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(54) METHOD OF TRANSFERRING AN INDUSTRIAL GAS

(57) The present invention relates to a method for transferring an industrial gas from a gas supplying device (110) providing the industrial gas to a gas consuming device (120) comprising connecting a gas and data transfer unit (130) with the gas supplying device (110) and with the gas consuming device (120); exchanging data bidirectionally between the gas supplying device (110) and the gas consuming device (120) via the gas and data transfer unit (130); evaluating whether to enable or to disable the transfer of the industrial gas from the gas supplying device (110) to the gas consuming device (120) in dependence of the exchanged data; transferring the industrial gas from the gas supplying device (110) to the gas consuming device (120) via the gas and data transfer unit (130) if the transfer of the industrial gas is enabled.

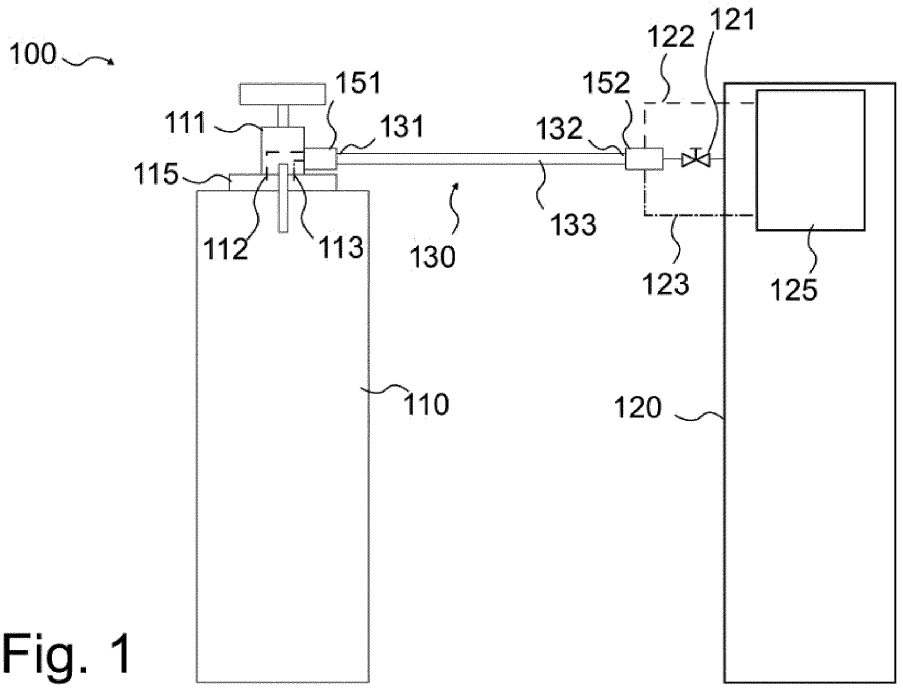

Fig. 1

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Description

[0001] The present invention relates to a method for transferring an industrial gas from a gas supplying device to a gas consuming device as well as to a gas and data transfer unit, to a device for supplying and/or consuming an industrial gas and to a system for transferring an industrial gas.

Background

[0002] For transferring industrial gases from devices supplying this industrial gas, e.g. from fluid storage and transportation devices like storage vessels, containers, tanks, trailers, cylinders, etc., to devices consuming or in need of this industrial gas like welding and cutting equipment, machines, robots, furnaces or the like, pipes, pipelines or hoses can be used.

[0003] If data is to be transferred between such fluid utilising devices, e.g. between sensors and control units, a wireless data connection or a wired data connection can be established between these devices. Establishing a wired connection between the devices may be rather elaborately, since a separate data transmission line needs to be connected with the corresponding devices. However, wireless communication may be limited and power consuming. A limiting factor for wireless data transfer can be the energy supply e.g. of measuring technology and transmitters. As every wireless data transfer increases energy consumption, the number of realised data transfer is oftentimes deliberately reduced to extend batteries lifetime, e.g. in smart cylinder valves. Energy limitations can determine data limitations. Another limiting factor for use of wireless data transfer especially in fabrication sites with large number of devices is the higher risk for technical cross-disturbances or even for cyber criminality.

Disclosure of the invention

[0004] The present invention relates to a method for transferring an industrial gas from a gas supplying device to a gas consuming device as well as to a gas and data transfer unit, to a device for supplying and/or consuming an industrial gas, and to a system for transferring an industrial gas for performing the method with the features of the independent claims. Further advantages and embodiments of the invention will become apparent from the description and the appended figures.

[0005] The gas and data transfer unit, the device for supplying and/or consuming the industrial gas and the system for transferring the industrial gas according to the present invention are in particular configured to perform the method according to the present invention or to be used in the course of the method according to the present invention. Advantages and advantageous embodiments of the method, the gas and data transfer unit, the device and the system according to the present invention shall arise from the present description in an analogous manner.

[0006] According to the present invention, for transferring the industrial gas from the gas supplying device to the gas consuming device, a gas and data transfer unit is connected with the gas supplying device and with the gas consuming device. For reasons of simplicity, this "gas and data transfer unit" is also referred to as "transfer unit". In particular, this transfer unit comprises a first end and a second end, wherein each of these two ends is configured to be connected with the corresponding gas supplying device and/or the gas consuming device. The transfer unit is further configured to transfer the industrial gas between these two ends and to transfer data bidirectionally between these two ends.

[0007] Data is bidirectionally exchanged between the gas supplying device and the gas consuming device via the gas and data transfer unit. For this purpose, each of the gas supplying device and the gas consuming device particularly comprise an electronic device, wherein the data is exchanged between these electronic devices via the transfer unit. For example, these electronic devices can be provided as computing units, logic devices or information technology devices for generating or processing data, e.g. as a microprocessor, a microcontroller, an electric control unit, a computer, a control unit like a numerical control (NC) or a computer numerical control (CNC), a sensor, an actuator, alarm, valve, shut-off valve, wireless transmitter, battery, etc.

[0008] In dependence of the exchanged data it is evaluated, whether to enable or to disable the transfer of the industrial gas from the gas supplying device to the gas consuming device. Particularly, this evaluation can be performed by the corresponding electronic device(s) of the gas supplying device and/or the gas consuming device. The exchanged data can expediently characterise the possible gas transfer between the devices in general. In particular, the exchanged data can characterise the gas supplying device and the gas consuming device in detail as well as the specific industrial gas supplied by the gas supplying device and the specific industrial gas needed or consumed by the gas consuming device. In dependence of these kind of data it can particularly be evaluated, whether the possible gas transfer is reasonable, safe and of high quality, or whether the gas transfer should reasonably not be performed e.g. because of safety risks or low-quality.

[0009] If the industrial gas transfer is enabled, the industrial gas is transferred from the gas supplying device to the gas consuming device via the gas and data transfer unit. For enabling the gas transfer, the corresponding electronic device(s) of the gas supplying device and/or the gas consuming device can particularly allow corresponding valves to be opened, e.g. by sending corresponding control signals or directly control corresponding valves.

[0010] The gas supplying device and the gas consuming device can each be provided as or can comprise a

device according to the present invention. The system according to the present invention comprises a corresponding gas supplying device and a corresponding gas consuming device, connected via a gas and data transfer unit according to the present invention, and is configured to perform or to be operated according to the method according to the present invention.

