Apparatus for extracting water from ambient air.
The present invention relates to apparatus for extracting liquid water from moisture in the ambient air.

Apparatus for producing desalted water from sea water is well-known. Apparatus for treating waste water from drains and the like to a high degree to obtain water of high clarity has been proposed. These types of apparatus require a solution containing liquid water as a main component for producing purified water. Thus, they could not be used to produce water in a place where no liquid water is found such as a desert area.

There is a need for apparatus for producing water even in a place where no liquid water is found. Apparatus has therefore been proposed for producing water from moisture in the air, making it possible to produce water in any place where moisture is present in the air. According to climatic data and the results of the inventors’ studies, even in the air in a large desert such as the central part of the Arabian Peninsula, 3 to 4 g of water is present in 1 m³ of the air, and accordingly, water can be produced. Thus, water can be obtained in an otherwise completely dry area and can be used for irrigation and plant cultivation. The water producing apparatus thus expands the areas for possible human habitation.

The principle of water producing apparatus of this type is to produce water by adsorbing moisture in the air in an adsorbent as the first step and then desorbing the water as steam by heating the adsorbent and condensing the steam in a condenser as the second step. The adsorbent is dehydrated to regenerate its adsorbing function whereby the adsorbent can be repeatedly used for adsorbing the moisture in air. Thus, liquid water can be continuously obtained from air.

One known type of apparatus operating on this principle comprises a plurality of chambers packed with an adsorbent for moisture in the air and each having an inlet and an outlet for air; means for desorbing moisture from the adsorbent comprising first and second desorbing sections aligned so as to be brought into register with the inlet and outlet respectively of one or more of the chambers to form an airflow passage from the first section through said one or more chambers to the second section, a recycling duct connecting the second section to the first to complete a desorption circuit, means for circulating air through said circuit to remove water from the adsorbent, means for heating the air in the circuit and means for removing water from the circuit; means for bringing one or more of the chambers into and out of register with the first and second desorbing sections and means for passing ambient air through the chambers not in register with said sections, whereby moisture from the ambient air is adsorbed on the adsorbent and subsequently removed from the adsorbent in each chamber as that chamber is brought into register with the said desorbing sections.

In this conventional water extracting apparatus, opening and closing means such as valves and pipe systems are unnecessary. This is an excellent system in view of its energy saving and ease of operation. There is, however, a problem of selection of the optimum conditions for operation to produce water with high efficiency depending upon the conditions of humidity and temperature in the ambient atmosphere.

For example, in the Arabian Peninsula, in summer, there is a relatively high temperature (35 to 50°C) and low humidity (3 to 8 g of water per 1 kg of air) in inland areas such as Riyadh and relatively low temperature (25 to 45°C) and relatively high humidity (11 to 15 g of a water content per 1 kg of air) in areas near the sea such as Dhahran. Although a water shortage is common to both areas, the weather conditions are remarkably different.

In order to produce water from the ambient air in high efficiency, it is necessary to prolong the adsorbing period relative to the desorbing period in areas of relatively high temperature and low humidity. It is, however, difficult to vary the ratio of the adsorbing period to the desorbing period depending upon weather conditions in the conventional water producing apparatus.

It is an object of the present invention to overcome the above difficulty and to provide a water producing apparatus for continuously producing water from air with high efficiency in a variety of weather conditions. The present invention therefore provides an improvement in apparatus of the type described above whereby the ratio of the number of said chambers in register with the desorbing sections to the number of chambers receiving moisture-laden air is variable so as to obtain optimum water extraction for various values of temperature and moisture content of the ambient air.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings wherein:

Figure 1 is a schematic side elevation of one embodiment of a conventional water producing apparatus;

Figure 2 is an elevation of the left-hand end of the apparatus as seen in Figure 1;

Figure 3 is an elevation of the right-hand end of the apparatus as seen in Figure 1;

Figure 4 is a sectional view taken along the line IV—IV of Figure 1;

Figure 5 is a schematic side elevation of one embodiment of a water producing apparatus in accordance with the present invention;
Figure 6 is a sectional view taken along the line VI—VI of Figure 5;
Figure 7 is a sectional view taken along the line VII—VII of Figure 5; and
Figure 8 is a schematic view illustrating the movable partitions and end-plates of the pre-desorbing section in the apparatus of Figures 5 to 7.

