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Starck et al.(10) **Pub. No.: US 2010/0064670 A1**(43) **Pub. Date: Mar. 18, 2010**(54) **REDUCTANT SUPPLY SYSTEM FOR A
WASTE GAS CLEANING CATALYST AND A
HEATING UNIT THEREFOR**(75) Inventors: **Roland Starck**, Bellheim (DE);
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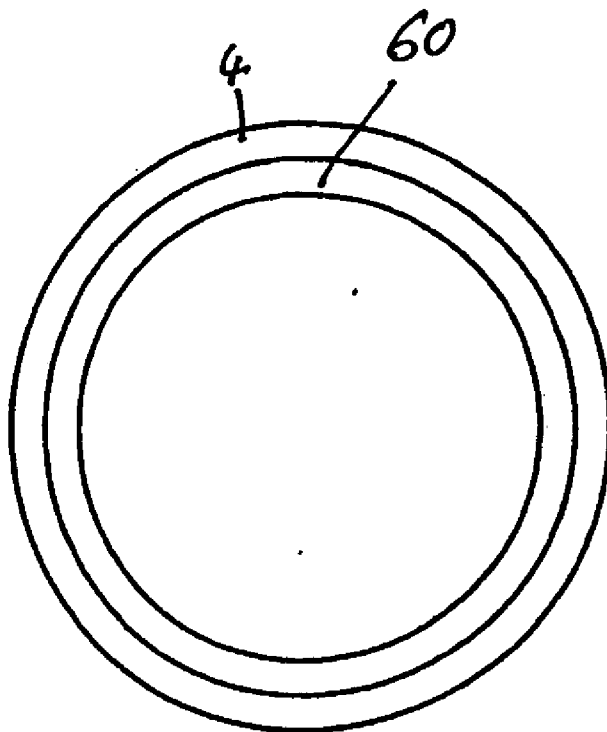
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The invention relates to a reductant supply system for a waste gas cleaning catalyst of an internal combustion engine, in particular of a vehicle, comprising a reductant tank (3) for the holding of reductant, a connection line (4, 5) in order to convey reductant from the reductant tank (3) to a waste gas cleaning catalyst (2), and a pump (6) to pump reductant from the reductant tank (3) to the catalyst (2). According to the invention it is provided that at least one section of the connection line (4, 5) is configured as a corrosion-resistant metal pipe being provided with electrical terminal lugs (10, 11, 12, 13) in order to convey an electrical heating current through the connection line (4, 5) for the defrosting of reductant. The invention relates further to a heating unit for such a supply system, comprising a corrosion-resistant metal pipe (4) for immersion into the solution, which pipe can be attached to the pump (6) as intake pipe for the conveyance of the defrosted solution, and at which are affixed terminal lugs (10, 11) for the conveyance of a heating current through the metal pipe (4), which current heats up the metal pipe (4) for the defrosting of solution.



