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Air Wells, Fog Fences & Dew Ponds

Methods for Recovery of Atmospheric Humidity

by

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See also: Air Well Patents (#1) // Air Wells Patents (#2) // Air Well Patents (#3) // ELLSWORTH : Air Well // JAGTOYEN : Auto Exhaust Water Recovery System // KLAPHAKE : Practical Methods for Condensation of Water from the Atmosphere // PARENT : Air Well // QINETIQ : Dew Collector // THEILOW : Air Well // WHISSON : Air Well

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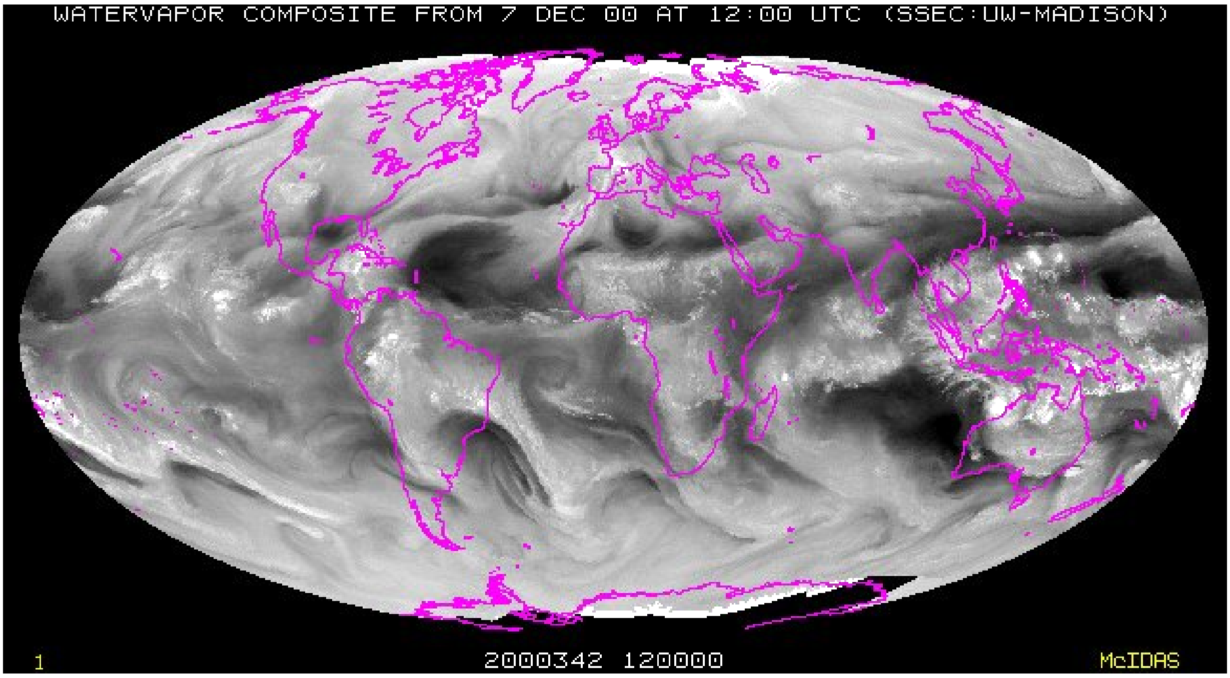
Introduction ~

Humans must drink about a gallon of water every day to remain alive. Modern urbanites easily consume 100 gal/day by bathing, laundering, and watering lawns, etc. If groundwater or rain is not available, there are several little-known alternative methods to obtain fresh water by condensing atmosphere humidity. We live in a dilute ocean of aerial moisture. There are also real "sky rivers" full of fresh water from which we can draw.

In 1993, Reginald E. Newell (M.I.T.), *et al*., found 10 huge filamentary structures that are the preferable pathways of water vapor movement in the troposphere (the lower 10-20 km of the atmosphere) with flow rates of about 165 million kilograms of water per second. These "atmospheric rivers" are bands from 200 to 480 miles wide and up to 4,800 miles long, between 1-2 kilometers above the earth. They transport about 70% of the fresh water from the equator to the midlatitudes, are of great importance in determining the location and amount of winter rainfall on coastlines. (Ref 1)

According to Newell, "A typical flow in [the] South American tropospheric river is very close to that in the Amazon (about 165 x 106 kg sec^{-1}). There are typically five rivers leading into the middle latitudes of the Southern Hemisphere and four or five leading into the Northern Hemisphere. The rivers persist for 10 days or more while being translated generally eastward at speeds of 6 m/sec^{-1}." (Figure 1)

Figure 1 ~ Tropospheric Rivers:



("Tropospheric Rivers" appear as bright white bands)

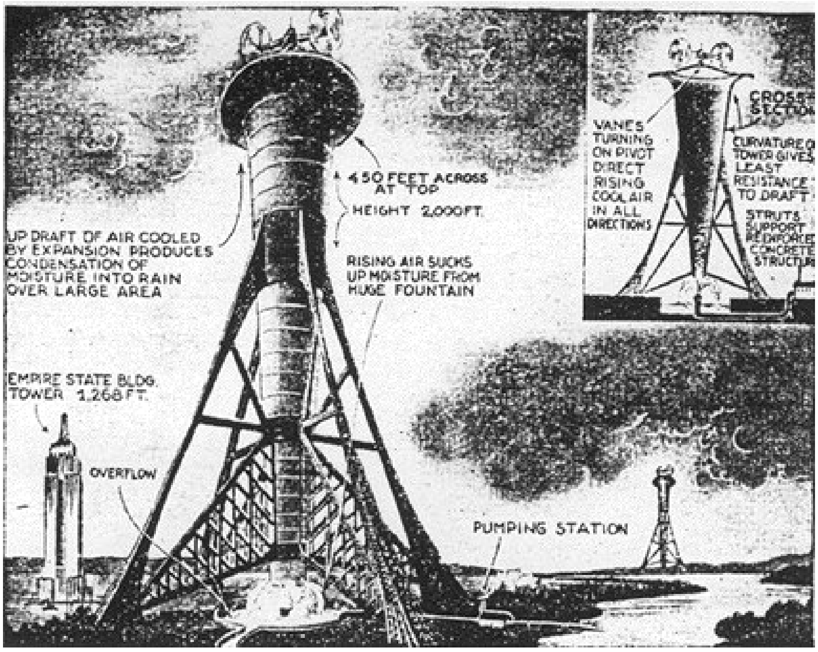
Approximately 3,100 cubic miles of water is in the atmosphere at any said time, 98% in the form of vapor, 2% in clouds. About 280 cubic miles of water evaporate or transpire into the atmosphere each day. A cubic mile of water contains over one trillion gallons. The continental USA receives about 4 cubic miles of rainfall daily. More than 2,000,000 cubic miles of fresh water is stored in underground aquifers; about 60,000 cubic miles of fresh water are stored in lakes, inland seas, and rivers. About 7,000,000 cubic miles of water are contained in glaciers and polar icecaps, and in Greenland. The world's reserves of fresh water are estimated at approximately 35 million cubic kilometers, including glaciers, ground water, wells, rivers, lakes, and precipitation as rain and snow. Yet it is inadequate for the ever-increasing, largely unrestrained demands of human civilization, so that alternative sources are desperately needed. While desalination of seawater is an obvious option, as yet the total quantity produced in this way amounts to about 10 km^3, which is only a very small percentage of the 3000 cubic km^3 consumed annually.

Mechanical Methods ~

It should be possible to draw water from atmospheric rivers. The engineering problem of reaching that height is not insurmountable if the construction is done atop mountains in appropriate areas, although the rivers move about considerably.

In 1935, the French meteorologist Bernard Dubos proposed the construction of 2,000 ft chimneys to create a humid draft from fountains at the base, ejecting it into the upper air to increase the saturation and produce rain (Figure 2). Towers like these also could draw water directly from the air at high altitudes by incorporating other inventions, such as Oscar Blomgren's Electrostatic Cooling (USP # 3,872,917) or the Hilsch-Ranque Vortex Tube (USP # 1,952,281).

