The invention relates to a method for harvesting water from the moisture in the air surrounding the Earth's surface by means of condensation from this air, with the cold required being taken from the cooler layers of air farther from the surface of the Earth and being conveyed to a condensation apparatus through a pipeline held in an almost vertical position by a freely suspended envelope of a balloon by means of a tow line, with warmed air being conveyed from this apparatus, as well as apparatus for performing the method.

There are no known practical methods for obtaining considerable quantities of fresh water by means of condensation from water from atmospheric moisture in hot, dry, drought or disaster-stricken areas having no or inadequate intact infrastructure that do not involve considerable expenditure of energy for the production of the cold required. The reason is probably that the scarcity of high quality fresh water in areas with shortages has only become pressing in recent years as a result of climate change and increased consumption. This is due to an increase in population and the consequences of rising standards of living and now requires a solution. A JP patent with publication number 2004-316398 describes water harvesting by condensation employing the Peltier effect with a thermo-electronic element, the condensation apparatus of which is held in the Earth's atmosphere by a helium balloon. The disadvantage of this apparatus, which involves the brazed heavy metals for inducing the Peltier effect and the remaining water harvesting apparatus being carried by the helium balloon, is the problem of the weight for the effective production of larger amounts of water.

Patent WO 1995/023499 A1 describes the production of water by means of condensation from the ambient air of a freely suspended plant that is held in a vertical position by a dual chamber balloon. The ambient air from the lower section of the plant is conveyed upward to the condensation plant, where water is condensed from the ambient air and conveyed from the lower section for utilisation via pipelines. The disadvantages of this method of water production are the costly operation of the upper chamber of the dual chamber balloon and annular balloons on the pipe system for the inert gas Helium or alternative gases. These are required as the lifting force of the hot air in the second lower chamber is extremely weak, the ambient air from the lower inlet of the pipeline cools rapidly when it flows through the pipe system and the condensation apparatus as a result of the method, and positioning the balloon and the apparatus is limited in colder regions due to the effects

of frost, such that the load-carrying capacity of the warm air is very low.
Another disadvantage is the weight of the pipe system column, which is burdened in terms of weight by dual-walled elements, pipelines arranged in a spiral manner, flanges and brackets and also the condensed water until it leaves the plant; this becomes very heavy and must be borne by the balloon.

Patent WO 1999/43997 describes a condensation plant in which water is harvested by means of condensation from air delivered by pipes and collected in a container. This form of harvesting condensation water described is based on the utilisation of the ambient air directly surrounding the apparatus, which must be subjected to significant heating during the day and sufficiently significant cooling in the evening. Heat is stored in the water during the day and in the evening it dissipates into and heats the air from which the water is to be condensed for the purpose of condensing water when the difference in temperature between the warmed air and the prevailing ambient air is sufficient.
As the temperature difference must be at least large enough for water to form condensate, this type of production is not always possible due to the weather. A disadvantage is also the voluminous technical and material effort required for storing heat in the water.
The object of the invention is to harvest drinking water at affordable production cost, employing plants in accordance with the invention at fixed or mobile locations that are self-sufficient, environmentally friendly and do not require expensive construction measures.

The invention achieves this objective by conveying the colder air as a cooling medium farther from the Earth's surface through an inlet filter and through a conduit to cool the condensation surfaces and to form water condensate in the condensation apparatus located on the surface of the Earth, with the air warmed by the cold/heat exchange when cooling the condensation surface being fed into a conduit flowing upward to the internal space of the balloon and acting as a supporting gas or lifting force for the balloon.

The proposed method is performed advantageously in such a manner that one or a plurality of lock apparatus for discharging this air from the internal space of the balloon into their surroundings is/are arranged on the upper side of the balloon.

One apparatus for performing this method involves the conduit in which the air flows

downward to the condensation apparatus being partially or fully sheathed by the conduit for protection against the sun's radiation and the input of heat from outside.

Further elements and advantages of the invention are explained in the following description with the drawing (Fig.1). This shows the production of water through condensation, with the cold being made available from layers of air that are higher and colder than those surrounding the condensation apparatus. Essentially, it shows a freely suspended envelope in the form of a balloon, which bears the air lifting and lowering system, and a condensation apparatus located on the ground with a water tank.