Referring to Figures 1 to 3, the reference numeral (1) designates a column for holding a solid adsorbent for adsorbing moisture, which has a cylindrical body with a circular cross-sectional view; (2) designates a rotary shaft for the adsorbent column (1); (3) designates partitions placed around the rotary shaft (2) with gaps of 45 degrees therebetween, partitioning the column (1) into 8 small chambers (1a); (4) designates a solid adsorbent packed in each of the small chambers (1a) of the adsorbent column (1); (5) and (6) respectively represent first and second cylindrical bodies having a cross-section coextensive with the adsorbent column (1) which are placed at both ends of the adsorbent column (1) and coaxially therewith; (7) designates first partitions for dividing the inner part of the first cylindrical body (5) placed on the inner wall of the first cylindrical body (5) at both the ends; (8) designates a second partition for dividing the inner part of the second cylindrical body (6), placed on the inner wall of the second cylindrical body (6) to be along the plane of the first partition (7); (9) designates a first bearing for rotatably supporting one end of the rotary shaft (2) for the adsorbent column (1) which is placed at the end of the first partition (7) in the adsorbent column (1); (10) designates a second bearing for rotatably supporting the other end of the rotary shaft (2) for the adsorbent column (1) which is placed at the end of the second partition (8) in the adsorbent column (1); (11) designates a belt for rotating the adsorbent column (1); (12) designates a pulley for driving the belt (11); (13) designates a motor for rotating the pulley (12); (14) designates a first closing plate for closing an opening of the lower section partitioned by the first partition (7) at the reverse side to the adsorbent column (1); (15) designates a second closing plate for closing an opening of the lower section partitioned by the second partition (8) of the second cylindrical body (6) at the reverse side to the adsorbent column (1); (16) designates a blower for adsorption which is placed at the opening of the first cylindrical body (5) at the reverse side of the adsorbent column (1) and which feeds the ambient air for adsorbing moisture by sucking it through the upper section partitioned by the first partition (7) into the adsorbent column (1); (17) designates a fitting plate for mounting the blower (16); (18) designates a duct for connecting to the lower section partitioned by the first partition (7) in the first cylindrical body (5) and the lower section partitioned by the second partition (7) in the second cylindrical body (6); (19) designates a blower for recycling the gas for desorption through the recycling passage consisting of the lower section of the first cylindrical body (5), the adsorbent column (1), the lower section of the second cylindrical body (6) and the duct (18); (20) designates a heater placed in the duct (18); (21) designates an AC power source for heating the heater (20); (22) designates a condenser positioned to draw off steam from the duct (18); (23) designates the pre-adsorbing section (except the lower section) of the first cylindrical body (5) for passing the air for adsorption sucked by the blower (16) into the adsorbent column (1); (24) designates the post-adsorbing section as the upper section adjacent to the lower section in the second cylindrical body, for passing the air out from the adsorbent column (1); (25) designates the pre-desorbing section as the lower section of the first cylindrical body (5) for passing the gas for desorption recycled by the blower (19) to the adsorbent column (1); and (26) designates a post-desorbing section as the lower section of the second cylindrical body (6) for passing the gas for desorption through the adsorbent column (1).

The operation of the conventional water producing apparatus will be illustrated.

At the start of the operation, two of the partitions (3) of the adsorbent column (1) are stopped so as to be in the same planes as those of the first and second partitions (7), (8) and the adsorbent (4) in the column (1) is in a dry condition without adsorbed moisture. (The desorbed condition).