Figure 2 ~ Dubos' Rain-Tower:

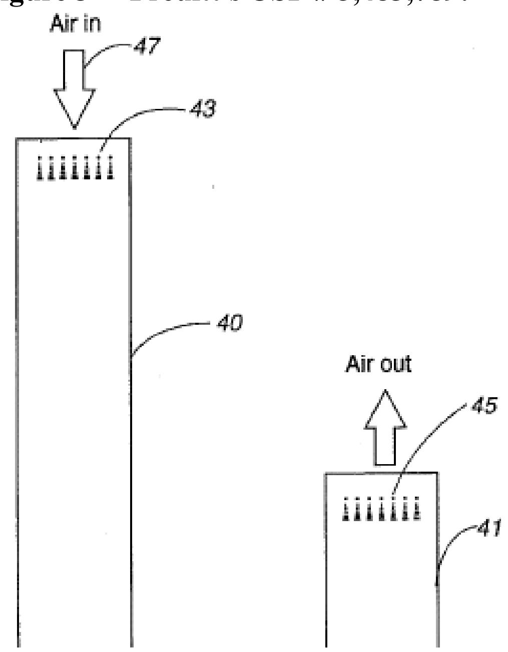


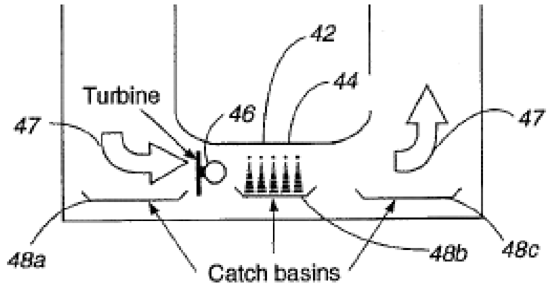
(*Everyday Science & Mechanics*, October 1935, p. 845)

The recent invention of acoustic refrigeration probably could be applied for this purpose. Sound does in fact produce rain at certain lakes in China's southern Yunnan province. People there simply yell for rain. The louder they rain, the more it rains, and the longer they yell, the longer it rains! This effect is possible because the air there is so saturated that sound waves can cause water molecules to condense.

Melvin Prueitt's US Patent # 5,483,798 for a "Convection Tower" claims to be "capable of cleaning the pollution from large quantities of air, of generating electricity, and of producing fresh water utilize the evaporation of water spayed into the towers to create strong air flows and to remove pollution from the air. Turbines in tunnels at the base generate electricity, and condensers produce fresh water" (See also Prueitt's US Patents # 5,477,684 ~ # 5,395,598 ~ 5,284,628). (Figure 3)

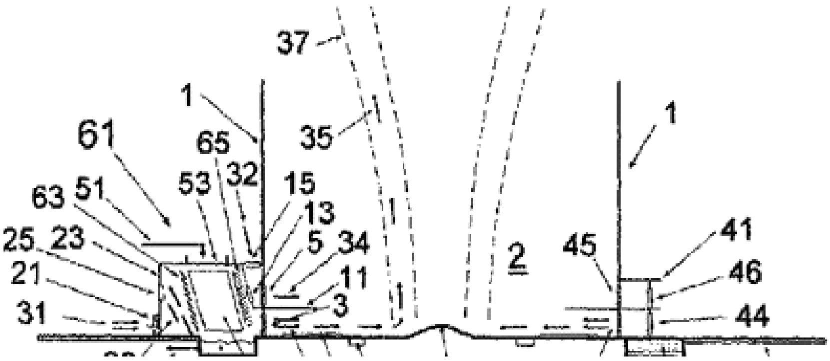
Figure 3 ~ Preuitt's USP # 5,483,789:





Similarly, the "Vortex Engine" invented by Louis Marc Michaud (WO 03/025395 ~ US Patent Application # 2004112055) describes "A tornado-like convective vortex... produced by admitting air tangentially in the base of a cylindrical wall. The vortex is started by heating the air within the circular wall with fuel. The heat required to maintain the vortex once established can be the naturally occurring heat content of the ambient air, or can be provided in a peripheral heart echanger means located outside the circular wall. The heat source for the peripheral exchanger can be waste industrial heat or warm seawater. The preferred heat exhanger means is a crossflow wet cooling tower. The mechanical energy is produced in a plurality of peripheral turbines. A vortex engine would have a diameter of 400 meters; the vortex could be 100 meters diameter at its base and extend to a height of 1 to 15 kilometers; the power putput copuld be in the 100 to 500 megawatt range. The vortex process could also be used to produce precipitation, to cool the invironment, or to clean or elevate polluted surface air." (Figure 4)

Figure 4 ~ Michaud's Vortex Engine:

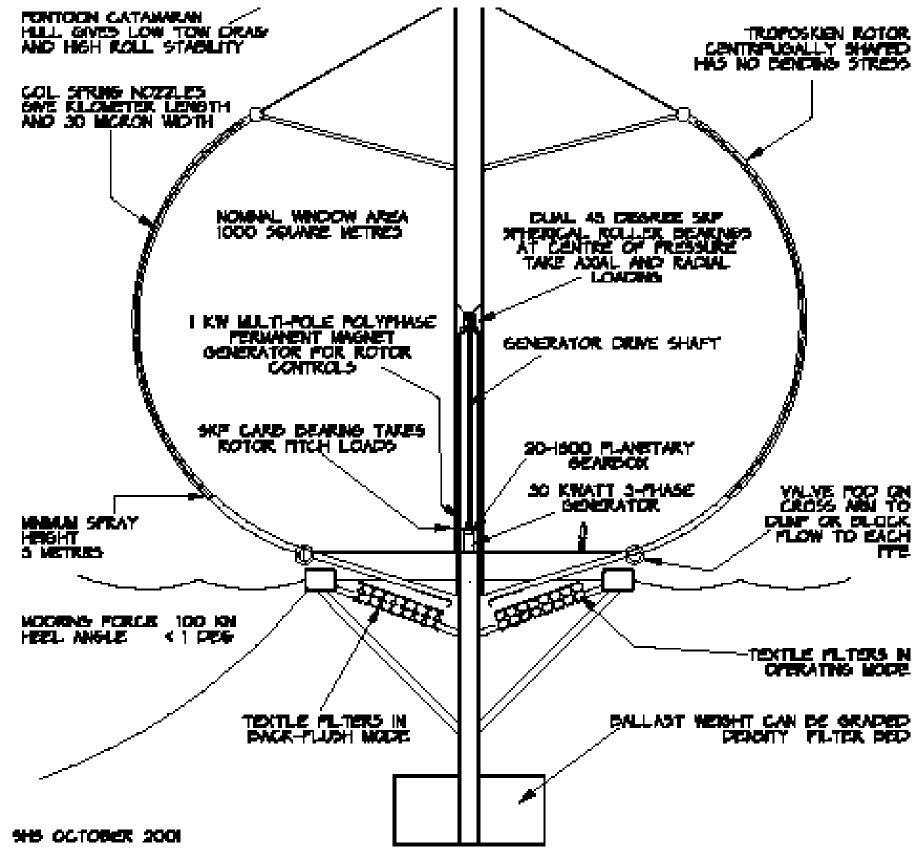


Prof. Stephen Salter (Edinburgh University, Division of Engineering) has designed a 200 ft high turbine that will spray vaporized seawater into the atmosphere and produce rain from clouds that do not contain enough moisture to precipitate. The British government has provided a grant for its construction. Prof. Salter described his invention at the 10th Congress of International Maritime Association of the Mediterranean (Crete, May 2002):

"The evaporation of water from the sea surface is slow and inefficient because of the need for large amounts of latent heat and because the perpendicular component of turbulence in the air vanishes at the surface leaving a stagnant humid layer. The wind has to blow over thousands of kilometres of warm sea before it can bring rain. Saudi Arabia is dry because the Red Sea and the Persian Gulf are narrow. Chile is dry because the Humboldt current is cold.