The reference numbers in the drawing denote the following:
A freely suspended envelope forms a known hot air balloon and is labelled as balloon 1. A bearing cable 2 serves as a towing device between the balloon 1 and the pipework system 3 to be borne on the one hand, and on the other it limits the height of the balloon 1 by being fastened to the anchor 9 on the Earth's surface. A first conduit 4 conveys the air from the inlet filter 5 to the condensation apparatus 10 on the Earth's surface. A second conduit 6 conveys air from the condensation apparatus 10 to the outlet opening 7 and from this into the balloon 1. The condensation surfaces 14 are cooled by the air flowing through the condensation apparatus 10. Conduit 4 is fastened to the bearing cable 2, which extends between the balloon 1 and the anchor 9. The conduit 6 surrounds the conduit 4 in order to fully or partially prevent the cool air in the conduit 4 from being heated by solar radiation and external heat. This conduit structure consisting of the bearing cable 2, conduit 4 and conduit 6 is denoted as the pipework system 3. The walls of the conduits 4 and 6 are made of especially lightweight, sealed fibrous fabric as used in ballooning, this being pulled over a frame made of light materials. The fan 11 assists the flow of air in the conduits 4 and 6 if required and in the condensation apparatus 10. The air flows into the condensation apparatus 10 through the openings 13 and out of the condensation apparatus 10 through the openings 16. The air coming from the opening 7 flows into the internal space 18 of the freely suspended envelope of the balloon 1 through the opening 17. Air from the atmosphere around the condensation apparatus 10 flows in through the inlet 12 and out of it again through the outlet opening 27. When the air flows through from the inlet 12 to the outlet 27 water from this air condenses on the condensation surfaces 14 and is collected in the water container 15 for subsequent use. The lock devices 20 and 25,

denoted as lock balloons 20 and 25, convey the air in the internal space 18 of the balloon, which has been utilised for heat and pressure purposes, out of the balloon 1 and release it into the atmosphere surrounding the balloon 1. The sides in the internal space 18 are denoted as 18a and 18b and there is no pressure differential. The vane 30 guides the air flowing into the internal space 18 of the balloon to the side 18a in one position and to 18b in another position. The balloon protrusion 33 also influences the direction of airflow in the internal space 18 of the balloon. Air flows in through the valve 21 and the conduit 22 and out of the lock balloon 20 through the valve with the weight 23. Air flows in through the valve 26 and the conduit 24 and out of the lock balloon 25 through the valve with the weight 28. 31 and 32 are temperature gauges in the balloon 1 and an airflow meter 19 is arranged in the conduit 6. A heating device 35 generates additional heat. The rope 29 serves to lower and attach the balloon 1.

Assumed data with respect to the functional description:
The altitude of the freely suspended envelope 1 in the Earth's atmosphere is 3900 m above sea level.
The position of the air filter 5 with an inlet opening to the conduit 4 is 3800 m above sea level.
The condensation apparatus 10 is located on the Earth's surface at an altitude of 800 m above sea level.
The air temperature at 3800 m above sea level is +2°C.
The air temperature at 800 m above sea level is +28°C at 50% relative atmospheric humidity.

Operation:
The freely suspended envelope of the balloon 1 holds the pipework system 3 in a roughly vertical position by means of a towing connection, the bearing cable 2, so that the opening of the air filter 5 is positioned at an altitude of approximately 3800 m at an ambient air temperature of approximately 2°C. This air flows from the opening of the air filter 5 through the conduit 4, through the opening 13 into and through the condensation apparatus 10. When this air flows through the condensation apparatus 10 from the opening 13 to the opening 16, the condensation surfaces 14 are cooled on the input side, with the effect that water is condensed from the moisture in the 28°C ambient air on the output side, which

flows from the opening 12 through the condensation apparatus 10 to and out of the opening 27, is condensed and collected in the water container 15. When the air flows through the condensation apparatus 10 from the opening 13 to the opening 16, this air is heated during the cooling of the condensation surfaces 14 as a result of the cold/heat exchange, changing its density, resulting in the now warmed air flowing in and through the opening 16 into the pipe 6, rising in this and flowing out of the opening 7 of the pipe 6. As the air flows through the inlet opening of the air filter 5, conduit 4, opening 13, condensation apparatus 10, opening 16, conduit 6 to the outlet opening 7 into a space sealed to the outside, an automatic inflow of air develops from the inlet filter 5 until it flows out through the opening 7. The flow of air from the air filter 5 to the outlet opening 7 can be supported and increased if required by means of the fan 11. The airflows for cooling the condensation surfaces are spatially separated from the airflows from which water is condensed.

The air flowing out of the opening 7, which was previously in the condensation apparatus 10 and heated by the sheath of the conduit 6, then flows through the opening 17 into the internal space 18 of the freely suspended envelope of the balloon 1 and exerts a load carrying and lifting force which keeps the envelope of the balloon 1 aloft.