The blower for adsorption (16) is driven to suck ambient moisture-laden air into the pre-adsorbing section (23) and to feed it into the half of the adsorbent column (1) in register with the pre-adsorbing section so as to pass it through the adsorbent (4) packed in this part, and is then passed through the post-adsorbing section (24) to be discharged. Periodically, the column (1) is turned through 180° by driving with the motor (13), the blower for recycling (19) is driven and the heater (20) is actuated, whereby the dry adsorbent (4) in the column (1) in register with the pre-adsorbing section (25) and the post-desorbing section (26) is moved up into register with the pre-adsorbing section (23) and the post-desorbing section (24), and ambient air is drawn through the fresh adsorbent by the blower for adsorption (16). On the other hand, the adsorbent (4) laden with adsorbed water in the chambers through which air has hitherto been drawn are moved downwardly into register with the pre-desorbing section (25) and the post-desorbing section (26). The air remaining in the recycling passage made up of the pre-desorbing section (25), the adsorbent column (1) in register with the pre-desorbing section (25), the post-desorbing section (26) and the duct (18) is circulated by the blower for recycling (19) and is heated to a desired tem-
perature by the heater (20). The desorbing step is started. In the desorbing step, the adsorbent (4) laden with water is heated by the air heated to the desired temperature by the heater (20), whereby water is desorbed and carried off of the adsorbent as steam. When a water storage tank (not shown) of open type is provided, a part of the air remaining in the recycling passage is fed through the condenser (22) connected to the duct (18), into the water storage tank and out of the system because of the volumetric expansion caused by the rising temperature of the air in the recycling passage after the initiation of the desorbing step. When the generation of steam is started, the remaining air in the circuit is gradually replaced by steam whereby the partial pressures of steam in the pre-desorbing section (25), the post-desorbing section (26) and the duct (18) are gradually increased to 1 atm pressure. The steam generated is passed through the same passage to reach to the condenser (22). When the condenser (22) is cooled to a temperature lower than 100°C, 100% of the steam is condensed into water and water is to be stored in the water storage tank. After a predetermined time, the adsorbent column (1) is turned through a further 180°C and the above-mentioned adsorbing step and desorbing step can be repeatedly carried out.

Referring to Figures 5 to 8, one embodiment of the water producing apparatus of the present invention will be illustrated.

The structure of the water extracting apparatus of the present invention is similar to that of the conventional apparatus shown in Figure 1 except that the ratio of the number of small chambers (1a) in register with the pre-adsorbing section (23) and the post-adsorbing section (24) to the number of small chambers (1a) connecting to the pre-desorbing section (25) and the post-desorbing section (26), in the adsorbent column (1) can be varied.

In the drawings, the reference numeral (27) designates a first rotary rod which is placed along the axis in a part of the first cylindrical body (5) at the side of the adsorbent column (1) and is rotatably held by the first bearing (9) at one end thereof; (28) designates a second rotary rod which is placed along the axis in a part of the second cylindrical body (6) and is rotatably held by the second bearing (10) at one end; (9a) designates a third bearing which rotatably supports the other end of the first rotary rod (27); (10a) designates a fourth bearing which rotatably supports the other end of the second rotary rod (28); (7a) designates a third partition which is mounted on the inner surface of the first cylindrical body (5) at one side surface and slidably contacts with the peripheral surface of the first rotary rod (27) at the other side surface and is placed in the plane including the axis of the first cylindrical body (5). The first bearing (9) and the third bearing (9a) are mounted on the third partition (7a). The reference numeral (6a) designates a fourth partition which is placed in the plane including the axis of the second cylindrical body (6) and in the same plane as that of the third partition (7a) and which is mounted on the inner surface of the second cylindrical body (6) at one side surface and slidably contacts with the peripheral surface of the second rotary rod (28) at the other surface. The second bearing (10) and the fourth bearing (10a) are mounted on the fourth partition (8a). The reference numeral (7b) designates a fifth partition which has one side surface slidably contacting with the first and third bearings (9), (9a) and is mounted on the peripheral surface of the first rotary rod (27) and has the other side surface slidably contacting with the inner wall of the first cylindrical body (5); (8b) designates a sixth partition which has one side surface slidably contacting with the second and fourth bearings (10) (10a) at each end and is mounted on the peripheral surface of the second rotary rod (28) and has the other side surface slidably contacting with the inner surface of the second cylindrical body (6); (14a) designates a third closing plate which is a fan-shaped plate having a central angle of 90 degrees (corresponding to two of the small chambers (1a) of the column (1)) and has one side surface mounted on the end surface of the third partition (7a) in the reverse side to the adsorbent column (1) and has a peripheral part mounted on the inner wall of the first cylindrical body (5) and has the central part mounted on the peripheral part of the third bearing (9a); (15a) designates a fourth closing plate which is a fan-shaped plate having a central angle of 90 degrees and has one side surface mounted on the end surface of the fourth partition in the reverse side to the adsorbent column (1) and has a peripheral part mounted on the inner surface of the second cylindrical body (6) and has the central part mounted on the peripheral surface of the fourth bearing (10a); (14b) designates a fifth closing plate which is a fan-shaped plate having a central angle of 135 degrees (corresponding to three of the small chambers (1a) of the adsorbent column (1)) and has one side surface mounted on the end surface of the fifth partition (7b) so as to slidably contact with the surface of the third closing plate (14a) and to slidably contact with the inner wall of the first cylindrical body (5) at the peripheral surface and to slidably contact with the peripheral surface of the third bearing (9a) at the center. In the condition of the fifth closing plate (14b) as shown in the drawings, the other side surface of the fifth closing plate (14b) contacts with the surface of the third partition (7a). The reference numeral (15b) designates a sixth closing plate which is a fan-shaped plate having a central angle of 135 degrees and has one side surface mounted on the end surface of the sixth partition (8b) so as to slidably contact with the peripheral surface of the fourth closing plate (15a) and to slidably contact with the inner wall of the second cylindrical body (6) at the peripheral
surface and to slideably contact with the peripheral surface of the fourth bearing (10a) at the center. In the condition of the sixth closing plate (15b) shown in the drawings, the other side surface of the sixth closing plate (15b) contacts with the surface of the fourth partition (8a). In this embodiment, the pre-desorbing section (25) is surrounded by the third and fifth partitions (7a), (7b) in the first cylindrical body (5), the third and fifth closing plates (14a), (14b) and the adsorbent column (1). The post-desorbing section (28) is surrounded by the fourth and sixth partitions (8a), (8b) in the second cylindrical body (6), the fourth and sixth closing plates (15a), (15b) and the column (1). In this embodiment, the fifth and sixth partitions (7b), (8b) are respectively turned around the rotary shafts of the first and second rotary rods (27), (28) whereby the number of small chambers (1a) in the adsorbent column (1) connecting the pre-desorbing section (25) to the post-desorbing section (28) can be varied from 3 to 5 and the ratio of the number of the small chambers (1a) connecting the pre-desorbing section (23) and the post-desorbing section (24) in the column (1) to the number of the small chambers connecting the pre-desorbing section (25) and the post-desorbing section (26) can be varied as desired to 5/3, 1 or 3/5.