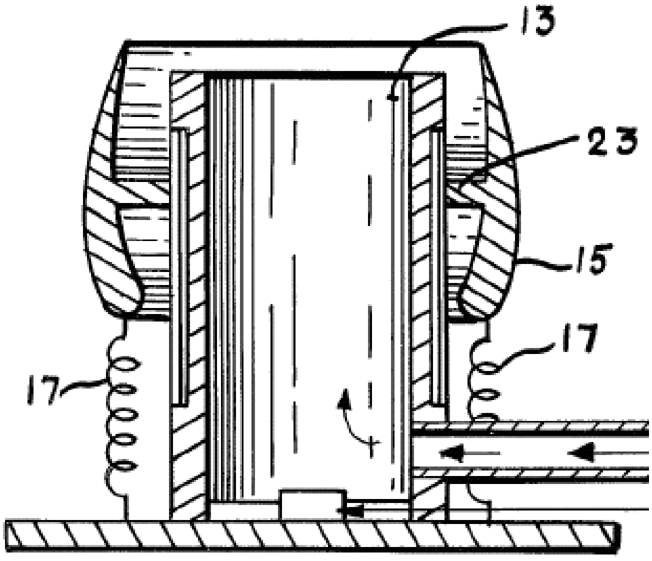
"Calculations show that some remediation may be possible using a mechanism that can be controlled to suit local needs. This paper describes the design of a floating, vertical-axis wind turbine which pumps sea water through the humid stagnant layer and sprays it in fine droplets with a large increase in surface area. The spray release height is chosen to give time for a large fraction of the water to evaporate when mixed with air in the turbine wake. The distance from land is chosen so that residual very salty drops fall into the sea. The humidified air is likely to produce rain when it reaches rising ground. The technique allows evaporation from narrow stretches of sea with winds blowing over the fetches associated with daily sea breezes caused by rising air ashore. Narrow waters can be made to behave like much wider oceans with seasonal prevailing winds but control remains in the hands of the turbine owners." (Figure 5)

Figure 5 ~ Prof. Stephen Salter's Spray Turbine:



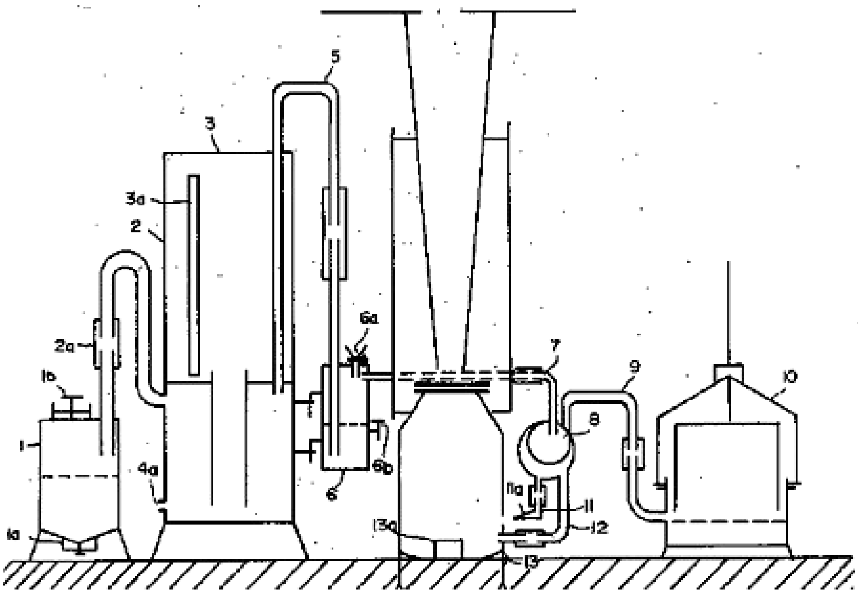
Vortex ring generators have been invented that project stable doughnut-shaped clouds of smoke for long distances. For example, in 1942 Dr Phillips Thomas of the Westinghouse company developed a vortex gun that was intended to eliminate smoke from factories by shooting it in vortex rings high into the atmosphere. US Patent # 3,940,060 was granted to Herman Viets in 1976 for a vortex generator that could penetrate clouds and atmospheric obstacles such as thermal inversions. When used in combination with acoustics, electric charges and water vapor or chemicals, this invention could be adapted to produce rain. (Figure 6)

Figure 6 ~ Viets' USP # 3,940,060:



The "Hail Stop" system invented by Gerald Ollivier has received four US Patents (# 3,848,801 ~ # 5,381,955 ~ # 5,411,209 ~ # 5,445,321), and it is commercially available (www.hailstop.com). The invention is "a process and apparatus for the transformation of the internal structure of visible cloud banks to induce rainfall or snow, or to avoid hailstorms, comprising igniting explosive compositions [acetylene] at time intervals of less than 25 seconds to create sudden upward movement of energy directed to form shock waves at cloud level to modify the internal structure of the cloud banks". (Figure

Figure 7 ~ Ollivier's "Hail Stop":



Electromagnetic Methods ~

The great inventor Nikola Tesla published an article about "The Wonder World to be Created by Electricity" in *Manufacturer's Record* (September 9, 1915), wherein he claimed that, "The time is very near when we shall have the precipitation of the moisture of the atmosphere under complete control, and then it will be possible to draw unlimited quantities of water from the oceans, develop any desired amount of energy, and completely transform the globe by irrigation and intensive farming. A greater achievement of man through the medium of electricity can hardly be imagined". Tesla invented the "Magnifying Transmitter" with which to accomplish this feat, but he was not able to complete the project. (Figure 8)

Figure 8 ~ Tesla Magnifying Transmitter:

It is in fact possible to influence tropospheric rivers by electromagnetic means. The US military certainly has been investigating weather modification since the 1950s. Capt. Howard Orville publicly stated in 1958 that the intent was "to manipulate the charges of the earth and sky and so affect the weather through electronic beams to ionize and de-ionize the atmosphere". That is being done today by the notorious American HAARP station at Gakona, Alaska, and smaller stations in Greenland and Norway. HAARP currently transmits up to 960 KW of energy into the upper atmosphere to produce its effects. Increased funding through DARPA will enable the Gakona station to increase its power to 3.6 MW by 2006. (Figure 9) (http://server5550.itd.nrl.navy.mil/projects/haarp/index.html)

Figure 9 ~ HAARP:

HAARP (High-Frequency Active Auroral Research Program) is a damnable weapon of mass destruction (invented by Bernard Eastlund: USP # 4,686,605 ~ # 5,38,664) that contravenes the United Nations "Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques" (approved in December 1976). The treaty prohibits "the use of techniques that would have widespread, long-lasting or severe effects through deliberate manipulation of natural processes and cause such phenomena as earthquakes, tidal waves, and *changes in climate and weather patterns*". The US government openly advertises its intentions in the publication "Weather as a Force Multiplier: Owning the Weather in 2025" by Col. T. House, *et al*. (August 1996) . The report acknowledges that, "The difficulty, cost and risk of developing a weather control system for military applications [is] extremely high". It justifies the effort, however, with the rationale (according to Dr Arnold Barnes, who consulted in the study) that the "opportunities to capitalize on investment militarily [are] medium/high" and the "political implications/health hazards medium/low". (www.au.af.mil.au/2025/volume3/chap15/v3c15-1.htm)

Such military programs also violate the National Environmental Protection Act (42 U.S.C. Sec. 4331a), the policy of which is to "create and maintain conditions under which man and nature can exist in productive harmony."

During the Cold War the Soviet Union developed Nikola Tesla's "Magnifying Transmitter" technology to a high degree and weaponized it. Tesla had discovered that atmospheric ionization could be altered by low frequency radio waves (10-80 Hz). The Soviets built Tesla transmitters at Angarsk and Khabarovsk (Siberia), Riga (Latvia), Gomel, Sakhalin Island, Nikolayev (Ukraine). The transmitter at

Riga was moved to Bejucal, about 60 miles south of Havana, Cuba. The coordinated operation of these transmitters apparently caused the long drought in California during the 1980s by creating a high pressure ridge about 800 miles off the coast of California and forcing it to remain there for several months. Another such "blocking pattern" that was held in position for 6 weeks caused severe flooding in the Midwest USA in 1993. Some investigators have claimed that the flooding was caused by an experiment involving the GWEN (Ground Wave Emergency Network) transmitters, which comprise an emergency commnication system that would be immune to electromagnetic pulse in the event of a nuclear war.

Since 1992, the Russian company Elate Intelligence Technologies, Inc. has demonstrated its ability to radio-control rainfall on demand over an area of 200 square miles. The corporate slogan is "Weather made to order". An Elate weather-control system is in operation at Moscow's Bykovo Airport. The *New York Times* (Sept. 24, 1992) reported that some Russian farmers were using the technology to improve their crops. Elate executive Igor Pirogoff was quoted in the *Wall Street Journal* (Oct. 2, 1992) as saying that his company could have transformed Hurricane Andrew "into a wimpy little squall".

On November 13, 1997, the *Wall Street Journal* also reported "Malaysia to Battle Smog with Cyclones" using "new Russian technology to create cyclones... to cause torrential rains washing the smoke out of the air". The Malaysian government approved the plan in conjunction with the Malaysian company BioCure Snd. Bhd. and "a government-owned Russian party".

The method of atmospheric ionization to modify weather was first patented by William Haight in 1925 (British Patent # 251,689). He actually constructed two electrical rain-making towers in California. Haight claimed that the earth contains a positive charge of static electricity and the atmosphere has a negatively-charged region. Between the two is an insulating region of dry air that prevents the positive and the negative charges from combining to produce a lower temperature that would cause clouds to condense and rain to fall. By discharging high frequency alternating current into the insulating layer, electrical contact is established between the positive and negative layers. The temperature drops in the clouds, causing them to condnese and rain.