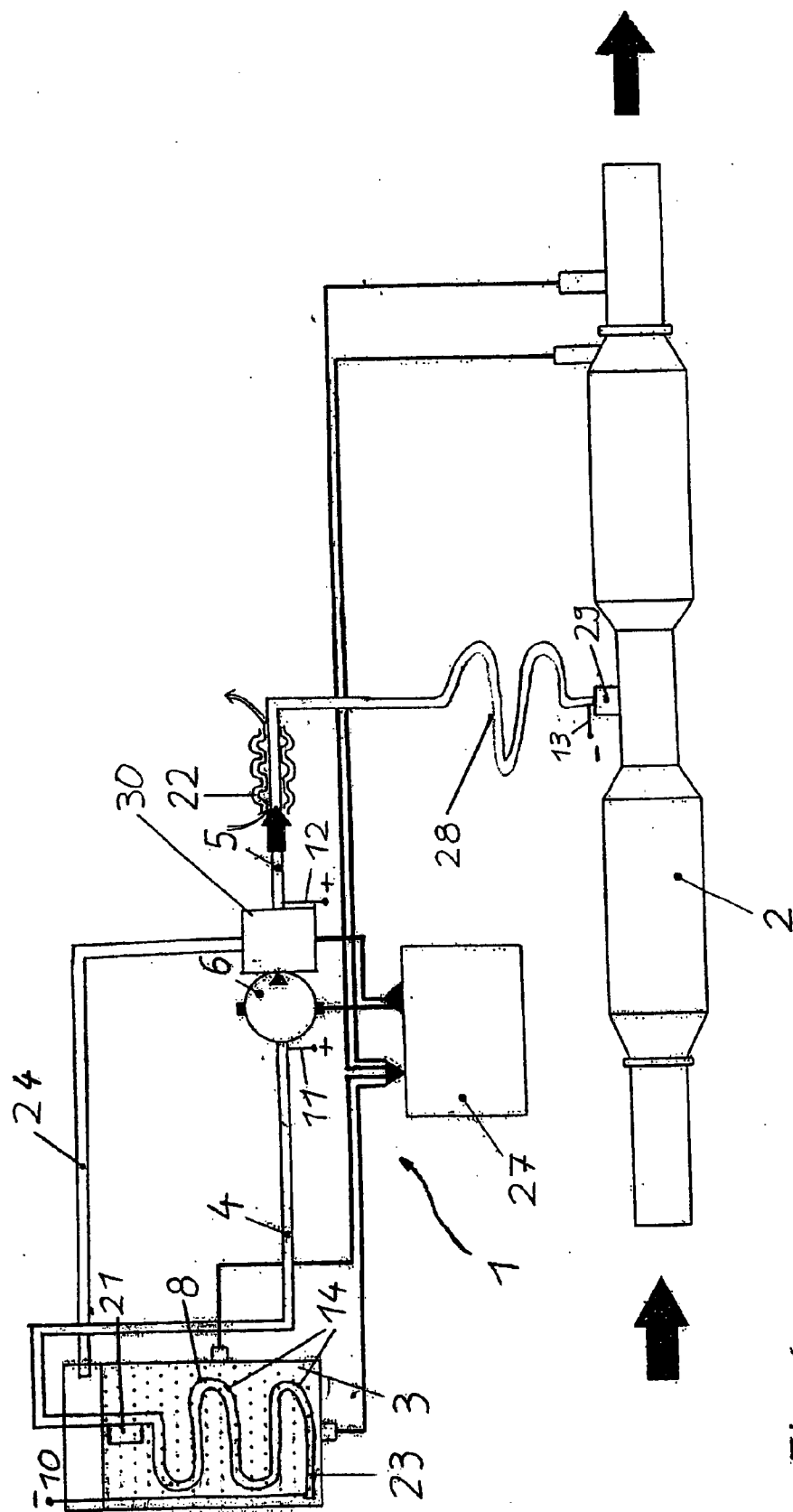


Fig. 1

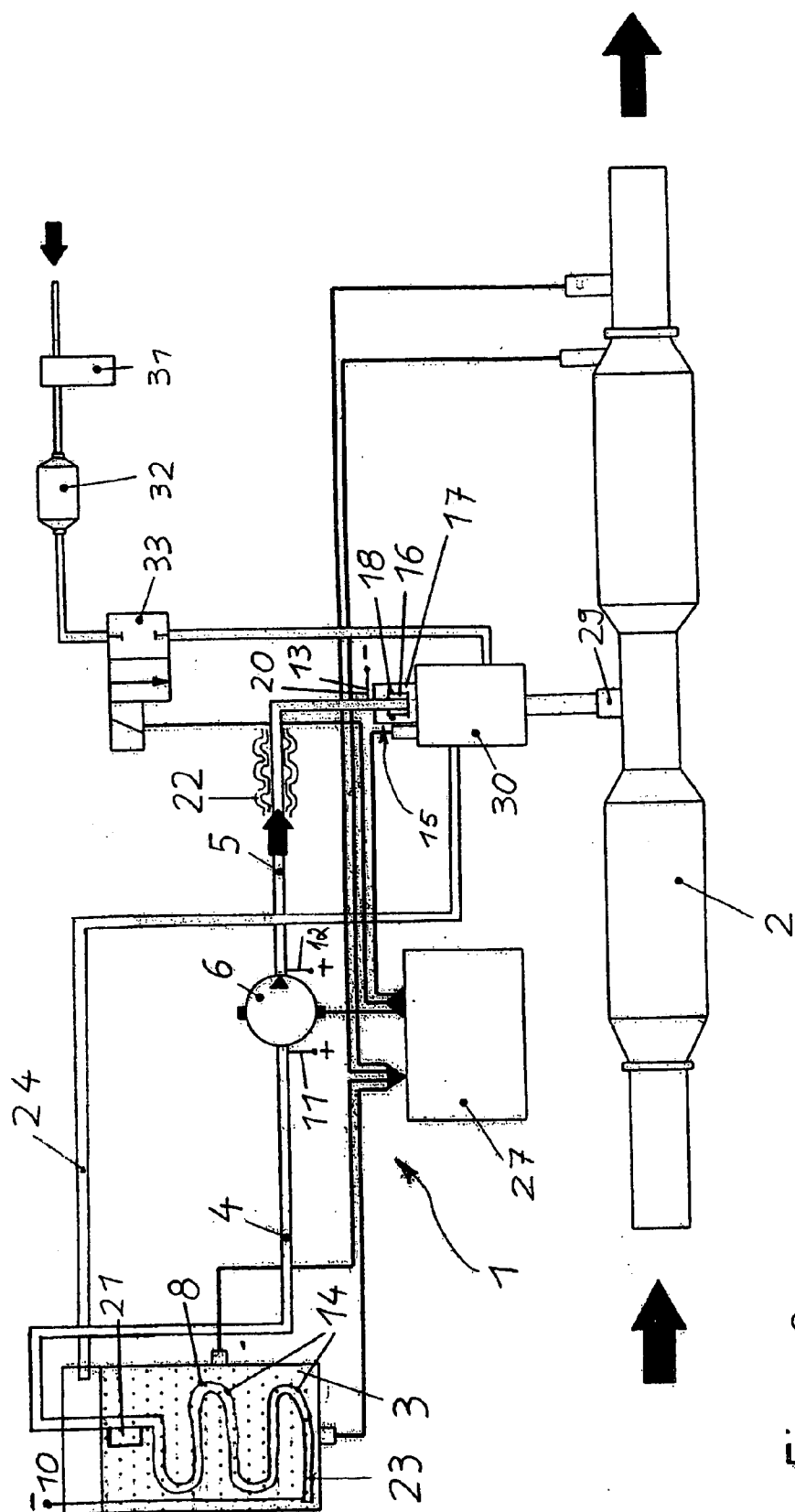


Fig. 2

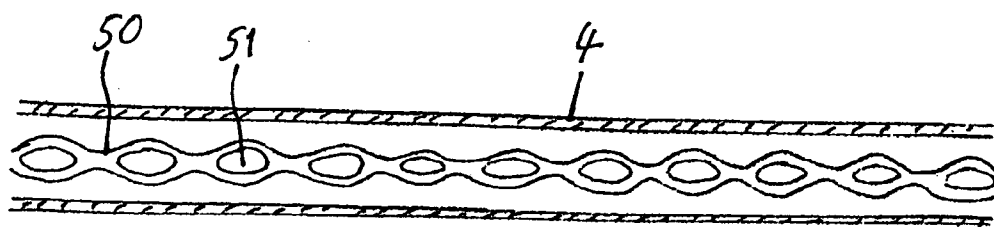


Fig. 3

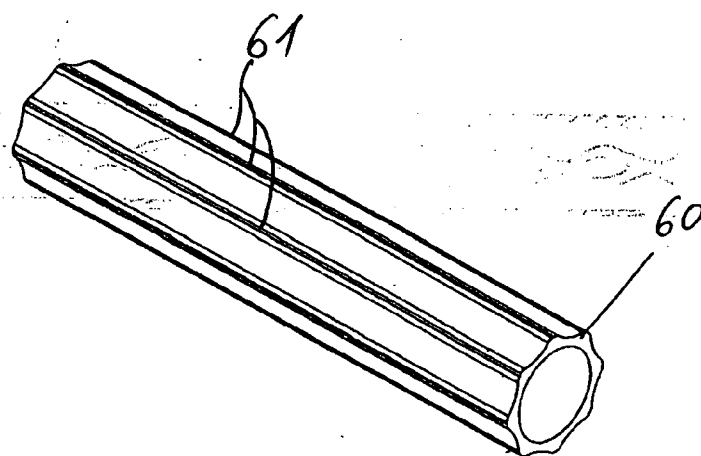


Fig. 5

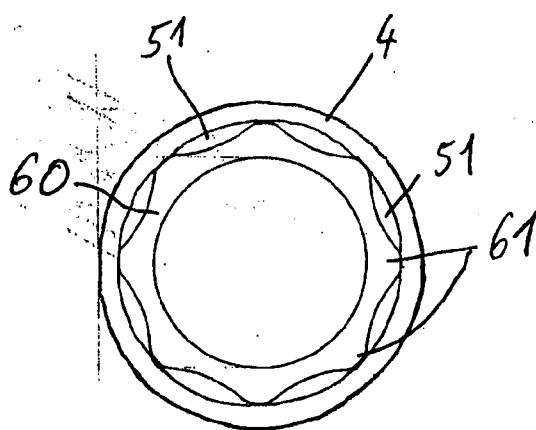


Fig. 4

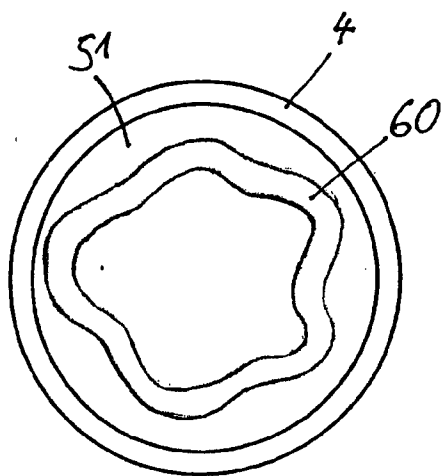


Fig. 6

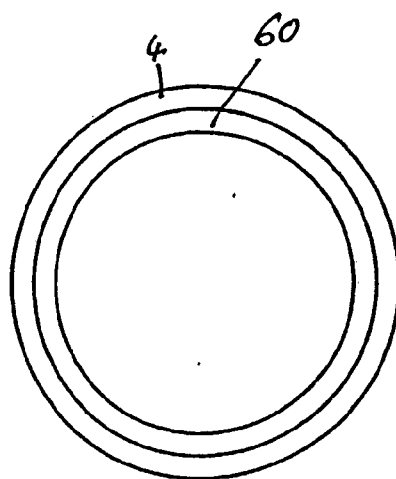


Fig. 7

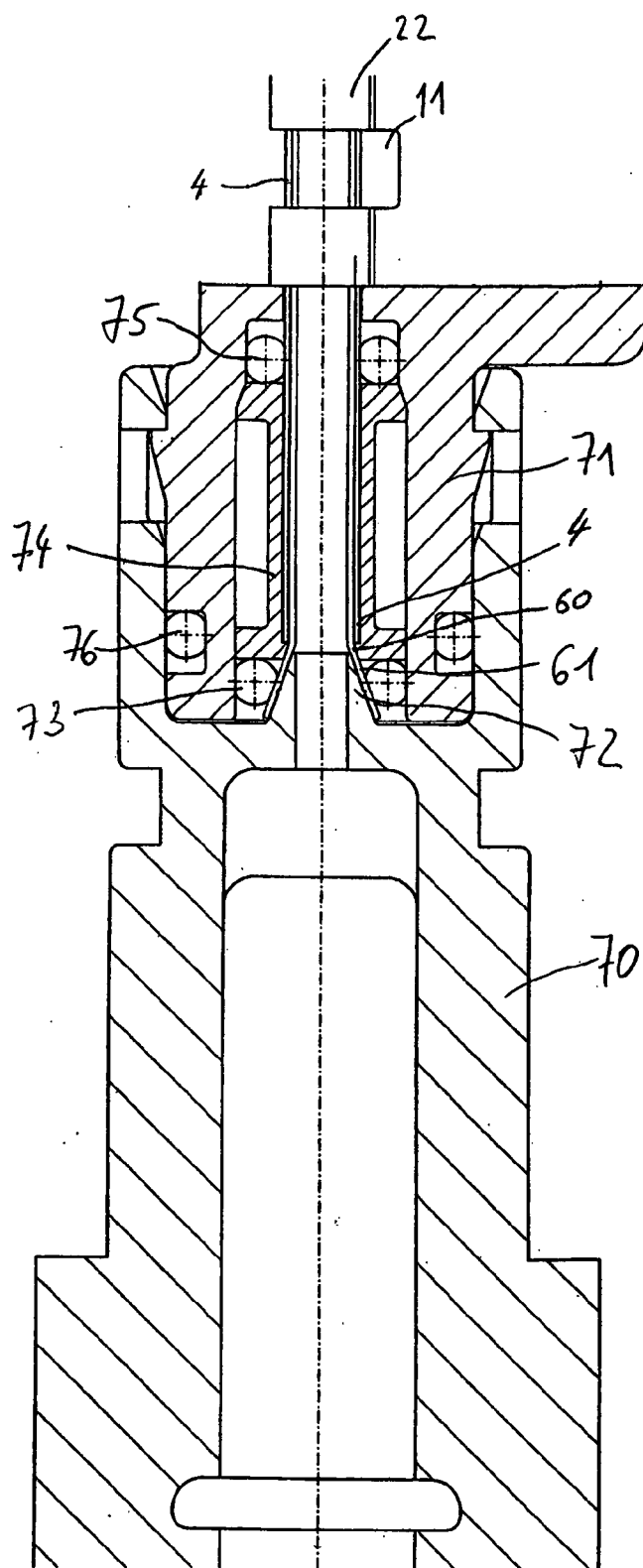


Fig. 8

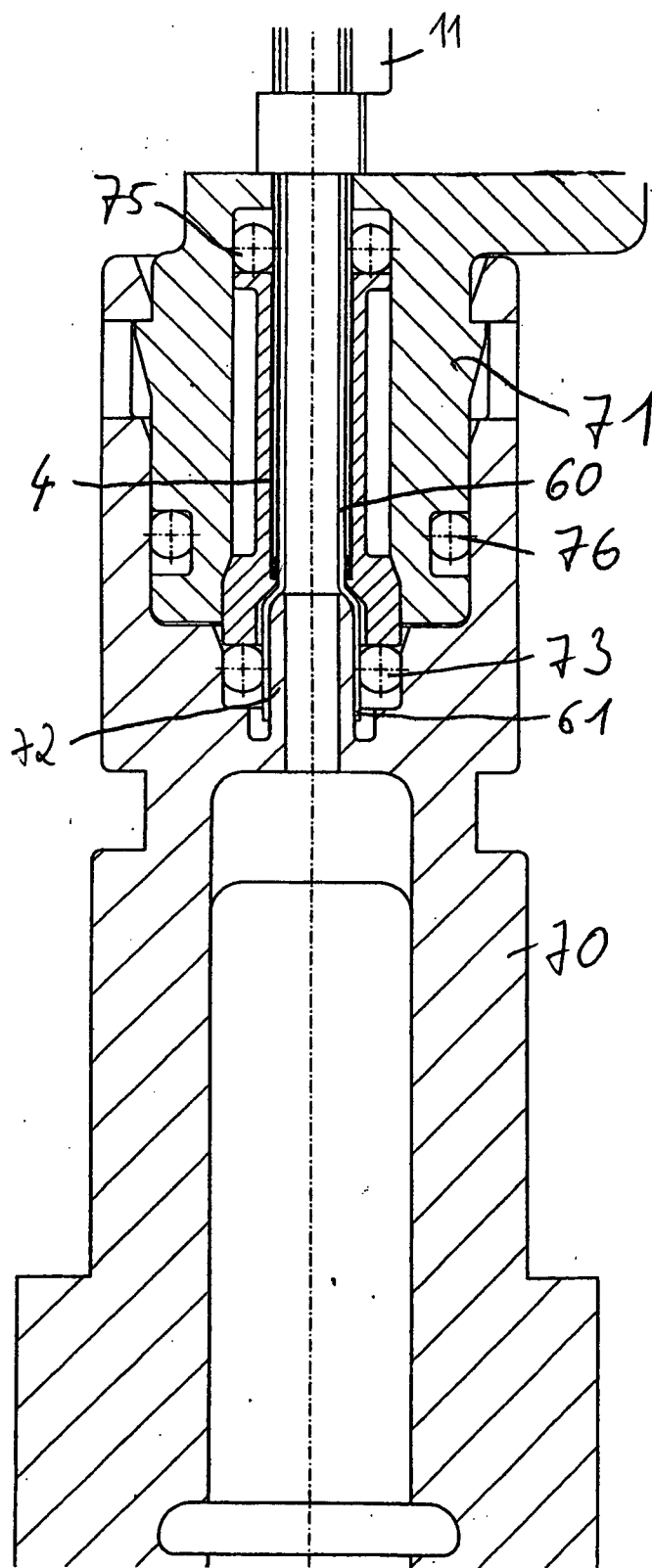


Fig. 9

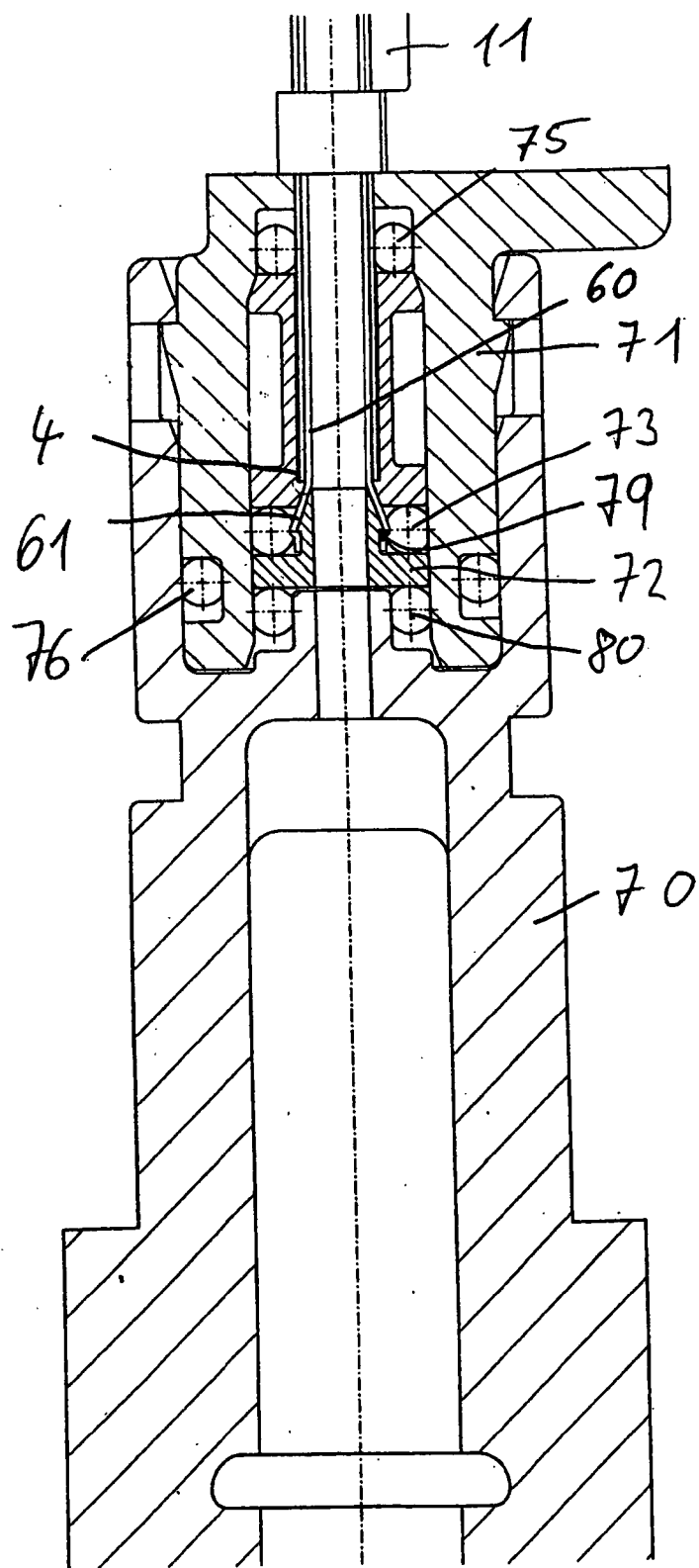


Fig. 10

**REDUCTANT SUPPLY SYSTEM FOR A
WASTE GAS CLEANING CATALYST AND A
HEATING UNIT THEREFOR**

[0001] The invention relates to a reductant supply system for a waste gas cleaning catalyst, usually installed as a standard feature in vehicles. Such a supply system comprises a reductant tank for holding reductant, a connection line to convey reductant from the reductant tank to the waste gas cleaning catalyst, and a pump to pump reductant via the connection line from the reductant tank to the catalyst. Such a reductant supply system is disclosed in DE 103 32 114 A1, for example.

[0002] In the waste gas cleaning catalyst nitrogen oxides are reduced to nitrogen by means of the reductant. Ammonia, which is obtained from urea, is usually used as reductant. Thus, within the intent of the application, under reductant must also be understood its initial product, e.g., urea from which in the chemical sense is obtained the actual reductant, e.g., ammonia.

[0003] A waste gas cleaning catalyst requires urea as its ammonia supplier. Since urea can freeze in the case of frost, a heating unit is required to defrost the urea solution as rapidly as possible so that the urea required for the catalyst's operation is available.