The operation of the embodiment of the water producing apparatus can be easily understood from the operation of the conventional water producing apparatus. The detail description is not repeated.

When the water producing apparatus of this embodiment is operated in the weather condition in the place at relatively high temperature and low humidity, it is the optimum condition for producing water from the ambient air in high efficiency to give the adsorbing period of 5 hours and the desorbing period of 3 hours. The ratio of the adsorbing period to the desorbing period is preferably 5/3. The ratio of the number of the small chambers (1a) connecting to the pre-desorbing section (23) and the post-desorbing section (24) to the number of the small chambers (1a) connecting to the pre-desorbing section (25) and the post-desorbing section (26) is set to be 5/3. The adsorbent column (1) is intermittently turned by 1/8 turn for each one hour. If the operation is started in the condition drying the adsorbent (4) in the adsorbent column (1), the normal operation for the adsorbing period of 5 hours and the desorbing period of 3 hours is provided after the operation for 8 hours, whereby water can be continuously produced from the ambient air in high efficiency in the optimum condition depending upon the weather condition.

On the contrary, when it is operated in a place at relatively low temperature and high humidity, the ratio of the numbers of the small chambers (1a) is set to be 3/5 and the adsorbent column (1) is intermittently turned each 1/8 turn for each one hour, whereby water can be continuously produced from the ambient air in high efficiency in the optimum condition depending upon the weather condition.

In this embodiment, in order to prevent the mixing of the air in the pre-desorbing section and post-desorbing section (23), (24) with the steam in the pre-desorbing section and post-desorbing section (25), (26), the adsorbent column (1) is intermittently turned by 1/8 turn. It is not necessary for each movement to be 1/8 turn, it is possible for each movement to be 1/4 turn or 3/8 turn. The time interval for intermittently turning the adsorbent column (1) can be set as desired depending upon the kind of the solid adsorbent, the temperature and the humidity of the ambient air for adsorption, the required amount of water and the rate of the ambient air fed into the adsorbent column (1) per hour etc. and it is not critical and it is preferably one turn per 30 minutes to 24 hours.