The technique can be adapted to produce clouds where none exist, or to disperse fog by forming clouds. The insulated apparatus was not grounded, so as to discharge only into the atmosphere. He used a 5 kilowatt generator to produce a 150-200 KHz signal (1200-2000 meters) that could control the weather within a radius of 5 miles. (Figures 10 & 11)

Figure 10 ~ Haight's Rain-Making Tower:

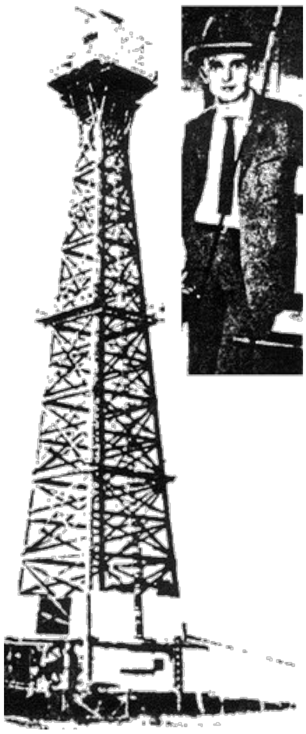
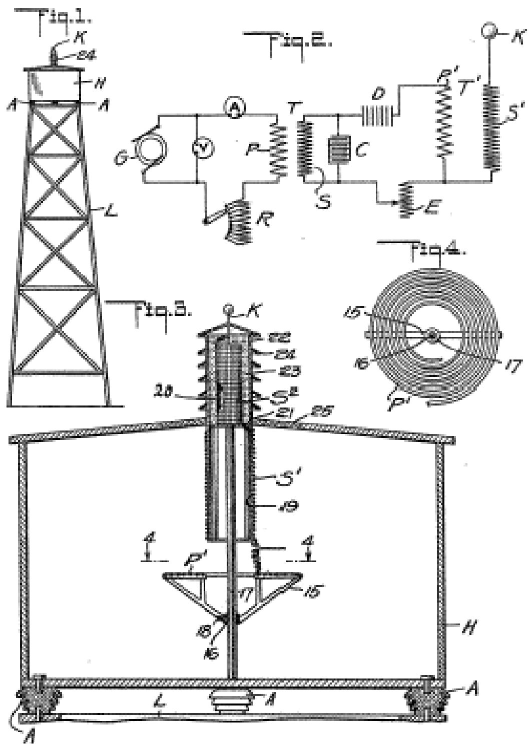


Figure 11 ~ Haight's British Patent # 251,689:



In September 2002, Russia's Emergency Situations Ministry announced that it had drawn rainclouds to Moscow and produced rain with a large ionizer. The device was described by Mikhail Shakhramanian, the director of the ministry's research institute, as "a metal cage crisscrossed by tungsten wire [that] emits a vertical flow of oxygen ions that stirs the air and raises humidity".

Orgone & Scalar Methods ~

Dr Wilhelm Reich's Orgone technology is arguably effective for purposes of rainmaking, but conventional scientists categorically deny this possibility without bothering to gain the experience of etheric engineering. Trevor Constable, who has conducted research and development of this technology for more than 30 years, now consults with the Singapore corporation Etheric Rain Engineering Pte. Ltd , which has commercialized the process. The company's website proclaims that "No chemicals, electric power or electromagnetic radiation in any form are utilized. These natural techniques are environmentally pure". (Figures 12-14) (http://www.ethericrainengineering.info/start.html)

Figures 12 - 14 ~
Orgone Engineering Devices:

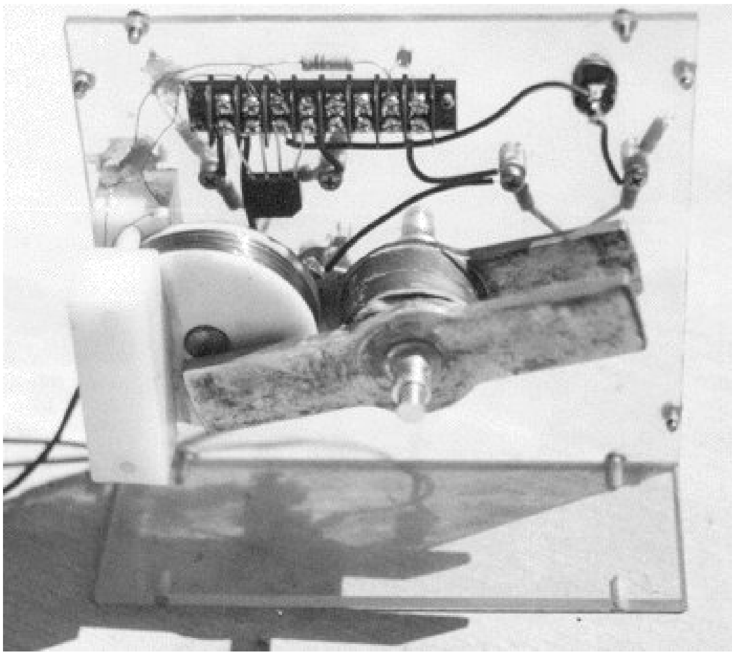
Figure 12 ~ Trevor Constable & Aerial "Bull":

Figure 13 ~ "Spider" Orgone Engineering Device:

Figure 14 ~ Reich "Cloudbuster":

A version of the controversial Newman Motor (Figure 15) has been found by David Wells to produce profound effects on weather by apparently scalar means, both locally and at great distances . This writer has confirmed those claims with satisfactory personal experimentation using both the Newman-Wells machine and Reich's "Cloudbuster", but these technologies cannot be recommended because they are easy to abuse, which would inevitably happen. (www.rexresearch.com/wells/wells.htm).

Figure 15 ~ Newman-Wells Weather Motor:



Chemical Methods ~

The technologies of weather modification with chemicals such as sodium chloride, urea, ammonium nitrate, iodates, etc., are well established, but they are expensive, unreliable, and pollute the air and water. The Dyn-O-Mat corporation (Riviera Beach, FL) manufactures "Dyn-O-Gel", which absorbs 2000 times it weight in water. It is marketed as "environmental absorbant products" under brand names such as "Dyn-O-Drought" and "Dyn-O-Storm", which are sold as as a weather-modifiers. The company's patent application states that, "The polymer is dispersed into the cloud an the wind of the storm agitates the mixture causing the polymer to absorb the rain. this reaction forms a gelatinous substance which precipitates to the surface below, thus diminishing the cloud's ability to rain". (www.dynomat.com)

Dyn-O-Mat used a US Air Force C-130 jet to disperse several tons of Dyn-O-Gel into a thunderstorm on July 16, 2001. A company spokesman claimed that Dyn-O-Gel is biodegradable and non-hazardous, and "burns up or dissolves when it hits salts water". On July 19, however, ABC News reported that a gelatinous "goo" was washing ashore at West Palm Beach. The substance was identified as Dyn-O-Gel.

The most successful method of producing rain by cloud-seeding was developed by Graeme Mather after 30 years of research. His breakthrough occurred with the observation that smoke from a local paper mill caused storm clouds to rain harder and longer. Mather's US Patent # 5,357,865 describes a method of hygroscopic particle seeding with a pyrotechnic flare containing a mixture of potassium chlorate and perchlorate. The formula consistently produces 40-65% more rain than unseeded storm clouds. His South African company Cloud Quest markets the technology. (www.soft.co.za/science/CloudQuest/default.htm)

In June 2003, Thailand's King Bhumibol Adulyadej received a patent for his "super-sandwich" technique for rain-making, involving aircraft to chemically "seed" warm and cold clouds at different altitudes to make rain. The king's technique can precisely target areas where the rain is intended to fall.

The pseudo-secret international program to spread "chemtrails" is the most glaring example of desparate government crimes against nature and humanity. Contrails (the vapor trails from jets) form at low temperatures (-76° F) at high altitudes with 70% humidity or more. Chemtrails are toxic formulas containing alumina and titanium oxide and polymer fibers. They are spread in grid patterns at lower altitudes with the intent to reflect sunlight and alleviate the greenhouse effect, or to control weather. Often they include barium stearate, which serves to enhance HAARP and military radar transmissions. (www.chemtrail.com ~ www.carnicom.com ~ www.chemtrailcentral.com)

The British Royal Air Force conducted a rainmaking exercise called Operation Columbus in 1952. A BBC report broadcast in August 2001 revealed that the project caused 35 deaths by drowning in Devon.

