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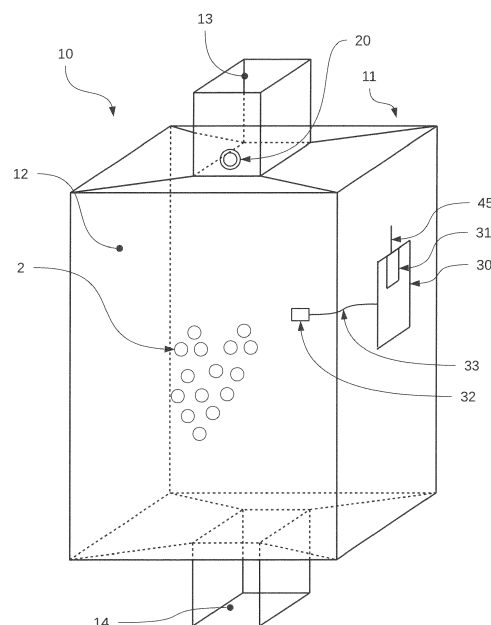
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(54) **A BULK CONTAINER FOR STORING FLOWABLE GOODS, A SYSTEM FOR PROCESSING ATMOSPHERIC MEASUREMENT DATA, A METHOD FOR ANALYZING ATMOSPHERIC MEASUREMENT DATA AND A COMPUTER-READABLE MEDIUM**

(57) The supervision of the atmospheric conditions in a bulk container with flexible material is labor intensive and requires on-site personal. This problem is solved by a bulk container (10) for storing flowable goods (2), comprising:

- a shell (11) of a flexible material, the shell (11) defining a load chamber (12);
 - at least one atmospheric sensor unit (30) adapted to capture atmospheric measurement data (111) from inside the load chamber (12), the atmospheric measurement data (111) indicating at least one atmospheric characteristic within the load chamber (12);
- wherein a communication unit (31) is adapted to establish a wireless communication link (3, 3') and further adapted to transfer the atmospheric measurement data (111) via the wireless communication link (3, 3').

Fig. 1



Description

[0001] The present application is directed towards a bulk container for storing flowable goods, a system for processing atmospheric measurement data, a method for analyzing atmospheric measurement data and a computer-readable medium.

[0002] Flexible Intermediate Bulk Containers (FIBCs) or "Big Bags" are large-volume containers made of flexible material, typically an artificial fabric, which forms a stable and flexible outer shell of the bulk container. Such containers are available in various designs and typically comprise a transport bag to which lifting loops are attached. These containers are suitable for the storage and transport of large quantities of bulk material or flowable goods that can weigh several tons. A flowable good can relate to liquid as well as to solid material, for example pellets or powders, that have a flowing capability. When empty, flexible bulk containers can be folded up to save space. Apart from building materials such as sand and cement, FIBCs are also used for the transport of granular materials and powders for the chemical industry as well as for seeds, fertilizers and food.

[0003] One particular kind of a bulk container is a bulk container that can contain a controlled atmosphere. With this kind of bulk container, the amount of oxygen, the level of CO₂ or other atmospheric parameters are strictly controlled. An FIBC with a controlled atmosphere is also called a modified atmosphere package (MAP).

[0004] After filling a bulk container with a flowable good, for example, the oxygen may be sucked out of the container using a valve to control the atmosphere. As such, the oxygen may be sucked out through the valve using a pump. Alternatively, a gas may be pumped into the container to replace oxygen within the bulk container. A suitable gas is CO₂ or nitrogen. When using a modified or controlled atmosphere in the bulk container, the bulk container is in particular suitable for the transport of perishable goods, for example food.

[0005] When transporting food, it is essential to monitor the atmospheric conditions within the bulk container in detail. Any deviation from a target atmosphere may have detrimental effects on the goods contained within the bulk container. In particular, the amount of CO₂ in the bulk container has a direct influence on, for example, the spread of pest infestation within the bulk container. Moreover, O₂ is linked with the oxidation process and thus the goods stored in the bulk container are negatively impacted.

[0006] As the atmospheric conditions within the bulk container need to be maintained, it is required to measure the atmospheric conditions during regular intervals. For this, atmospheric sensors can be used. From US 2019375572 A1 it is known to insert sensors into a container that provides a visual indication of the oxygen level within a container through a transparent window. Thus, it is possible to monitor the oxygen level within a bulk container and to infer whether the stored goods are in an

acceptable condition.

[0007] Still, using a transparent window to monitor the atmospheric conditions requires a manual inspection of each container. Having to manually review each bulk container has several drawbacks. For example, monitoring a large quantity of bulk containers is very labor intensive. Moreover, monitoring multiple containers that are stacked on top of each other is not possible. In addition, the current solutions require the presence of on-site personnel. Furthermore, during transport of a bulk container, the bulk containers are loaded onto trucks or on ships. Thus, during this time, monitoring the atmospheric conditions using visual indicators is not possible.

[0008] It is thus an objective of the present invention to overcome the described drawbacks of the prior art. In particular, it is an object of the present invention to allow monitoring the atmospheric conditions anytime and from any place. More in particular, the present invention has the object to allow monitoring multiple bulk containers in a user friendly way.

[0009] The object is solved by the bulk container according to claim 1, the system according to claim 10, the method according to claim 14 and the computer-readable medium according to claim 15.

[0010] The object is in particular solved by a bulk container, in particular a flexible intermediate bulk container (FIBC), for storing flowable goods, comprising:

- a shell of a flexible material, the shell defining a load chamber, wherein the load chamber is adapted to be filled with a gas or to be vacuumed, thereby creating a controlled atmosphere within the load chamber;
- at least one atmospheric sensor unit adapted to capture atmospheric measurement data from inside the load chamber, the atmospheric measurement data indicating at least one atmospheric characteristic within the load chamber;

wherein a communication unit is adapted to establish a wireless communication link and further adapted to transfer the atmospheric measurement data via the wireless communication link.

[0011] A core of the present invention is the wireless transfer of sensor data from the bulk container. This has many benefits. For examples, using a wireless communication link enables the supervision of the conditions in a bulk container without the need for manual inspection. Moreover, it is possible to monitor multiple bulk containers at the same time. Furthermore, it is possible to monitor bulk containers that do not provide direct access, for example when multiple containers are stacked on top of each other. Lastly, a wireless communication link allows remote monitoring such that clients or customers may monitor the current status of the cargo from a remote company site.

[0012] In one embodiment, the flexible material of the shell may be made of a flexible fabric with gas barrier capabilities and/or water barrier capabilities, in particu-

lar of a polymer type.

[0013] A gas barrier or water barrier capability may be present when the water and/or oxygen transmission rate is less than a predetermined value. The water transmission rate is calculated as the grams of water permeating through the shell per square meter during a 24 hours period, measured at 30° C room temperature with 90% humidity. The gas transmission rate is calculated as the grams of oxygen permeating through the shell per square meter over 24 hours period measure at 23°C room temperature with 75% humidity.

[0014] A water barrier capability is considered to be achieved when the water transmission rate is less than 1, preferably less than 0,5 and more preferably less than 0,05. A oxygen barrier capability is considered to be achieved when the oxygen transmission rate is less than 0,6, preferably less than 0,06, more preferably less than 0,006.

[0015] In order to facilitate inspection of the goods stored within the container, the flexible fabric may be made with oxygen and/or water barrier capabilities. The amount of oxygen stored within the bulk container is one key indicator for the current quality of the stored goods. Polymer type materials can be made flexible such that the bulk container may be folded and stored in a compact fashion.

[0016] In one embodiment, the shell may comprise at least one outer layer and at least one inner layer, wherein the inner layer may be made of a material with oxygen and/or water barrier capabilities, in particular of a polymer type, of a low density polyethylene type, of an ethylene vinyl alcohol type, of an aluminum type, of an antistatic and/or of an electrically conducting type, and wherein the valve unit is adapted to at least seal the inner layer.

[0017] Generally, the shell may be made out of a single layer or of at least two layers. In a multiple layer configuration, i.e. with at least two layers, an outermost layer may be made of a rugged material that can sustain heavy loads. An inner layer may be made out of material with oxygen and/or water barrier capabilities and thus may guarantee the controlled atmosphere. The layers may be attached to each other in attachment sections. For example, multiple layers of the shell may be sewn together, glued together and/or welded together.