In the embodiment, the column for adsorbent (1) is divided into 8 parts by the partitions (3). This is not critical and the column (1) can be divided into n parts (n is an integer of 3 or more) preferably 3 to 32 parts. When the adsorbent column (1) is divided into 2 parts (n=2), the ratio of the adsorbing period to the desorbing period for the adsorbent is fixed to 1:1. The present invention is not attained. When the adsorbent column (1) is divided into more than 32 parts, the manufacture of the apparatus is not easy and is not suitable for the practical purpose. When the adsorbent column (1) is divided into n small chambers (equal), and the number of the small chambers connecting to the pre-desorbing section and the post-desorbing section is m, the number of the small chambers connecting to the pre-desorbing section and the post-desorbing section is n-m. In a place at relatively high temperature and low humidity such as a desert, it is preferable that the adsorbing period is longer than the desorbing period for the adsorbent, in view of the production of water in high efficiency. The movable parts of the pre-desorbing section and the post-desorbing section (the fifth and sixth partitions (7b), (8b) in this embodiment) can be preferably controlled so as to give m>n−m that is, m>n/2. On the contrary, in a place at relatively low temperature and high humidity, the movable parts of the pre-desorbing section and the post-desorbing section can be preferably controlled so as to give m<n/2. Usually the adsorbent column (1) is intermittently turned each 1/n turn (each one small chamber). Thus, it is possible to intermittently turn each 2/n, 3/n . . . or (n−m)/n turn, if desired. The structure of the water producing apparatus of the present invention is not limited to the structure of the embodiment and can be modified within the scope of the appended claims. For example, only one of the pre-desorbing section and the post-desorbing section can be present instead of both sections. When only the pre-desorbing section is formed,
a compressing type blower for adsorption is equipped. When only the post-adsorbing section is formed, a suction type blower for adsorption is equipped. It is possible to equip a filter and/or a flow controlling plate in the pre-adsorbing section or the post-adsorbing section. It is also possible to equip a flow control plate in the pre-desorbing section or the post-desorbing section.

In this embodiment, an electric heater is used as the heater. It is not necessary to have an electric heater, other heaters can be employed which use a combustion waste gas, a superheated steam, a Dowtherm gas etc. The condenser can be a system other than an air cooling system. In this embodiment, the adsorbent column is turned by means of the belt. It is not necessary to use the belt but it is possible to use gears.

The adsorbent used in the column can be solid adsorbents such as molecular sieve 3A, 4A, 5A, 10X and 13X; silica gel, alumina gel, silica-alumina, activated alumina, activated carbon, activated bauxite and activated clay. The absorbent used in a form of an aqueous solution such as lithium bromide and lithium chloride can be used by supporting them on a suitable carrier such as alumina and asbestos to form the adsorbent. The adsorbent can be in a form of grains, beads, pellets, and tablets. It is also possible to form parallel passage type bed using a honeycomb type adsorbent. The adsorbent can be selected depending upon the adsorbing characteristics, the temperature and the humidity.

The condition for the operation of the adsorption and desorption of the adsorbent can be selected as desired depending upon the adsorbent and is not critical.

In this embodiment, the water storage tank is the open type. Thus, it can be a closed type tank or a tank which is initially opened and closed after purging air from the recycling system with the desorbed steam or modifications thereof, in the present invention.

As described in detail, in the water producing apparatus of the present invention, the ratio of the number of the small chambers for the adsorption to the number of the small chambers for the desorption can be varied, whereby water can be continuously produced in high efficiency in any weather condition.

Claims

1. Apparatus for extracting water from moisture-laden ambient air, comprising a plurality of chambers (1a) packed with an adsorbent (4) for moisture in the air and each having an inlet and an outlet for air; means for desorbing moisture from the adsorbent comprising first and second desorbing sections (25, 26) aligned so as to be brought into register with the inlet and outlet respectively of one or more of the chambers to form an airtight passage from the first section (25) through said one or more chambers (1a) to the second section (26), a recycling duct (18) connecting the second section (26) to the first (25) to complete a desorption circuit, means (19) for circulating air through said circuit to remove water from the adsorbent, means (20) for heating the air in the circuit and means (22) for removing water from the circuit; means (11, 12, 13) for bringing one or more of the chambers (1a) into and out of register with the first and second desorbing sections and means (18) for passing ambient air through the chambers not in register with said sections, whereby moisture from the ambient air is adsorbed on the adsorbent (4) and subsequently removed from the adsorbent in each chamber as that chamber is brought into register with the said desorbing sections, characterised in that the ratio of the number of chambers (1a) in register with the desorbing sections (25, 26) to the number of chambers (1a) receiving moisture-laden air is variable so as to obtain optimum water extraction for various values of temperature and moisture content of the ambient air.

