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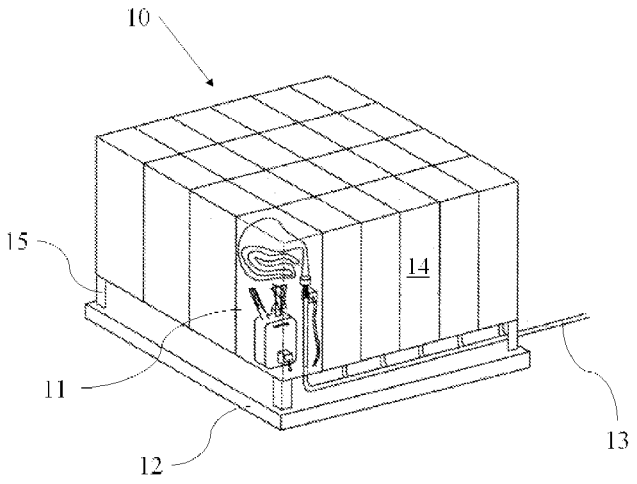

Fig. 1

(57) Abstract: An automatic balloon release apparatus (10) for sonde units (21, 22) and a method for automatically releasing sonde units, the balloon release apparatus (10) comprising at least one balloon reserve (14) for storing at least one sonde unit (21, 22), control means for controlling the filling operation, filling means for filling the balloons (21) of the sonde units (21, 22) of the balloon reserve (14) and release means for releasing the sonde unit. The balloon reserve (14) of the apparatus according to the invention is formed of a basket-like matrix, removable as a unit, with gas fill conduits (13, 24) being brought into connection therewith for filling the balloon (21) of each sonde unit (21, 22). In the method according to the invention the sonde units (21, 22) are stored pre-charged in the balloon reserve (14) prior to release and the sonde unit (21,22) is released by means of an automatic balloon release apparatus (10) according to the invention. In the method the balloon reserve (14) is kept stationary during storage and release. In case of a malfunction the next suitable sonde unit (21, 22) is chosen for release from the balloon reserve.

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AUTOMATIC BALLOON LAUNCHER AND METHOD FOR THE AUTOMATIC LAUNCH OF METEOROLOGICAL BALLOONS

The present invention relates to an automatic balloon release apparatus for releasing gas-filled balloons according to the preamble of the independent apparatus claim.

The present invention also relates to a method of automatically releasing balloons according to the preamble of the independent method claim.

The present invention relates to releasing meteorological observation balloons. The weather balloons are released from the ground. The balloons, usually filled with hydrogen or helium gas, are provided with a meteorological apparatus, often a kind of a radiosonde. The connected radiosonde travels the distance determined by the travel capacity of the weather balloon, measuring during the travel, among others, the ambient temperature, humidity, pressure, ozone, wind speed or other quantities relating to weather observations. When the observation balloon and the radiosonde – here referred to as the sonde unit – reach an altitude of about 30 kilometres, the balloon explodes and the radiosonde falls to the ground. During the flight, the radiosonde transmits the measured data to a receiving apparatus on the ground, the apparatus converting the received data to weather observations that are often automatically transferred for world-wide use.

It is known that weather balloons can be released one by one from a manned or automatic release station, which means that at least some degree of operator participation is a requirement of successful operation of the station. In fully manned operation the operator prepares the balloons and the components provided therewith and performs the actual release operation. Correct filling degree is an essential part of the preparation and it must be monitored during the release operation to ensure successful filling. The filling degree of the balloon is monitored by measuring its buoyancy, which can be estimated by means of auxiliary weight arrangements. The auxiliary weights can be used, for example, so that when all auxiliary weights have been lifted off their respective base, the buoyancy can be considered sufficient for releasing the balloon. Alternatively, the flow of the filling gas can be monitored to determine the volume of the gas flowed into the balloon and to further determine the buoyancy of the balloon.

In automatic operation the operator is not directly needed for releasing the balloon, but the operator is instead present only when preparing the station into release condition, meaning loading the balloon reserve with balloons in operation condition. Automatic release stations are used especially in places with difficult access or that are situated in remote locations or both. The operation of release stations can also be controlled by means of a number of arrangements. The release decision can be based on, for example, the state of air traffic or it can be timed to take place at a pre-determined time. The balloon reserve is typically a certain kind of index table, the storage bays of which contain balloons in an amount sufficient to last in unmanned operation for a desired time. During release, the balloon reserve is moved so that the balloon to be released is in the correct position for release or it is transported further to the release capsule. In order to transport the balloon to the automatic release system a large number of moving parts is usually needed.