[0004] The object of the invention is to show a cost-effective manner in which at temperatures below freezing a reductant supply system for a waste gas cleaning catalyst of an internal combustion engine can be quickly brought into an operational state.

[0005] According to the invention, this object is solved by means of a reductant supply system of above mentioned type wherein at least one section of the connection line is configured as a corrosion-resistant metal pipe, preferably out of high-grade steel, which is provided with electrical connections in order to convey via the connection line an electrical heating current for the defrosting of reductant.

[0006] The object is further solved by a heating unit comprising a corrosion-resistant metal pipe to be immersed into the solution, which pipe can be attached to a pump as an intake pipe for the conveying of the defrosted solution and being provided with electrical connections to convey a heating current through the metal pipe, which current heats said pipe for the defrosting of solution.

[0007] Because urea is usually used for waste gas cleaning catalysts of internal combustion engines, to explain the invention, reference is made hereinafter to a urea supply system and instead of the general term "reductant" the word urea is used.

[0008] According to the present invention, in a urea supply system is used a corrosion-resistant metal pipe both as a resistance heating element for the defrosting of urea solution and as conduit for the conveyance of defrosted urea solution. In such a manner, a separate heating insert is superfluous and frozen urea solution can be defrosted with a minimum of effort.

[0009] Because according to the present invention, the metal pipe is used both as resistance heating element as well as a conduit, except for the electrical connections for supplying the heating current, no additional components are required in order to ensure, even at temperatures below freezing, the operation of the urea supply system. Compared with solutions with separate heating inserts, which are more or less

