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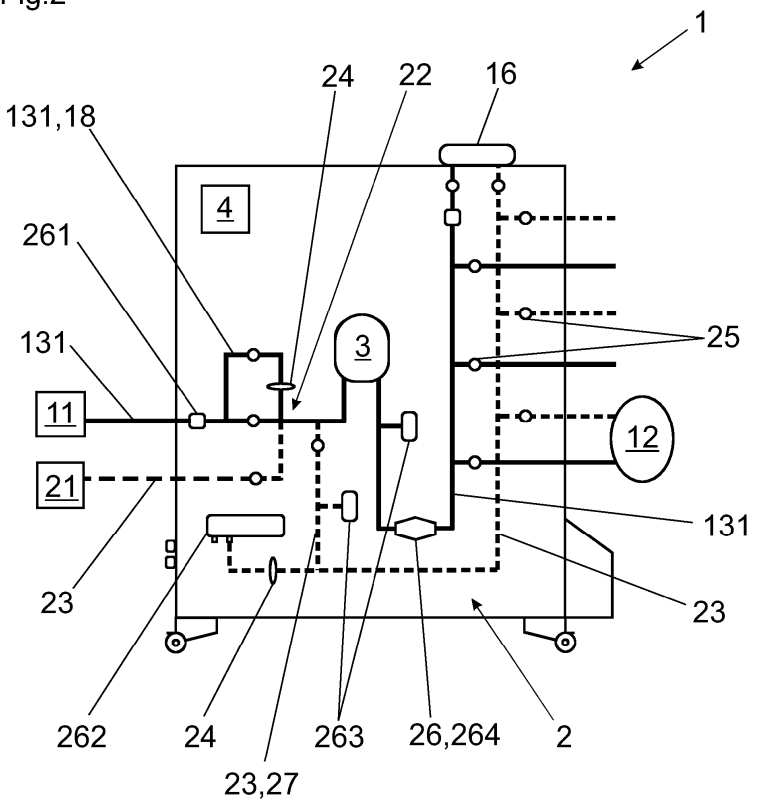
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(54) DEVICE FOR TRANSFERRING A LIQUID

(57) Device (1) for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container (11) to at least one container (12) comprising at least one conduit path (13) configured to receive at least one liquid-transfer conduit (131) for transferring the liquid from the bulk storage container (11) to the at least one container (12), wherein there is provided a flushing system (2) which is configured to flush at least one part of the liquid-transfer conduit (131) and/or at least one venting conduit (23) and/or the at least one container (12) with at least one inert gas, preferably nitrogen.

Fig.2



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Description

[0001] The present disclosure relates to a device for transferring a liquid, preferably flammable and/or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container to at least one container.

[0002] In biopharmaceutical production processes, it is common to dispense large amounts of fluids into smaller packages while simultaneously ensuring an aseptically closed system.

[0003] For this purpose, either manual labor or automated filling units are used to aliquot the fluid into multiple, smaller sized containers.

[0004] To distribute the fluid in an aseptic way, so called single-use assemblies (SUAs) are being used. These units are for example gamma irradiated to ensure the sterility of the fluid path.

[0005] Before the filling process, some liquids need to be mixed with other substances for process specific reasons. These substances may be flammable and/or explosive substances such as ethanol.

[0006] As a consequence, the atmosphere inside the single-use assembly and/or the containers to be filled is explosive due to the direct exposure to the flammable and/or explosive substances.

[0007] Standard filling systems using SUAs are not suitable for filling flammable and/or explosive substances.

[0008] Due to the nature of SUAs, being aseptically closed systems, the atmosphere within the SUA is highly explosive, when filling certain substances.

[0009] Furthermore, a bubble-free liquid conduit cannot be guaranteed. The air pockets (bubbles) may contain oxygen, which could cause the transferred flammable and/or explosive liquid to ignite.

[0010] Another aspect of danger using standard filling units presents itself by the electrostatic charges generated by the liquid flow through the SUA, which in turn may lead to a spark that ignites the flammable and/or explosive substances.

[0011] Also, as the filling device is positioned in an environment, that can be at least temporarily an explosive atmosphere, one cannot simply start the filling process since it needs to be ensured beforehand that there are no explosive gases present, which might lead to a fire and/or explosion in response to starting the electrical components of the filling device.

[0012] It is the object of the present disclosure to at least partially eliminate the above-mentioned disadvantages and to ensure a safe and reliable filling process.

[0013] This task is solved by a device for transferring a liquid, preferably flammable and/or explosive liquid, from a bulk storage container to at least one container according to claim 1.

[0014] The device according to claim 1 comprises at least one conduit path configured to receive at least one liquid-transfer conduit for transferring the liquid from the bulk storage container to the at least one container, wherein there is provided a flushing system which is configured to flush at least one part of the liquid-transfer conduit and/or at least one venting conduit and/or the at least one container with at least one inert gas, preferably nitrogen.

[0015] The advantage of this is that flammable and/or explosive substances can be removed from the device and/or reduced below a predetermined limit in a safe, easy and reproducible manner.

[0016] Preferable embodiments of the invention are defined in the dependent claims.

[0017] According to one preferred embodiment of the invention the flushing system comprises

- at least one gas storage container, configured to store the at least one inert gas, and/or
- at least one connection, operable to connect at least one gas storage container with at least a part of the at least one liquid-transfer conduit in a fluid-conductive manner, and/or
- at least one venting conduit, wherein the at least one venting conduit, is operable to connect the liquid-transfer conduit and/or the gas storage container and/or the at least one container with the environment and/or an additional gas storage container in a fluid-conductive manner.

[0018] Inert gases do not readily undergo chemical reactions with other substances and thus are foremost used to prevent unwanted chemical reactions. Generally, all noble gases except oganesson **(i.e.** helium, neon, argon, krypton, xenon, and radon) as well as nitrogen, carbon oxide and gaseous molecular compounds such as sulphur hexafluoride are considered inert gases.

[0019] However, the designation as an inert gas also depends on the area of application, **e.g.** the temperature. Especially preferred for the present invention is the use of nitrogen as inert gas.

[0020] In order to flush at least one part of the liquid-transfer path with an inert gas it is necessary to connect the at least one gas storage container with the at least one liquid transfer path in a fluid-conductive manner. The at least one connection is preferably located outside a housing of the device.

[0021] In another preferred embodiment the flushing system and/or the device further comprises:

- at least one filter, configured to let only gas pass through, and/or
- at least one pinch valve, configured to open and/or close at least one part of the at least one liquid-transfer conduit and/or venting conduit, and/or
- at least one sensor.

[0022] The at least one filter is positioned preferably at the beginning of the liquid-transfer conduit. Before flushing with at least one inert gas, any air or flammable gas is

removed from the liquid-transfer conduit and/or at least one venting conduit and/or the at least one container by starting to pump the fluid through the at least one filter into the at least one liquid-transfer conduit.