There are considerable disadvantages with the above-mentioned technique. The labour costs caused by manned release stations are obvious, but the prior art automatic release stations also need considerable labour sacrifices, due to the well-known fact that the balloon reserves must be charged one balloon at a time, leading to long preparation periods. The essential problem with preparation periods is that the elaborate stage of charging the balloon reserve must be carried out at the release station, requiring the time of the operator and reducing efficiency.

Due to the balloon reserves, the current release methods are vulnerable especially in case of malfunctions. In case there is a malfunction, such as explosion of the balloon during feeding stage, the known systems can not release a replacement balloon into the air in such a situation, which is not desirable especially with regard to the requirements of operational reliability of the product. In known systems, the large number of moving parts also makes the situation difficult, whereby the tendency to malfunctions simultaneously with production and maintenance costs increases even more.

The purpose of the invention is to solve at least some of the above-mentioned problems and to create an improved automatic balloon release apparatus and a method for automatically releasing a weather balloon.

The automatic balloon release apparatus according to the invention comprises at least one balloon reserve for storing one or more sonde units, control means for controlling the filling operation and filling means for filling the balloons of the sonde units of the balloon reserve as well as release means for releasing the sonde unit. Further, the balloon reserve of the automatic balloon release apparatus according to the invention is formed of a basket-like matrix, removable as a unit, with gas fill conduits being brought into connection therewith for filling the balloon of each sonde unit. More specifically, the automatic balloon release apparatus according to the invention is characterized by what is disclosed in the characterizing part of the independent apparatus claim 1.

In the method according to the invention for automatically releasing sonde units the sonde units are stored pre-charged in the balloon reserve prior to the release, the balloon reserve being kept stationary during storage and release. Further, during the release phase of the method according to the invention the sonde unit is released by means of an automatic balloon release apparatus, the release of which is controlled by control means on the basis of data automatically acquired from measurement apparatuses. In case of a malfunction, according to the invention the next suitable sonde unit is chosen for release from the balloon reserve. More specifically, the method for automatically releasing sonde units according to the invention is characterized by what is disclosed in the characterizing part of the independent method claim 10.

Considerable advantages are achieved with the present invention. Due to the reliable and simple design the automatic balloon release apparatus according to the invention can realize considerable cost savings. First, the novel unmanned method of releasing the balloons to air allows personnel cost savings and reduces release delays. In a solution according to the invention there is only little need for the presence of an operator, as the sonde units can be precharged into the basket at factory or other location, where it is possible to focus on this operation, thus reducing unit costs. Thus, the operator is only needed at the release location for removing the used sonde basket and installing a new one and no special service or charging space is needed at the release site. In addition, due to the simple construction, the automatic balloon release apparatuses according to the invention can be produced as units in various sizes having a similar basic design, whereby the product can be produced as a modular product, thus further creating cost

savings and an increase of reliability as batch sizes increase, as can be derived from known modular endeavours. Thus, reliability is the second central advantage of the apparatus and method according to the invention. Due to its robust design the present automatic balloon release apparatus contains no moving parts, excluding the solenoids, the operation reliability of which is known to be very good. The design is additionally nearly insensitive to malfunctions, as in case of e.g. a filling problem a replacement sonde unit can be released from the apparatus. Thus, the apparatus is not very vulnerable even in case of unforeseen filling problems.

In the following, the embodiments of the invention are described in more detail by means of reference to the appended drawings.

Figure 1 illustrates an automatic balloon release apparatus 10.

Figure 2 illustrates the contents of one balloon storage bay 11 according to one embodiment.

As can be seen from figures 1 and 2, the automatic balloon release apparatus 10 is preferably a matrix-like balloon reserve 14 containing a number of balloon storage bays 11 for the release and storage prior to the release of the sonde units. The balloon storage bay 11 can be a modular unit connected to the body 14 of the balloon reserve by means of, for example, a form bond. Thus a defective or empty balloon storage bay 11, for example, can easily be replaced by an intact or full one. In the case of figure 1 there are 24 balloon storage bays 11, each bay being connected to a dedicated gas conduit 13 through which the gas filling the balloon 21 is directed into the balloon. The gas conduits 13 can be an integral part of the balloon reserve 14, whereby in installation situation the balloon reserve 14 can be quickly placed on support pieces, subsequent to which the collector tube of the gas conduits 13 is connected to the gas connection of the release station. The gas conduits 13 can also be separate from the balloon reserve 14, whereby the gas connection is separately connected into each balloon storage bay 11 during installation. In both cases the fill head 24 of the gas conduit 13 is connected to the mouth of the balloon 21, whereby the gas connection from the gas system of the release station to the balloon 21 is formed. Similarly, in both cases the gas fill is

electrically controlled by means of a magnet valve 25 connected to the fill head 24. Correspondingly, the used balloon reserve 14 can be completely removed from the balloon release apparatus 10, whereby the balloon release apparatus 10 can be completed with a new sonde unit kit simply by replacing the empty balloon reserve 14 by a full, precharged balloon reserve 14.