[0018] Using multiple layer has the advantage that each layer may fulfil a particular function with preferred properties, such as being very sturdy or blocking certain gases.

[0019] In one embodiment, the shell and/or the outer layer of the shell may comprise lifting loops in a top section of the bulk container.

[0020] The lifting loops may be used to lift the bulk container for transport and thus ease the handling of the container.

[0021] In one embodiment, an/the outer layer of the shell may be of a polypropylene type material. Polypropylene type material has the advantage of being heat resistant and leads to sturdy material characteristics.

[0022] In one embodiment, the bulk container may comprise a valve unit arranged on the shell to fill the load chamber with a gas or to vacuum the load chamber, thereby creating a controlled atmosphere within the load chamber.

[0023] Hence, the controlled atmosphere can be created by the using the valve. This is in particular beneficial as the atmosphere can be restored in case the atmospheric measurements indicate that this is required.

[0024] In one embodiment, the at least one atmospheric sensor unit and/or the communication unit may be arranged inside a pocket formed on the inside of the shell, in particular on the inside of an/the inner layer.

[0025] Using a pocket to store the at least one atmospheric sensor unit and/or the communication unit has the advantage that the respective unit may be easily inserted or taken out of the bulk container for inspection. Moreover, it is easily possible to replace a malfunctioning unit. Lastly, using a pocket formed on the inside of the shell enables the use of flexible material to hold the sensor and/or communication unit in place.

[0026] In one embodiment, the at least one pocket is made of a micro-perforated material, whereby gas flow is provided. Such a configuration allows the effective measurement of the atmosphere within the bulk container without the need for a sensor probe that reaches into the load chamber.

[0027] In one embodiment, the at least one atmospheric sensor unit and/or the communication unit may be embedded, in particular interwoven, with the shell material, in particular interwoven with an/the inner layer.

[0028] Embedding the sensor and/or communication unit with the shell material has the advantage of shielding the respective unit from the goods stored in the bulk container. As a result, the functioning of the communication and/or sensor unit can easily be maintained.

[0029] In one embodiment, the at least one atmospheric sensor unit and/or the communication unit may be at least partially arranged outside the inner layer and/or outside the shell, wherein a sensor probe of the at least one atmospheric sensor unit extends through a measurement opening of the shell and/or inner layer.

[0030] The aforementioned embodiment has the advantage that the sensor and/or communication unit may be shielded from the goods stored in the container and in addition allow easy maintenance and/or replacement of the respective unit. A sensor probe may be injected into the inside of the bulk container using a rubber seal through which the sensor probe may be inserted into the inside of the bulk container.

[0031] In one embodiment, the at least one atmospheric sensor unit and/or the communication unit may further comprise a power unit, in particular a battery, preferably a removable battery.

[0032] To provide an easy way of powering the sensor and/or communication unit, a power unit may be provided. The power unit may be attached or arranged in close range to the communication and/or sensor unit.

[0033] In one embodiment, a/the power unit may comprise at least one coil or at least one capacitor, whereby the power unit is rechargeable using inductive and/or resonant charging.

[0034] Using inductive or resonant charging enables to store the power unit within the bulk container while retaining the ability to charge the power unit. Thus, using a configuration that enables inductive or resonant charging provides more flexibility regarding the attachment or storage of the power unit as well as the communication and/or sensor unit.

[0035] In one embodiment, at least one solar panel may be arranged on the outside of the shell, preferably on a top part of the shell, wherein the at least one solar panel may be electrically coupled with the power unit to supply power to the atmospheric sensor unit.

[0036] It is also possible to charge the power unit using solar panels that are attached to the outside of the shell. With this configuration, it is not necessary to manually or automatically charge the power unit. As a result, the respective embodiment provides great flexibility with regards to using the bulk container. For example, with such a configuration it is possible to store a bulk container on the outside for an extended duration.

[0037] In one embodiment, the bulk container may comprise at least one antenna to broadcast and receive data, the at least one antenna being communicatively coupled to the communication unit.

[0038] The at least one antenna can be of different types. For example, the antenna may be a patch antenna, which may be glued on the outside of the shell or a rod antenna. In a different embodiment, the antenna may be arranged inside a sensor case, wherein preferably a sensor case is made out of a non-conducting material. In other embodiments, the case may be made of stainless steel. Stainless steel in particular provides additional benefits in case the case may get into contact with perishable goods, like food.

[0039] In one embodiment, a/the at least one antenna is arranged on the outside or inside wall of a sensor case, the communication unit, a control unit and/or the at least one atmospheric sensor unit being at least partially, preferably fully, arranged within the sensor case.

[0040] Arranging the antenna closely to the sensor case, the communication unit, a control unit and/or the at least one atmospheric sensor unit has the advantage of reducing the required cable lengths. In particular, an integrated construction allows deploying with different bulk containers.

[0041] The different components may be arranged inside the sensor case using a potting process. Potting may refer to the filling of the sensor case with a solid or gelatinous compound. For example, epoxy resin, thermosetting plastics or silicone rubber may be used.

[0042] In one embodiment, a/the at least one antenna may be arranged on the outside of the shell.

[0043] In one embodiment, a/the at least one antenna may be embedded within the shell, preferably interwoven

with the shell material, in particular an/the outer layer.

[0044] A very advantageous embodiment can be achieved when the antenna is embedded within the shell. Thus, the antenna may easily radiate outside of the shell and still be in close proximity to the sensor and/or communication unit. Moreover, the antenna may be protected by the shell material.

[0045] In one embodiment, the bulk container may comprise a control unit, wherein the control unit may be adapted to initiate measuring at least one measurement of the at least one atmospheric sensor unit, preferably at predetermined intervals.

[0046] A control unit may thus be used to control the measurements of the sensor unit. For example, the control unit may be used to initiate sensor readings at predefined intervals or at specific times. Moreover, it is possible to trigger a measurement using a received trigger signal from a device via the communication unit. Thus, the extended supervision of the atmospheric conditions within the bulk container can be ensured.

[0047] In one embodiment, the bulk container may comprise a memory unit adapted to store the atmospheric measurement data, wherein the communication unit may be adapted to transfer the stored atmospheric measurement data at a predetermined time and/or at predetermined time intervals.

[0048] The memory unit may store one or more measurement values. Thus it is possible to only transfer the stored measurement data at predefined times and/or predefined intervals. As the transmission of the data consumes energy, a reduction in transmission intervals may reduce the overall energy consumption of the bulk container.

[0049] In one embodiment, the at least one atmospheric sensor unit may be adapted to measure one or more of: gas type, preferably using spectroscopy, humidity, pressure, light, in particular light temperature and/or light intensity, temperature, mass, vibration, acceleration, location, time, current or voltage.

[0050] As a result, various different atmospheric indicators may be measured. The measured indicators may be used to derive the status of the goods stored within the bulk container. Such a computation may either be performed on the computation unit or on a unit receiving the measurement data.

[0051] In one embodiment, it is also possible that the communication unit only transmits measurement data whenever a measurement value of the measurement data is below and/or above a predetermined threshold. Using this embodiment, the energy consumption can be further reduced by reducing the number of times of transmitting the measurement data. As a result, only relevant data is transmitted.

[0052] The object of the present invention is further in particular solved by a system for processing atmospheric measurement data, in particular of flexible intermediate bulk containers, comprising:

a plurality of bulk containers, each in particular as described above;

a processing unit adapted to receive atmospheric measurement data from the plurality of bulk containers, the processing unit adapted to process the atmospheric measurement data and to store the received and/or processed atmospheric measurement data in a processing memory.

[0053] With the described system it is possible that the processing unit receives the atmospheric measurement data from a plurality of bulk containers. As a result, a big cargo or all goods of a particular vendor and/or customer may be monitored using the aforementioned system.

[0054] The processing unit may be a server computer or a plurality of server computers. Moreover, it is conceivable that the processing unit is implemented as at least one processor. In addition, the processing unit may also refer to an entire network of interconnected processors/servers. As a result, the processing unit may also refer to an entire distributed computing system or a cloud infrastructure. Of course, further configurations of the processing unit are conceivable and the aforementioned list may not be understood in a limiting manner.

[0055] In one embodiment, the system may further comprise at least one first gateway unit adapted to receive atmospheric measurement data from the plurality of bulk containers and/or from at least one second gateway unit, wherein a gateway unit may be adapted to transfer the received atmospheric measurement data to the processing unit.