[0023] The at least one filter prevents liquid from entering the at least one liquid-transfer conduit and only allows gas to pass through. This ensures that the fluid to be filled is free of gas bubbles, which might lead to an ignition or explosion during a filling process.

[0024] According to a preferred embodiment the at least one sensor is

- a bubble sensor, configured to detect gas within a liquid and/or measure the amount of gas within a liquid, and/or
- an oxygen sensor, configured to detect oxygen and/or measure the amount of oxygen, and/or
- a pressure sensor, configured to measure the pressure of the gas within the system for conveying gas.

[0025] A signal from the bubble sensor can be used to prevent gas from being left in the liquid unintentionally and/or serve as a kind of timer for the start of flushing.

[0026] The oxygen sensor ensures that the amount of oxygen within the device after the flushing is below a certain threshold, preferably below 5%.

[0027] The pressure sensor helps to prevent a critical overpressure within the device.

[0028] In a preferred embodiment, additionally or alternatively to at least one filter at the beginning of the liquid-transfer conduit, at least one further filter or at least one filter is positioned within the venting conduit before the oxygen sensor and prevents liquid to enter the oxygen sensor and/or exit into the environment.

[0029] In another embodiment of the invention the at least one liquid-transfer conduit and the at least one venting conduit are connected to each other in a fluid-conducting manner at at least one point, preferably such that a continuous path is created between the at least one bulk storage container, the at least one container and the at least one oxygen sensor

[0030] In a preferred embodiment additionally at least one pump is provided, particularly preferred a variable pump, configured to change the direction of flow of a conveyed fluid.

[0031] Furthermore, it may be beneficial to adjust the capacity of the at least one pump and thus the flow velocity of the conveyed fluid.

[0032] The pump may in particularly preferred embodiments be a peristaltic pump in which the at least one liquid-transfer conduit may be placed. The liquid is then pumped by the peristaltic pump in the at least one liquid-transfer conduit by peristaltic action on the at least one liquid-transfer conduit. This has the advantage that the at least one liquid-transfer conduit does not have to be separated in order to connect to inlet and outlet port of the pump which would have negative implications for ensuring the sterility of the at least one liquid-transfer conduit.

[0033] Further embodiments of the pump may be at least one gear pump, diaphragm pump, piston pump etc.

[0034] In a further preferred embodiment, the device additionally comprises at least one open-loop and/or closed-loop controller.

[0035] The at least one open-loop and/or closed-loop controller can thereby be operable to control the fluid flow through the liquid-transfer conduit and/or venting conduit by controlling the at least one pump and/or the at least one pinch valve.

[0036] Additionally or alternatively, the at least one open-loop and/or closed-loop controller can be operable to control the flushing of at least one part of the liquid-transfer conduit with at least one inert gas by controlling the at least one pump (3) and/or the at least one pinch valve (25).

[0037] Close monitoring increases the safety of the device and further helps to automize process of flushing and filling.

[0038] Preferably the at least one conduit path comprises at least one earthing device for electrostatic discharge of at least parts of the device.

[0039] The earthing device is particularly preferred realised as at least one stainless-stell holder.

[0040] Electrostatic charging is generally defined as the occurrence or generation of a net charge on macroscopic bodies (i.e. electrical charge), which leads to electrostatic attraction or repulsion.

[0041] Electrostatic discharge (short: ESD) is the sudden transfer of this electrical charge between two objects with different electrical potentials.

[0042] Free radicals are highly reactive molecules with so-called unpaired electrons at their breaking point. They can stabilise the accumulations of charged particles and thus make their strong accumulation possible in the first place. The radicals, mostly peroxides, neutralise part of the charge inwards, so that the particles no longer repel each other to a greater or lesser extent.

[0043] Thus, alternatively or additionally, the at least one conduit path and/or the at least one liquid-transfer path can be treated with at least one agent comprising at least one antioxidant. This can remove the electrostatic charge within a short period of time.

[0044] In a preferred embodiment of the device further comprises a housing, and additionally there is provided a system operable to create and/or maintain a predetermined overpressure within the housing, preferably a control cabinet, of the device (short: overpressure system).

[0045] The over pressure system preferably comprises:

- at least one overpressure valve in fluid connection with the environment and operable to release excess fluid, preferably gas, into the environment, and/or
- at least one open-loop and/or closed-loop control unit, operable to control the pressure within the

device and/or stop the transfer of fluid in case a predetermined maximum value of the pressure is exceeded.

[0046] The overpressure system ensures that there is no explosive atmosphere within the housing, preferably the control cabinet, of the device.

[0047] Furthermore, the overpressure system enables a minor overpressure to be maintained during the operation of the device.

[0048] Overpressure in this sense is a pressure within a system that is greater than the pressure of the environment that surrounds that system.

[0049] In case of doubt, the environmental pressure is considered to be atmospheric pressure, which is defined as 101,325 Pa.

[0050] Protection is also sought for a method for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container to at least one container according to claim 10.

[0051] Such a method comprises at least the following steps:

- optionally arranging at least one liquid-transfer conduit along the at least one conduit path, and
- flushing at least one part of the liquid-transfer conduit and/or at least one venting conduit and/or at least one container with at least one inert gas, preferably by means of a flushing system according to claim 1, and
- transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container to at least one container through the at least one liquid-transfer conduit.

[0052] In an embodiment of this method chronologically before arranging at least one liquid-transfer conduit along the at least one conduit path, a predetermined pressure, preferably an overpressure, within at least one part of the device, preferably the control cabinet, is created, and preferably maintained.

[0053] For example, this can be achieved by either sucking gas in or pumping gas into the corresponding part of the device. Potentially explosive fluid within the corresponding part of the device is discharged into the environment. After a certain period of time or the like, the corresponding part of the device is sealed fluid-tight, while gas continues to be sucked in or pumped in until a predetermined pressure is reached.

[0054] This ensures that there is a non-explosive atmosphere within at least one part of the device, preferably within all of the device and/or at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container.

[0055] Maintaining a slight overpressure during all the method steps prevents some flammable and/or explosive gas from entering the corresponding part of the device, preferably the control cabinet, during the process, which might lead to a possibly dangerous situation due to the high probability for an ignition and/or explosion.

[0056] In a preferred embodiment the method is a computer-implemented method and the predetermined pressure within at least one part of the device is open-loop and/or closed-loop controlled.

[0057] For example, at least one signal from at least one pressure sensor can be transmitted to a control unit of the device, which open- or closed-loop controls the gas supply and venting on the basis of the at least one signal.