[0011] The present invention expediently increases quality, quality assurance and safety of the industrial gas transfer, especially such that only an industrial gases with optimal quality properties is exchanged between the devices and especially such that no safety risks can occur during the connection of the devices and during the industrial gas transfer. By means of exchanging and evaluating data automatically and autonomously after the connection between the gas supplying and the gas utilising device is established, the industrial gas can expediently only be transferred between the two devices if predetermined conditions, criteria or requirements are fulfilled, in particular regarding safety and quality.

[0012] For example, the exchanged data can be analysed as to whether a correct, accurate, compatible gas supplying/consuming devices are connected with each other. Only when compatible devices are connected, the transfer of the industrial gas is enabled. If wrong or incompatible devices are connected with specifications not matching predetermined parameters, the transfer of the industrial gas can be disabled. This way, safety can be improved by avoiding the industrial gas to enter devices which are not designed or approved for it. Further, the gas consuming device can reject transfer of an industrial gas which does not fulfil required and pre-set specifications.

[0013] Further, the exchanged data can for example be analysed as to the specific industrial gas provided by the gas supplying device. Expediently, only when the gas supplying device offers an industrial gas, which is safe to be transferred to the gas consuming device and which fulfils predetermined quality standards of the gas consuming device, the transfer of the industrial gas is enabled. However, if transferring the gas would yield in a safety risk or if the provided gas is of low-quality, the transfer can be disabled.

[0014] By transferring both data and the industrial gas via the same transfer unit, it is particularly not necessary to provide different wired connections or lines for transferring these different kinds of streams, thereby reducing or saving costs, expenditure, time, material, space, and energy. Separate handling effort for transferring the industrial gas and the data is particularly not necessary and safety risks can be reduced. With only one transfer unit needing to be connected to the corresponding gas supplying/consuming devices, a space-saving possibility to transfer different kinds of streams is provided, which can comply with reduced and limited construction space. Moreover, the gas and data transfer unit expediently yields the possibility to also transfer power between the gas supplying/utilising device, thereby allowing to transfer the industrial gas, data and power via the same unit, thus further reducing or saving costs, expenditure, time, material, space, and energy.

[0015] Expediently, a data connection can automatically be established between the gas supplying and gas consuming device, when the transfer unit is connected. Problems and disadvantages with wireless data transfer can be avoided. Wireless data transfer systems oftentimes require additional effort for energy supply, either continuous or for loading batteries, are limited by energy availability (energy consumption, battery lifetime, etc.), and add cost to the corresponding device. Thus, by transferring data via the gas and data transfer unit, energy, effort and costs can be reduced. Furthermore, by transferring the data via a wired connection by means of the transfer unit and not via a wireless communication method, safety and security of the data exchange can be increased, since wired connections are less susceptible for data breaches than wireless connections. In particular, information security of the data exchange can be increased, since access protection can be increased such that unauthorized access to the data can be reduced or minimised. It can especially be prevented that attackers read out or even manipulate the exchanged data. Further, functional or operational safety of the various hardware and software units of the gas supplying device and the gas consuming devices can be increased and their correct operation can be enabled, since manipulation by attackers can be prevented.

[0016] The present invention thus provides a possibility to transfer data and industrial gases between different gas supplying and utilising devices with low costs and low expenditure in a time-saving, material-saving, space-saving, energy-saving, effective manner with a high level of safety and quality.

[0017] The term "industrial gas" in the present context is particularly to be understood as a fluid, especially provided for use in an industrial application, wherein the term "fluid" particularly designates a gas or a mixture of gases or a liquid or a mixture of liquids. The industrial gas can particularly be a chemical substance in its gaseous form . Particularly, the industrial gas can also be a liquefied gas, often also referred to as cryogenic liquefied gas, refrigerated liquefied gas, deeply refrigerated gas or cryogenic liquid, i.e. a chemical substance, which is in its gaseous state at room temperature and which has been refrigerated into its liquid state. The industrial gas can particularly also be a cryogenic gas or a cryogenic liquefied gas, i.e. a cryogenic liquid, which has been vaporised and may still be at a low temperature. For example, the industrial gas can be hydrogen, compressed natural gas or biogas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG), etc.

[0018] The gas supplying device or device for supplying the industrial gas is particularly to be understood as a device, which supplies delivers or provides the industrial gas to the corresponding gas consuming device. The gas consuming device or device for consuming the in-

dustrial gas is particularly to be understood as a device, which uses or utilises the corresponding industrial gas provided by the gas supplying device in any manner, e.g. which stores, consumes, process, etc. the corresponding industrial gas.

[0019] For example, the gas supplying device and/or the gas consuming device can be provided as or can comprise a fluid storage and/or transportation devices like a vessel, container, cylinder, tank, trailer, truck, etc.

[0020] For example, the gas supplying device can be provided as or can comprise a device or plant for generating the industrial gas, e.g. operated by a gas supplier or gas provider, e.g. a gas generation plant, a gas production site, an air separation unit (ASU), etc. The gas supplying device can e.g. also be an outlet point of a central fluid supply line at a customer end.

[0021] For example, the gas consuming device can be provided as or can comprise a fluid powered device or a fluid processing device, e.g. operated by a costumer, e.g. machine or a process engineering apparatus like a welding equipment, burner, furnace, reactor, cleaning device, freezer, plasma device, laser, robot, automated fabrication line, analytical equipment, mixer, multiplexer, manifold or analyser etc.

[0022] For example, the gas supplying device and/or the gas consuming device can be provided as or can comprise a mobile or transportable device or a stationary device. A mobile device of that kind can e.g. be a truck or bulk supply truck for transporting and delivering the industrial gas from a supplier to a costumer. A stationary device of that kind can e.g. be located at a production site or plant operated by the costumer, to which the industrial gas shall be delivered by the mobile device. The stationary device can e.g. also be located at the supplier site, e.g. for filling the industrial gas into the mobile device, which shall then deliver the industrial gas to the costumer. For example, the mobile device can also be a vehicle powered by the industrial gas, e.g. a hydrogen vehicle, and the stationary device can be a fuelling station for fuelling the vehicle with the industrial gas, e.g. with hydrogen, compressed natural gas or biogas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG), etc.

[0023] Communication and data exchange within a corresponding stationary device like a machine or plant, e.g. between different sensors and control units, can oftentimes be performed by means of wired communication methods, e.g. via a safe and secure bus-system. When connecting a corresponding mobile device like a truck to the stationary device, a wired communication link can automatically be established between the bus-system of the stationary and the mobile device via the gas and data transfer unit, thereby increasing safety and security of the data exchange between the stationary and the mobile device.

[0024] Each end of the gas and data transfer unit can particularly be provided as or comprise a port, terminal or interface configured to be connected with a corresponding port, terminal or interface of the respective gas supplying/consuming device. Each end of the transfer unit can particularly be configured to being connected to a valve of the respective gas supplying/consuming device for transferring the industrial gas. Each end can also expediently comprise a valve of its own, e.g. configured to being connected to a valve of the corresponding device. Further, each end of the transfer unit can particularly be configured to being connected to an electronic device of the respective gas supplying/consuming device for the data transfer. The transfer unit could also comprise one or several corresponding electronic devices of its own, e.g. a logic like a sensor, actuator, alarm, or the like.