2. Apparatus according to claim 1 characterised in that the adsorbent (4) is packed in an adsorbent column (1) rotatably mounted on a shaft (2) from which partitions (3) extend radially to divide the column into said chambers (1a), whereby said chambers can be brought into and out of register with said desorbing sections (25, 26) by rotation of the column (1) about the shaft (2).

3. Apparatus according to claim 2 characterised in that said first and second desorbing sections are defined by cylindrical outer walls (5, 6) coaxial with the column, respective end walls (14, 15) and side walls (7a, 7b, 8a, 8b) extending radially from respective shafts (27, 28) coaxial with the shaft (2) of the column, at least one said side wall of each section being rotatable about its shaft to adjust the area of the end of the section in register with the adsorbing chambers.

4. Apparatus according to claim 2 or claim 3 characterised in that said adsorbent column (1) is separated into 3 to 32 small chambers (1a) by said radial partitions (3).

5. The water producing apparatus according to any preceding claim characterised in that said adsorbent is packed into n chambers (1a) and the number m of said chambers receiving ambient air can be adjusted to a value such that m>n/2 in an atmosphere of relatively high temperature and low humidity.

6. The water producing apparatus according to any preceding claim characterised in that said adsorbent is packed into n chambers (1a) and the number m of said small chambers receiving ambient air can be adjusted to a value such that m<n/2 in an atmosphere of relatively low temperature and high humidity.

7. Apparatus according to any preceding claim characterised in that said adsorbent (4) is...
8. Appareil according to any preceding claim characterised in that the means for removing water from the desorption circuit comprises a condenser (22) which is connected to said recycling duct (18) to condense steam desorbed from the adsorbent.

9. Appareil according to any preceding claim further characterised by a driving device (13) for intermittently rotating said chambers (1a) around a shaft (2) relative to said first and second desorbing sections (25, 26) and an adsorbing passage (23, 24) for ambient air.

Revendications

1. Appareil pour extraire l'eau de l'air ambiant chargée d'humidité, comprenant une série de chambres (1a) garnies d'un adsorbant (4) pour l'humidité de l'air et ayant chacune une entrée et une sortie pour l'air; des moyens pour désorber l'humidité de l'adsorbant, comprenant une première et une seconde sections de désorption (25, 26) alignées de manière à pouvoir être aménées en concordance respectivement avec l'entrée et la sortie d'une ou de plusieurs chambres afin d'établir un passage étanche à l'air depuis la première section (25), à travers lesdites une ou plusieurs chambres (1a), vers la seconde section (26), un conduit de recyclage (18) reliant la seconde section (26) à la première section (25) pour compléter un circuit de désorption, des moyens (19) pour faire circuler de l'air dans ledit circuit afin de soustraire l'eau de l'adsorbant, des moyens (20) pour chasser l'air dans le circuit et des moyens (22) pour soustraire l'eau du circuit; des moyens (11, 12, 13) pour mettre une ou plusieurs chambres (1a) en et hors de concordance avec les premières et seconde sections de désorption et des moyens (16) pour faire passer de l'air amiant à travers les chambres qui ne sont pas en concordance avec lesdites sections, de sorte que l'humidité de l'air amiant est adsorbée sur l'adsorbant (4) et ensuite retransmise à l'adsorbant dans chaque chambre lorsque cette chambre vient en concordance avec lesdites sections de désorption, caractérisé en ce que le rapport du nombre desdites chambres (1a) en concordance avec les sections de désorption (25, 26) au nombre de chambres (1a) recevant l'air chargé d'humidité est variable de manière à obtenir une extraction optimale d'eau pour diverses valeurs de température et de teneur en humidité de l'air amiant.

2. Appareil selon la revendication 1, caractérisé en ce que l'adsorbant (4) garnit une colonne (1) d'adsorbant montée à rotation sur un arbre (2) à partir duquel des cloisons (3) s'étendent radialement pour diviser la colonne selon lesdites chambres (1a), lesdites chambres pouvant ainsi être aménées en concordance et hors de concordance avec les sections de désorption (25, 26) par rotation de la colonne (1) autour de l'arbre (2).