[0058] According to preferred embodiment of the method the flushing of at least one part of the liquid-transfer conduit and/or at least one venting conduit and/or at least one container with at least one inert gas comprises conveying at least one inert gas from the at least one gas storage container at least once through at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container.

[0059] Preferably the at least one inert gas is retained within the at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container for a predetermined time.

[0060] In a further embodiment of the method the at least one inert gas is conveyed through at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container in two different flow directions.

[0061] This can allow the inert gas to be fed into the corresponding conduit and be released from it via a bypass without a separate drain or vent system.

[0062] For example, a single pump can be placed within the liquid-transfer conduit. In a first step the pump conveys the fluid in a first direction to fill a part of the liquid-transfer conduit with the fluid. In a next step the pump switches pumping directions, such that the fluid within the part liquid-transfer conduit is conveyed into a direction opposite to the first direction. A pinch valve prevents the fluid to re-enter the bulk storage container or gas storage container. Instead, the fluid is conveyed through a bypass into the venting conduit and can exit the flushing system at this point. An additional pump and/or separate drain or vent system is thus avoided.

[0063] Furthermore, by changing the flow direction of the conveyed gas different parts of the corresponding conduit can be flushed with an inert gas without the need of a separate pump.

[0064] Hence material and space needed within the device can be effectively reduced.

[0065] In a preferred method the at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container is flushed with at least one inert gas until a predetermined value of oxygen within the at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container is reached.

[0066] The flushing can depend on a signal of the at least one oxygen sensor. Only if the oxygen sensor detects an amount of oxygen, preferably below 15% or 10% or 5%, within the corresponding part of the device the inert gas is released again.

[0067] In a preferred embodiment of the method chronologically before conveying at least one inert gas from the at least one gas storage container through at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container,

- the at least one liquid is transferred through the at least one liquid-transfer conduit to at least one filter, and/or
- the air and/or flammable gas and/or explosive gas transfers through the at least one filter, and/or
- the air and/or flammable gas and/or explosive gas, and preferably gas from the gas storage container, is transferred through at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit.

[0068] Thereby it is ensured that the at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit is free of air and/or any flammable gas and/or explosive gas.

[0069] The filter prevents the liquid from entering the at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and thus only lets gas pass through.

[0070] In a preferred embodiment of the method the method steps of flushing with at least one inert gas and/or transferring at least one gas and/or transferring the at least one liquid are open-loop and/or closed-loop controlled by at least one open-loop and/or closed-loop controller.

[0071] This allows the flushing process to be at least partially automated. This saves time, increases the quality of the flushing process and the process no longer depends on the skill and/or experience of the operator.

[0072] It is especially preferred to carry out at least one leakage test chronologically before conveying at least one inert gas through at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container.

[0073] This leakage test preferably comprises the following steps:

- measuring the current pressure within at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container at least once, and/or
- waiting for a predetermined time interval, without changing any settings of the device, and/or
- measuring the pressure within at least one part of the liquid-transfer conduit and/or at least one part of the venting conduit and/or the at least one container again, and/or
- if the measured pressure falls below a predetermined value, shut down the device, otherwise continue with the method for transferring a liquid.

[0074] The purpose of this test is to ensure that there are no leakages within the system, through which gas and/or liquid could possibly escape.

[0075] Protection is also sought for a computer program which when it is executed by an open and/or closed loop controller according one of the embodiments of the device carries out a computer-implemented method of at least one of the embodiments of the methods 12 and/or 18.

[0076] Furthermore, protection is also sought for the use of a device according to claim 1 for carrying out a method according claim 10 and/or 20 preferably for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container to at least one container through the at least one liquid-transfer conduit.

[0077] Further details and advantages of the invention are explained in more detail below with reference to the figures. Therein shows:

Fig. 1: a schematic front view of one of the embodiments of the device 1

Fig. 2: a schematic drawing of an embodiment of the device 1 with a flushing system 2

Fig. 3: a schematic cross-sectional view of the conduit path 13 with an earthing system 5 and the inserted liquid-transfer path 131 or venting conduit 23

Fig. 4: a flow chart of an embodiment of the method for flushing at least one part of a liquid-transfer conduit 131 and/or at least one venting conduit 23 and/or at least one container 12 with at least one inert gas

[0078] Fig.1 shows a schematic drawing of the one embodiment of the device 1 in a frontal view.

[0079] The device 1 for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container 11 to at least one container 12 comprises at least one conduit path 13 configured to receive at least one liquid-transfer conduit 131 for transferring the liquid from the bulk storage container 11 to the at least one container 12.

[0080] The front of the embodiment of the device 1 in Fig.1 features a main switch 64 operable to turn, preferably all, electrical components of the device 1 on and/or off.

[0081] The device 1 in Fig.1 further comprises a HMI 6. HMI stands for human machine interface and refers to a dashboard that enables users to communicate with machines, computer programmes or systems (in this case

with the device 1 and/or any subsystem thereof e.g. the flushing system 2). HMIs display real-time data and enable a user to control machines via a graphical user interface.

[0082] For example, the user can enter a batch number and/or product ID and/or select a recipe.

[0083] For this purpose, the device 1 also comprises a barcode scanner 61. However, the input device can also take the form of a keyboard, a mouse, a touchscreen etc.

[0084] The emergency switch 63 is operable to sever the electric connection and shut down the device 1 immediately in case of an emergency.

[0085] In Fig.1 the device 1 comprises a separate overpressure control panel 62 configured to control a system operable to create and/or maintain a predetermined overpressure within the housing 14 of the device 1 (short: overpressure system).

[0086] While the pressure within the housing 14 of the device 1 is below a predetermined overpressure the power supply of parts of the device 1, which cannot be assigned to the overpressure system, is interrupted and/or if the pressure within the housing 14 of the device 1 falls below a predetermined overpressure the power supply of parts of the device 1, which cannot be assigned to the overpressure system, is interrupted

[0087] The overpressure control panel 62 preferably stands in direct contact to at least one open-loop and/or closed-loop control unit 41, operable to control the pressure within the device 1 and/or stop the transfer of fluid in case a predetermined maximum value of the pressure is exceeded.

[0088] It allows the user to separately control and survey the overpressure within the at least one part of the device 1. Especially in the case of a malfunctioning HMI 6 this feature can be essential for the safety of a user.

[0089] The overpressure control panel 62 can alternatively be integrated into the HMI 6.

[0090] The device 1 additionally comprises at least one venting container 16, preferably a venting bag. According to Fig.1 the venting container 16 is positioned on top of the device 1, preferably within a cavity and/or indentation of the housing 14.

[0091] The device 1 in Fig.1 comprises at least one overpressure valve 15 in fluid connection with the environment and operable to release excess fluid, preferably gas, into the environment. The overpressure valve 15 is preferably integrated into the housing 14.