assembled in a complex manner, the invention is not only more cost-effective but it also functions in a more reliable manner because due to fewer utilized components there is also a correspondingly lower number of possible sources of defects.

[0010] Another advantage of the invention consists in that with very little effort the heating unit can be adapted to any shape of a urea tank by an adequate bending of the metal pipe. As a rule, in each new model of a passenger vehicle, the shape of the utilized urea tank is adapted to modified spatial conditions. While in the case of urea supply systems with a separate heating insert, the construction of the heating insert must be frequently changed at great expense, in the case of the invention the adapting to a different geometry can be effectuated by means of a correspondingly modified bending of the metal pipe. In particular, the heating power of the metal pipe can be specifically directed to each of the areas of the urea supply system that, as matter of priority, must be defrosted in order to supply the waste gas cleaning catalyst or that contain larger quantities of urea solution requiring thus a greater heating power. By way of example, the metal pipe can extend into the urea tank and be arranged there in several coils such as, e.g., a spiral or a helix. In such a manner, the heating power can be concentrated in the bottom area of the tank, into which extends the intake opening, so that rapidly a small but sufficient amount of urea solution can be drawn off. In particular, the metal pipe can be arranged in a defrosting vessel of very limited capacity separated from the main tank, so that its contents can be defrosted rather quickly.