[0025] Furthermore, each end of the transfer unit can expediently be connected to an electric energy source of the respective gas supplying/consuming device, e.g. a battery, a generator, etc., for transferring power. Electric energy can then e.g. be transferred from a power source of one of the devices for powering an electronic device of the other device or e.g. for loading or charging a battery. For example, electric energy can be transferred between different batteries for charging the battery with the lower state of charge. In this case, e.g. one of the devices can be a device with a constant supply of power, e.g. a welding equipment, a gas production site, etc., whereas the other device can e.g. be a portable device without constant supply of power, e.g. a portable fluid storage vessel or the like.

[0026] According to a preferred embodiment, device related data and/or gas related data are bidirectionally exchanged between the gas supplying device and the gas consuming device. These device related data preferably comprise information characterising the gas supplying device and/or the gas consuming device. The gas related data preferably comprise information characterising the industrial gas provided by the gas supplying device and/or a gas needed or to be consumed by the gas consuming device. By exchanging these kinds of data, the gas supplying device can expediently introduce itself to the gas consuming device and can state to the gas consuming device which kind of industrial gas it offers. Vice versa, the gas consuming device can expediently introduce itself to the gas supplying device and can state to the gas supplying device which kind of industrial gas it needs. In dependence of these device related data it can particularly be evaluated, whether the two devices are compatible with each other. Based on the gas related data it can expediently be evaluated, whether the offered gas is a desired or needed gas of a required quality and whether the offered gas should reasonably be transferred. For example, exchanging and evaluating these kinds of data allows recognising a vehicle type, tank status, customer identity, statistics and thus enables an optimised filling process, smart payment methods, safety improvements, avoidance of wrong filling pressure when using the same transfer unit for different devices, etc.

[0027] Advantageously, the exchanged data, especially the device related data, comprise properties of the

gas supplying device, properties of the gas consuming device, an identification of the gas supplying device, an identification of the gas consuming device, safety data of the gas supplying device and/or safety data of the gas consuming device. These device related data can particularly describe the type and characteristics of the corresponding device in general and further expediently its current required specification for the industrial gas, e.g. current consumption conditions like a current filling state, pressure etc. The corresponding properties can e.g. characterise the specific type and configuration of the respective device as well as physical, chemical, mechanical properties, etc. These identification related data can e.g. comprise a unique registration ID, type number and/or a digital nameplate e.g. in the form a cluster of distinct identification information about the corresponding device. The safety related data can e.g. characterise safety regulations or safety precautions of the corresponding device, e.g. whether the device comprises explosion protection, which specific kinds of fluids the correspond device can safely handle, etc. For example, if the gas consuming device comprises no explosion protection, transfer of a highly flammable industrial gas or an industrial gas with highly flammable components can be disabled. By means of these kinds data it can especially be evaluated, whether the two devices are compatible with each other and whether a gas transfer between the devices can be performed safely.

[0028] Advantageously, the exchanged data, especially the gas related data, comprise properties of the industrial gas provided by the gas supplying device and/or properties of a gas needed or to be consumed by the gas consuming device. These gas related data can especially characterise conditions of the corresponding offered or needed industrial gas, e.g. its quality, purity, mixing accuracy, chemical composition, pressure, temperature, flowrate, amount, safety data, etc. By means of these kinds of data it can expediently be evaluated, whether the offered gas is suitable for the needs of the gas consuming device.

[0029] Alternatively or additionally the exchanged data, especially the gas related data, advantageously comprise information on gases or gas components, which may not be transferred to the gas consuming device, especially for safety reasons. For example, highly flammable gases or gas components may not be transferred, e.g. if the gas consuming device comprises no explosion protection. Safety of the gas transfer and operation of the devices can thus further be increased.

[0030] According to a preferred embodiment, evaluating whether to enable or to disable the transfer of the industrial gas comprises evaluating whether the exchanged data fulfil predetermined requirements, especially related to safety and/or quality. In particular, it can be evaluated whether the data characterising the gas supplying device fulfils corresponding requirements of the gas consuming device and vice versa. These requirements can define certain conditions, criteria or scenarios, under which industrial gas can safely be transferred with high-quality.

[0031] Preferably, evaluating whether to enable or to disable the transfer of the industrial gas comprises evaluating whether the gas supplying device and the industrial gas provided by the gas supplying device fulfil safety and/or quality requirements of the gas consuming device. Expediently, these requirements can characterise which specific types of gas supplying devices are compatible and can safely be coupled with the gas consuming device. Further, these requirements can expediently characterise specific requirements, types and properties of the needed industrial gas such that the gas consuming device can consume the correspond gas with optimum efficiency and quality.

[0032] Advantageously, if the transfer of the industrial gas is enabled and if the industrial gas is transferred from the gas supplying device to the gas consuming device, payment data is exchanged bidirectionally between the gas supplying device and the gas consuming device via the gas and data transfer unit regarding a payment of the transferred industrial gas. Expediently, these payment data can characterise an amount of the industrial gas transferred from the gas supplying device to the gas consuming device. For example, this amount can be fixed and predetermined in advance before the transfer. Alternatively, the amount can flexibly be determined during the transfer and can e.g. be a necessary amount to fill a tank of the consuming device. Further, the payment data can e.g. relate to or characterise a user, costumer or owner of the respective devices, e.g. to a customer identity, account number, etc.

[0033] According to a preferred embodiment, if the transfer of the industrial gas is enabled and if the industrial gas is transferred from the gas supplying device to the gas consuming device, the transfer of the industrial gas is controlled in dependence of the exchanged data. Expediently, one or several electronic devices of the gas supplying device and/or the gas consuming device can perform this control, e.g. a microprocessor, a microcontroller, an electric control unit, etc. For this purpose, corresponding data can expediently be exchanged during the industrial gas transfer, for example data characterising the transfer itself, e.g. sensor data related to the transferred industrial gas. The transferred industrial gas can particularly be analysed, e.g. by means of sensors, and results of this analysis can be exchanged as corresponding data via the transfer unit. For example, this exchanged data can characterise the current quality, purity, mixing accuracy, composition, pressure, temperature, flowrate, amount, etc. of the transferred industrial gas. After a predetermined amount of the industrial gas is transferred, valves or actuators can expediently be controlled such that the industrial gas flow is stopped.

[0034] Advantageously, the gas and data transfer unit is provided as a pipe for transferring the industrial gas with at least one data line for bidirectionally exchanging the data. For example, at least one fibre or wire can be

provided as data line(s). The at least one data line, e.g. the at least one fibre or wire, is preferably provided in a wall of the pipe and/or at an inner surface of the wall of the pipe and/or at an outer surface of the wall of the pipe. The industrial gas can expediently be transferred through an inner volume of the pipe, i.e. through a volume enclosed by the walls of the pipe, wherein data and also electric energy can be transferred though the corresponding integrated data line(s) provided within the wall or at surfaces of the wall. It is also possible that the pipe can be made of a conductive polymer, i.e. a polymer or plastic with electric conductivity. In this case, data can particularly be exchanged bidirectionally via the pipe itself.

[0035] It should be noted that the previously mentioned features and the features to be further described in the following are usable not only in the respectively indicated combination, but also in further combinations or taken alone, without departing from the scope of the present invention.