[0092] Furthermore, the device 1 in Fig.1 features a pressurized air supply 17 operable to feed the overpressure system with air with a predetermined pressure, wherein the value of the pressure is greater than the pressure of the surrounding environment.

[0093] Fig.2 shows the device 1 from Fig.1 with the flushing system 2, which is not shown in Fig.1 for the sake of clarity.

[0094] The flushing system 2 is configured to flush at least one part of the liquid-transfer conduit 131 and/or at least one venting conduit 23 and/or the at least one container 12 with at least one inert gas, preferably nitrogen.

[0095] The liquid-transfer conduit 131 in Fig.2 is drawn as thick continuous line and comprises a bypass 18. Within the bypass 18 a pinch valve 25 and a filter 24 are placed.

[0096] The bypass 18 is configured to convey a fluid to be filled into at least one container 12 to the filter 24. The filter 24 only lets gas pass through, whereas the liquid part of the fluid accumulates inside the bypass 18 before the filter 24. Hence, potentially flammable and/or explosive gas can be discharged into the environment.

[0097] The venting conduit 23 in Fig.2 is drawn as thick dashed line and comprises a bypass 27. Within the bypass 27 a pinch valve 25 and a pressure sensor 263 are placed.

[0098] The bypass 27 acts as a connection between the liquid-transfer conduit 131 and the venting conduit 23, thus creating a continuous path between the at least one bulk storage container 11, the at least one container 12 and the at least one oxygen sensor 262.

[0099] The flushing system 2 in Fig. 2 comprises at least one gas storage container 21, configured to store the at least one inert gas, at least one connection 22, operable to connect at least one gas storage container 21 with at least a part of the at least one liquid-transfer conduit 131 in a fluid-conductive manner, and at least one venting conduit 23, wherein the at least one venting conduit 23, is operable to connect the liquid-transfer conduit 131 and/or the gas storage container 21 and/or the at least one container 12 with the environment and/or an additional gas storage container in a fluid-conductive manner.

[0100] In Fig.2 only two pinch valves 25 were explicitly labelled for simplicity and better clarity of the figure. However, the other pinch valves 25 can be clearly identified in Fig. 2 since they are drawn analogously to the labelled ones.

[0101] In total there are twelve pinch valves depictured in Fig.2. They are configured to open and/or close at least one part of the at least one liquid-transfer conduit 131 and/or venting conduit 23.

[0102] The flushing system 2 in Fig.2 further comprises several sensors 26 in the form of pressure sensors 263, bubble sensors 261, an oxygen sensor 262 and a flow sensor 264.

[0103] They are clearly distinguished in the schematic drawing by different shapes. The bubble sensors 261 are depictured as squares with rounded corners, the pressure sensors 263 are depictured as upright rectangles with rounded corners, the flow sensor 264 is depictured as a hexagon and the oxygen sensor 262 is depictured as a rectangle with an inlet and an outlet.

[0104] The bubble sensor 261 is configured to detect gas within a liquid and/or measure the amount of gas within a liquid.

[0105] The oxygen sensor 262 is configured to detect oxygen and/or measure the amount of oxygen.

[0106] the pressure sensor 263 is configured to measure the pressure of the gas within the system for conveying gas.

[0107] This allows a close monitoring of the flushing system 2 as well as enables a user or machine to control the processes according to the momentary state of the device 1.

[0108] In Fig.2 the at least one liquid-transfer conduit 131 and the at least one venting conduit 23 are connected to each other in a fluid-conducting manner at at least one point, such that a continuous path is created between the at least one bulk storage container 11, the at least one container 12 and the at least one oxygen sensor 262.

[0109] The pump 3 is preferably a variable pump and configured to change the direction of flow of a conveyed fluid.

[0110] The device 1 in Fig.2 can additionally comprise at least one open-loop and/or closed-loop controller 4, operable to

- control the fluid flow through the liquid-transfer conduit 131 and/or venting conduit 23 by controlling the at least one pump 3 and/or the at least one pinch valve 25, and/or

- control the flushing of at least one part of the liquid-transfer conduit 131 with at least one inert gas.

[0111] Moreover, the device 1 in Fig.2 comprises at least one controller 4 signal-connected to at least one electrical and/or electrically controllable component (e.g. sensors 26, controllable valves, the HMI, etc.), preferably all electrical and/or electrically controllable components.

[0112] Since electrically controllable components are at least partially electrical (i.e. regarding the controlling) they are in the following included when referring to electrical components.

[0113] The controller 4 can send signals to and/or receive signals from the connected electrical components via, preferably electrical, wiring (not explicitly shown) and/or wirelessly.

[0114] The controller 4 can be located within the device 1 or outside the device 1, preferably in the form of a separate controlling tool or as part of a cloud system.

[0115] Furthermore, in Fig.2 only one container 12 is illustrated exemplarily. If only one container 12 should be connected to the device 1 during a flushing and filling process, the pinch valves 25 at the supply lines to the other containers 12, that are not connected to the device 1 must be closed, such that no fluid can escape.

[0116] According to the norms [EN IEC 60079-0:2018, EN 60079-2:2014, EN 60079-14:2014] of the ICE (International Electrotechnical Commission) areas at risk of gas explosions are divided into three categories:

"Zone 0": A zone in which an explosive atmosphere consisting of a mixture of air with flammable substances in the form of gas, vapor or mist is present continuously or for long periods of time.

"Zone 1": A zone in which an explosive atmosphere consisting of a mixture of air and flammable substances in the form of gas, vapor or mist is likely to occur in normal operation.

"Zone 2": A zone in which an explosive atmosphere consisting of a mixture of air and flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

[0117] Thus, the atmosphere around the device 1 falls under the criteria of an "EX-zone 2" and the liquid-transfer conduit 131, the venting conduit 23 and the containers 12 fall under the criteria of an "EX-zone 0".

[0118] Fig.3 shows a part of the conduit path 13 with an earthing system 5, that holds the at least one liquid-transfer conduit 131 and/or the venting conduit 23.

[0119] The earthing system 5 depictured in Fig.3 is preferably at least one stainless steel holder with a cavity or indentation to insert and hold the liquid-transfer conduit 131 and/or the venting conduit 23.

[0120] The earthing device 5 is configured for electrostatic discharge of at least parts of the device 1.

[0121] Due to the frictional electricity caused by the fluid flow within the liquid-transfer conduit 131 and/or the venting conduit 23 a potential difference arises that without an earthing device 5 would discharge uncontrollably and possibly ignite the flammable and/or explosive fluid with the corresponding conduit 131,23.

[0122] Fig.4 shows a flow chart of an embodiment of the method for flushing at least one part of a liquid-transfer conduit 131 and/or at least one venting conduit 23 and/or at least one container 12 with at least one inert gas.