Typically, the balloon release apparatus 10 is installed horizontally to the release tank of the unmanned balloon release station providing weather protection to the apparatus. In connection with the release the door of the release tank is opened, whereby the released sonde unit 21, 22 can rise from the tank and commence probing.

As can be seen from figure 2, the balloon storage bay 11 includes a sonde unit 21, 22 consisting of a balloon 21 and a radiosonde 22 connected thereto by means of, e.g. a rope, as well as means for filling and releasing it. The size of the balloon 21 is determined by the desired probing height and the balloon reserve can be filled with balloons of different sizes, if needed. The balloon 21 is provided with a balloon-specific radiosonde 22 having sensors for measuring the desired quantities, as well as the necessary positioning sensors, such as a GPS receiver. The radiosonde 22 can also be provided with a control apparatus 23 having a release solenoid, providing the radiosonde 22 with current during storage and acting as a communication interface between it and the release station. Prior to release, the radiosonde 22 is not in operational condition. Thus the radiosonde 22 must be switched to operational connection with a control apparatus 23 just before the release.

During switching to release condition the control apparatus 23 starts and initializes the radiosonde 22 by, among others, executing a test program in order to find out the operational condition, by calibrating it and by setting the correct operation frequencies. When the radiosonde 22 is being switched to operational condition the control apparatus 23 can provide it with voltage that can be used for charging the battery of the radiosonde 22, in case non-rechargeable batteries are not used as voltage source. The preparing to operational condition can also be performed using remote control, whereby there is no need for a balloon storage bay specific control apparatus 23, instead, the apparatus can be a centralized control apparatus based on wireless data transmission.

When the start and initialization are ready, the radiosonde 22 is in operational condition and the release solenoid of the control apparatus 23 can cut the communication connection by pushing the radiosonde 22 off the control apparatus 23. Alternatively the release solenoid can be a separate apparatus instead of a part of the control apparatus 23.

During the filling phase of the balloon 21 its weight is monitored by means of an electronic scale 12 measuring the weight of the balloon reserve 14, the value of which is used for determining the buoyancy of the balloon 21 and, further, its degree of filling. The calculation of the degree of filling requires that the weight of each balloon size when full of gas is known with a reliable accuracy to avoid under- and overfilling. The weight of the balloon size also always varies a bit and in addition to size, the weight of the sonde connected thereto, the weight of the filling gas and the ambient temperature have an effect on it. The electronic scale 12 can in practice be any means reacting to pressure and being capable of electronically transmitting measurement data, which is a requirement for remote control. The scale must additionally be very accurate at its operation range. Said means reacting to pressure can be, for example, in addition to electronic scales, pressure sensors of various types and pietzo-electric elements, for example.

The actual release is provided by means of a release solenoid 26, preferably located between the fill head 24 and the balloon 21. Having received an electric control signal the release solenoid 26 releases the balloon 21from the fill head 24, while the magnet valve 25 simultaneously closes the gas feed to the balloon 21. When the release solenoid 26 has released the balloon 21 from the fill head 24, the mouth of the balloon 21 is sealed, and the fill pressure can not leak from the balloon 21. Subsequent to this the balloon 21 rises from the storage bay 11, pulling with it the radiosonde 22 connected thereto, the radiosonde 22 having been brought to operational condition with an operation switch 23. Alternatively, the release solenoid 26 can be made as a part of the magnet valve 25, whereby the same actuator contains the valve controlling the gas feed and the solenoid releasing the balloon 21. Further alternatively the releasing of the balloon 21 from the fill head 24 can be carried out so that the filled balloon 21 is released by itself from the fill head 24 as it rises from the balloon storage bay 11.

In order to verify a successful release the balloon storage bay 11 can be provided with a separate presence switch or the presence data can be obtained from the control data history of the operation switch 23. The separate presence switch can be, for example, a proximity sensor, the presence data of which can be based on, for example, measuring the inductance or dielectricity constant of the subject or it can be based on contact. The main point of the operation of the presence switch is, however, that its measurement data can be transmitted and received electronically. In this context the term "sonde unit" means a balloon to be filled with gas and a radiosonde connected thereto. The term "balloon reserve", on the other hand, refers to the magazine used for storage prior to the release of the sonde units that can in the case of the current invention be used for the release of sonde units as well.