[0036] The present invention will now be described further, by way of example, with reference to the accompanying drawings, in which

Figure 1 schematically shows a preferred embodiment of a system for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

Figure 2 schematically shows a preferred embodiment of a system for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

Figure 3 schematically shows a preferred embodiment of a system for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

Figure 4 schematically shows a preferred embodiment of a system for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

Detailed description

[0037] Figure 1 schematically shows a preferred embodiment of system 100 for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

[0038] The system 100 comprises a first device 110 for supplying and/or consuming an industrial gas and a second device 120 for supplying and/or consuming an industrial gas connected via a gas and data transfer unit 130.

[0039] The gas and data transfer unit 130 comprises a first end 131 and a second end 132. The first end 131 of the transfer unit 130 is configured to be connected with the first device 110 by means of a first transfer interface unit 151 and the second end 132 of the transfer unit 130 is configured to be connected with the second device 120 by means of a second transfer interface unit 152.

[0040] The transfer unit 130 is configured to transfer an industrial gas between the first end 131 and the second end 132 and thus between the first and the second device 110, 120. The transfer unit 130 is further configured to bidirectionally transfer data and especially also electric energy between the first end 131 and the second end 132 and thus between the two devices 110, 120.

[0041] For this purpose, the transfer unit 130 for example comprises a pipe 131, wherein the industrial gas is transferred though an inner volume enclosed by a wall of the pipe. Further, at least one data line, e.g. at least one wire and at least one optical fibre, are provided inside this wall for transferring electric energy and data. Wire(s) and fibre(s) can e.g. also be provided at an inner surface or an outer surface of the wall.

[0042] According to the present invention, when connecting the devices 110, 120 with each other via the gas and data transfer unit 130, data is exchanged bidirectionally between these devices 110, 120 via the transfer unit 130 and it is evaluated in dependence of these exchanged data whether to enable or to disable the transfer of the industrial gas. Only when if the transfer of the industrial gas is enabled as a result of this evaluation, the industrial gas is transferred between the devices 110, 120 via the transfer unit 130, as shall be explained hereafter.

[0043] The first device 110 is for example provided as a fluid storage device, e.g. as a storage cylinder.

[0044] The second device 120 can for example be a gas supplying device providing the industrial gas to the cylinder 110. In this case, the first device is provided as a gas consuming device for consuming or storing the industrial gas provided by the gas supplying device 120. For example, the second device 120 can be an air separation unit (ASU), etc.

[0045] The second device 120 can also be a provided as a gas consuming device, e.g. a welding equipment, burner, furnace, etc., and the first device 110. In this case, the industrial gas is transferred from the cylinder 110 to the second device 120.

[0046] In the following, the latter example shall be discussed that the cylinder 110 is provided as a gas supplying device providing the industrial gas to the second device 120 as a gas consuming device, e.g. a welding equipment.

[0047] In the present example, the first transfer interface unit 151 is fixedly connected to the first device 110 and the second transfer interface unit 152 can fixedly be connected to the second device 120. The first end 131

and the second end 132 of the transfer unit 130 can e.g. be provided as ports or terminals configured to be connected with the respective transfer interface unit 151, 152. However, it is also possible, that the transfer interface unit 151 is fixedly connected with the first end 131 and that the second transfer interface unit 152 is fixedly connected with the second end 132 of the transfer unto 130. These transfer interface units can then be connected with a corresponding port of the respective fluid utilising device 110, 120.

[0048] The first transfer interface unit 151 is connected with a valve 111 of the first device 110 for transferring the industrial gas between the transfer unit 130 and the device 110. Further, the first transfer interface unit 151 is connected with an electronic device 115 of the first device via an electrical wire 112 and a data line 113 for transferring electric energy and data between the transfer unit 130 and the first device 110. For example, the electronic device 115 can be provided as a control unit and can comprise sensors, e.g. for measuring a flow, temperature and pressure of the gas, as well as actuators for opening and closing the valve 111. The electronic device 115 can also comprise an electric energy source, e.g. a battery, to be loaded by the transferred electric energy.

[0049] The second transfer interface unit 152 is connected with a valve 121 of the second device 120 for transferring the industrial gas between this device 120 and the transfer unit 130. Further, the second transfer interface unit 152 is connected with an electronic device 125 of the second device 120 via an electrical wire 122 and a data line 123 for transferring electric energy and data between the transfer unit 130 and the second device 120. This electronic device 125 can e.g. be provided as a control unit. The electronic device 125 can further serve as an energy source providing electric energy to be transferred via the transfer unit 130.

[0050] Thus, electric energy can be transferred from the control unit 125 to the electronic device 115 via the transfer unit 130 in order to power said device. Further, data can be exchanged between the control unit 125 and the electronic device 115 via the transfer unit 130.

[0051] When connecting the first device, i.e. the cylinder 110, with the second device 120, i.e. welding equipment, via the transfer unit 130, the electronic devices or control units 115, 125 of the devices 110, 120 exchange bidirectionally data with each other via the transfer unit 130.

[0052] These exchanged data for example comprises device related data characterising the gas supplying device 110 and the gas consuming device 120 as well as gas related data characterising the industrial gas provided by the gas supplying device 110 and a gas needed or to be consumed by the gas consuming device 120.

[0053] The device related data e.g. characterises an identification or registration ID and the specific type and configuration of the respective device 110, 120 as well as physical, chemical, mechanical properties, etc. The gas related data further e.g. comprises safety related data characterising safety regulations or safety precautions of the corresponding device 110, 120, e.g. whether the corresponding device 110, 120 comprises explosion protection, which specific kinds of fluids the correspond device can safely handle, etc.

[0054] The gas related data e.g. characterises properties of the industrial gas provided by the gas supplying device 110 and properties of the gas needed by the gas consuming device 120, e.g. quality, purity, mixing accuracy, chemical composition, pressure, temperature, flowrate, amount, safety data of the corresponding gases. The gas related data further comprises information on gases or gas components, which may not be transferred to the gas consuming device 120 for safety reasons.

[0055] By exchanging these data, the cylinder 110 can introduce itself to the welding equipment 120 and can state which specific kind of industrial gas it offers. Vice versa, the welding equipment 120 can introduce itself to the cylinder 110 and can state which specific kind of industrial gas it needs. In dependence of the exchanged data it is evaluated, whether the two devices 110, 120 are compatible with each other and whether the offered gas is suitable for the needs of the gas consuming device 120.

[0056] Based on these exchanged data, the electronic devices or control units 115, 125 of the devices 110, 120 evaluate, whether to enable or to disable the transfer of the industrial gas. For this purpose, the control units 115, 125 evaluate whether the exchanged data fulfil predetermined requirements, especially related to safety and/or quality. For example, it is evaluated whether the type of the cylinder 110 is compatible and can safely be used with the welding equipment 120, e.g. whether the cylinder 110 comprises required safety precautions for welding procedures. For example, if the cylinder comprises no explosion protection, the gas transfer is disabled. It is e.g. further evaluated, whether the properties of the offered industrial gas, e.g. its quality, composition, and mixing accuracy, fulfil requirements and are suitable for the welding process to be performed by the welding equipment 120.

[0057] Only when the exchanged data fulfil the predetermined requirements, the control units 115, 125 enable the transfer of the gas. For this purpose, the control units 115, 125 control the respective valves 111, 121 to be opened. By means of this evaluation, it can e.g. be prevented that a wrong or incompatible cylinder 110 is used in connection with the welding equipment 120 or that a wrong type of gas is transferred to the welding equipment 120, which could reduce quality of the welding process or which could pose a safety risk.