[0123] At the beginning of the method all electrical components (such as HMI 6, sensors 26, controller 4 etc.) are turned off.

[0124] Then a predetermined pressure, preferably an overpressure, within at least one part of the device 1 is created by flushing the housing 14 with pressurized air from the pressurized air supply 17.

[0125] The excess air can escape via the at least one overpressure valve 15 and/or minor gaps within the housing 14.

[0126] In total the housing is flushed at least five times with fresh air from the pressurised air supply 17 to ensure that there is no explosive atmosphere within the housing 14.

[0127] In a next step at least one electrical component, preferably all electrical components, are turned on via actuating the main switch 64 and a, preferably minor, overpressure within at least parts of the device 1 is maintained.

[0128] Important is that as long as there is an explosive atmosphere within the device 1 and/or as soon as the pressure falls below a predetermined pressure even though the main switch 64 is actuated the power supply

to the electronical components is or stays interrupted. This is in accordance with the technical guidelines of the TRGS 727 (January 2016).

[0129] At this point a user can log in on the HMI 6, select a recipe, insert a batch number and/or product ID, etc.

[0130] Then the at least one liquid-transfer conduit 131 is inserted into the conduit path 13, preferably via the earthing device 5, and at least one, preferably all, containers 12 are connected to corresponding supply conduits of the device 1.

[0131] In a further step at least one leakage test is performed, wherein the leakage test comprises:

- measuring the current pressure within at least one part of the liquid-transfer conduit 131 and/or at least one part of the venting conduit 23 and/or the at least one container 12 at least once, and/or
- waiting for a predetermined time interval, without changing any settings of the device 1, and/or
- measuring the pressure within at least one part of the liquid-transfer conduit 131 and/or at least one part of the venting conduit 23 and/or the at least one container 12 again, and/or
- if the measured pressure falls below a predetermined value, shut down the device 1, otherwise continue with the method for transferring a liquid.

[0132] In a next step the gas is filtered from the product (i.e. the to be filled liquid), since the product can still contain air and/or flammable and/or explosive gas bubbles. For this purpose the at least one liquid is transferred through the at least one liquid-transfer conduit 131 to at least one filter 24, the air and/or flammable gas and/or passes through the filter 24, and the air and/or flammable gas and/or explosive gas, and preferably gas from the gas storage container 21, is transferred through at least one part of the liquid-transfer conduit 131 and/or at least one part of the venting conduit 23.

[0133] Preferably all pinch valves 25 in Fig.2 are closed at the beginning. Then the product is transferred through the liquid-transfer conduit 131. The pinch valve 25 within the bypass 18 opens and the product is conveyed to the filter 24 within the bypass 18. Only gas can pass through the filter 24 and the liquid accumulates inside the bypass 18 before the filter 24. Once the bubble sensor 261 at the beginning of the liquid-transfer conduit 131 detects no gas for a predetermined time interval the pinch valve 25 within the bypass 18 closes again.

[0134] Next follows the actual flushing with an inert gas, wherein the at least one part of the liquid-transfer conduit 131 and/or at least one part of the venting conduit 23 and/or the at least one container 12 is flushed with at least one inert gas until a predetermined value of oxygen within the at least one part of the liquid-transfer conduit 131 and/or at least one part of the venting conduit 23 and/or the at least one container 12 is reached.

[0135] Preferably this takes place in several steps: first flushing the liquid-transfer conduit 131, then the venting conduit 23, a bypass 27 connecting the liquid-transfer conduit 131 and the venting conduit 23, and lastly all connected containers 12. Especially preferred each container 12 is flushed separately with inert gas.

[0136] To separate the different parts of the conduits, the pinch valves 25 are used. Preferably they are open-loop and/or closed-loop controlled by at least one open-loop and/or closed-loop controller 4.

[0137] Preferably to flush the liquid-transfer conduit 131 all pinch valves 25 in Fig.2 are closed at the beginning. Then the pinch valve 25 right before the venting bag 16 within the liquid-transfer conduit 131 and pinch valve 25 right after the gas storage container 21 are opened. The pump 3 pumps inert gas from the gas storage 21 to the venting bag 16 until a predetermined pressure within the venting bag 16 is reached. The pressure is preferably measured by the pressure sensor 263 within the liquid-transfer conduit 131.

[0138] To flush the venting conduit 23 in Fig. 2 after flushing the liquid-transfer conduit 131 and as soon as a predetermined pressure within the venting bag 16 is reached, preferably the pinch valve 25 right after the venting bag 16 within the venting line 23 is opened. The pump 3 pumps inert gas through the opened path comprising parts of the liquid-transfer conduit 131 and the venting conduit 23 to the oxygen sensor 262 until a predetermined oxygen value, preferably below 5%, is reached.

[0139] Preferably to flush the bypass 27 in Fig.2 in a next step the pinch valve 25 right after the venting bag 16 within the venting line 23 and the pinch valve 25 right after the gas storage container 21 are closed again. The pinch valve 25 right before the venting bag 16 within the liquid-transfer path 131 stays open and additionally the pinch valve 25 within the bypass 27 is opened. Preferably the pump 3 changes the direction of flow of a conveyed inert gas. Thus, the inert gas within the liquid-transfer conduit 131 and the venting bag 16 is used to flush the bypass 27 until a predetermined oxygen value, preferably below 5%, is reached. The inert gas can preferably leave the system at the oxygen sensor 262.

[0140] Preferably to flush a container 12 connected to the device 1 of Fig.2 all pinch valves 25 are closed again. Then pinch valve 25 right after the gas storage container 21 within the venting conduit 23 and the pinch valves 25 at the corresponding container 12 within the liquid-transfer conduit 131 and the venting conduit 23 are opened. The pump 3 starts pumping inert gas through the liquid-transfer conduit 131 to the container 12 and from the container 12 through the venting conduit 23 to the oxygen sensor 262 until a predetermined oxygen value, preferably below 5%, is reached.

[0141] During the flushing of the container 12 preferably the pressure at the pressure sensors 263 is monitored in order to avoid critical overpressure within the container 12. This could happen if the pump 3 feeds more inert gas into the container 12 than can escape through the vent filter 24.

[0142] The process of flushing a container 12 with inert gas described above is preferably repeated for the other containers 12, that are connected to the device 1.

[0143] The excess inert gas, preferably nitrogen, from flushing at least parts of the system can exit the device 1 preferably through the oxygen sensor 262.

[0144] Eventually, the filling process can be started.

[0145] Preferably the pressure measured at the pressure sensors 263 is observed and/or controlled by at least one control unit 41 during the filling process.

[0146] Moisture in the air or liquid particles that find their way into the venting conduit 23 could block the filter 24 and create a dangerous pressure that could damage the containers 12.