In 1967 during the Vietnam War, the 54th Weather Reconnaisance Squadron engaged in Operation Popeye to cause flooding along Viet Cong supply lines. The operation was exposed by columnist Jack Anderson in 1971, and a subsequent Congressional investigation documented many more weather modification programs.

Fortunately, however, It is not necessary to abuse the sensitive atmosphere with large-scale high technologies that are difficult or impossible to control. There are several safe, simple and small passive methods to condense potable aerial water vapor: air wells, dew ponds, and fog fences in various preferred embodiments and combinations.

Air Wells ~

The collection of atmospheric humidity is an ancient technology that has been rediscovered in modern times. In 1900, while he was engaged in clearing forests in Crimea (Ukraine), Russian engineer Friedrich Zibold discovered 13 large conical tumuli of stones, each about 10,000 feet square and 30-40 feet tall, on hilltops , near the site of the ancient Byzantine city of Feodosiya. Because there were numerous remains of 3-inch diameter terracotta pipes about the piles, leading to wells and fountins in the city, Zibold concluded (albeit allegedly incorrectly, according to Beysens, *et al.*) that the stacks of stone were condensers that supplied Feodosiya with water. Zibold calculated that each "air well" produced more than 500 gallons daily, up to 1000 gallons under optimal conditions.

To verify his hypothesis, he first wrote a book entitled "*Underground Dew and New Theory on the Ground Origins of Spring Water*" (1906), and then constructed a stone-pile condenser at an altitude of 288 meters on Mt. Tepe-Oba near Feodosiya. Zibold's condenser was surrounded by a 1-meter wall, 20 meters wide, around a bowl-shaped collection area with drainage. He used sea stones (10-40 cm diameter) piled 6 meters high in a truncated cone that was 8 meters diameter across the top. It began to operate in 1912 with a maximum daily production of 360 liters. The base developed leaks which forced the experiment to end in 1915. The site was partially dismantled and then abandoned. Beysens, *et al*., rediscovered the site in 1993 and cleaned it up. Zibold's condenser has the distinction of actually working on a large scale, due to a fortuitous combination of circumstances. The shape of the stone pile allowed sufficient radiative cooling with only minimal thermal contact between the stones. Thus the ratio of condensation mass to surface area was sufficient to enable dew to condense within the pile. (Figures 16, 17)

Figure 16 ~ Model Reconstruction of Zibold's Air Well:

(Photo: D. Vincon)

Figure 17 ~ Zibold's Air Well Today:

(Photos: International Organization For Dew Utilization)

Depending on the temperature and partial pressure (p), air contains varying amounts of water vapor. When the partial pressure at a given temperature exceeds a certain level of saturation (saturation pressure, p_S), then condensation occurs. The term Relative Humidity (RH) is the ration of the partial pressure and saturation pressure: HR = p/ps. The saturation pressure and the carrying capacity of air increases with the air temperature and pressure.

When a suitable substrate is available and its temperature is below the dew point, dew can form and be collected. The substrate can be cooled to various degrees by radiation or conduction to the ground or atmosphere, best during the night. The process of cooling by radiation is of course inhibited during daylight hours. The process of condensation releases latent heat which must be dissipated.

With such principles in mind, the Belgian inventor Achille Knapen built an air well on a 600-foot high hill at Trans-en-Provence in France. The construction of his "Puits Aerien" took him 18 months to complete (July 1930-December 1931). It still stands today, albeit in dilapidated condition. The unique structure was described in *Popular Mechanics Magazine*, thus:

"The tower... is about 45 feet tall. The walls are from 8 to 10 feet thick to prevent the heat radiation from the ground from influencing the inside temperature. It is estimated that the aerial well will yield 7,500 gallons of water per 900 square feet of condensation surface." (Figures 18-22)(Ref. 2)

Figure 18 ~ Knapen's Air Well:

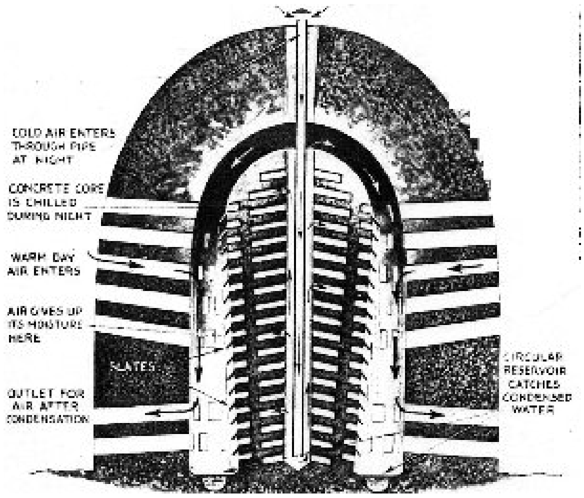


Figure 19 ~ Knapen's USP # 1,816,592:

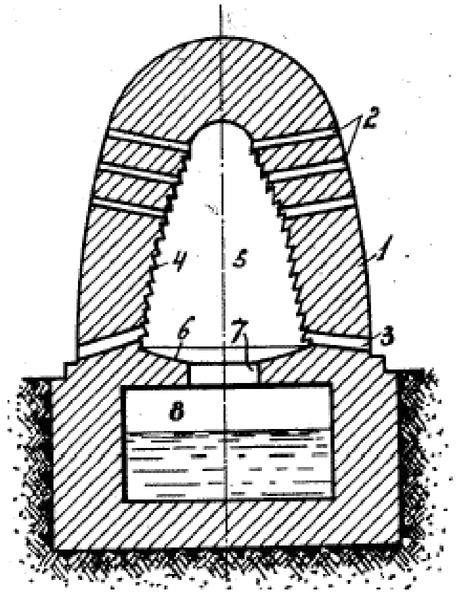


Figure 20 ~ Knapen's Air Well, Improved:

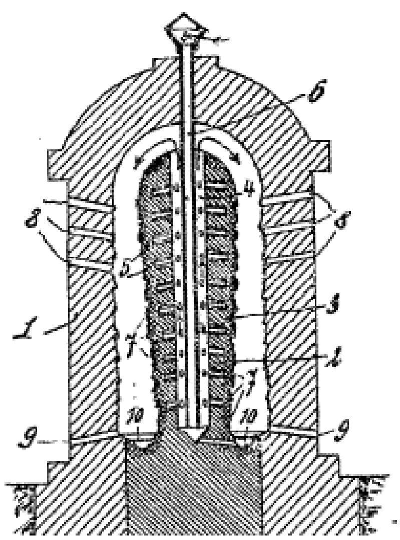


Figure 21 ~ Knapen's Wall-Attached Air Well:

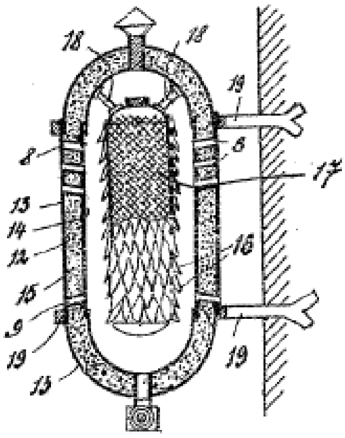
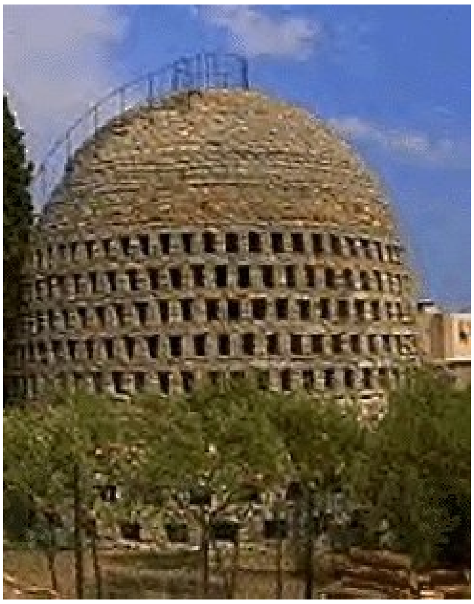


Figure 22 ~ Knapen's "Puit Aerien" Today:


[Photo: International Organization For Dew Utilization]

An article in *Popular Science Magazine* (March 1933) also featured Knapen's air well and included these details of its construction:

"[The air well has] a mushroom-like inner core of concrete, pierced with numerous ducts for the circulation of air; and a central pipe with its upper opening above the top of the outer dome.

"At night, cold air pours down the central pipe and circulates through the core... By morning the whole inner mass is so thoroughly chilled that it will maintain its reduced temperature for a good part of the day. The well is now ready to function.