[0056] A gateway unit may be used to collect the measurement data of several bulk containers that are in close proximity to the gateway unit. Thus, the measurement data of several bulk containers may be grouped and sent to the processing unit together, which reduces the number of times data has to be transmitted, which in turn reduces the required energy consumption.

[0057] In one embodiment, the at least one first and/or the at least one second gateway unit may be adapted to receive the atmospheric measurement data via a first communication link of a first communication technology and further adapted to transfer the received atmospheric measurement data to the processing unit using a second communication link of a second communication technology.

[0058] Using two different communication technologies for the different communication links facilitates optimising the overall communication. For example, the first communication technology may refer to a short range wireless technology, such as Wi-Fi or a technology using Zig-Bee or Bluetooth. The second communication technology may refer to a communication technologies used for long-range communication, such as mobile technologies such as LTE, UMTS or GSM or a 5G based technology.

[0059] In one embodiment, a/the at least one first gate-

way is arranged on a bulk container.

[0060] As a result, it is also possible that the bulk container itself serves as the gateway such that no additional hardware systems are required. As such, the bulk container with the gateway serves as a master unit wherein the remaining bulk containers may serve as slave units.

[0061] In one embodiment, the processing unit is further adapted to determine a value for at least one quality criteria based on the atmospheric measurement data, in particular based on a measured concentration of oxygen.

[0062] A quality criteria may refer to a degree of oxidation. In addition, the processing unit may be adapted to compute a degree of infestation or a risk of infestation based on the degree of oxidation. Moreover, a quality criteria may also refer to monetary value of the goods stored in a bulk container or stored in multiple bulk containers.

[0063] In one embodiment, a visualization unit may be adapted to visualize the stored atmospheric measurement data.

[0064] Providing a visualisation to the user enables a comfortable supervision of multiple containers. In addition, bulk containers with measurements outside a defined range may be highlighted such that manual inspection of these containers may be initiated. Moreover, prioritization of the bulk containers during production is facilitated. For example, a bulk container for which the measurement data indicates a deviation of predetermined values may be used first during the production of an end product.

[0065] The object of the present invention is further in particular solved by a method for analyzing atmospheric measurement data, the method comprising the following steps:

Measuring at least one atmospheric characteristic within a load chamber of at least one bulk container to generate atmospheric measurement data, in particular using at least one atmospheric sensor unit of a bulk container as described above;

Wirelessly transferring the atmospheric measurement data to a gateway unit or to a processing unit, in particular a gateway unit or a processing unit of a system as described above, using a first communication link;

Receiving the atmospheric measurement data at a processing unit, in particular a processing unit as described above;

Processing the received atmospheric measurement data, in particular by the processing unit, to determine a value for at least one quality criteria based on the received atmospheric measurement data, in particular based on a measurement of the concentration of oxygen within the load chamber.

[0066] In one embodiment, the method may further comprise visualizing the determined value of the least one quality criteria, in particular on an end-user device.

[0067] An end-user device may be a smartphone or a tablet or any other personal computing device. Still, other devices are conceivable, for example a laptop.

[0068] The object of the present invention is further in particular solved by a computer-readable medium storing instructions that, when executed by at least one processor, cause the at least one processor to implement a method as described above.

[0069] Further embodiments are described by the dependent claims.

[0070] In the following, embodiments of the invention are described with reference to the accompanying figures. The figures show:

Figure 1: a schematic overview of a bulk container with a sensor unit;

Figure 2: a schematic overview of an atmospheric sensor;

Figure 3: an overview of a first charging mechanism;

Figure 4: an overview of a second charging mechanism;

Figure 5: a schematic overview of a bulk container with a solar panel;

Figure 6: a schematic overview of a bulk container with an antenna on a sensor case;

Figure 7: a schematic overview of a bulk container with a patch antenna;

Figure 8: a schematic overview of a sensor unit arranged in a pocket;

Figure 9: a schematic overview of a sensor unit integrated into the shell of the bulk container;

Figure 10: an overview of a sensor probe which is inserted into the bulk container;

Figure 11: a schematic overview of a system for processing atmospheric measurement data; and

Figure 12: a flow diagram of a method for analyzing atmospheric measurement data.

[0071] In the following, same or similar entities are denoted by the same reference numerals.

[0072] Figure 1 illustrates a bulk container 10. The bulk container 10 comprises a shell 11 which defines a load chamber 12. The load chamber 12 can be loaded using

a loading opening 13 which is arranged on the top part of the bulk container 10. Inside of the load chamber 12, flowable goods 2 are stored. In the embodiment shown in figure 1, the flowable goods 2 are perishable goods that are sensitive to the presences of oxygen.

[0073] On the bottom part of the bulk container 10, a discharge opening 14 is arranged. Using the discharge opening 14 the flowable goods 2 may be discharged.

[0074] In order to preserve a controlled atmosphere inside the load chamber 12, the top part of the bulk container 10 comprises a valve 20. Thus, once the load chamber 12 is filled with flowable goods 2, the top part can be sealed and remaining oxygen and/or CO₂ may be sucked out of the load chamber 12 using the valve 20.

[0075] To monitor the atmospheric conditions within the load chamber 12, an atmospheric sensor 30 is arranged on the shell 11 of the bulk container 10. The atmospheric sensor 30 comprises a communication unit 31 with an antenna 45, whereby wireless communication is facilitated. To measure the atmospheric conditions within the load chamber 12, the atmospheric sensor 30 comprises a sensor probe 32, which is connected to the atmospheric sensor 30 with a sensor probe connection 32.

[0076] The sensor probe 32 may be adapted to measure the amount of oxygen. Thus, various implementations of the sensor probe 32 are known to the person skilled in the art. The sensor probe 32 may be implemented with regards to the principles of electro-galvanic oxygen sensors. It is further conceivable that the sensor probe 32 is implemented using the principles of the Clark electrode. Measurement data transferred from the sensor probe 32 using the sensor probe connection 33 to the atmospheric sensor 30 may be analogue or digital.

[0077] The atmospheric sensor 30 is further adapted to wirelessly transfer the recorded measurement data by the sensor probe 32 using a communication unit 31 via the antenna 45 to an external device, for example a smartphone.

[0078] The communication unit 31 may be adapted to transmit the measurement data wirelessly using the antenna 45. For this, the communication unit 31 may be adapted to use any communication technology enabling the transmission of the measurement data. In particular, the communication unit 31 may be adapted to use a GSM, UMTS or LTE-based technology. Moreover, it is possible that the communication unit 31 uses the ZigBee, Z-Wave standard or Bluetooth low energy, Bluetooth Smart or Thread standard. These technologies differ with regard to the supported range. For example, Bluetooth Smart may support the transmission of data in an area of less than 10 m. ZigBee, Thread, and Z wave are usually adapted for ranges of less than a hundred meters around the communication unit 31. Traditional mobile technologies, like GSM, UMTS or LTE are adapted for the transmission of data over distances spanning up to several kilometers. Of course, Wi-Fi standards, like IEEE 802.11n or similar standards may be supported by the

communication unit 31.

[0079] Figure 2 shows a more detailed schematic of the atmospheric sensor 30. The atmospheric sensor 30 according to figure 2 comprises a sensor case 39. Within the sensor case 39, the communication unit 31, a sensor processing unit 34 as well as a sensor memory unit 35 are arranged. In addition, a battery compartment 37 is arranged within the sensor case 39.

[0080] The sensor processing unit 34 is connected to the sensor probe 32 via a sensor probe connection 33. As a result, measurement data may be transmitted from the sensor probe 32 to the processing unit 34. The processing unit 34 may analyze the measurement data to determine whether the measured atmospheric conditions within the load chamber 12 fulfil a preset requirement. For example, the processing unit 34 may be adapted to compare a measurement value of the measurement data with a predetermined threshold value, for example for the amount of oxygen. As such, the processing unit may be adapted to identify an increase in the oxygen concentration within the load chamber 12, which may indicate a defect in the shell 11 of the bulk container 10. The predetermined threshold value together with a respective quality criteria may be stored in the sensor memory unit 35.

[0081] The sensor processing unit 34 in the present embodiment is implemented as a field programmable gate array (FPGA). Still, other implementations of the sensor processing unit 34 are possible, for example as application-specific integrated circuits (ASIC) or general-purpose processors, for example using an x86 or ARM architecture.