[0011] By virtue of its relatively low mass, it is possible to heat up the metal pipe very quickly. Thus, the defrosting of urea solution in the connection line requires considerably less time than for the defrosting of urea solution in the urea tank. Thus, it is preferred to first concentrate the power of a car battery only at a section of the connection line that extends into the urea tank. Preferably, only a later time, when some urea has been defrosted, will the connection line be heated along its entire length.

[0012] Using a metal pipe as connection line of a urea supply system has the additional benefit that, unlike hose, it does not hang down. Therefore it is easier to install because, to a great extent, additional measures to fasten it at a desired spot become superfluous. Furthermore, the metal pipe can be used as pressure line so that urea solution can be injected into the catalyst at a pressure of, e.g., 5 to 6 bars. Preferably, the metal pipe has an outside diameter of less than 3 mm and a wall thickness between 0.1 mm and 0.3 mm so that, when being installed, it can be easily bent to the desired shape.

[0013] Further details and advantages of the invention are explained by embodiments with reference to the accompanying drawings. The therein described features can be used either separately or combined to create preferred embodiments of the invention. Herein:

[0014] FIG. 1 shows a schematic representation of a urea supply system according to the invention for a waste gas cleaning catalyst of a vehicle;

[0015] FIG. 2 shows another embodiment of a urea supply system according to the invention;

[0016] FIG. 3 shows a longitudinal view of a connection line of the embodiment;

[0017] FIG. 4 Shows a cross-section of another embodiment of a connection line with inserted hose;

[0018] FIG. 5 shows a diagonal view of the tube illustrated in FIG. 4;

[0019] FIG. 6 shows a cross-section of another embodiment of a connection line with the inserted hose;

[0020] FIG. 7 shows the embodiment illustrated in FIG. 6 in another operating state;

[0021] FIG. 8 shows an embodiment of the coupling of the connection line to a fitting;

[0022] FIG. 9 shows another embodiment of the coupling of the connection line to a fitting;

[0023] FIG. 10 shows another embodiment of the coupling of the connection line to a fitting.

[0024] FIG. 1 shows schematically a urea supply system 1 of a waste gas cleaning catalyst 2 of a vehicle. In the waste gas cleaning catalyst 2 nitrogen oxides (NO , NO_2) are reduced to nitrogen by means of ammonia (NH_3). For this, the required ammonia is obtained from urea solution which is provided by the urea supply system 1.

[0025] The urea supply system 1 illustrated in FIG. 1 comprises a urea tank 3 for the holding of urea solution, a connection line 4, 5 that links the urea tank 3 with the catalyst 2, and a pump 6 with a dosing valve 30 in order to pump urea solution through the connection line 4, 5 from the urea tank 3 to the catalyst. The connection line 5 ends in a nozzle 29 by means of which urea solution is injected into the catalyst 2. The illustrated urea supply system 1 also comprises a control unit 27 to control its components.

[0026] FIG. 2 illustrates another embodiment, in which the dosing valve 30 is connected to a pressurized air system, comprising an air supply 31, an air compressor 32 and a control valve 33. The dosing valve 30 opens into the nozzle 29, so that the injecting of urea solution into the catalyst 2 is effectuated by means of pressured air.

[0027] Since in the case of frost, urea solution can freeze and it must then be defrosted before the required urea can be made available to the catalyst 2. Thus, the illustrated urea supply system 1 comprises a heating unit for the defrosting of urea solution. This heating unit 8 is made an integral part of the connection line 4, 5.

[0028] The connection line 4, 5 is configured as a metal pipe out of high-grade steel, preferably out of V4A steel, at which are affixed terminal lugs 10, 11, 12, 13 to convey heating current through the metal pipe 4, 5 to heat it up for the defrosting of solution. The metal pipe 4 extends as intake pipe with one of its ends 23 into the urea tank 3 and is there arranged in several coils 14 that, as intended, immerse into the urea solution so that in the urea tank 3 a correspondingly large portion of the heating power released by the metal pipe 4 is available for the defrosting of urea solution. In such a manner, the metal pipe 4 advantageously effectuates in a satisfactory manner not only the function of a resistance element to defrost urea solution but also that of an intake pipe for the conveyance of urea solution.

[0029] In the illustrated embodiment, the connection line 4, 5 consists of two sections between which are installed the pump 6 and the dosing valve 30. Each of the metal pipes 4, 5, that constitute these sections, is provided with a terminal lug 11, 12 at its end facing the pump 6 which, as intended, is connected to the positive pole of a car battery. In such a manner, it is obtained that the urea solution on its path through the pump 6 and the dosing valve 30 does not pass through an electrical potential difference and, therefore, the possibility of an undesired electrolysis is practically precluded.

[0030] Each of the other ends of the two sections 4, 5 of the connection line are provided with another terminal 10, 13 which, as intended, is connected to the negative pole of the car

battery. Thus, the connection line 4, 5 is heated in a beneficial manner along its entire length, including its end sections. Attention has to be paid that the terminal 10 affixed at the end of the metal pipe 4, extending into the urea tank 3, is corrosion-resistant so that it will not be attacked by urea solution. Preferably, the terminal 10 leads out of the tank 3 through an upper aperture. In order to increase the mechanical stability, the terminal 10 and the coils 14 can be connected to a plastic support, e.g., a support frame.

[0031] Preferably, the electrical resistance of the metal pipe 4 is chosen in such a manner that, because of the heating current, a heating power of at least 30 Watts is released in the section extending into the urea tank 3. Especially beneficial is an electrical resistance of such a magnitude that between the terminal lugs 10, 11 of the metal pipe 4 a heating power of 50 to 300 Watts, preferably 80 to 150 Watts, is released. Thus, with a customary car battery's distribution voltage of 13.5 V, high-grade steel, especially V4A steel, is particularly suitable as material for the connection line 4, 5 because of its relatively low electrical conductivity. In view of the typical conveyance capacity of a urea supply system 1 and the required heating powers, the metal pipe 4, 5 has preferably an inside diameter between 1.5 and 3 mm, especially preferred between 1.8 and 2.5 mm. In the case of the illustrated embodiment, the inside diameter is 2.0 mm. The wall thickness is preferably between 0.1 and 0.3 mm, while in the illustrated embodiment it is 0.2 mm, so that the pipe can be easily bent during assembly and has a relatively high electric resistance. Such slight wall thicknesses and diameters result in a relatively low total mass of the metal pipe 4, 5 and, thus, to short heating-up times.

[0032] At the start-up of the urea supply system, by means of the control unit 27 it is possible to concentrate the power delivered by the car battery at first on the metal pipe 4, so that urea solution in the urea tank defrosts as rapidly as possible. In view of the relatively low mass of the connection line 5, the therein contained urea solution can be rapidly defrosted, so that it suffices to use only at a later time the power delivered by the car battery for the heating of the metal pipe 5.