[0058] After opening the valves 111, 121, data corresponding to the transferred gas can be measured via the corresponding sensor and can be exchanged between the control units 115, 125 via the transfer unit 130, e.g. data characterising the current quality, purity, mixing accuracy, composition, pressure, temperature, flowrate,

amount, etc. of the transferred industrial gas. One or both of the control units 115, 125 can control the transfer of the gas in dependence of these exchanged data. After a predetermined amount of the industrial gas is transferred, the control units 115, 125 can control the corresponding valves 111, 121 to be closed and to stop the industrial gas transfer.

[0059] Further, payment data may be exchanged bidirectionally between the gas supplying device 110 and the gas consuming device 120 or their corresponding control units 115, 125 via the gas and data transfer unit 130 regarding payment of the transferred industrial gas. These payment data e.g. characterise the amount of the industrial gas transferred and can further identify the user, costumer or owner of the respective devices 110, 120, e.g. via a customer identity, account number, etc.

[0060] Figure 2 schematically shows another preferred embodiment of a system 200 for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

[0061] The system 200 comprises a fluid mixer 220 for generating a fluid mixture as a gas consuming device. This fluid mixer 220 is connected with several fluid storage devices 210, e.g. storage cylinders storing individual fluids, wherein each fluid storage device 210 is provided as a gas suppling device. The fluid mixer 220 can extract individual amounts of these different fluids from the cylinders 210 in order to produce a predetermined fluid mixture. For this purpose, the fluid mixer 220 is connected to each of the cylinders 210 via one gas and data transfer unit 230 for transferring the corresponding fluid as well as data. Each gas and data transfer unit 230 comprises a pipe 233 with integrated fibre(s) and wire(s). The mixing mechanism in the fluid mixer 220 is not illustrated in detail.

[0062] Correspondingly to Fig. 1, a first interface unit 251 connects each transfer unit 230 with a valve 211 of the corresponding cylinder 210 for transferring the fluid as well as with an electronic device 215 of the corresponding cylinder 210 for transferring data. In accordance to the electronic device 115 of Fig. 1, these electronic devices 215 comprise a control unit, sensors, e.g. for measuring a flow, temperature and pressure of the fluid, and actuators for opening and closing the respective valve 211. Further, these electronic devices 215 can comprise a battery.

[0063] Accordingly, a second interface unit 252 connects each transfer unit 230 with a valve 221 of the fluid mixer 220 for transferring the corresponding fluid as well as with a control unit 225 of the mixer 220 via an electrical wire 222 and a data line 223 for transferring electric energy and data.

[0064] By exchanging and evaluating data between the control units 215, 225, it is evaluated, whether the individual cylinders 210 are compatible and can safely be used with the mixer 220. It is further evaluated whether the corresponding fluid or industrial gas provided by the individual cylinders 210 meet requirements of fluids needed by the mixer 220. The control units 215, 225 can further individually control the extraction of the fluids from each of the cylinders 210 by means of the data exchanged via the transfer units 230. Therefore, the control units 215, 225 can flexibly control the mixing of the fluid mixture.

[0065] Figure 3 schematically shows another preferred embodiment of a system 300 for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

[0066] A central fluid supply pipe line system 310 is provided as a gas suppling device. This pipe line system 310 can supply an industrial gas or fluid to a gas consuming device 320, e.g. a welding equipment, burner, furnace, etc. For this purpose, the devices 310, 320 are connected with a gas and data transfer unit 330 for transferring the industrial gas as well as data. For this purpose, the gas and data transfer unit 330 comprises a pipe 333 with integrated fibres and wires. A first end 331 of the transfer unit 330 is connected to the supply pipe line system 310 via a first interface unit 351 and a second end 332 of the transfer unit 330 is connected with the gas consuming device 320 via a second interface unit 152.

[0067] The first interface unit 351 can fixedly be connected to the supply system 310 and can particularly be connected with a valve 311 of the system 310 for transferring the industrial gas between the transfer unit 330 and the system 310. The first transfer interface unit 351 can further be connected with an electronic device 315 of the system 310 via an electrical wire 312 and a data line 313 for transferring electric energy and data between the transfer unit 330 and the supply system 310. The electronic device 315 can comprise a control unit, sensors, e.g. for measuring flow, temperature and pressure, as well as an actuator for opening and closing the valve 311.

[0068] The second transfer interface unit 352 can fixedly be connected to the gas consuming device 320, e.g. with a valve 321 of the device 320 and further with an electronic device 325, e.g. a control unit, via an electrical wire 322 and a data line 323 for transferring the industrial gas, electric energy and data between the transfer unit 330 and the gas consuming device 320.

[0069] In dependence of the data exchanged via the transfer unit 330, it is evaluated whether the individual devices 310, 320 are compatible with each other and whether the supply system 310 provides an industrial gas needed by the gas consuming device 320.

[0070] Figure 4 schematically shows another preferred embodiment of a system 400 for transferring an industrial gas according to the present invention, configured to perform a preferred embodiment of the method according to the invention.

[0071] For example, a bulk supply truck 410 is provided as a gas supplying device delivering an industrial gas to a gas consuming device 420 e.g. in the form of a produc-

tion site or plant. For this purpose, the truck 410 and the plant 420 are connected via a gas and data transfer unit 430 comprising a pipe 422 with integrated wires and fibres.

[0072] The transfer unit 430 can be connected to the bulk truck 410 via a first transfer interface unit 451 and to the plant 420 via a second transfer interface unit 452. For example, the first transfer interface unit 451 can be fixedly connected with the first end 431 of the transfer unit 430 and can be configured to be connected with a corresponding port of the truck 410. The second transfer interface unit 452 can for example also be fixedly connected with the second end 432 of the transfer unit 430 and can be configured to be connected with a corresponding port of the utilising device 420.

[0073] The first transfer interface unit 451 can e.g. be connected with a valve 411 of the truck 410 and with an electronic device 415, e.g. a control unit, of the truck 410 via an electrical wire 412 and a data line 413 for transferring fluid, electric energy and data between the transfer unit 430 and the bulk supply truck 410.

[0074] The second transfer interface unit 452 can be connected with a valve 421 of the second device 420 as well as with an electronic device 425, e.g. a control unit, via an electrical wire 422 and a data line 423 for transferring the fluid, electric energy and data between the transfer unit 430 and the device 420.

[0075] In dependence of the data exchanged between the control units 415, 425 via the transfer unit 430, the transfer of fluid can be controlled, e.g. by means of the control unit 425. For example, after connecting the transfer unit 430 with the utilising devices 410, 420, the control unit 415 of the truck 410 sends data regarding the truck 410 via the transfer unit 430 to the control unit 425. The control unit 425 evaluates this received data, for example as to whether the truck 410 is a correct, accurate, compatible device. When this is the case, the control unit 425 enables the transfer of the industrial gas and instructs the control unit 415 to open the valve 411 of the truck 410. If the truck is not compatible, the control unit 420 disables the transfer of the industrial gas. This way, safety can be improved. After a predetermined amount of fluid is transferred, the control unit 425 instructs the control unit 415 to close the valve 411 of the truck 410.