[0147] The amount of liquid to be filled in a single container 12 is determined and/or monitored by a scale or a flow sensor 264.

[0148] After filling at least one, preferably all, containers 12, they can be disconnected from the device 1.

Reference list

[0149]

1 device for transferring a liquid
11 bulk storage container
12 container
13 conduit path
131 liquid-transfer conduit
14 housing
15 overpressure valve
16 venting container
17 pressurized air supply
18 bypass

2 flushing system
21 gas storage container
22 connection
23 venting conduit
24 filter
25 pinch valve
26 sensor
261 bubble sensor
262 oxygen sensor
263 pressure sensor
264 flow sensor
27 bypass

3 pump

4 controller
41 control unit

5 earthing system
6 HMI (human machine interface)
61 Barcode scanner
62 overpressure control panel
63 emergency stop
64 main switch

Claims

1. Device (1) for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container (11) to at least one container (12) comprising at least one conduit path (13) configured to receive at least one liquid-transfer conduit (131) for transferring the liquid from the bulk storage container (11) to the at least one container (12), **characterised in that** there is provided a flushing system (2) which is configured to flush at least one part of the liquid-transfer conduit (131) and/or at least one venting conduit (23) and/or the at least one container (12) with at least one inert gas, preferably nitrogen.

2. Device (1) according to the previous claim, wherein the flushing system (2) comprises

- at least one gas storage container (21), configured to store the at least one inert gas, and/or
- at least one connection (22), operable to connect at least one gas storage container (21) with at least a part of the at least one liquid-transfer conduit (131) in a fluid-conductive manner, and/or
- at least one venting conduit (23), wherein the at least one venting conduit (23), is operable to connect the liquid-transfer conduit (131) and/or the gas storage container (21) and/or the at least one container (12) with the environment and/or an additional gas storage container in a fluid-conductive manner.

3. Device (1) according to at least one of the previous claims, wherein the flushing system (2) and/or the device (1) further comprises:

- at least one filter (24), configured to let only gas pass through, and/or
- at least one pinch valve (25), configured to open and/or close at least one part of the at least one liquid-transfer conduit (131) and/or venting conduit (23), and/or
- at least one sensor (26).

4. Device (1) according to the previous claim, wherein the at least one sensor (26) is

- a bubble sensor (261), configured to detect gas within a liquid and/or measure the amount of gas within a liquid, and/or
- an oxygen sensor (262), configured to detect oxygen and/or measure the amount of oxygen, and/or
- a pressure sensor (263), configured to mea-

sure the pressure of the gas within the system for conveying gas and/or
- a flow sensor (264), configured to measure a flow rate of a passing fluid.

5. Device (1) according to at least one of the claims 2 to 4, wherein the at least one liquid-transfer conduit (131) and the at least one venting conduit (23) are connected to each other in a fluid-conducting manner at at least one point, preferably such that a continuous path is created between the at least one bulk storage container (11), the at least one container (12) and the at least one oxygen sensor (262).

6. Device (1) according to at least one of the previous claims, wherein the device (1) additionally comprises at least one pump (3), preferably a variable pump, configured to change the direction of flow of a conveyed fluid.

7. Device (1) according to at least one of the previous claims, wherein the device (1) additionally comprises at least one open-loop and/or closed-loop controller (4), operable to

- control the fluid flow through the liquid-transfer conduit (131) and/or venting conduit (23) by controlling the at least one pump (3) and/or the at least one pinch valve (25), and/or
- control the flushing of at least one part of the liquid-transfer conduit (131) with at least one inert gas by controlling the at least one pump (3) and/or the at least one pinch valve (25).

8. Device (1) according to at least one of the previous claims, wherein the at least one conduit path (13) comprises at least one earthing device (5) for electrostatic discharge of at least parts of the device (1).

9. Device (1) according to at least one of the previous claims, wherein the device (1) comprises a housing (14), and additionally there is provided a system operable to create and/or maintain a predetermined overpressure within the housing (14) of the device (14), and preferably comprising:

- at least one overpressure valve (15) in fluid connection with the environment and operable to release excess fluid, preferably gas, into the environment, and/or
- at least one open-loop and/or closed-loop control unit (41), operable to control the pressure within the device (1) and/or stop the transfer of fluid in case a predetermined maximum value of the pressure is exceeded.

10. Method for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container (11) to at least one container (12), preferably by means of a device (1) according to at least one of the claims 1 to **9,** comprising:

- optionally arranging at least one liquid-transfer conduit (131) along the at least one conduit path (13), and
- flushing at least one part of the liquid-transfer conduit (131) and/or at least one venting conduit (23) and/or at least one container (12) with at least one inert gas, preferably by means of a flushing system according to claim 1, and
- transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container (11) to at least one container (12) through the at least one liquid-transfer conduit (131).

11. Method according to the previous claim, wherein the method further comprises creating a predetermined pressure, preferably an overpressure, within at least one part of the device (1), and preferably maintaining the predetermined pressure, chronologically before arranging at least one liquid-transfer conduit (131) along the at least one conduit path (13).

12. Computer-implemented method according to the previous claim, wherein the method further comprises open-loop and/or closed-loop controlling of the predetermined pressure within at least one part of the device (1).

13. Method according to at least one of the claims 10 to 12, wherein the flushing of at least one part of the liquid-transfer conduit (131) and/or at least one venting conduit (23) and/or at least one container (12) with at least one inert gas comprises conveying at least one inert gas from the at least one gas storage container (21) at least once through at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12).

14. Method according to one of the claims 10 to 13, wherein the method further comprises retaining at least one inert gas within the at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12) for a predetermined time.

15. Method according to claim 10 to 14, wherein the method further comprises conveying at least one inert gas through at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12) in two different flow directions.

16. Method according to at least one of the claims 10 to 15, wherein the method further comprises flushing at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12) with at least one inert gas until a predetermined value of oxygen within the at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12) is reached.

17. Method according to at least one of the claims 10 to 16, wherein chronologically before conveying at least one inert gas from the at least one gas storage container (21) through at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12),

- transferring the at least one liquid through the at least one liquid-transfer conduit (131) to at least one filter (24), and/or
- transferring the air and/or flammable gas and/or explosive gas through the at least one filter (24), and/or
- transferring the air and/or flammable gas and/or explosive gas, and preferably gas from the gas storage container (21), through at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23).

18. Computer-implemented method according to one of the claims 10 to 17, wherein the method steps of flushing with at least one inert gas and/or transferring at least one liquid comprise open-loop and/or closed-loop controlling by at least one open-loop and/or closed-loop controller (4).

19. Method, preferably a computer-implemented method, according to at least one of the claims 10 to 18, wherein the method further comprises carrying out at least one leakage test chronologically before conveying at least one inert gas through at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12).