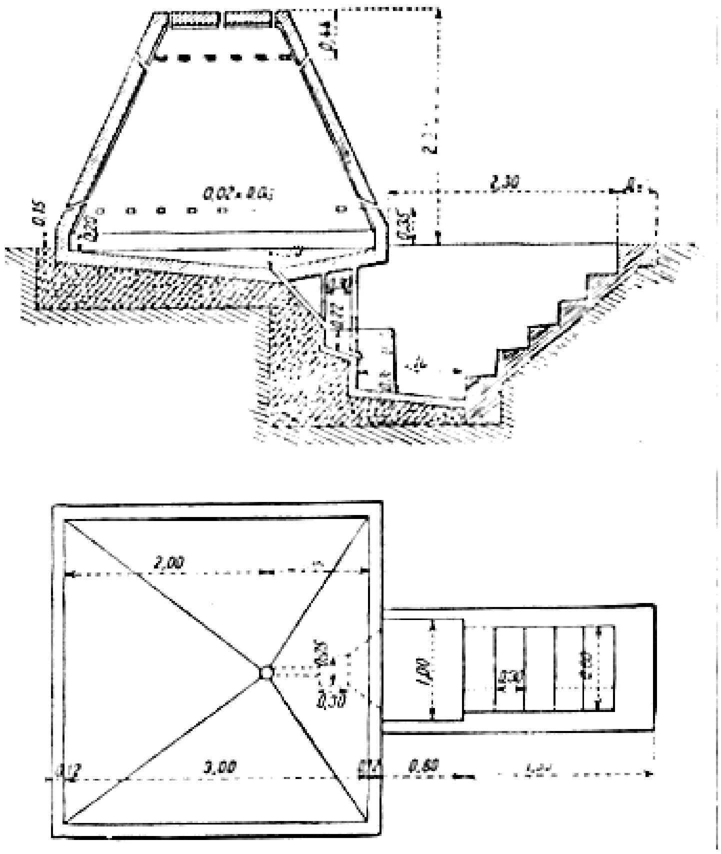
"Warm, moist outdoor air enters the central chamber, as the daytime temperature rises, through the upper ducts in the outer wall. It immediately strikes the chilled core, which is studded with rows of slates to increase the cooling surface. The air, chilled by the contact, gives up its moisture upon the slates. As it cools, it gets heavier and descends, finally leaving the chamber by way of the lower ducts. Meanwhile the moisture trickles from the slates and falls into a collecting basin at the bottom of the well." (Refs. 3, 4)

The structure did not perform well, however; at best, it collected about 5 gallons per night.

Knapen was inspired by the work of bioclimatologist Leon Chaptal, director of the French Agricultural Physics and Bioclimatology Station at Montpellier, who built a small air well near Montpellier in 1929 after being inspired in turn by the work of Zibold. The pyramidal concrete structure was 3 meters square and 2.5 meter in height, with rings of small vent holes at the top and bottom. Its volume (8 m^3) was filled with pieces of limestone (5-10 cm) that condensed the atmospheric vapor and collected it in a reservoir. The yield ranged from 1-2.5 liters/day from March to September. In 1930, the structure collected about 100 liters from April to September, but only half that much in 1931, when conditions were less favorable. The maximum yield was 5.5 lb/day. Accordingly, a pyramid with 2,500 cubic meters volume would furnish about 600 liters/day.

Chaptal found that the condensing surface must be rough, and the surface tension sufficiently low that the condensed water can drip. The incoming air must be moist and damp. The low interior temperature is established by reradiation at night and by the lower temperature of the soil. Air flow was controlled by plugging or opening the vent holes as necessary. (Ref. 5)(Figure 23)

Figure 23 ~ Chaptal's Air Well:



The German-Australian researcher Wolf Klaphake tested several forms of airwells in Yugoslavia and on Vis Island (Croatia) in the Adriatic Sea during the 1920s and 30s. Klaphake began to study air wells after he read the works of Maimonides, a Spaniard who wrote in the Arabic language about 1,000 years ago. In his description of Palestine, Maimonides mentions the use of water condensers there. Klaphake summarized his own experiments as follows:

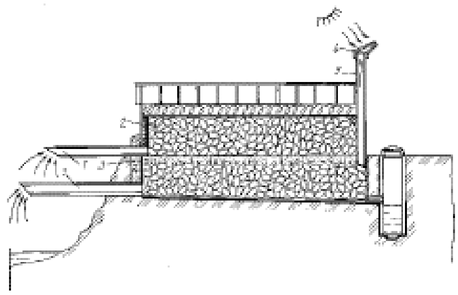
"A better method consisted in selecting a mountain slope, smoothing it with cementitious or other material apt to make the surface watertight, and covering it with an insulating material, so that the cover formed over the area a canopy or roof which was supported by pillars or ridges. The sides of the canopy were closed, whereas the upper and lower ends were left open by constructing holes or vents to allow the air to pass under the roof. This construction proved to be very successful, as the cooling surface of the inner part was highly effective. The disadvantage was that the structure was very expensive, and so a return was made to the block house type.

"Many types of building were tried, but that finally adopted was a sugarloaf-shaped building, about 50 ft high, with walls at least 6 ft thick, with holes on the top and at the bottom, the inner surface being enlarged by a network of walls of a material with great surface. The outer wall is made of concrete to be able to take up a great amount of thermal units, the inner surface consists of sandstone or any other porous material. The building produces water during the day and cools itself during the night; when the sun rises, the warm air is drawn through the upper holes into the building by the out-flowing cooler air, becomes cooled on the cold surface, deposits its water, which then oozes down and is collected somewhere underneath. It is wrong to think that this process works only on days with dew, as the inner surface becomes much cooler than one should expect. In Dalmatia, that day was a rare exception which failed to produce water.

"The essential principle in obtaining water from the air has thus been shown to be --- a great water condensing surface which must be well protected against the heat of the sun and at the same time it is necessary that the air should pass to the condensing surface slowly, in order that it may cool properly and so deposit its water. The conclusion of this is --- that a big heap of stones would do the same thing as the above-described buildings." (Ref. 6)

Oleg Bernikov received Russian Patent # 2,190,448 for an "Independent Complex for Separating Moisture from Air", for use near seas. The construction contains two levels of pebbles separated by a water-permeable floor. Wet air is pumped from the surface through intake pipes into low-pressure cavities in the pebble beds created by sun-heated suction pipes. Moisture settles on the pebbles and drains into a reservoir. Bernikov states that "Because the floor is constantly wet, it reduces the temperature of the lower level of pebbles to and below the dew point, which results in intensive backflow of moisture into the water collector." (Figure 24)

Figure 24 ~ Bernikov's Russian Patent # 2,190,448:



Two main forms of dew condensers have been developed. The first is characterized as massive (such as the designs by Klaphake and Zibold), which maintain a fairly constant temperature by producing very high specific heat. Modern research conducted by the non-profit International Organization For Dew Utilization (OPUR), however, shows that the best materials for the collection of atmospheric humidity should be light weight, thermally insulated radiative condensers that radiate heat quickly. Such materials were not widely available until recently.

Nikolayev, *et al.*, have shown that for massive dew collectors, which "produce very high specific heat to maintain their temperature as constant as possible despite latent condensation heat levels" (2500 Joules per gram at 20° C), and "taking into account the different exchanges between the found and the atmosphere... the yield decreases dramatically when the mass to surface ratio increases". (Ref. 7)

Natural radiative cooling is limited to between 25 and 150 W/m^2 at night. After compensating for latent condensation heat, the ideal maximum yield could not be over 1 liter per sq. m. One acre could produce several hundred gallons each night. Thus, according to D. Beysens, *et al.*, the ideal dew collector would be a "radiative aerial condenser" such as developed by M. Nilsson, who has tested a polyethylene film containing micro-particles of titanium oxide that produces 100 ml/day on 1.44 sq. m. (Ref. 8-12)

OPUR has developed a commercial model (CRSQ-250) that is available in a portable kit which includes a foldable condenser, operating manual, a computer program for data recording, and 30-days technical assistance. Beysens, *et al.*, have constructed an experimental radiative aerial foil dew collector (10 x 3 m at a 30° angle) at the Vignola laboratory of the University of Corsica. The collector faces west to allow dew recovery during the early morning, at which time atmospheric temperature is closest to the dew point. The system collected 0.1-0.4 liters/m^2. from July-December 2000.(Figure 25)

Figure 25 ~ FogQuest Dew Collector (Vignola, Corsica):

In the 1960s, Israelis irrigated plants dew condensers constructed of polyethylene. A similar method was developed in the 1980s using specially prepared foil condensers to irrigate saplings. (Refs. 13, 14)

In the Sahara Desert there exist many miles of ancient underground passages called "foggaras" that have been dug into the sides of mountains. The tunnels connect with the surface through an air vent every 75 feet or so, serving to collect humidity and seepage. Similar excavations exist in Afghanistan, and have served to hide the movement of troops from observation by Soviets and Americans.