Claims

1. An automatic balloon release apparatus (10) for sonde units (21, 22), the balloon release apparatus (10) comprising:
- at least one balloon reserve (14) for storing one or more sonde units (21, 22);
- control means for controlling the filling operation;
- filling means for filling the balloons (21) of the sonde units (21, 22) of the balloon reserve (14); and
- release means for releasing the sonde unit,
characterized in that
- the balloon reserve (14) is formed of a basket-like matrix, removable as a unit; and that
- in order to fill each balloon (21) of the sonde unit (21, 22) the balloon reserve (14) is provided with gas fill conduits (13, 24).

2. An automatic balloon release apparatus (10) according to claim 1, **characterized** in that
the gas fill conduits (13, 24) or controllable valves (25) or both are integral with the construction of the balloon reserve (14).

3. An automatic balloon release apparatus (10) according to claim 1, **characterized** in that
the gas fill conduits (13) or controllable valves (25) or both are separate from the balloon reserve (14).

4. An automatic balloon release apparatus (10) according to any of the above claims, **characterized** by
control means comprising measurement means (12) further comprising a scale or a corresponding means reacting to pressure, the measurement data of which can be electronically received, the scale or a corresponding device being arranged to measure either directly or indirectly the weight of the automatic

balloon release apparatus (10), from which value the fill degree of the balloon (21) to be filled can be obtained.

5. An automatic balloon release apparatus (10) according to any of the above claims,
characterized in that
- the balloon reserve (14) comprises at least one balloon storage bay (11) for storing the sonde unit (21, 22), and that
- each balloon storage bay (11) or some of them is/are provided with a presence switch, especially a push switch, and its conductors for acquiring and transmitting the presence data of the sonde unit (21, 22).

6. An automatic balloon release apparatus (10) according to claim 5,
characterized in that
one or more balloon storage bay(s) (11) is/are modular and separately removable from the balloon reserve (14).

7. An automatic balloon release apparatus (10) according to any of the above claims,
characterized in that
the release solenoid (26) provided for each balloon storage bay (11) of the sonde unit (21, 22) is arranged to release the sonde unit (21, 22) on the basis of a release command.

8. An automatic balloon release apparatus (10) according to any of the above claims,
characterized in that
the valve to be controlled (25), especially a magnet valve, is arranged to adjust the filling of the balloon (21).

9. An automatic balloon release apparatus (10) according to any of the above claims,
characterized in that

the balloon reserve (14) is arranged horizontally so that its longest side is horizontal.

10. A method of releasing sonde units (21, 22), in which method:
- the sonde units (21, 22) are stored pre-charged in the balloon reserve (14) prior to the release;
- the sonde unit (21, 22) is released by means of the automatic balloon release apparatus (10);
characterized in that
- the balloon reserve (14) is kept stationary during storage and release;
- the release is controlled automatically by means of control means on the basis of information received from measurement apparatuses (12);
- in case of a malfunction the next suitable sonde unit (21, 22) is selected for release from the balloon reserve (14).

11. A method according to claim 10 for automatically releasing sonde units (21, 22);
characterized in that
the weight of the balloon (21) is measured by means of measurement apparatuses either directly or indirectly, and the fill degree of the balloon (21) is derived from these results.

12. A method according to claim 10 or 11 for automatically releasing sonde units (21, 22);
characterized in that
the release decision is made automatically on the basis of the fill degree of the balloon (21).

13. A method according to claim 12 for automatically releasing sonde units (21, 22);
characterized in that
the fill degree is measured by means of a scale or a corresponding means reacting to pressure, the measurement data of which is electronically received form, the scale or the like measuring directly or indirectly the weight of the

automatic balloon release apparatus (10), the fill degree of the balloon (21) to be filled being derived from this value.

14. A method according to any of claims 11-13 for automatically releasing sonde units (21, 22);
characterized in that
the presence data of sonde units (21, 22) is acquired by means of presence switches.

15. A method according to any of claims 10-14 for automatically releasing sonde units (21, 22);
characterized in that
the balloon reserve (14) can be removed in its entirety from the balloon release apparatus (10), whereby the sonde units (21, 22) of the balloon release unit (10) can be completed by replacing the balloon reserve (14) with a new one.