Reference list

[0076]

100 system for transferring an industrial gas
110 device for supplying and/or consuming an industrial gas
111 valve
112 electrical wire
113 data line
115 electronic device, sensors, actuators
120 device for supplying and/or consuming an industrial gas
121 valve
122 electrical wire
123 data line
125 electronic device, control unit
130 gas and data transfer unit
131 first end of the gas and data transfer unit
132 second end of the gas and data transfer unit
133 pipe with wires and/or fibres
151 first interface unit
152 second interface unit

200 system for transferring an industrial gas
210 gas supplying device, fluid storage device
211 valve
215 electronic device, control unit, sensors, actuators
220 gas consuming device, fluid mixer
221 valve
222 electrical wire
223 data line
225 electronic device, control unit
230 gas and data transfer unit
233 pipe with wires and/or fibres
251 first interface unit
252 second interface unit

300 system for transferring an industrial gas
310 gas supplying device, central fluid supply pipe line system
311 valve
312 electrical wire
313 data line
315 electronic device, control unit, sensors, actuators
320 gas consuming device
321 valve
322 electrical wire
323 data line
325 electronic device, control unit
330 gas and data transfer unit
331 first end of the gas and data transfer unit
332 second end of the gas and data transfer unit
333 pipe with wires and/or fibres
351 first interface unit
352 second interface unit

400 system for transferring an industrial gas
410 gas supplying device, bulk supply truck
411 valve
412 electrical wire
413 data line
415 electronic device, control unit
420 gas consuming device, production plant
421 valve
422 electrical wire
423 data line
425 electronic device, control unit
430 gas and data transfer unit
431 first end of the gas and data transfer unit
432 second end of the gas and data transfer unit

433 pipe with wires and/or fibres
451 first interface unit
452 second interface unit

Claims

1. A method for transferring an industrial gas from a gas supplying device (110, 210, 310, 410) providing the industrial gas to a gas consuming device (120, 220, 320, 420) comprising:

   connecting a gas and data transfer unit (130, 230, 330, 430) with the gas supplying device (110, 210, 310, 410) and with the gas consuming device (120, 220, 320, 420);
   exchanging data bidirectionally between the gas supplying device (110, 210, 310, 410) and the gas consuming device (120, 220, 320, 420) via the gas and data transfer unit (130, 230, 330, 430);
   evaluating whether to enable or to disable the transfer of the industrial gas from the gas supplying device (110, 210, 310, 410) to the gas consuming device (120, 220, 320, 420) in dependence of the exchanged data;
   transferring the industrial gas from the gas supplying device (110, 210, 310, 410) to the gas consuming device (120, 220, 320, 420) via the gas and data transfer unit (130, 230, 330, 430) if the transfer of the industrial gas is enabled.

2. The method according to claim 1, wherein exchanging the data comprises:

   exchanging device related data bidirectionally between the gas supplying device (110, 210, 310, 410) and the gas consuming device (120, 220, 320, 420) comprising information characterising the gas supplying device (110, 210, 310, 410) and/or the gas consuming device (120, 220, 320, 420); and/or
   exchanging gas related data bidirectionally between the gas supplying device (110, 210, 310, 410) and the gas consuming device (120, 220, 320, 420) comprising information characterising the industrial gas provided by the gas supplying device (110, 210, 310, 410) and/or a gas to be consumed by the gas consuming device (120, 220, 320, 420).

3. The method according to claim 1 or 2, wherein the exchanged data comprise:

   properties of the gas supplying device (110, 210, 310, 410); and/or
   properties of the gas consuming device (120, 220, 320, 420); and/or
   an identification of the gas supplying device (110, 210, 310, 410); and/or
   an identification of the gas consuming device (120, 220, 320, 420); and/or
   safety data of the gas supplying device (110, 210, 310, 410); and/or
   safety data of the gas consuming device (120, 220, 320, 420).

4. The method according to any one of the preceding claims, wherein the exchanged data comprise:

   properties of the industrial gas provided by the gas supplying device (110, 210, 310, 410), especially a quality and/or a purity and/or a mixing accuracy and/or a composition and/or a pressure and/or a temperature and/or a flowrate and/or an amount and/or safety data of the provided gas; and/or
   properties of a gas to be consumed by the gas consuming device (120, 220, 320, 420), especially a quality and/or a purity and/or a mixing accuracy and/or a composition and/or a pressure and/or a temperature and/or a flowrate and/or an amount and/or safety data of the gas; and/or
   information on gases or gas components, which may not be transferred to the gas consuming device (120, 220, 320, 420).

5. The method according to any one of the preceding claims, wherein evaluating whether to enable or to disable the transfer of the industrial gas comprises:
   evaluating whether the exchanged data fulfil predetermined requirements, especially related to safety and/or quality.

6. The method according to any one of the preceding claims, wherein evaluating whether to enable or to disable the transfer of the industrial gas comprises:
   evaluating whether the gas supplying device (110, 210, 310, 410) and the industrial gas provided by the gas supplying device (110, 210, 310, 410) fulfil safety and/or quality requirements of the gas consuming device (120, 220, 320, 420).

7. The method according to any one of the preceding claims, further comprising, if the transfer of the industrial gas is enabled and if the industrial gas is transferred from the gas supplying device (110, 210, 310, 410) to the gas consuming device (120, 220, 320, 420):
   exchanging payment data bidirectionally between the gas supplying device (110, 210, 310, 410) and the gas consuming device (120, 220, 320, 420) via the gas and data transfer unit (130, 230, 330, 430) regarding a payment of the transferred industrial gas.

8. The method according to any one of the preceding claims, further comprising, if the transfer of the industrial gas is enabled and if the industrial gas is transferred from the gas supplying device (110, 210, 310, 410) to the gas consuming device (120, 220, 320, 420):
controlling the transfer of the industrial gas in dependence of the exchanged data.

9. A gas and data transfer unit (130, 230, 330, 430),

comprising a first end (131, 331, 432) and a second end (132, 332, 432), each one of these two ends being configured to be connected with a gas supplying device (110, 210, 310, 410) and/or a gas consuming device (120, 220, 320, 420);
the gas and data transfer unit (130, 230, 330, 430) being configured to transfer an industrial gas between these two ends and to transfer data bidirectionally between these two ends.

10. The gas and data transfer unit (130, 230, 330, 430) according to claim 9 being provided as a pipe (133, 233, 333, 433) for transferring the industrial gas with at least one data line for bidirectionally exchanging the data.

11. The gas and data transfer unit (130, 230, 330, 430) according to claim 10, wherein the at least one data line is provided in a wall of the pipe (133, 233, 333, 433) and/or at an inner surface of the wall of the pipe (133, 233, 333, 433) and/or at an outer surface of the wall of the pipe (133, 233, 333, 433).

12. A device (110, 120, 210, 220, 310, 320, 410, 420) for supplying and/or consuming an industrial gas,

configured to be connected with a gas and data transfer unit (130, 230, 330, 430) according to any one of the claims 9 to 11;
configured to send and receive data via the gas and data transfer unit (130, 230, 330, 430);
configured to evaluate whether to enable or to disable a transfer of an industrial gas;
configured to transfer or receive the industrial gas via the gas and data transfer unit (130, 230, 330, 430) if the industrial gas transfer is enabled.