In 1982, Calice Courneya patented an underground air well (USP # 4,351,651) that employs the same principle of using the ground as a heat sink:

"The air well is buried about 9 feet deep. The entrance pipe is 3-inch diameter PVC pipe (10 ft long), terminating just near the ground... This is an advantage because the greatest humidity in the atmosphere is near the surface." (Figures 26 & 27)(Ref. 15)

Figure 26 ~ Courneya's Air Well (USP # 4,351,651):

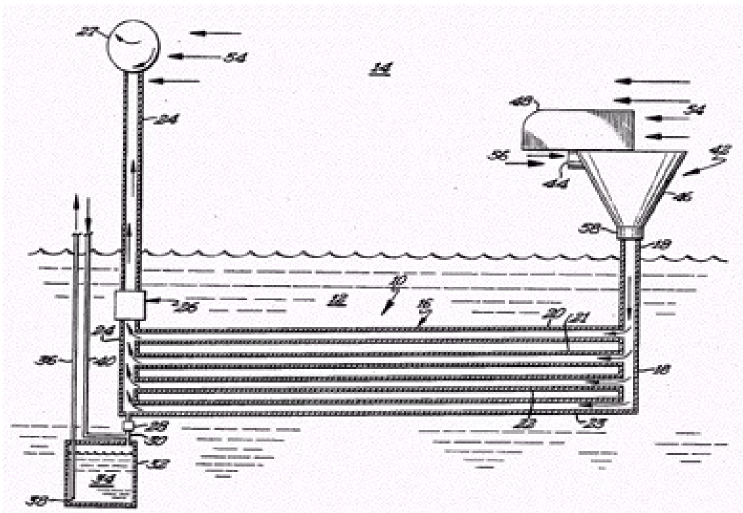
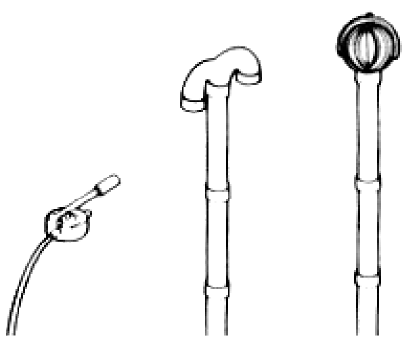
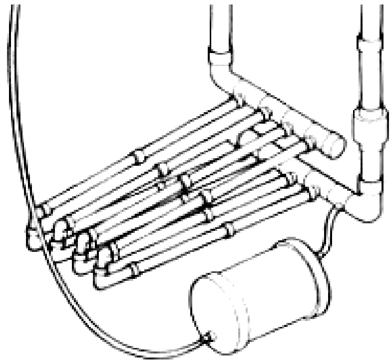


Figure 27 ~ Courneya's Air Well:





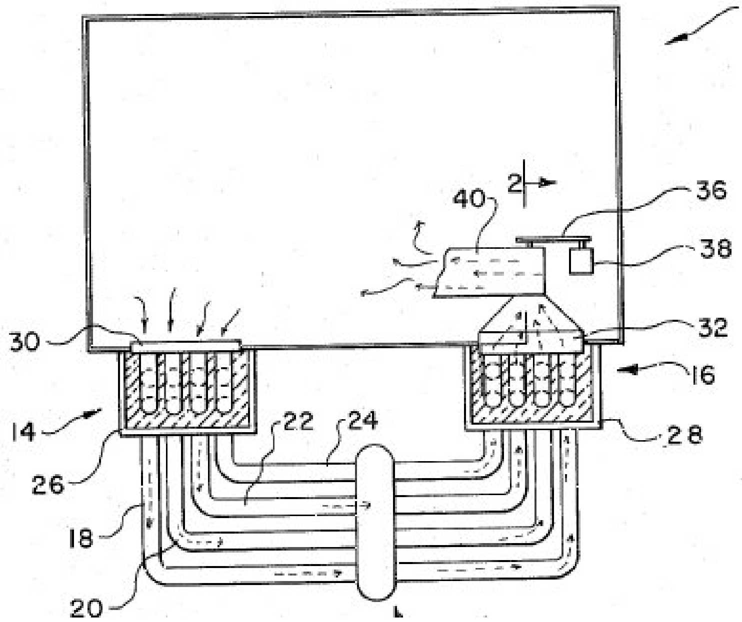
In a preferred embodiment, the intake is provided with a cyclone separator to precipitate dust before the air enters the pipe. In addition, a flow restrictor device can be installed before the exit.

Air flows through the pipes at 2,000 cubic feet per hour at 45^{o} F with a 5 mph wind. This translates to about 48,000 ft^3/day (over 3,000 lb of air daily). Courneya's first air well used a turbine fan to pull air through the pipes. Later designs employed an electric fan for greater airflow. At 90^{o}F and 80% Relative Humidity (RH), the air well yields about 60 lb water daily. At 20% RH, the yield is only about 3 lb/day. The yield is even lower at lower temperatures. The water collected by the Courneya air well is relatively pure, equivalent to single-distilled water. Analysis of water collected by an air well near a busy street found no sulfur or lead (measured in ppm). The yield depends on the amount of air and its relative and specific humidity, and the soil temperature, thermal conductivity, and moisture.

Acoustic resonance within the pipes might enhance condensation. The more recent invention of acoustic refrigeration could be used to advantage, as well as the Hilsch-Ranque vortex tube. Oscar Blomgren's invention of Electrostatic Cooling (USP # 3,224,492 and # 3,872,917) also is recommended for its simplicity and high efficiency. Passive solar-heated water-ammonia intermittent absorption refrigeration also could augment the yield of water in a desert environment.

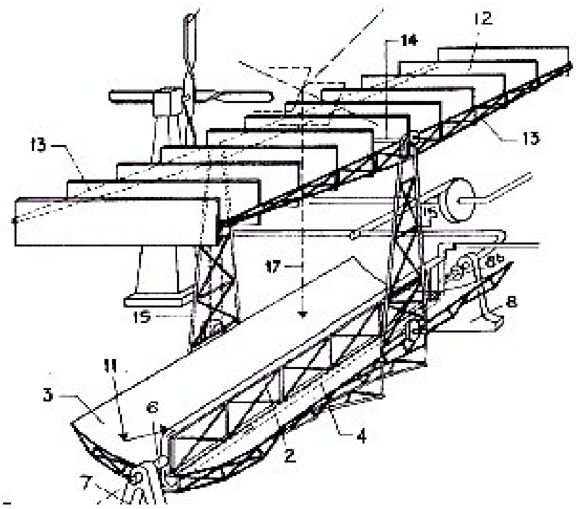
Courneya's design is similar to Walter Rogers' earlier USP # 4,234,037, issued for an "Underground Heating and Cooling System", which includes a water trap. (Figure 28)

Figure 28 ~ Walters' USP # 4,234,037:



In the 1950s, the French inventor Henri Coanda designed an elegant method to desalinate water in Morocco (USP #2,803,591). He built a silo with reflective walls, mounted several inches over a tidal pool, angled so as to catch and multiply the sunlight, thus superheating the air in the chimney. The rising hot air drew in cold air from the bottom, and became super-saturated with moisture by the time it reached the top. Pure water flowed from the condensers there. The residual brine also is of great value to chemical industry and in the construction of solar ponds. The French government forced Coanda to cease operations because his device threatened their monopoly on salt production. (Figure 29)

Figure 29 ~ Coanda's USP # 2,803,591:



Coanda also received USP # 2,761,292 for his "Device for Obtaining Drinkable Water" from the saturated air of sea coasts. He recommended that the condenser be buried so the earth could absorb the heat through a double radiator:

"For example, one cubic meter of air from a wind whose temperature is about 40° C can contain up to about 50 grams of water vapor; if the wind is forced to enter a certain space by passing along... a radiator in which a fluid circulates at the temperature existing 7 or 8 meters below the round level, that is of about 11° C, this wind will immediately precipitate on the radiator walls the portion of the water content which is in excess of that permitted by its saturation point at the cooler temperature, that is, about 40 grams per cubic meter of air, as the saturation point of air at 11° C is 10 grams per cubic meter. The heat given off, which must be carried away by the fluid in the radiator, represents approximately 32 calories for said one cubic meter of air... It is advisable to pass the fluid through a second radiator of larger dimension disposed in the ground at a certain depth.