A lock balloon 20 with the valve flaps 21 and 23 is connected to the internal space 18 of the freely suspended envelope of the balloon 1 by the conduit 22, as is a lock balloon 25 with valve flaps 26 and 28 via the conduit 24. These lock balloons 20 and 25 and the valves 21, 23, 26 and 28 which cooperate with the flow meter 19 and temperature gauge 31 + 32 and airflow vane 30, facilitate the optimum utilisation of the load bearing capacity of the air in the internal space 18 of the balloon 1 by controlling the discharge from it.

Warm air flowing into the internal space 18 from the opening 7 out of the conduit 6 and through the opening 17 is guided by the flow device 30 to the inner side 18b when it is positioned toward the inner side 18a and then influenced by protrusion 33, and toward inner side 18a when positioned in the other direction toward 18b and influenced again by protrusion 33. Air which streams from 18a to 18b then immediately flows through conduit 22 into the previously collapsed lock balloon 20 after the valve 21 is opened. As the valve 23 is closed, the lock balloon 20 is opened by the differences in the density of the air inside and outside the lock balloon 20, such that air flows out of the internal space 18 of the freely suspended envelope of the balloon 1 into the lock balloon 20. If the valve 21 is

closed and the valve 23 is opened, the air that had previously flowed into the lock balloon 20 flows out of this and escapes as a result of the collapse and folding up of the envelope of the lock balloon 20, because a weight at the valve 22 compresses this envelope. Air that flowed from 18b to 18a flows into the previously compressed lock balloon 25 through the conduit 24 after the valve 26 is opened. As the valve 28 is closed, the lock balloon 25 is opened by the differences in the density of the air inside and outside the lock balloon 1, such that air flows out of the internal space 18 of the freely suspended envelope of the balloon 1 into the lock balloon 25. If the valve 26 is closed and the valve 28 is opened, the air that had previously flowed into the lock balloon 25 flows out of this and escapes as a result of the collapse and folding up of the envelope of the lock balloon 25, because a weight at the valve 22 compresses this envelope. This process repeats itself. Outflowing air in conduit 6 can be heated additionally using the heating device 35.

Additional thermal insulation of the conduit 4 and the conduit 6 or the use of partially absorbent materials for the conduit 6 is dependent upon the type of installation and the climatic conditions. In order to protect the first conduit 4 from solar radiation and external thermal input, it is fully or partially surrounded by the conduit 6.

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CLAIMS

1. Method for harvesting water from the moisture in the air surrounding the Earth's surface by means of condensation from this air, with the cold required being taken from the colder layers of air farther from the surface of the Earth and being conveyed to a condensation apparatus through a pipeline held in an almost vertical position by a freely suspended envelope of a balloon by means of a tow line, with heated air being conveyed from said apparatus, wherein the colder air farther from the Earth's surface is conveyed as a cooling medium through an inlet filter (5) and through a first conduit (4) to cool the condensation surfaces (14) and to form condensation from water in the condensation apparatus (10) arranged on the surface of the Earth, and the air warmed by the cold/heat exchange in cooling the condensation surfaces (14) is fed into a second conduit (6) flowing upward to the internal space (18) of the balloon (1) and acts as a supporting gas or lifting force for the balloon (1).

2. Apparatus for performing the method in accordance with Claim 1 with a balloon, a tow line, a first and second pipeline and a condensation apparatus, wherein one or a plurality of lock apparatus (20) for discharging air from the internal space (18) of the balloon (1) into its surroundings is/are arranged on the upper side of the balloon (1).

3. Apparatus for performing the method in accordance with Claim 1 with a balloon, a first tow line, a first and second pipeline and a condensation apparatus, wherein the first conduit (4), in which air flows downward to the condensation apparatus (10), is completely or partially sheathed by the second conduit (6).

ABSTRACT

The invention relates to a method and apparatus for harvesting water from the moisture in the air surrounding the Earth's surface by means of condensation from this air, with the cold required being taken from the colder layers of air farther from the surface of the Earth and being conveyed to a condensation apparatus through a pipeline held in an almost vertical position by a freely suspended envelope of a balloon by means of a tow line, with heated air being conveyed from this apparatus, with the colder air farther from the Earth's surface being conveyed as a cooling medium through an inlet filter (5) and through a first conduit (4) downward to cool the condensation surfaces (14) and to form water condensation in the condensation apparatus (10) arranged on the surface of the Earth, and the air warmed by the cold/heat exchange in cooling the condensation surfaces (14) being fed into a second conduit (6) flowing upward to the internal space (18) of the balloon (1) and acting as a supporting gas or lifting force for the balloon (1).