[0082] The sensor processing unit 34 is communicatively connected with the sensor memory unit 35. As a result, the measurement data may be stored within the sensor memory unit 35. Furthermore, the sensor memory unit 35 is adapted to store application instructions that are used by the sensor processing unit 34 to analyze the measurement data.

[0083] In addition, the sensor processing unit 34 is communicatively coupled with the sensor communication unit 31. As a result, the sensor processing unit 34 is adapted to initiate the transfer of measurement data using the sensor communication unit 31. In addition or alternatively, the sensor processing unit 34 may be adapted to initiate the transfer of measurement data at predetermined intervals or at predetermined times.

[0084] The sensor case 39 further comprises a battery compartment 37, which comprises a battery compartment opening 37. When opening the battery compartment opening 37, a battery 38 may be inserted into the battery compartment 37 to provide power to the atmospheric sensor 30. Hence, the battery 38 is at least electrically coupled to the sensor processing unit 34. The battery 38 may be rechargeable and of any type of battery. For example, the battery 38 may be a lithium ion battery.

[0085] Figure 3 shows a different embodiment of the

battery compartment 37. As in the embodiment of figure 2, the battery 38 is inserted into the battery compartment 37. In order to recharge the battery 38, a battery plug 40 is provided. As a result, the power unit 30 that provides power to the atmospheric sensor 30 may be charged without having to eject the battery 38.

[0086] Figure 4 shows an alternative embodiment of the battery recharge mechanism. As with the embodiment of figure 3, the embodiment shown in figure 4 comprises a battery compartment 37 with a battery 38 therein. In order to recharge the battery 38, a coil 41 is connected to the battery 38. Opposite of the coil 41, a charging plate 42 is arranged, such that the battery 38 may be charged using induction. The details of such an implementation are known to the person skilled in the art. This embodiment provides significant advantages with regards to how to charge the battery when the sensor case 39 is stored within the lower chamber 12. In such an embodiment, the charging plate 42 is not part of the sensor unit 30 but is a separate device.

[0087] Figure 5 shows a further embodiment of how the battery 38 may be recharged. In the embodiment shown in figure 5, the bulk container 10 comprises a solar panel 43, which is attached on the outside of the shell 11. The solar panel 43 is electrically coupled with the atmospheric sensor 30 using a solar panel connection 44. As a result, the atmospheric sensor 30 can either be directly powered using the solar panel 43 or the battery 38 stored within the atmospheric sensor 30 may be recharged using the power provided by the solar panel 43.

[0088] Moreover, figure 5 shows an embodiment, where in the atmospheric sensor 30 is attached on the outside of the shell 11.

[0089] Figure 6 shows an embodiment, wherein the antenna 45 of the atmospheric sensor 30 is arranged on the outside of the atmospheric sensor 30, i.e. on the outside of the sensor case 39. The antenna 45 may be a rod antenna.

[0090] Figure 7 shows a different embodiment, wherein the antenna 45 is implemented as a patch antenna 45 which may be arranged on the outside of the shell 11. In particular, the patch antenna 45 may be flexible and thus allow for a compact storage of an empty bulk container 10.

[0091] Figures 8 and 9 illustrate further embodiments how the atmospheric sensor 30 may be arranged on the bulk container 10.

[0092] Figure 8 shows that the atmospheric sensor 30 may be arranged inside a pocket 16 on the inside 15 of the shell 11.

[0093] The shell 11 may be made of at least two layers. In such an arrangement, the pocket 16 may be arranged on the inside of the innermost layer 15 of the shell 11. In particular, the pocket 16 may be made out of stretch material, such that the atmospheric sensor is solidly arranged. In addition, the pocket 16 may comprise an opening or may be fully closed. Thus in one embodiment, it is possible to remove the atmospheric sensor 30 from the

pocket 16 whereas in other embodiments it is not possible to simply remove the atmospheric sensor 30 without physically open the pocket 16.

[0094] Figure 9 shows an embodiment, wherein the atmospheric sensor 30 is interwoven in a weave area 17 with the material of the shell 11. This embodiment has the advantage that the atmospheric sensor 30 is fixated on the inside 15 of the shell 11.

[0095] Figure 10 shows how the sensor probe 32 may be connected to the atmospheric sensor 30 in case the atmospheric sensor 30 is arranged on the outside 19 of the shell 11. Figure 10 shows that the atmospheric sensor 30 is arranged on the outside 19 of the shell 11 covering a measurement opening 18. Through that measurement opening 18, the sensor probe 32 may be connected to the atmospheric sensor. As a result, the measurement probe 32 is arranged on the inside 15 of the shell 11. The measurement opening 18 may be filled with a rubber seal, that prevents goods 2 from the inside of the lower chamber 12 to get in contact with the atmospheric sensor 30. Moreover, the rubber seal may provide gas and/or water blocking capabilities, while at the same time allowing a connection between the sensor probe 32 with the atmospheric sensor 30.

[0096] Figure 11 illustrates a system 1 that comprises a plurality of bulk containers 10, 10'. The bulk containers 10, 10' differ in that they are arranged at different locations. A first set of bulk containers 10 uses a first communication link 3. A second set of bulk containers 10' uses a second communication link 3'.

[0097] The first set of bulk containers 10 is adapted to communicate with a first gateway 50 using the first communication link 3. As a result, measurement data transmitted from the first set of bulk containers 10 may be aggregated using the first gateway 50.

[0098] The second set of bulk containers 10' is adapted to communicate with a second gateway 50' using the second communication link 3'.

[0099] In the shown embodiment, the first and second set of bulk containers 10, 10' are each adapted to communicate with the first gateway 50 and second gateways 50', using a short range communication technology like ZigBee, respectively.

[0100] The gateways 50, 50' may be arranged separate from the bulk containers 10, 10' but may also be arranged on bulk containers 10, 10', respectively.

[0101] The second gateway 50' is further adapted to transmit received measurement data to the first gateway 50 using a communication link 60' that is based on a communication technology that is different from the technology of the first and second communication link 3, 3'. As a result, multiple gateways may be arranged in a daisy chain fashion, where in the daisy chain may be implemented wirelessly.

[0102] The first gateway 50 is adapted to transmit the measurement data of the first set of bulk containers 10 as well as the measurement data received from the second gateway 50' to a processing unit 80 using a commu-

nication link 60, for example using a mobile technology standard, like GSM or LTE. In the shown embodiment, the processing unit 80 is a computing center providing computing resources in a cloud infrastructure. As such, the processing unit 80 is connected to a storage system 70, which in the present embodiment is implemented as a relational database, like SQL. In other embodiments, schema less databases are possible as well.

[0103] The processing unit 80 is adapted to collect the measurement data of multiple bulk containers 10, 10' and is adapted to analyze the received data. In particular, the processing unit 80 is configured to identify bulk containers 10, 10', whose atmospheric conditions deteriorate. Thus, an end user using a mobile device 90 may be informed that the particular bulk container 10, 10' needs a manual inspection to identify the problem. In addition or alternatively, the end user could use/consume the contents the bulk container 10, 10'. In addition, the processing unit 80 is further adapted to perform various computation tasks. For example, the processing unit 80 may be adapted to compute a monetary value for the goods 2 stored in each bulk container 10, 10'. As the monetary value of the goods 2 stored may be directly influenced by the atmospheric conditions within the respective container 10, 10', a monetary value may be computed. For example, the amount of oxygen within the bulk container 10, 10' influences the probability of infestation and/or product oxidation within the bulk container 10, 10'.

[0104] In addition, the processing unit 80 may be adapted to run a Web server such that a mobile device 90 may access a website that is hosted by the processing unit 80. The website may show the status of all bulk containers 10, 10' using a dashboard. As a result, a user may easily retrieve information on the status of his/her cargo.

[0105] Figure 12 shows a flow diagram of a method 100 processing measurement data 111. In a measuring step 110, atmospheric measurement data 111 is obtained using an atmospheric sensor 30 in a bulk container 10, 10'. The atmospheric measurement data 111 is subsequently transferred to either one or more gateways 50, 50' or directly to a processing unit 80 in a transfer step 120. The processing unit 80 receives the atmospheric measurement data 111 in a receiving step 130. Once the atmospheric measurement data 111 is received by the processing unit 80, the atmospheric measurement data 111 is processed. For example, quality indicators are computed by the processing unit 80 during the processing step 140 as described above. A value 141 of this computation is subsequently visualized in a visualization step 150.