13. A system (100, 200, 300, 400) for transferring an industrial gas, configured to perform a method according to any one of the claims 1 to 8,

comprising a gas supplying device (110, 210, 310, 410) providing the industrial gas, which is provided as or comprises a first device according to claim 11, a gas consuming device (120, 220, 320, 420), which is provided as or comprises a second device according to claim 11, and a gas and data transfer unit (130, 230, 330, 430) according to any one of the claims 9 to 11 connected with the gas supplying device (110, 210, 310, 410) and the gas consuming device (110, 210, 310, 410);
configured to exchange data bidirectionally between the gas supplying device (110, 210, 310, 410) and the gas consuming device (120, 220, 320, 420) via the gas and data transfer unit (130, 230, 330, 430);
configured to evaluate whether to enable or to disable the transfer of the industrial gas from the gas supplying device (110, 210, 310, 410) to the gas consuming (120, 220, 320, 420) in dependence of the exchanged data;
configured to transfer the industrial gas from the gas supplying device (110, 210, 310, 410) to the gas consuming device (120, 220, 320, 420) via the gas and data transfer unit (130, 230, 330, 430) if the gas transfer is enabled.

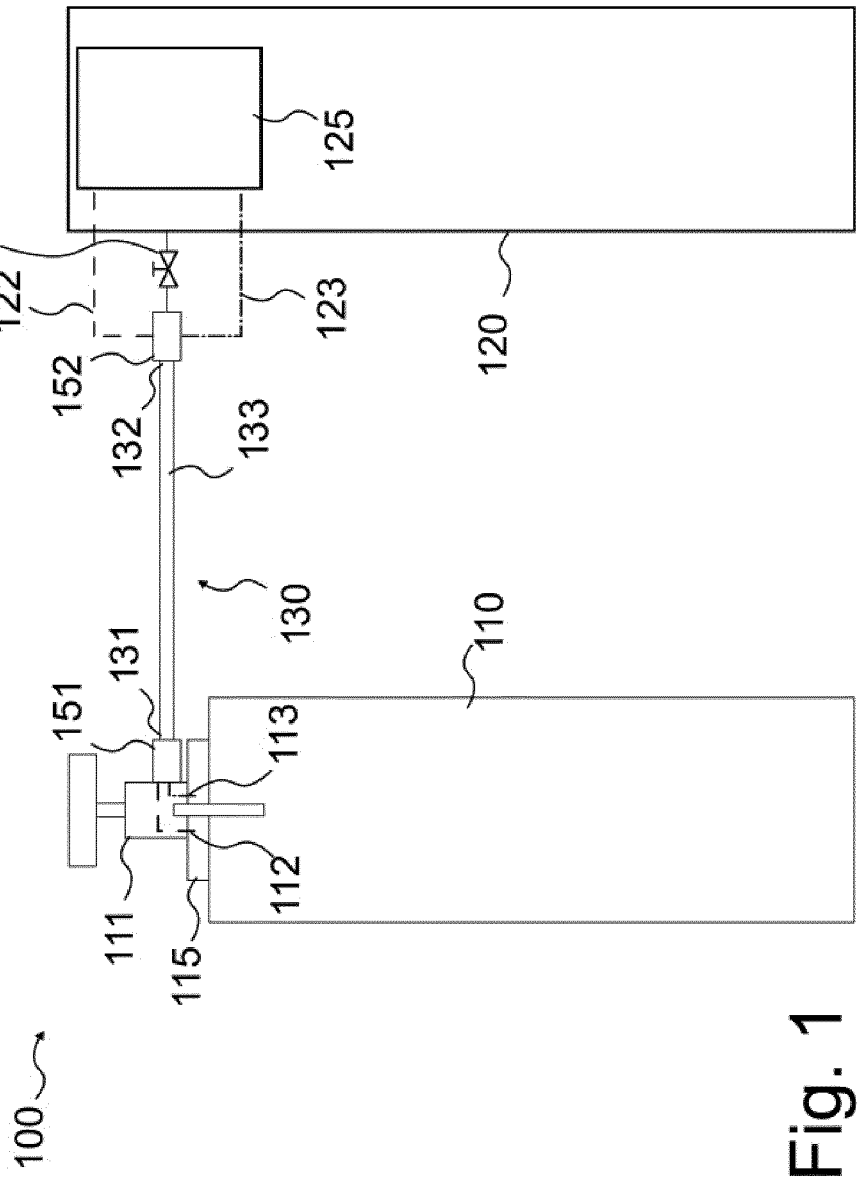
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Fig. 1

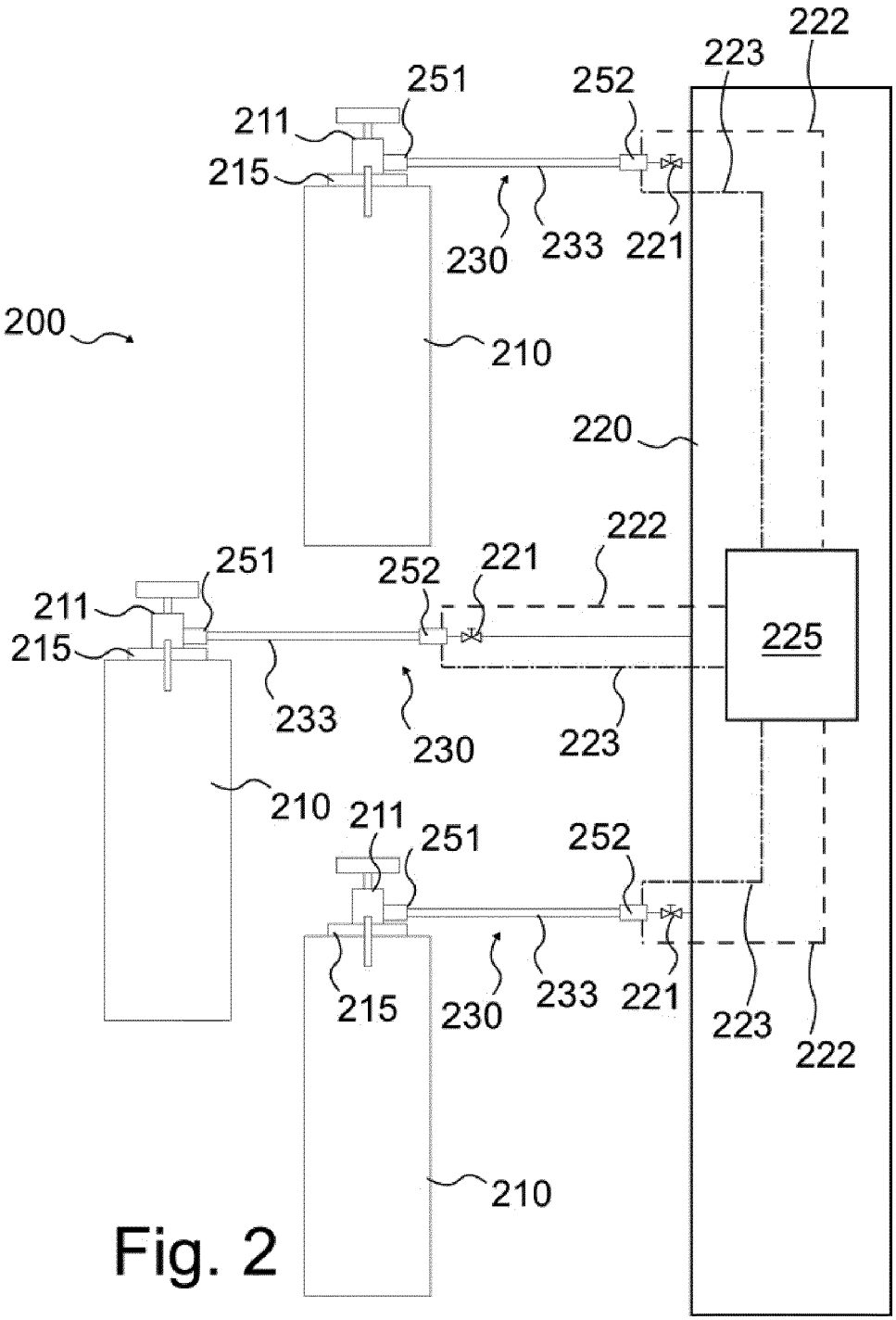
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Fig. 2