3. Appareil selon la revendication 2, caractérisé en ce que les premières et secondes sections de désorption sont définies par des parois cylindriques extérieures (5, 6) coaxiales avec la colonne, des parois terminales respectives (14, 15) et des parois latérales (7a, 7b, 8a, 8b) s'étendant radialement à partir des arbres respectifs (27, 28) coaxiaux avec l'arbre (2) de la colonne, au moins une paroi latérale de chaque section étant rotative autour de son arbre pour régler la surface de l'extrémité de la section en concordance avec les chambres d'adsorption.

4. Appareil selon la revendication 2 ou 3, caractérisé en ce que la colonne d'adsorbant (1) est séparée en 3 à 32 petites chambres (1a) par lesdites cloisons radiales (3).

5. Appareil de production d'eau selon l'une des revendications précédentes, caractérisé en ce que ledit adsorbant garnit n chambres (1a) et que le nombre m desdites chambres recevant de l'air ambiant peut être réglé à une valeur telle que m>n/2 dans une atmosphère de relativement haute température et faible humidité.

6. Appareil de production d'eau selon l'une des revendications précédentes, caractérisé en ce que ledit adsorbant garnit n chambres (1a) et que le nombre m desdites chambres recevant de l'air ambiant peut être réglé à une valeur telle que m<n/2 dans une atmosphère de relativement basse température et forte humidité.

7. Appareil selon l'une des revendications précédentes, caractérisé en ce que ledit adsorbant (4) est un adsorbant solide choisi parmi les tamis moléculaires 3A, 4A, 5A, 10X et 13X, le gel de silice, le gel d'alumine, la silice-alumine, l'alumine activée, la bauxite activée et l'argile activée.

8. Appareil selon l'une des revendications précédentes, caractérisé en ce que les moyens pour soustraire l'eau du circuit de désorption comprennent un condenseur (22) relié au conduit de recyclage (18) pour condenser la vapeur d'eau désorbée de l'adsorbant.

9. Appareil selon l'une des revendications précédentes, caractérisé en outre par un dispositif d'entraînement (13) pour faire tourner par intermittences lesdites chambres (1a) autour d'un arbre (2) par rapport auxdites premières et secondes sections de désorption (25, 26) et un passage d'adsorption (23, 24) pour l'air amiant.

Patentansprüche

1. Vorrichtung zum Extrahieren von Wasser aus feuchtigkeitsbeladener Umgebungsluft, umfassend eine Vielzahl von Kammern (1a), welche mit einem Adsorptionsmittel (14) für Feuchtigkeit in der Luft bepackt sind und jeweils einen Einlaß und einen Auslaß für Luft ausweisen; Einrichtungen zum Desorbieren von
Feuchtigkeit aus dem Adsorptionsmittel, umfassend erste und zweite Desorptions- 
abschnitte (25, 26), die in der Weise ausge- 
richtet sind, daß sie mit dem Einlaß bzw. Auslaß 
von einer oder mehreren der Kammern unter 
Bildung einer luftdichten Passage von dem 
ersten Abschnitt (25) durch die genannten eine 
odermehrere Kammern (1a) zu dem zweiten 
Abschnitt (26) in Übereinstimmung gebracht 
werden können, eine Kreislaufleitung (18), 
welche den zweiten Abschnitt (26) mit dem 
ersten Abschnitt (25) zur Vervollständigung 
eines Desorptionskreislaufs verbindet. Ein- 
richtungen (19) zum Zirkulieren von Luft durch 
den genannten Kreislauf, um Wasser aus dem 
Adsorptionsmittel zu entfernen, Einrichtungen 
(20) zum Erhitzen der Luft in dem Kreislauf und 
Einrichtungen (22) zur Entfernung von Wasser 
aus dem Kreislauf; Einrichtungen (11, 12, 13), 
mit denen eine oder mehrere der Kammern (1a) 
mit den ersten und zweiten Desorptions- 
abschnitten in Übereinstimmung oder in Nicht- 
übereinstimmung bringbar sind und Einrich- 
tungen (16) zum Durchleiten von Umgebungs- 
luft durch die Kammern, die in Nichtüberein- 
stimmung mit den genannten Abschnitten sind, 
wohl Feuchtigkeit aus der Umgebungsluft an 
dem Adsorptionsmittel (4) adsorbiert wird und 
an anschließend aus dem Adsorptionsmittel in 
jeder Kammer entfernt wird, wenn die Kammer 
mit den genannten Desorptionsabschnitten in 
Übereinstimmung gebracht ist, dadurch gekenn- 
zeichnet, daß das Verhältnis der Zahl der 
Kammern (1a), die mit den Desorptionsab- 
schnitten (25, 26) in Übereinstimmung stehen, 
zur Zahl der Kammern (1a), welche Feuchtig- 
keitsbeladene Luft empfangen, veränderbar 
is, und zwar in der Weise, daß für verschiedene 
Werte von Temperatur und Feuchtigkeitsgehalt 
der Umgebungsluft das Optimum der Wasser- 
extraktion erhalten wird.