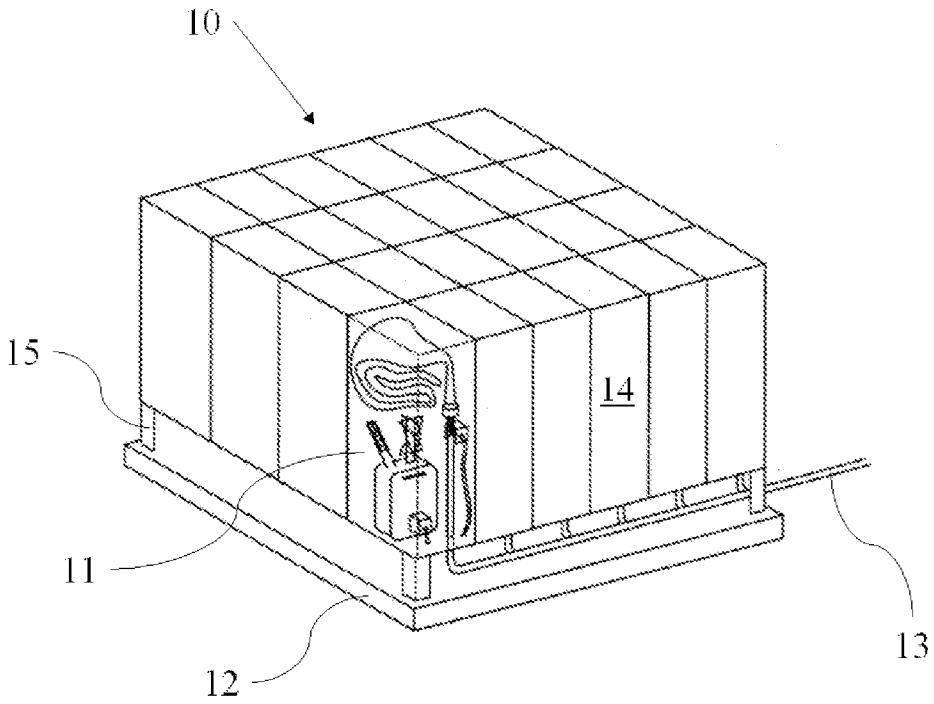

Fig. 1

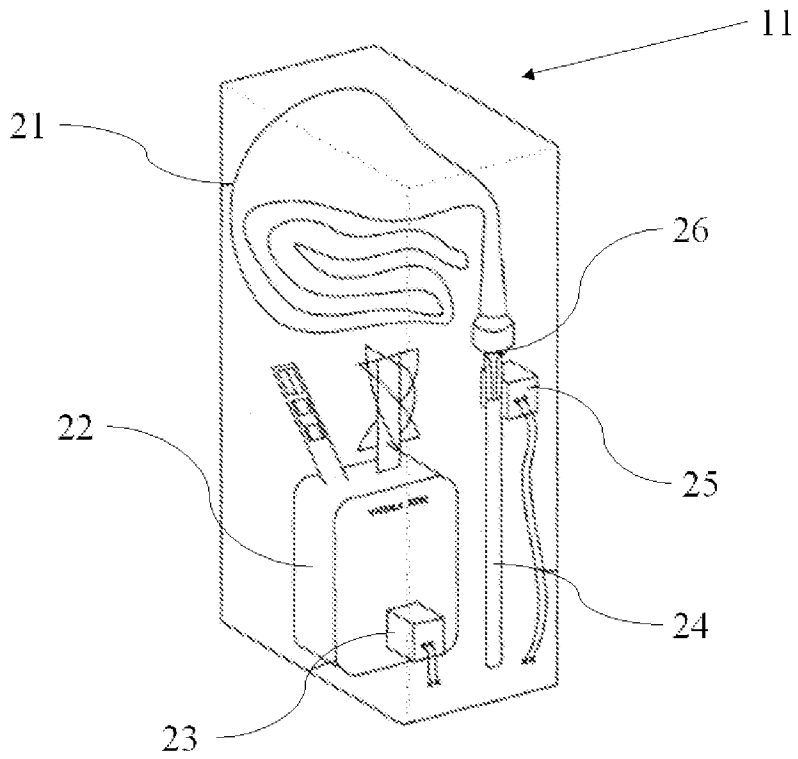

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2009/050596

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01W1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01W B64B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 895 010 A (AURILIO ET AL) 20 April 1999 (1999-04-20) the whole document	1-15
X	JP 2006 038725 A (MEISEI ELECTRIC CO LTD) 9 February 2006 (2006-02-09) the whole document	1-15
X	US 4 564 159 A (HILL ET AL) 14 January 1986 (1986-01-14) abstract; figures 1,2 columns 3-5	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 October 2009	27/10/2009

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/FI2009/050596

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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