20. Method, preferably computer-implemented method, according to the previous claim, wherein the leakage test comprises:

- measuring the current pressure within at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12) at least once, and/or
- waiting for a predetermined time interval, without changing any settings of the device (1), and/or
- measuring the pressure within at least one part of the liquid-transfer conduit (131) and/or at least one part of the venting conduit (23) and/or the at least one container (12) again, and/or

21. Use of a device (1) according to one of the claims 1 to 9 for carrying out a method according to one of the claims 10 to 20, preferably for transferring a liquid, preferably a flammable or explosive liquid, particularly preferably a pharmaceutical liquid, from a bulk storage container (11) to at least one container (12) through the at least one liquid-transfer conduit (131).

Fig.1

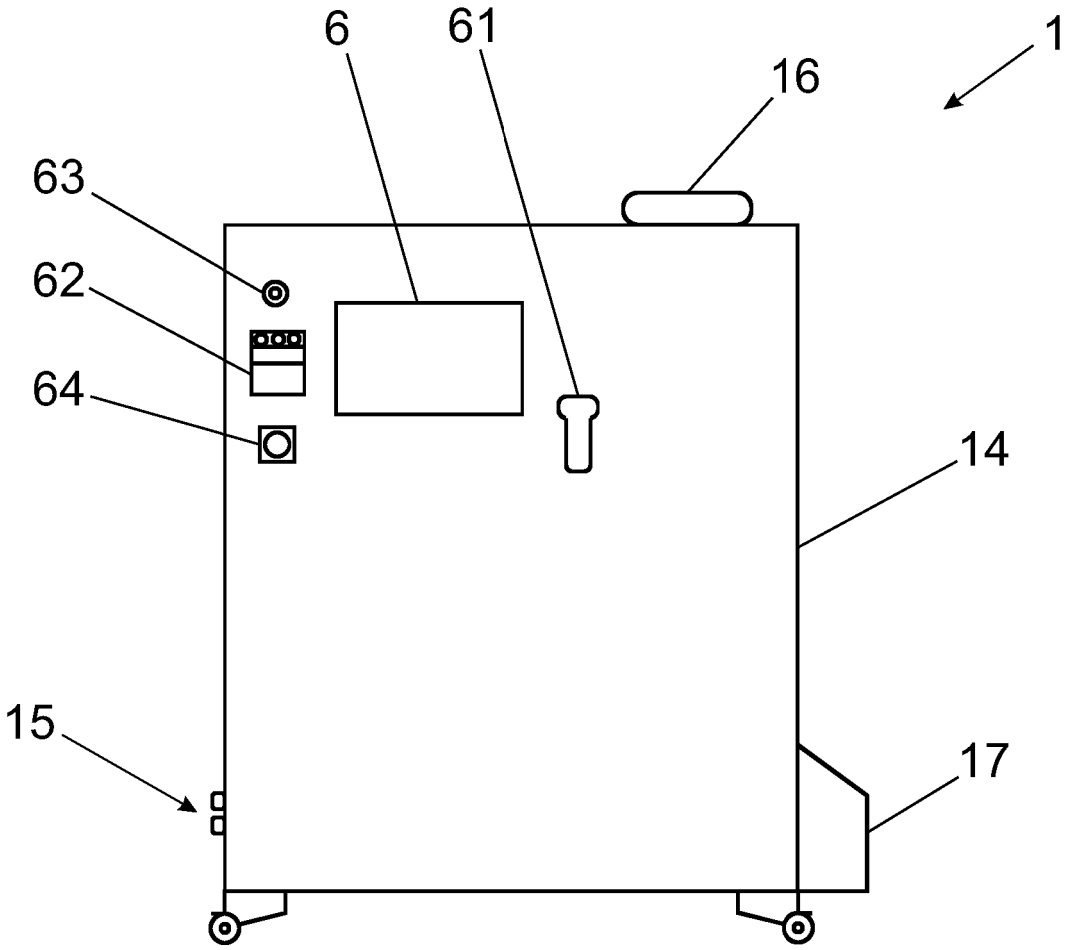


Fig.2

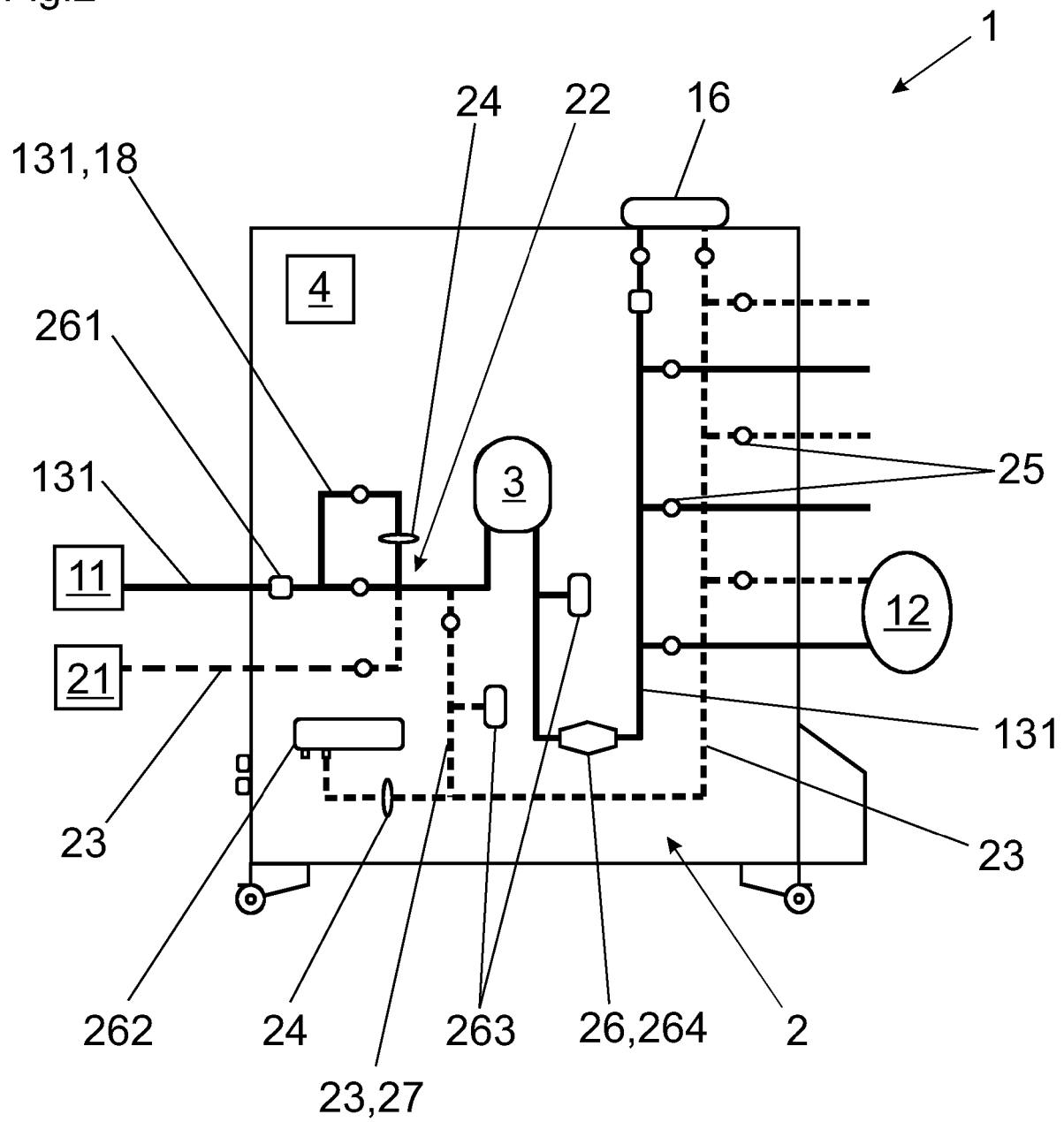

1
24
22
16
131,18
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23,27

Fig.3

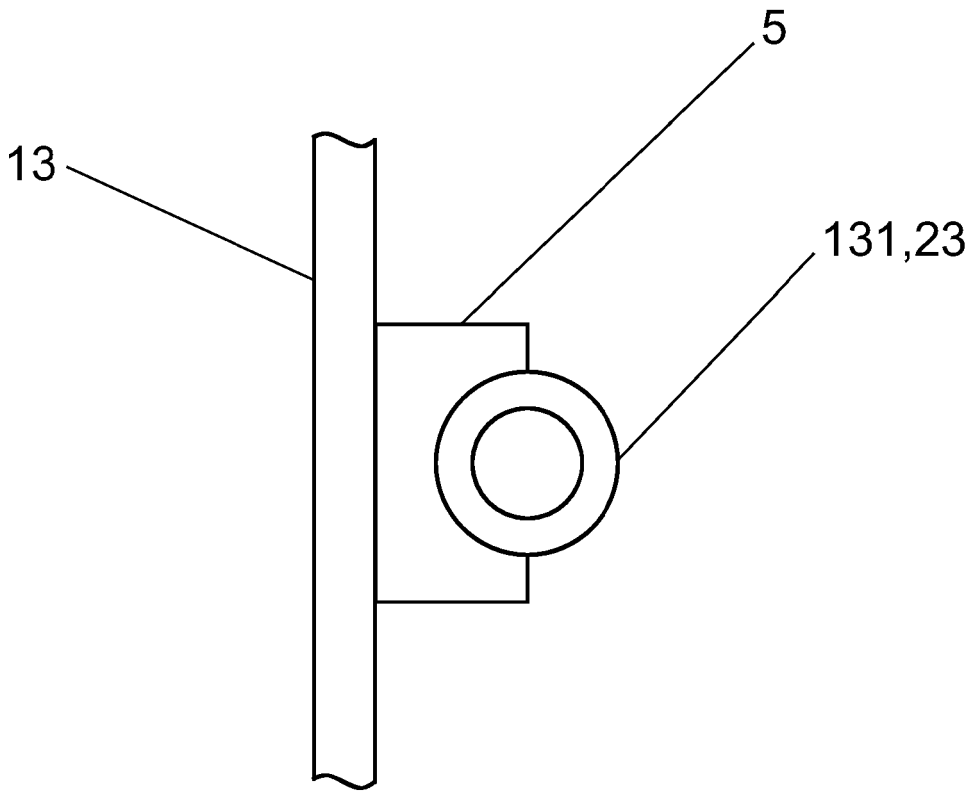
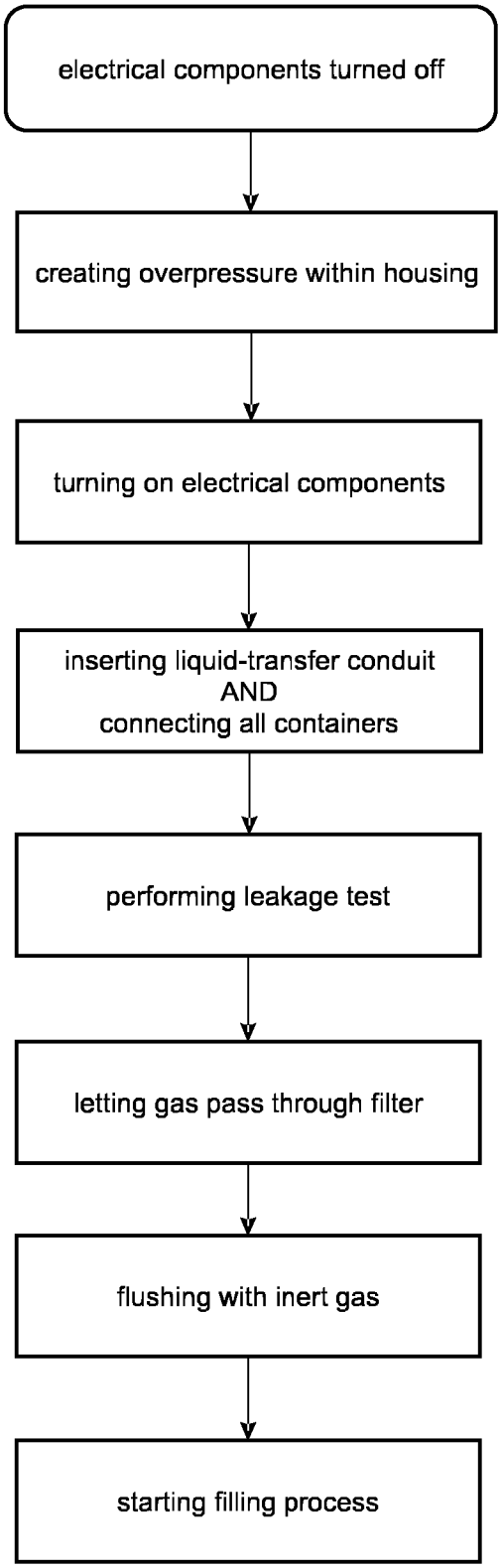


Fig.4


electrical components turned off
creating overpressure within housing
turning on electrical components
inserting liquid-transfer conduit
AND
connecting all containers
performing leakage test
letting gas pass through filter
flushing with inert gas
starting filling process

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EUROPEAN SEARCH REPORT

Application Number
EP 25 16 7774

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F17C
B67D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 September 2025	Dick, Birgit

CATEGORY OF CITED DOCUMENTS

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