2. Vorrichtung nach Anspruch 1, dadurch 
gekennzeichnet, daß das Adsorptionsmittel (4) 
in eine Adsorptionsmittelsäule (1) gepackt ist, 
die drehbar auf einer Welle (2) gelagert ist, 
von der sich Trennwände (3) radial erstrecken, 
und die Säule in den genannten Kammern (1a) zu 
unterteilen, wobei die Kammern durch Drehung 
der Säule (1) um die Welle (2) in Überein- 
stimmung und in Nichtübereinstimmung mit den 
Desorptionsabschnitten (25, 26) gebracht 
werden können.

3. Vorrichtung nach Anspruch 2, dadurch 
gekennzeichnet, daß die ersten und zweiten 
Desorptionsabschnitte definiert sind durch 
zylindrische Außenwände (5, 6), welche coaxial 
mit der Säule angeordnet sind, jeweilige End- 
wände (14, 15) und Seitenwände (7a, 7b, 8a, 
8b), welche sich radial von den jeweiligen 
Wellen (27, 28) erstrecken, welche coaxial mit 
der Welle (2) der Säule angeordnet sind, wobei 
wenigstens eine der Seitenwände jedes Ab- 
schnitts zur Einstellung der Endfläche des Ab- 
schnitts, der mit den Adsorptionskammern in 
Übereinstimmung steht, um ihre Welle drehbar 
ist.

4. Vorrichtung nach einem der Ansprüche 2 
or 3, dadurch gekennzeichnet, daß die 
Adsorptionsmittelsäule (1) durch die radialen 
Trennwände (3) in 3 bis 32 kleine Kammern 
(1a) aufgeteilt ist.

5. Vorrichtung nach einem der vorstehenden 
Ansprüche, dadurch gekennzeichnet, daß das 
Adsorptionsmittel in n Kammern (1a) gepackt 
ist und die Zahl m der Kammern, welchen 
Umgebungsluft zugeführt wird, eingestellt 
werden kann auf einen solchen Wert, daß in 
einer Atmosphäre von relativ hoher Temperatur 
und geringer Luftfeuchtigkeit m>n/2 ist.

6. Vorrichtung nach einem der vorstehenden 
Ansprüche, dadurch gekennzeichnet, daß das 
Adsorptionsmittel in n Kammern (1a) gepackt 
ist und die Zahl m der kleinen Kammern, 
en welchen Umgebungsluft zugeführt wird, 
eingestellt werden kann auf einen solchen Wert, 
 daß in einer Atmosphäre von relativ niedriger Tem- 
peratur und hoher Luftfeuchtigkeit m<n/2.

7. Vorrichtung nach einem der vorstehenden 
Ansprüche, dadurch gekennzeichnet, daß das 
Adsorptionsmittel (4) ein festes Adsorptions- 
mittel ist, ausgewählt unter Molekularsieb 3A, 
4A, 5A, 10X und 13X, Silicagel, Aluminium- 
mioxidgel, Silica-Aluminiumoxid, aktiviertem 
Aluminiumoxid, Aktivkohle, aktiviertem Bauxid 
und aktiviertem Ton.

8. Vorrichtung nach einem der vorstehenden 
Ansprüche, dadurch gekennzeichnet, daß die 
Einrichtungen zur Entfernung des Wassers aus 
dem Desorptionskreislauf einen Kühler (22) 
umfassen, welcher an die Kreislaufleitung (18) 
angeschlossen ist, um den aus dem Adsorpsionsmittel desorbierten Dampf zu kon- 
densieren.

9. Vorrichtung nach einem der vorstehenden 
Ansprüche, ferner gekennzeichnet durch eine 
Antriebeinrichtung (13) zum intermittierenden 
Drehen der Kammern (1a) um die Welle (2) 
relativ zu den ersten und zweiten Desorptions- 
abschnitten (25, 26) und einem Adsorptions- 
durchgang (23, 24) für Umgebungsluft.