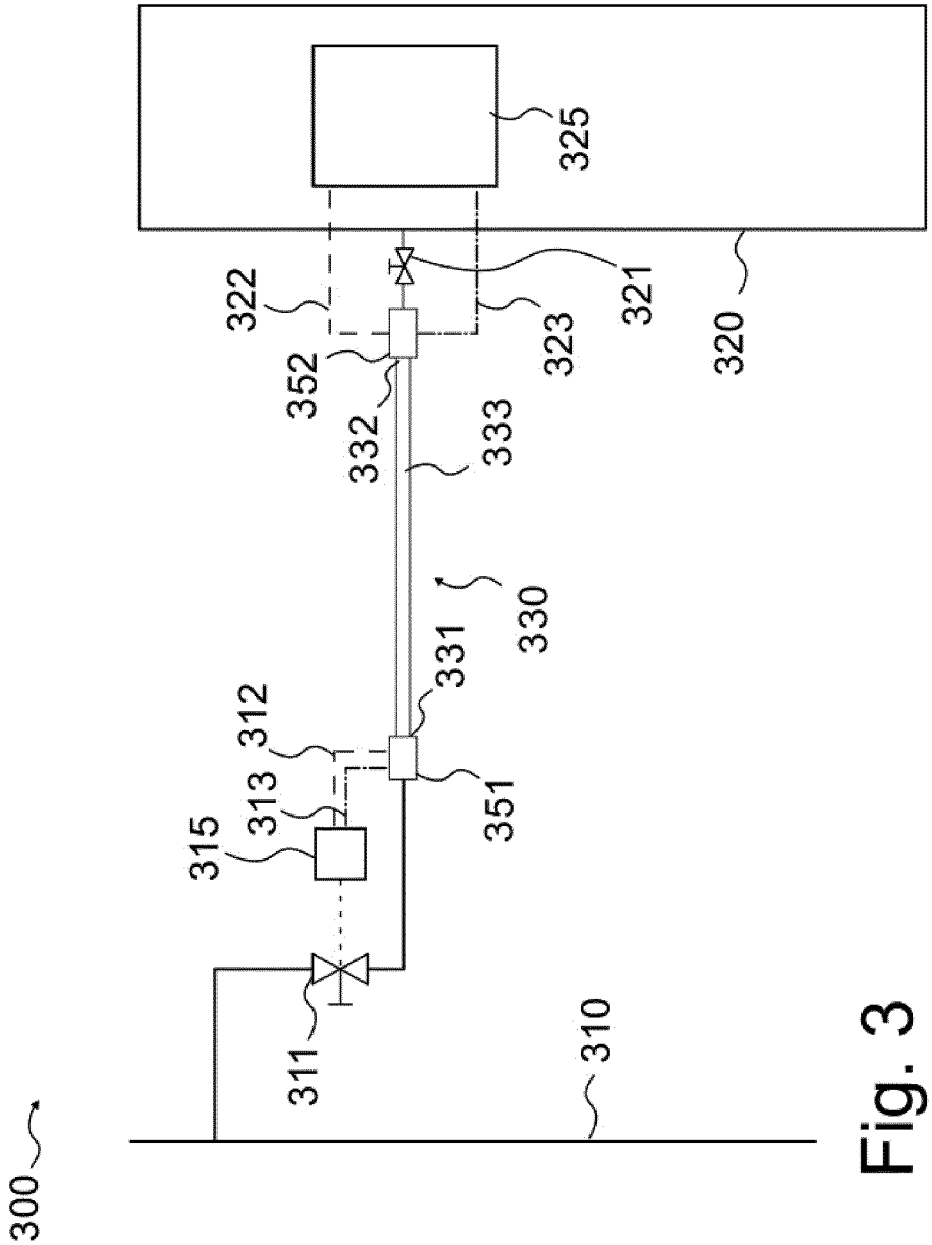
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Fig. 3

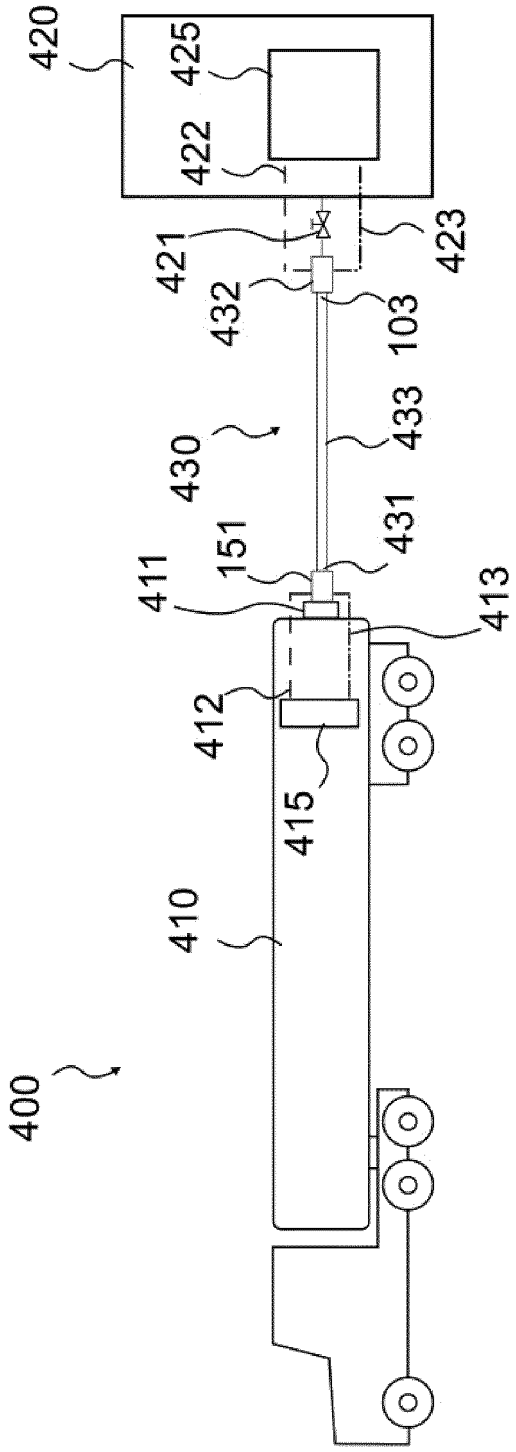
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Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 22 02 0021

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 June 2022	Papagiannis, Michail

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