[0033] In order to throttle the conveyance capacity of the urea supply system 1 for a given application, the cross-section of the metal pipe 4, 5 can be reduced at any point by deformation. Advantageously, the length of the metal pipe and its other parameters remain unchanged with such action so that its total electric resistance and, thus, the heating power continue being the same.

[0034] In the illustrated embodiment, the connection line 5 has a total length of about 4 meters. In order to simplify the assembly, the metal pipe constituting the connection line 5 can be assembled by several sections by means of a plug-in coupling. In order to connect the metal pipes 4, 5 to the pump 6, the dosing valve 30 and the nozzle 29 they are provided at their corresponding ends with an appropriate connecting coupling 15 which, by way of example, is illustrated in FIG. 2. By way of example, it can be configured as a metal sleeve to be slipped on, provided with electrical contacts. Another possibility would be to use a welded-on fitting as the connecting coupling, configured as a bushing 16 to enlarge the diameter, that is encased in a molded-on plastic cap 17 with an O-ring seal 18. By way of example, the terminal 13 can be constituted by an electrical connecting lug 20 that is preferably arranged immediately ahead of the molded-on cap. It is also possible to use a prefabricated circular connector.

[0035] It is beneficial to provide the connecting coupling 15, preferably on the catalyst side, with a vibration element in

order absorb the vibrations of the vehicle. By way of example, an appropriate plastic element or an expansion bellows can be used for this purpose. Preferably, the connection line 5 itself is configured as a vibration element, i.e., by means of coils 28 ahead of the point of connection. It would be beneficial to attach the metal pipe 5 directly to the nozzle 29, as illustrated in FIG. 1.

[0036] As protection against overheating, at the metal pipe 4 is attached a temperature sensor 21 so that in the case of an overheating a corresponding decrease of the heating current is effectuated. Preferably, the temperature sensor 21 is configured as a PTC element (positive temperature coefficient) or as a NTC element (negative temperature coefficient). A PTC element is a PTC resistor whose electric resistance increases drastically with a temperature rise, while the electric resistance of a NTC element decreases greatly with a temperature increase. However, through an appropriate design of the heating power it can be obtained that an overheating is precluded and that, therefore, it is not necessary to monitor the temperature. Another possibility to prevent an overheating consists in manufacturing the metal pipe 4, 5 out of a PTC material.

[0037] For electric insulation, the metal pipe 4, 5 can be coated inside and/or outside with a coat of lacquer or plastic, by way of example PVDF. In the illustrated embodiment, however, the connection line 5 is protected between the pump 6 and the waste gas cleaning catalyst 2 by an outside pipe, in the illustrated embodiment a finned tube 22 (shown only partially), that advantageously provides not only electric and thermal external insulation but also gives rise to a good mechanical protection. Polypropylene is the preferred material for the finned tube 22.

[0038] The external tube 22 can further be used for an additional heating so that frozen urea solution can be defrosted with a lower current consumption. For this, between the external tube 22 and the metal pipe 5 is conveyed a heated fluid, especially a fluid heated by the waste heat of the internal combustion engine such as, e.g., waste gas. The illustrated reduction supply system is therefore provided with a fluid inlet and a fluid outlet that are attached at the external tube 22 so as to convey fluid heated by the waste heat of the internal combustion engine between the external tube 22 and the metal pipe 5. In this connection, an especially effective heat exchange is effectuated because the inside pipe 4, 5 is a metal pipe.

[0039] As mentioned earlier, high-grade steel, especially V4A steel, is preferably used as material for the connection line 4, 5. V4A steel is sufficiently corrosion-resistant so that it is not attacked by urea solution. In principle, the metal pipe constituting the connection line 4, 5 can be also manufactured out of less corrosion-resistant metals or metal alloys, if because of an appropriate corrosion-resistant protective layer a detrimental effect of the urea solution can be precluded.

[0040] In the herein illustrated embodiments, a return line 24 branches off the connection line 5, by means of which defrosted urea solution can be conveyed back to the urea tank 3. In such a manner, one can counteract the forming of an insulating air gap between the intake pipe 23 and frozen urea solution in the urea tank 3. According to the invention, a heating of the return line 24 is possible but not necessary, so that it does not have to be absolutely configured as a metal pipe and, e.g., can also be a plastic tube. Preferably, metal pipes with different inside diameter should be utilized for the

various sections of the connection line 4, 5, in order to optimize the heating power and the conveyance volume for different sections.

[0041] In the embodiment shown in FIG. 1, the spatial proximity to the heated components of the urea supply system 1 (metal pipe 4, pump 6) cause a simultaneous heating of the return line 24.

[0042] In the case of frost, the urea solution in the connection line 4, 5 can freeze and, because of the thereto resulting increased volume of approximately 7%, it can damage or even burst the connection line 4, 5. In order to prevent such frost damages, metal pipes not having a round cross-section, but preferably an oval or elliptical one, can be used. When urea solution freezes in a metal pipe 4 with such a cross-section, the thereby generated volume expansion leads to that the cross-section of the metal pipe comes close to a circular form or even reaches it. In such a manner, the cross-sectional surface of the metal pipe 4 and therefore the inside volume of the connection line 4, 5 can adapt themselves in the case of frost, so that bursting is prevented.

[0043] Preferably, for the metal pipe 4 is chosen a material, e.g., spring steel, that is elastic to such an extent that, when being defrosted, said metal pipe 4 returns to the greatest possible extent to its original shape. In principle, however, such elastic properties of the metal pipe 4 are not necessary because the connection line 4, 5 is usually emptied before the urea supply system 1 and the thereto belonging heating unit are disconnected. A freezing of urea solution in the connection line 4 can then occur only in the case of a malfunction, the effects of which, in the case of the described embodiments, can be intercepted in a non-destructive manner.

[0044] Preferably, in order to prevent the described frost damages, however, another measure is applied that is hereinafter described by means of FIG. 3. FIG. 3 shows a longitudinal view of a connection line 4, 5 of the urea supply system 1 described in FIGS. 1 and 2. A volume-elastic equalizer 50 is arranged in the metal pipe 4 constituting the connection line which, in the case of a freezing of surrounding urea solution, is compressed in order to compensate for a volume expansion of the urea solution. In the illustrated embodiment the equalizer 50 is a tube with gas-filled chambers 51.

[0045] For this, the chambers 51 are configured by a sectional welding of an originally continuous hollow hose. It is also possible to link separate volume-elastic elements such as, e.g., balls by means of an elastic stocking and to insert them as equalizer 50 into the connection line 4, 5.

[0046] By way of example, as equalizer 50 can also be used closed hollow fibers or foamed materials. Appropriate foamed materials can be manufactured, in particular, out of thermoplastics whereby attention must be paid only that some of the cells of the foamed materials are closed-cells so that they assume the function of the gas-filled chambers of the tube illustrated in FIG. 3, and that they can be compressed by the ice pressure caused by the freezing of urea solution.

[0047] In order to prevent frost damages, it suffices to arrange the volume-elastic equalizer in a section of the metal pipe 4. It is not necessary that it extends over the entire length of the connection line 4, 5.

