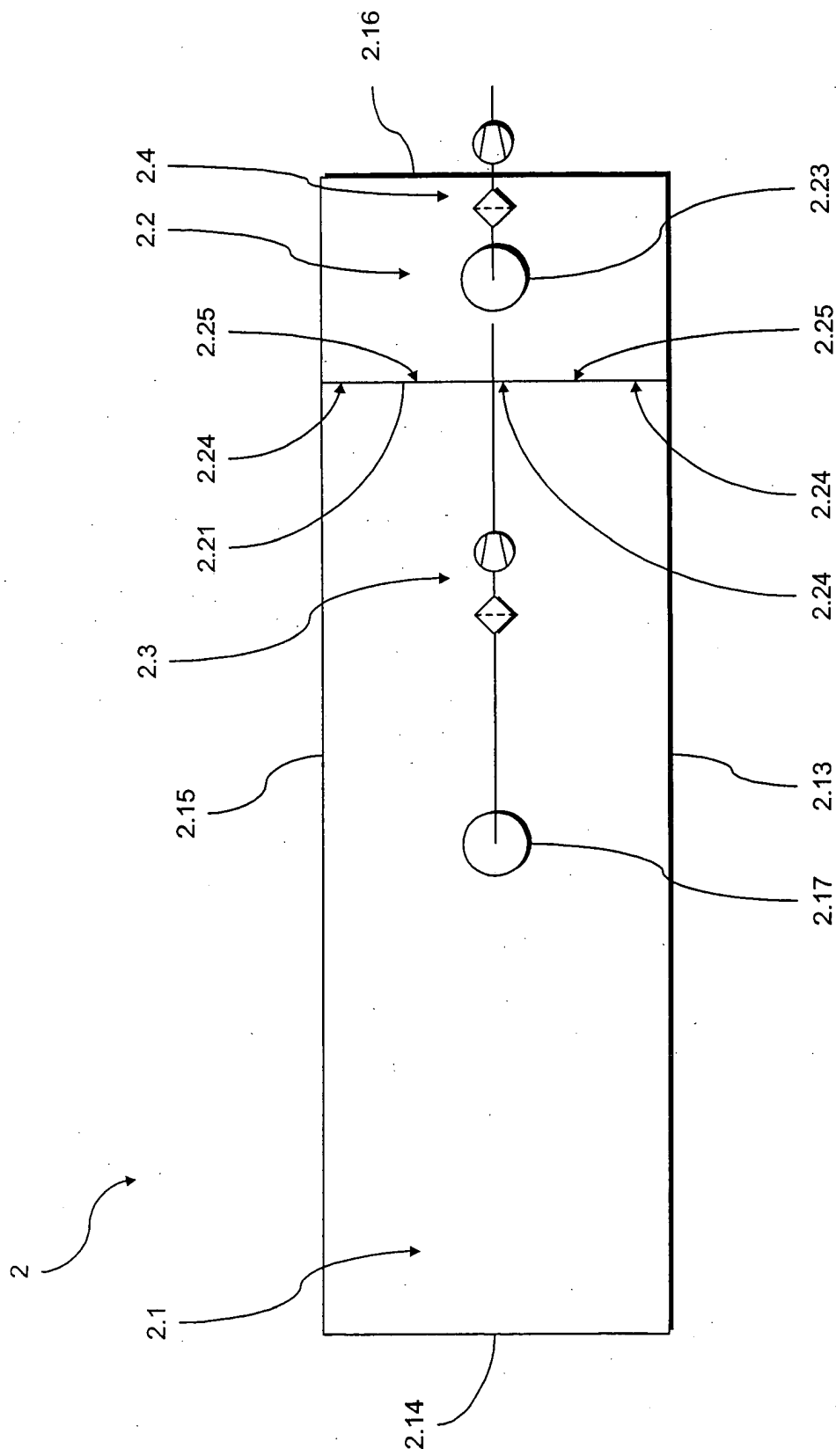


Fig. 3

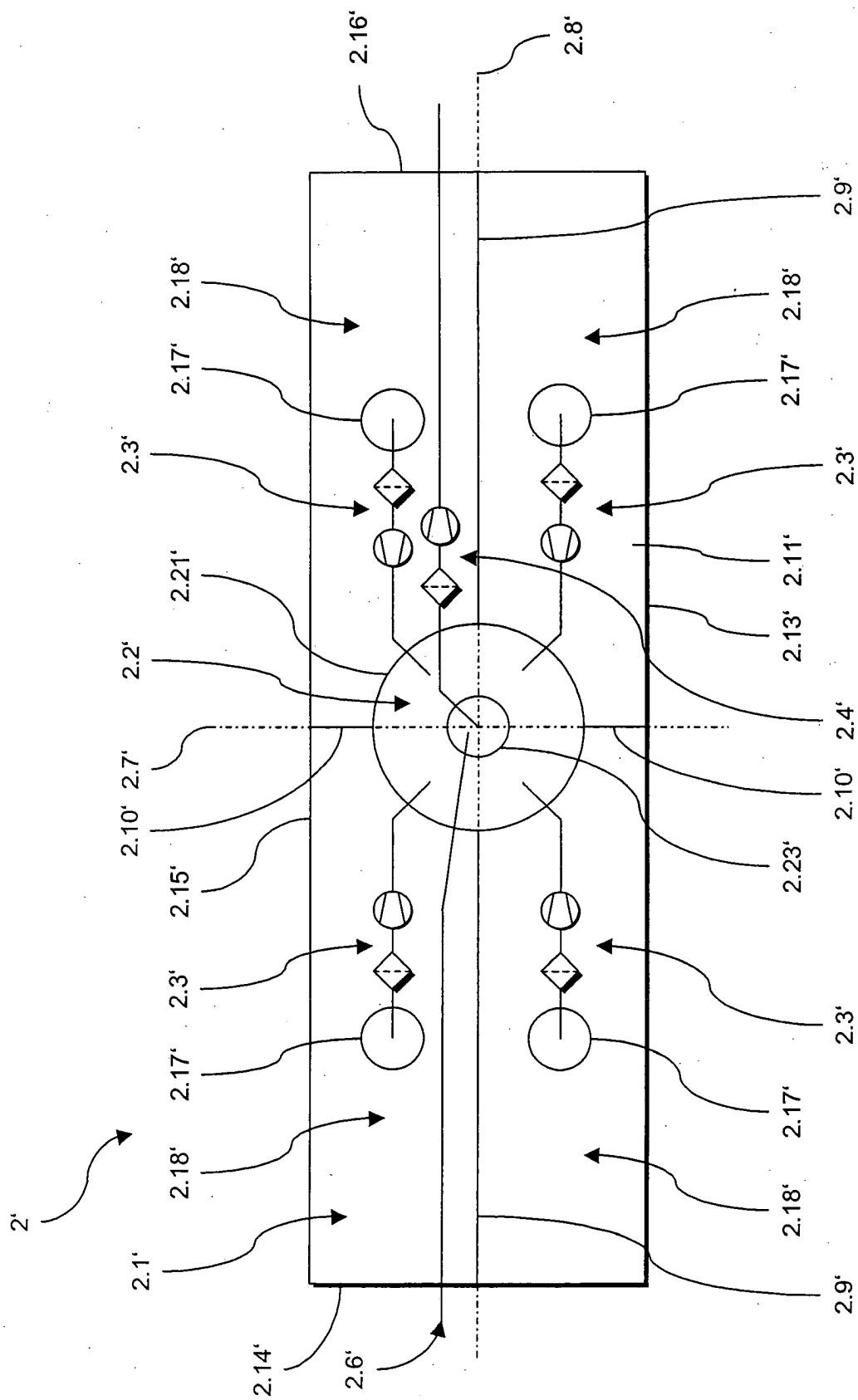


Fig. 4



European Patent
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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 Munich		Date of completion of the search 8 September 2005	Examiner Fuchs, A
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