[0106] It should be noted at this point that all the parts described above, taken individually and in any combination, in particular the details shown in the drawings, may be considered to relate to the invention. Modifications of this are possible.

[0107] At this point, it should also be pointed out that all parts or features described above are considered in-

dividually - even without features additionally described in the respective context, even if these are not explicitly identified individually as optional features in the respective context, e.g. by using: in particular, preferably, for example, e.g., if necessary, round brackets etc. - or in combination or any sub-combination as independent features or further developments of the invention, as defined in particular in the introduction to the description and the claims. Deviations from this are possible. Specifically, it should be noted that the word in particular or round brackets, in the respective context, should explicitly indicate non-obligatory features.

Reference numerals:

[0108]

1	system
2	flowable goods
3, 3'	communication link
10, 10'	bulk container
11	shell
12	load chamber
13	loading opening
14	discharge opening
15	inside of shell/inner layer
16	pocket
17	weave area
18	measurement opening
19	outside of shell/outer layer
20	valve
30	atmospheric sensor
31	communication unit
32	sensor probe
33	probe connection
34	sensor processing unit
35	sensor memory unit
36	battery compartment opening
37	battery compartment
38	battery
39	sensor case
40	battery plug
41	coil
42	charging plate
43	solar panel
44	solar panel connection
45	antenna
50, 50'	gateway
60, 60'	communication link
70	storage system
80	processing unit
90	user device
100	method
110	measuring step
111	atmospheric measurement data
120	transferring step
130	receiving step
140	processing step

141	value
150	visualizing step

5 Claims

1. Bulk container (10), in particular flexible bulk container, more in particular intermediate bulk container (10), for storing flowable goods (2), comprising:

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- a shell (11) of a flexible material, the shell (11) defining a load chamber (12);
 - at least one atmospheric sensor unit (30) adapted to capture atmospheric measurement data (111) from inside the load chamber (12), the atmospheric measurement data (111) indicating at least one atmospheric characteristic within the load chamber (12);

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- characterized by**
a communication unit (31) adapted to establish a wireless communication link (3, 3') and further adapted to transfer the atmospheric measurement data (111) via the wireless communication link (3, 3').

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2. The bulk container (10) according to any of the preceding claims,
characterized in that
the at least one atmospheric sensor unit (30) and/or the communication unit (31) is arranged inside a pocket (16) formed on the inside of the shell (11), in particular on the inside of an inner layer (15).

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3. The bulk container (10) according to any of the preceding claims,
characterized in that
the at least one atmospheric sensor unit (30) and/or the communication unit (31) is embedded, in particular interwoven, with the shell (11) material, in particular interwoven with an inner layer (15).

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4. The bulk container (10) according to any of the preceding claims,
characterized in that
the at least one atmospheric sensor unit (30) and/or the communication unit (31) is at least partially arranged outside an inner layer (15) and/or outside the shell (11), wherein a sensor probe (32) of the at least one atmospheric sensor unit (30) extends through a measurement opening (18) of the shell (11) and/or inner layer (15).

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5. The bulk container (10) according to any of the preceding claims,
characterized in that
the at least one atmospheric sensor unit (30) and/or the communication unit (31) further comprises a power unit (38), in particular a battery (38), preferably

a removable battery (38).

6. The bulk container (10) according to any of the preceding claims, in particular according to claim 5, **characterized in that**

a/the power unit (38) comprises at least one coil (41) or at least one capacitor, whereby the power unit (38) is rechargeable using inductive and/or resonant charging; and/or wherein at least one solar panel (43) is arranged on the outside of the shell (11), preferably on a top part of the shell, wherein the at least one solar panel (43) is electrically coupled with the power unit (38) to supply power to the atmospheric sensor unit (30).

7. The bulk container (10) according to any of the preceding claims, **characterized by**

at least one antenna (45) to broadcast and receive data (111), the at least one antenna (45) being communicatively coupled to the communication unit (31).

8. The bulk container (10) according to any of the preceding claims, in particular according to claim 7, **characterized in that**

a/the at least one antenna (45) is arranged on the outside wall of a sensor case (39), the communication unit (31), a control unit (34) and/or the at least one atmospheric sensor unit (30) being at least partially, preferably fully, arranged within the sensor case (39); and/or wherein a/the at least one antenna (45) is embedded within the shell (11), preferably interwoven with the shell (11) material, in particular an/the outer layer (19).

9. The bulk container (10) according to any of the preceding claims, **characterized by**

a control unit (34), wherein the control unit (34) is adapted to initiate measuring at least one measurement of the at least one atmospheric sensor unit (30), preferably at predetermined intervals.

10. System (1) for processing atmospheric measurement data, in particular of flexible intermediate bulk containers (10), comprising:

- a plurality of bulk containers (10, 10'), each in particular according to any of the preceding claims;
- a processing unit (80) adapted to receive atmospheric measurement data (111) from the plurality of bulk containers (10, 10'), the processing unit (80) adapted to process the atmospheric measurement data (111) and to store the received and/or processed atmospheric measurement data (111) in a processing memory (70).

11. The system (1) according to claim 10, **characterized by**

at least one first gateway unit (50) adapted to receive atmospheric measurement data (111) from the plurality of bulk containers (10, 10') and/or from at least one second gateway unit (50'), wherein a gateway unit (50) is adapted to transfer the received atmospheric measurement data (111) to the processing unit (80).

12. The system (1) according to any of the claims 10 to 11, **characterized in that**

the at least one first and/or the at least one second gateway unit (50, 50') is adapted to receive the atmospheric measurement data (111) via a first communication link (60) of a first communication technology and further adapted to transfer the received atmospheric measurement data (111) to the processing unit (80) using a second communication link (60') of a second communication technology.

13. The system (1) according to any of the claims 10 to 12, **characterized in that**

the processing unit (80) is further adapted to determine a value (141) for at least one quality criteria based on the atmospheric measurement data (111), in particular based on a measured concentration of oxygen.

14. A method (100) for analyzing atmospheric measurement data (111), the method comprising the following steps:

- Measuring (110) at least one atmospheric characteristic within a load chamber (12) of at least one bulk container (10, 10') to generate atmospheric measurement data (111), in particular using at least one atmospheric sensor unit (30) of a bulk container (10, 10') according to any of the claims 1 to 9;
- Wirelessly transferring (120) the atmospheric measurement data (111) to a gateway unit (50, 50') or to a processing unit (80), in particular a gateway unit (50, 50') or a processing unit (80) of a system (1) according to any of the claims 10 to 13, using a first communication link (60);
- Receiving (130) the atmospheric measurement data (111) at a processing unit (80), in particular a processing unit (80) according to any of the claims 10 to 13;
- Processing (140) the received atmospheric measurement data (111), in particular by the processing unit (80), to determine a value (141) for at least one quality criteria based on the received atmospheric measurement data (111), in particular based on a measurement of the con-

centration of oxygen within the load chamber
(12).

15. A computer-readable medium storing instructions
that, when executed by at least one processor, cause
the at least one processor to implement a method
according to claim 14.