[0048] In view of the foregoing it results that especially a gas-filled chamber 51 can be used as a volume-elastic equalizer. Such a gas-filled chamber 51 can be arranged in a compensating means such as, e.g., the hose 50 of FIG. 3 that is inserted into the metal pipe 4. However, it is also possible to configure the chamber 51 as a gap between the inside of the

connection line 4, 5 and the outside of a tube 60 arranged in the connection line 4, 5, that conveys urea solution during operation. In this respect it is important that the compressing of the gas-filled chamber 51 does not necessarily bring about an increased gas pressure in the chamber 51. Namely, if the gas-filled chamber 51, according to FIG. 4, is configured as a gap between the inside of the metal pipe 4, 5 and the outside of a therein arranged tube 60 that conveys the fluid, at the compression of chamber 51, pressure compensation is possible via the pipe ends of the metal pipe 4, 5. In such a case, to compensate for a volume expansion of the freezing fluid, the elastic properties of the chamber walls formed by the tube 60 are decisive for the compression of the chamber 51. At a volume expansion of the freezing fluid, the chamber walls formed by the tube 60 warp, causing a decrease of the volume of chamber 51.

[0049] FIG. 5 illustrates an embodiment of a suitable tube 60. FIG. 4 illustrates a cross-section of a connection line 4, 5 with therein inserted tube 60. Appropriate materials for the compensating means, in particular for the tube 60, are, e.g., thermoplastics under which, within the scope of the invention, must also be understood thermoplastic elastomers. In particular, polyamide, polyethylene and polypropylene are well suited. Especially well suited are fluorocarbon polymers, in particular modified irradiated fluorocarbon polymers such as, e.g., polyvinyl difluoride.

[0050] Between the tube 60, as compensating means, and the connection line 4 are formed gas-filled chambers 51 as volume-elastic compensating means, which are illustrated in FIG. 4. The tube 60 is provided with ribs 61 on its outside with which it lies against the inside of the metal pipe 4, so that air-filled chambers 51 are delimited by the ribs 61. Preferably, the ribs 61 are longitudinal ribs because this would facilitate a cost-effective manufacture of the tube by extrusion. In principle, the ribs 61 at the outside of the tube 60 could also be superfluous because even with the use of a smooth tube, having a suitable diameter, a gap as a gas-filled filled chamber can be created between a fluid-conveying tube and the metal pipe of the connection line 4, 5. As an additional measure, when disconnecting the reductant supply system, one or several gas-filled chambers 51 can be filled with a fluid, especially compressed air, in order to press, e.g., reductants from the supply line into the urea tank 3.

[0051] A cross-section of such an embodiment is schematically illustrated in FIGS. 6 and 7. FIG. 6 shows the metal pipe 4 of the supply system with the internal tube 60 through which reductant flows while in operation. Between the tube 60 and the metal pipe 4 is a gas-filled gap 51 constituting, as an air-filled chamber, a volume-elastic compensating means. In the embodiment illustrated in FIG. 6, after a disconnecting of the reductant supply system, the gap 51 was filled with compressed air. Because during operation, there is no fear of a freezing of the reductant, the compressed air can be released from the gap 51. As a result, the operating pressure of the reductant flowing through the tube 60 causes that the tube 60 lies against the inside of the metal pipe 4 and that the gap 51 disappears.

[0052] An important aspect of the present invention which, independently, can also be of importance relates thus to a reductant supply system, protected against frost damages, for a waste gas cleaning catalyst of an internal combustion engine, in particular of a vehicle, comprising:

[0053] a reductant tank 3 for the holding of reductant;

[0054] a connection line 4, 5 to convey reductant from the reductant tank to a waste gas cleaning catalyst;

[0055] a pump 6 to pump reductant via the connection line 4, 5 from the reductant tank 3 to the catalyst 2

wherein a volume-elastic equalizer 50 is arranged in the connection line 4 which, in the case of a freezing of the reductant in the connection line, is compressed in order to compensate for a volume expansion of the reductant. In principle, such a reductant supply system can be heated also in another manner than by the passing of an electric heating current through a connection line 4, 5 configured as a metal pipe.

[0056] In order to compensate a volume expansion of the reductant, in the case of a freezing of the reductant in the connection line 4, 5, the connection line 4, 5, as compensating means, can contain as an alternative, deviating from the circular cross-section or the described volume-elastic equalizer 50, flexible chambers which, by way of example, are incorporated into joints with which the connection line 4, 5 is connected to the urea tank 3, the dosing valve 30, the nozzle 29, or the pump 6. By using suitable flexible synthetic materials for these joints, there can be effectuated an adapting of the volume of the connection line 4, 5 by means of a change in the length of the joints of the connection line 4, 5 or an expansion of a corresponding chamber.

[0057] The use of a urea-conveying tube 60 as compensating means in the connection lines 4, 5 has the advantage that additional measures for the insulating of the metal pipe 4, 5 with respect to the fluid (urea solution) to be heated are no longer necessary because the tube 60 constitutes both an electric as well as material insulation. Instead of a relatively expensive high-grade steel for the metal pipes 4, 5 cost-effective, less corrosive-resistant metals can be used for the connection lines. However, when using a urea-conveying tube 60 in the connection line 4, 5 attention must be paid that at the tie-in points of the connection line no reductant seeps into the gas-filled gap(s) 51 between the outside of the tube 60 and the inside of the metal pipe 4, 5. By means of FIGS. 8 to 10, hereinafter are explained some embodiments for a suitable coupling of the connection line 4, 5 to, e.g., the pump 6.

[0058] FIG. 8 shows a cross-section of the coupling of the electrically heated connection line 4 to a fitting 70 such as, e.g. the pump 6. The metal pipe 4 is encased in an outer insulating plastic tube 22 and bears a terminal lug 11. The metal pipe 4 extends with the therein arranged fluid-conveying tube 60 into an internal fitting 71 that is interlocked with the outer fitting 70. The tube 60 is pressed with its expanded tube end face 61, protruding from the metal pipe 4, to a conical shaped projection 72 of the fitting 70. In the illustrated embodiment, the end face 61 of the tube 60 is pressed against the projection 72 by means of a seal 73 such as, e.g., an O-ring. This seal 73 is compressed between the fittings 70 and 71. This seal 73 transfers this pressure to the end face 61 of the tube, so that the latter is imperviously pressed against the projection 72.

[0059] In order to prevent that fluid can seep out in the case of damage to the tube 60, the connection line 4 is additionally encased by a seal 75, which in the case of the illustrated embodiment it is an O-ring, that is pressed by the fitting 71 against the connection line 4. The seal 75 is fastened by the fitting 74 in the position illustrated in FIG. 8. In order to increase safety, another seal 76, in the shape of an O-ring, is arranged between the fittings 70 and 71.

[0060] FIG. 9 illustrates another embodiment of the impervious coupling of the connection line 4. The essential difference between the embodiment illustrated in FIG. 9 and the embodiment illustrated in FIG. 8 is that the tube end face 61 is pressed against a cylindrically shaped mating connector 72 of the fitting 70 whereby the seal 73 is pressed into a groove of the fitting 70.

[0061] FIG. 10 illustrates another possibility for an impervious coupling of the connection line 4. The embodiment shown in FIG. 10 differs from the embodiment shown in FIG. 8 in that the mating connector 72 is pressed against the end face 61 of the tube 60, that it is provided with an undercut in order to improve the seat of the end face 61. It is difficult to realize the undercut 79 in a mating connector 72 incorporated in the fitting 70, as it is the case for the embodiments 8 and 9. Thus, in the embodiment illustrated in FIG. 10, the mating connector 72 is a separate element, that is clamped between the fittings 70 and 71 with the seals 73 and 80 configured as O-rings.

[0062] The above described invention can be used for the defrosting of any fluids. Thus, it relates to a heating unit, comprising a metal pipe 4 for the conveyance of the defrosted fluid, wherein the metal pipe 4 is provided with electrical terminal lugs 10, 11 in order to convey a heating current through the metal pipe 4, which heats the metal pipe 4.

[0063] An aspect of the above invention, explained by means of the various embodiments, consists in that a metal pipe is used not only for the conveyance of a fluid but also to convey a heating current to defrost the fluid. This aspect is also realized in the embodiment, described by means of FIGS. 4 and 5, in which the fluid is conveyed through a tube 60 arranged in the metal pipe 4. In the case of an eventual damage to the internal tube 60, the unit continues to be operational and merely the protection against frost is limited because fluid can penetrate into one or several of the chambers 51, so that a freezing of the fluid can cause damage to the metal pipe. Since plastic tubes can become damaged and leaky easier than metal pipes, this safety concerning the leaking of fluid is an important advantage of the above described invention.

[0064] Should this safety be disregarded and if one accepts an eventual leaking of fluid such as, e.g., if the connection lines 4, 5 of a urea system are manufactured as plastic tubes without impervious metal pipes, the installing of the connection line 4, 5 can be facilitated by metal heating elements that are arranged either on the inside or the outside which, on the one hand, impart upon the tube the advantageous dimensional stability of a metal pipe and, on the other hand, facilitate the heating up of the fluid inside the tube. By way of example, these heating elements can be configured as a slotted or perforated metal pipe, wherein the tube runs in heat-conducting contact. Particularly advantageous are slots or slotted holes in the metal pipe. In the case of a freezing of the fluid, the tube can expand in the slots of the metal pipe so that the volume expansion connected with the freezing can be absorbed. Furthermore, a plait metal pipe, in particular a high-grade steel plait pipe, which supports the tube either outside or inside, can be used.

1. A reductant supply system for a waste gas cleaning catalyst of an internal combustion engine, in particular for a vehicle, comprising:

a reductant tank (1) for the holding of reductant;
a connection line (4, 5) for the conveyance of reductant from the reductant tank (3) to a waste gas cleaning catalyst (2), and

a pump (6) to pump reductant via the connection line (4, 5) from the reductant tank (3) to the catalyst (2),

characterized in that at least one section of the connection line (4, 5) is configured as corrosion-resistant metal pipe that is provided with terminal lugs (10, 11, 12, 13) in order to convey an electric heating current through the connection line (4, 5) for the defrosting of reductant.

2. A reductant supply system according to claim 1, characterized in that the metal pipe (4, 23) extends into the reductant tank (3) wherein it is arranged in several coils (14).

3. A reductant supply system according to any of above claims, characterized in that the metal pipe (4, 5) is constituted by several sections by means of a coupling, especially a plug-in coupling.

4. A reductant supply system according to any of above claims, characterized in that the pump (6) is arranged between two sections of the connection line (4, 5), each of which is configured as a metal pipe and provided with terminal lugs (10, 11, 12, 13), wherein each of the terminal lugs (11, 12) closest to the pump (6) of the two metal pipes (4, 5) has the same voltage while in operation.

5. A reductant supply system according to any of above claims, characterized in that a section of the metal pipe (5) is encased by an external pipe (22) or tube.

6. A reductant supply system according to any of above claims, characterized in that a section of the metal pipe (5) is encased by a finned or corrugated tube (22) out of plastic.

7. A reductant supply system according to claim 5, characterized by a fluid inlet and a fluid outlet in order to convey between the external tube (22) and the metal pipe (5) a heated fluid, especially a fluid to be heated by the loss of heat of the internal combustion engine.

8. A reductant supply system according to any of above claims, characterized in that the connection line (4, 50) contains an equalizer (50, 51, 60) in order to compensate, in the case of a freezing of the reductant, for a volume expansion of the reductant in the connection line (4, 5).

9. A reductant supply system according to claim 8, characterized in that the equalizer means is a volume-elastic equalizer (50, 51) installed in the connection line (4, 5) that is compressed during the freezing of reductant in order to compensate for a volume expansion of the reductant.

10. A reductant supply system according to claim 9, characterized in that the equalizing means is a gas-filled chamber (51).

11. A reduction supply system according to claim 10, characterized in that the gas-filled chamber (51) is configured as a gap between the inside of the connection line (4, 5) and the outside of a tube (60) arranged in the connection line, which tube conveys urea while in operation.

12. A reductant supply system according to claim 11, characterized in that the tube (60) has ribs (61) on the outside, especially longitudinal ribs (61).

13. A reductant supply system according to claim 9 or 10, characterized in that the equalizer (50) is a tube with gas-filled chambers (51).

14. A reductant supply system according to any of above claims, characterized in that the metal pipe (4) has a cross-section that deviates from being circular, preferably by being oval or elliptical.

15. A heating unit for the defrosting of a corrosive solution, in particular for a urea tank of a urea supply system according to any of above claims, comprising:

a metal pipe (4) for the conveyance of the defrosted solution, wherein terminal lugs (10, 11) are affixed at the metal pipe (4) in order to convey a heating current through the metal pipe (4) that heats up the metal pipe (4) for the defrosting of the solution.

16. A heating unit according to claim 15, characterized in that the metal pipe (4) is a corrosion-resistant metal pipe to be extended into the solution, which pipe can be attached as an intake pipe to a pump (6).

17. A heating unit according to claim 15 or 16, characterized in that the wall thickness of the metal pipe (4) is between 0.1 mm and 0.3 mm.

18. A heating unit according to claim 15, 16 or 17, characterized in that the inside diameter of the metal pipe (4) is between 1.0 mm and 4 mm, preferably between 1.2 mm and 3 mm.

19. A heating unit according to any of the claims 15 to 18, characterized in that a temperature sensor (21) is affixed to the metal pipe (4).

20. A heating unit according to any of the claims 15 to 19, characterized in that the metal pipe (4) is bent into several coils (14).

21. A heating unit according to any of the claims 15 to 20, characterized in that at one end of the metal pipe (4) is affixed a plug-in coupling for the coupling to a pump (6).

22. A heating unit according to any of the claims 15 to 21, characterized in that in the metal pipe (4) is arranged a volume-elastic equalizer (50, 51) that, with a freezing of fluid in the metal pipe (4), is compressed in order to compensate for a volume expansion of the fluid.

23. Use of a metal pipe (4, 5) in a reductant supply system for a waste gas cleaning catalyst (2) of an internal combustion engine as a resistance heating element for the defrosting of reductant and for the conveyance of defrosted reductant.

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