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Fig. 1

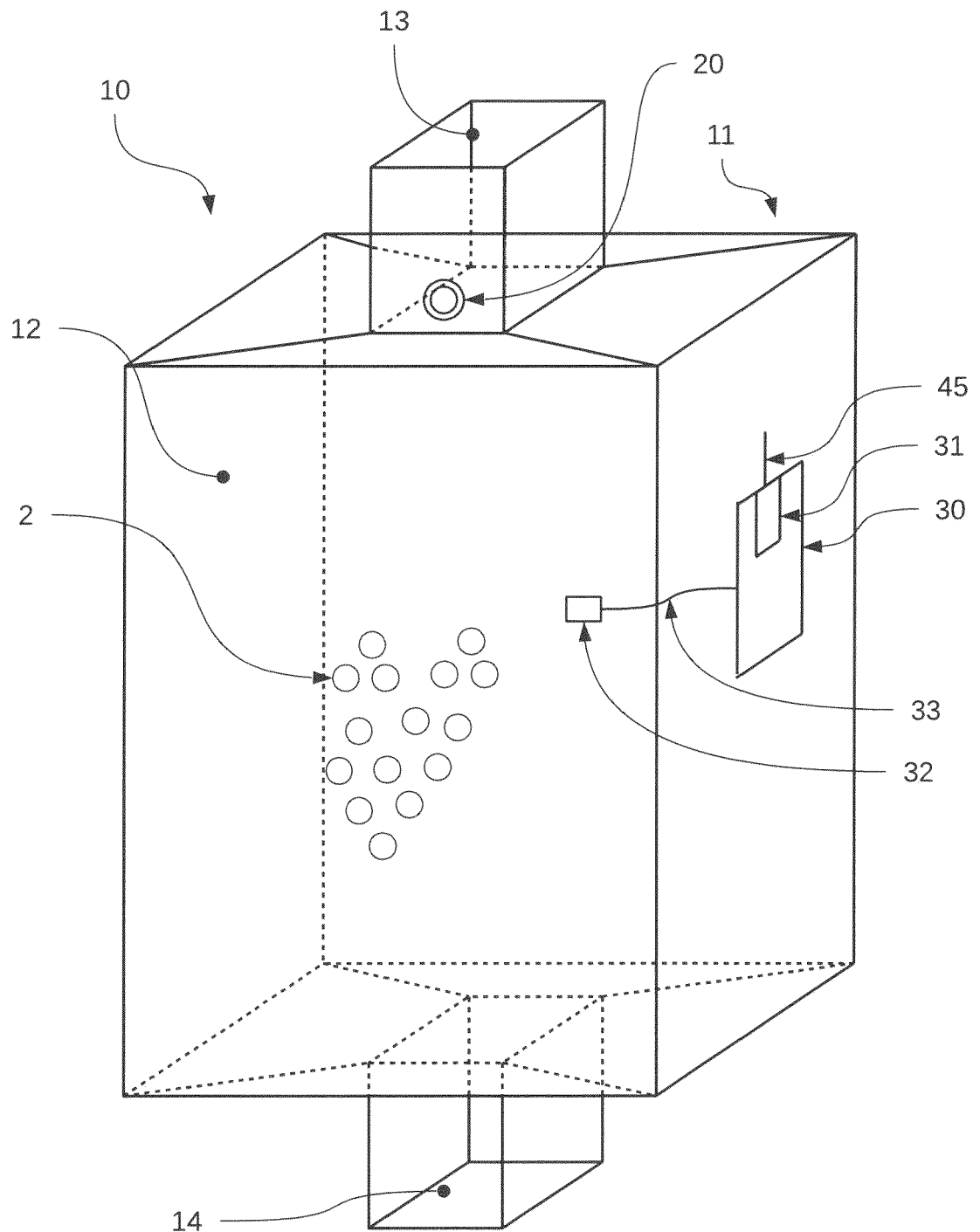


Fig. 2

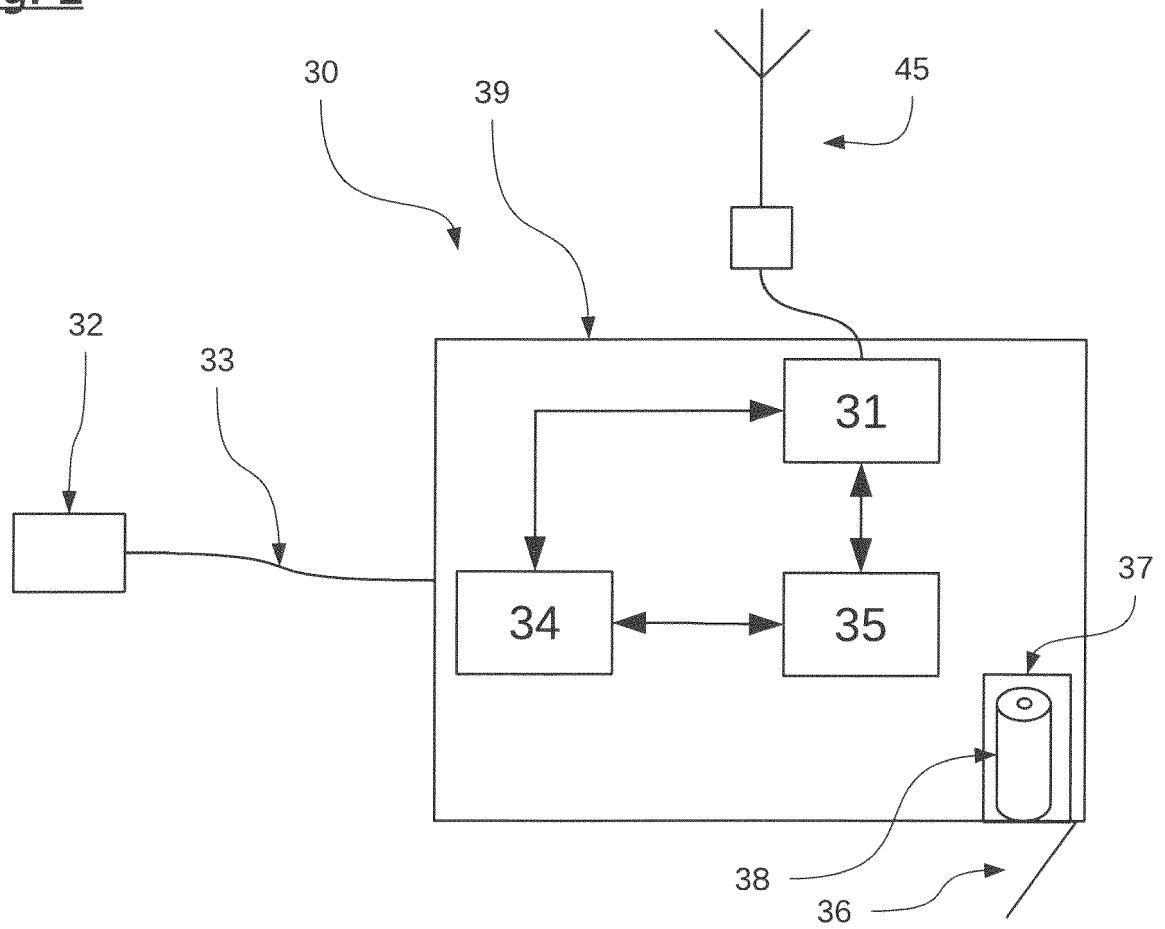


Fig. 3

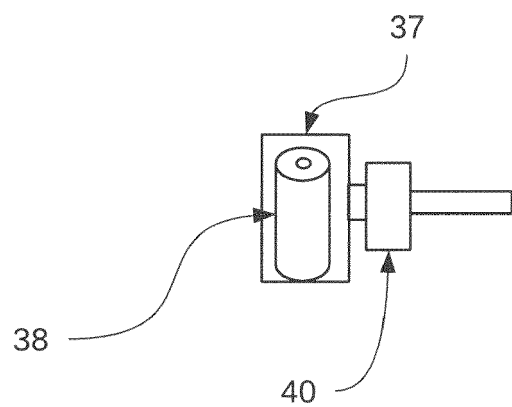


Fig. 4

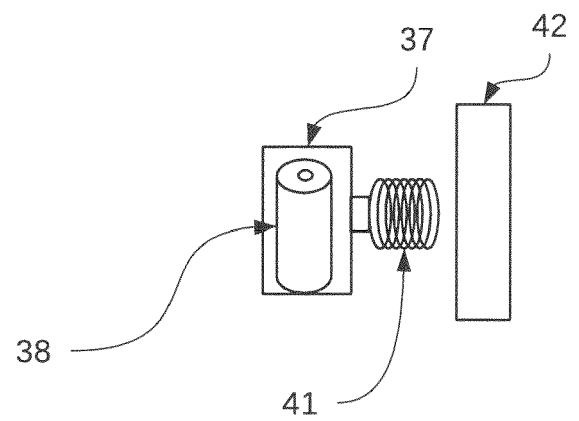


Fig. 5

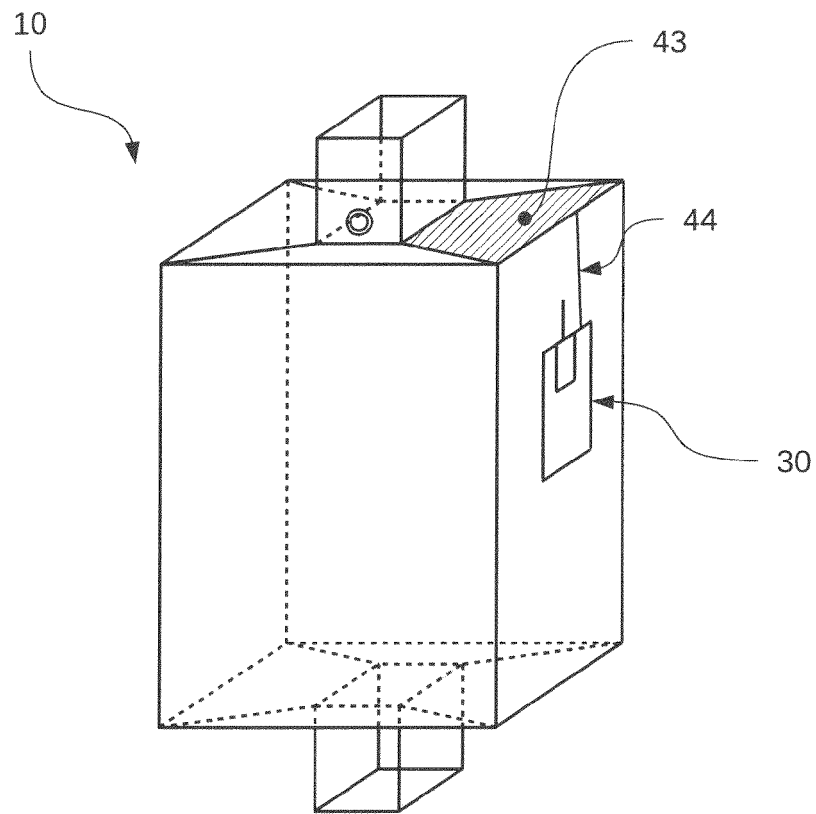


Fig. 6

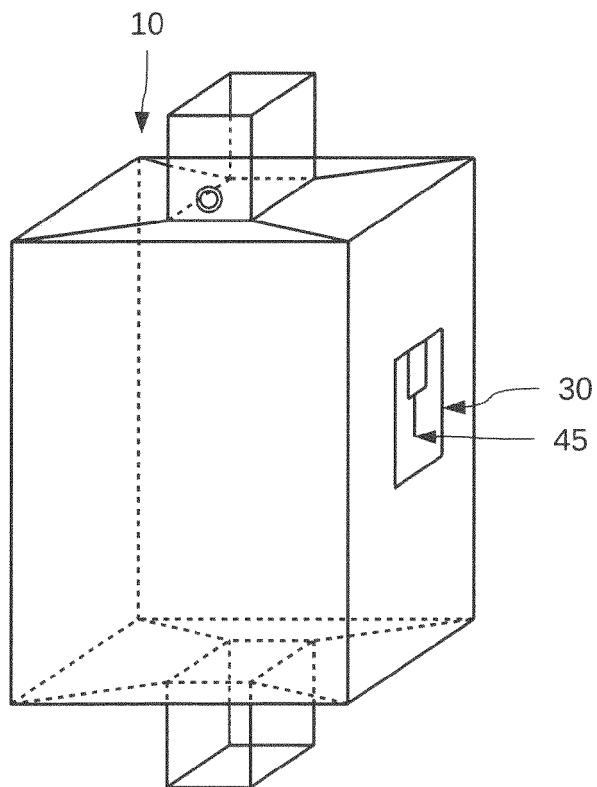


Fig. 7

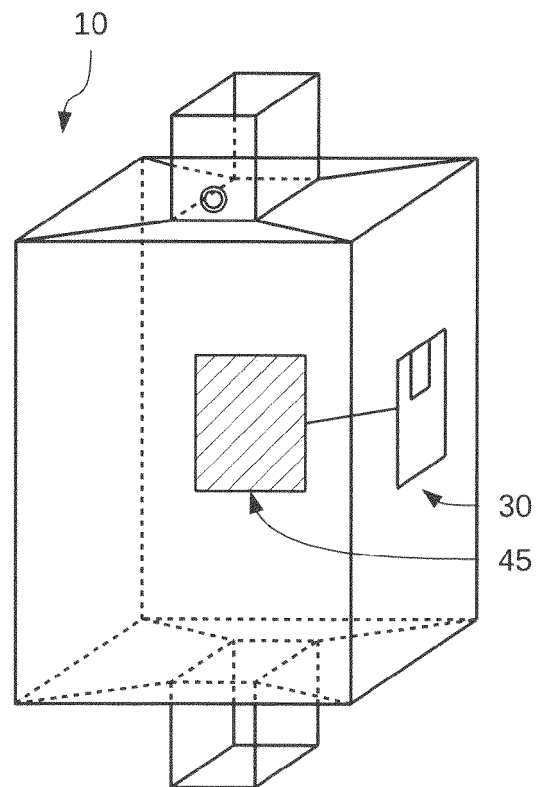


Fig. 8

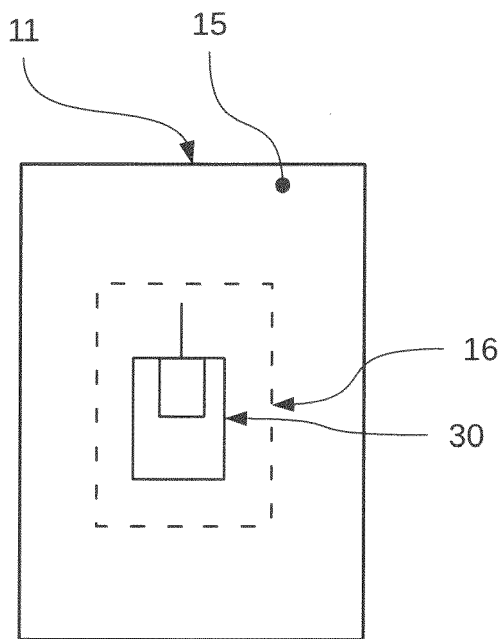


Fig. 9

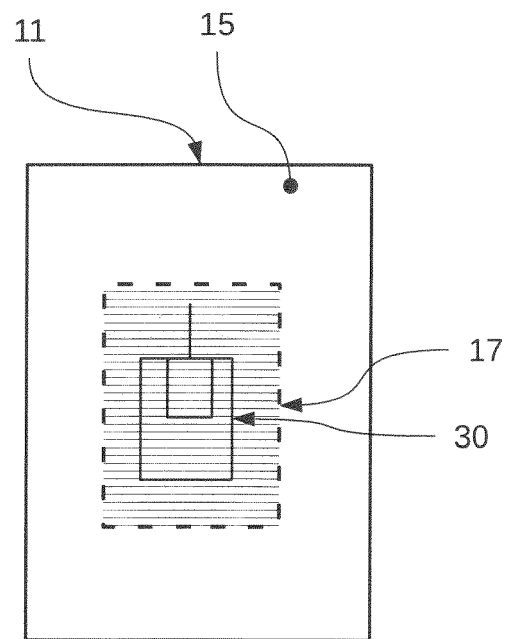


Fig. 10

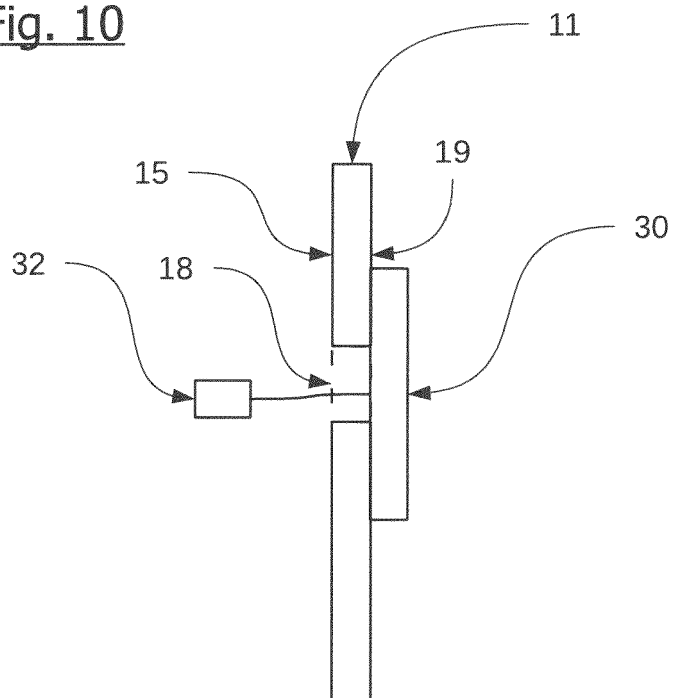


Fig. 11

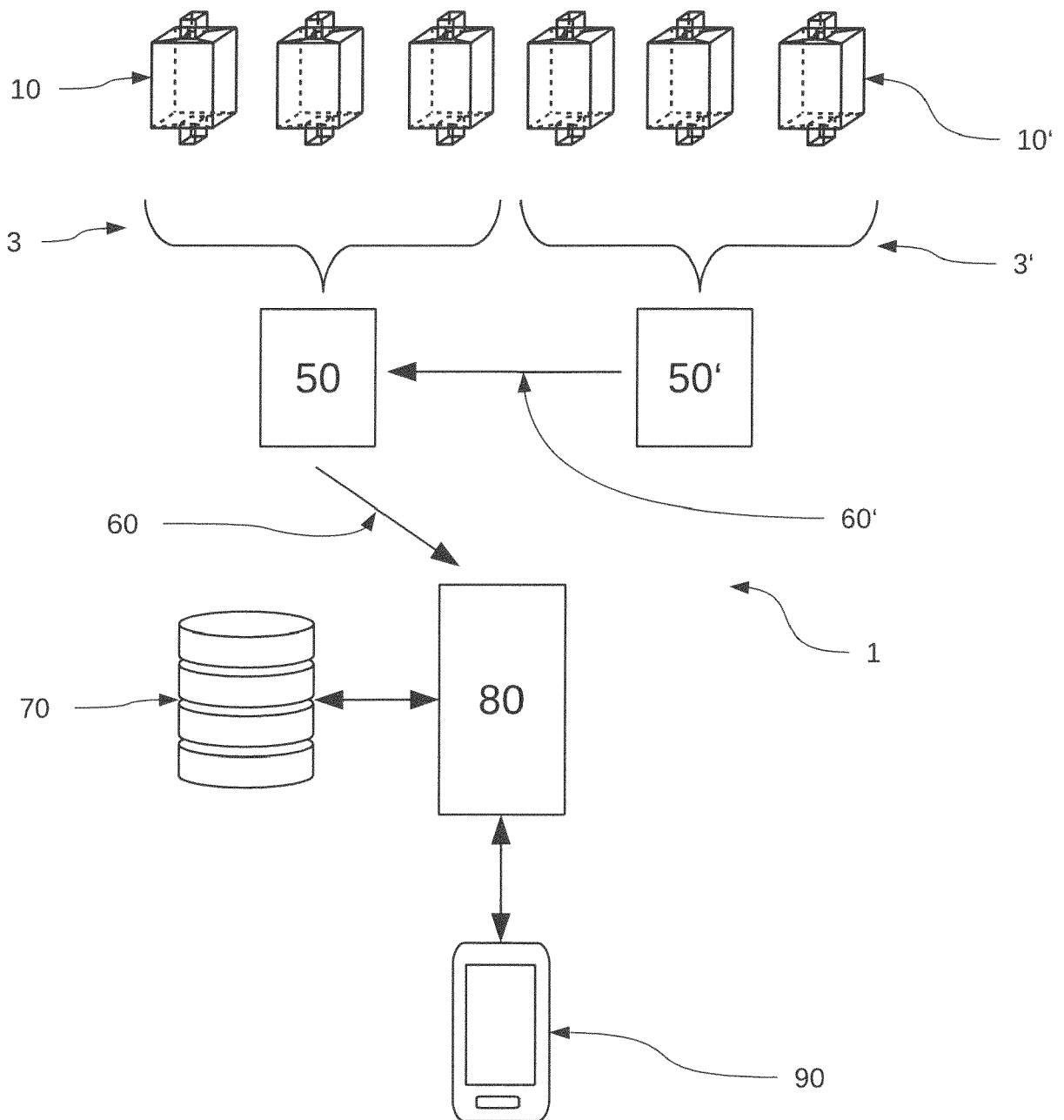
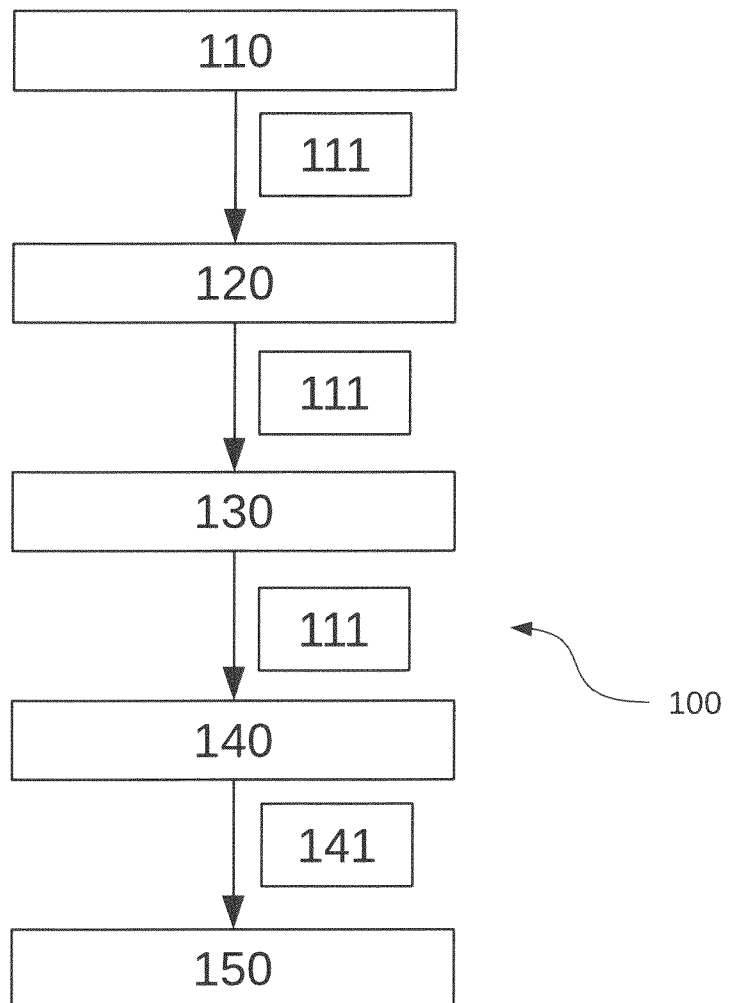


Fig. 12





EUROPEAN SEARCH REPORT

 Application Number
 EP 20 18 2432

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2005/002992 A1 (STORSACKEUREA TECHNOLOGY GMBH [DE]; SAMADIJAVAN AMIR [AT] ET AL.) 13 January 2005 (2005-01-13) * page 8, line 9 - page 10, line 30; figures 1-9 *	1-15	INV. B65D88/16 B65D90/48
Y	DE 10 2004 026879 A1 (EUREA VERPACKUNG [DE]) 17 February 2005 (2005-02-17) * paragraph [0017] - paragraph [0021]; figures 1,2 *	1-15	
Y	WO 2009/070754 A1 (KARR LAWRENCE J [US]; MURPHY KEVIN C [US]; DEROCCO PAUL D [US]) 4 June 2009 (2009-06-04) * paragraph [0006] - paragraph [0265]; figures 1-19D *	1-15	
Y	US 2006/237490 A1 (TWITCHELL ROBERT W JR [US]) 26 October 2006 (2006-10-26) * paragraph [0105] - paragraph [0145]; figures 3-6 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			B65D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 August 2020	Examiner Lämmel, Gunnar
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 EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 18 2432

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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26-08-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005002992 A1	13-01-2005	EP 1641685 A1 WO 2005002992 A1	05-04-2006 13-01-2005
DE 102004026879 A1	17-02-2005	NONE	
WO 2009070754 A1	04-06-2009	CA 2706759 A1 CN 102017437 A EP 2220777 A1 JP 5524073 B2 JP 2011505307 A US 2009201152 A1 WO 2009070754 A1	04-06-2009 13-04-2011 25-08-2010 18-06-2014 24-02-2011 13-08-2009 04-06-2009
US 2006237490 A1	26-10-2006	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2019375572 A1 [0006]