"If the humidity of the warm air is definitely below 50 grams of water per cubic meter, that is, if the air is far from its saturation limit, and if the device for obtaining fresh water is disposed near the sea, it is possible to use [windmills] for spraying sea water into the warm air in fine droplets, thereby increasing the amount of water contained in the warm air through the partial evaporation of the sea water thereinto." (Figures 30 & 31)

Figure 30 ~ Water in Air:

FIG. 1

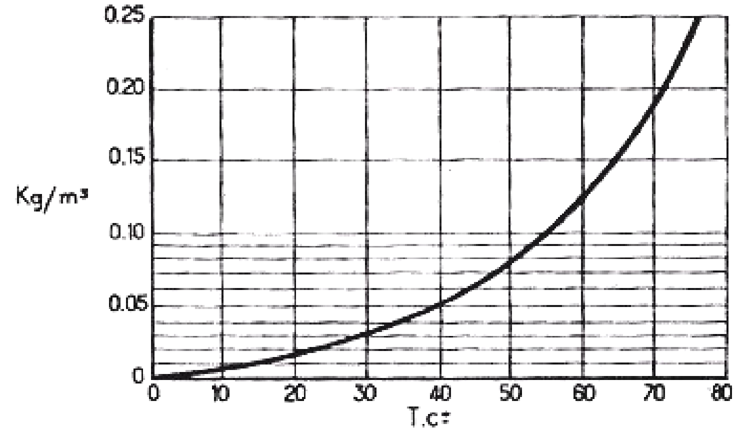
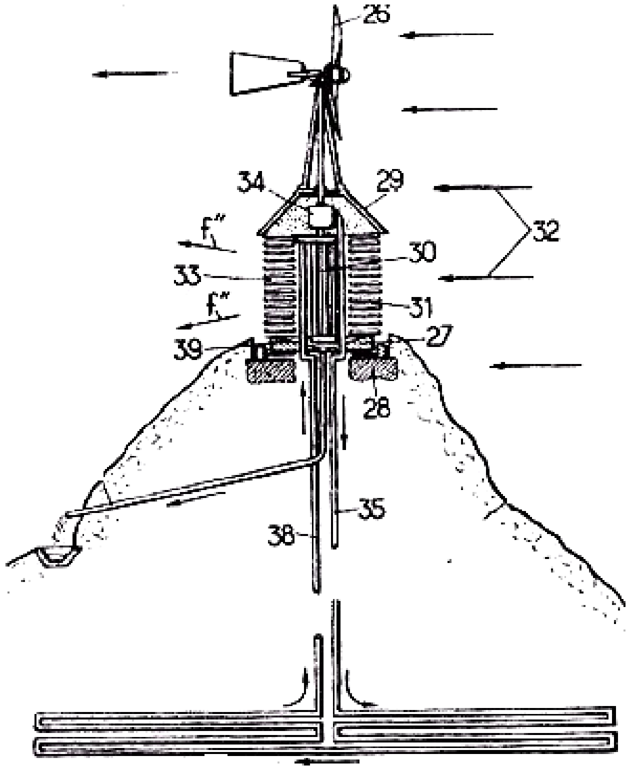


Figure 31 ~ Coanda's Air Well:



Seawater also can be used as a coolant; deep-sea water (at 4.5° C from 500 meters) can be pumped to cool a heat exchanger which is humidified with seawater and exposed to air currents. Such a system is installed at the Ukraine Maritime Hydrophysics Institute. It requires, however, several KW/m^2/day to operate. Wave-power pumps could be implemented to eliminate the associated fuel costs. (Refs. 16, 17)

There are several patents extant for glorified air conditioners that dehumidify the air to produce potable water, but they all require electrical power. Soviet cosmonauts aboard space station Mir used a system that recovered water from the air. The Aqua-Cycle, invented by William Madison, has been marketed since 1992. It resembles a drinking fountain and functions as such, but it is not connected to any plumbing. It contains a refrigerated dehumidifier and a triple-purification system (carbon, deionization, and UV light) that produces water as pure as triple-distilled. Under optimal operating conditions (80^o/60% humidity) the unit can produce up to 5 gallons daily (US Patents # 6,644,060 ~ # 6,490,879). The devices are sold by Vapair Technologies, Inc (Sandy, UT) for about $2500. (**www.vapair.com** ; 1-866-233-0296). Other manufacturers of humidity condensers (providing up to 1500 gpd) are: **www.aquamagic.us** ; **www.wataireindustries.com** ; **www.islandsky.com** ; **www.aquasciences.com** ; **www.globalrainbox.com**

Figure 32 ~ "Vap-Air" Humidity Condenser:

US Patents # 6,182,453 and # 6,490,879 were granted for such a design. Francis Forsberg's European Patent # EP 1,142,835 describes a similar system. Several other patents have been granted for various forms of dehumidifiers, employing for example the the thermoelectric Peltier Effect: USP # 2,779,172, # 2,919,553, # 2,944,404, # 3,740,959, # 4,315,599, # 4,506,510, etc. (Figures 33 - 36)

Figure 33 ~ USP #2,799,172:

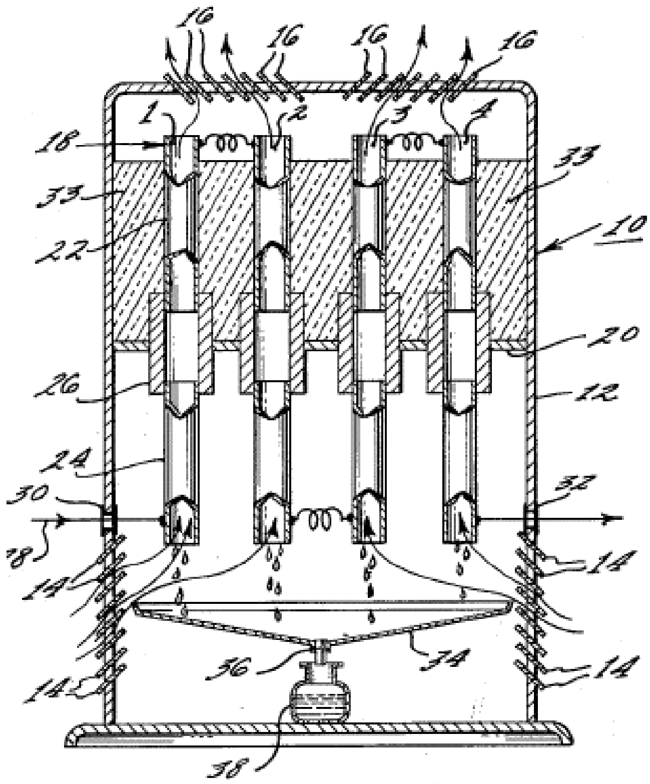


Figure 34 ~ USP # 3,740,959:

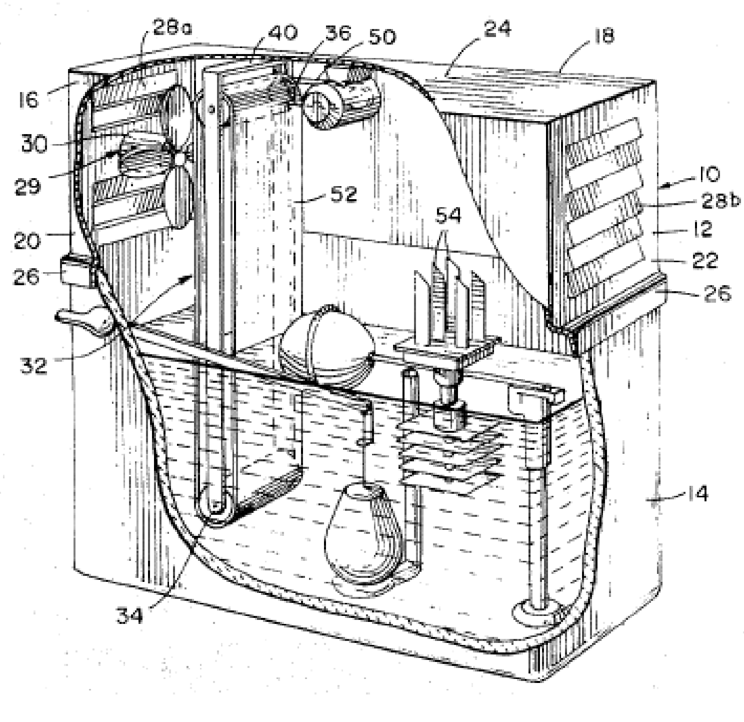


Figure 35 ~ USP # 4,315,599

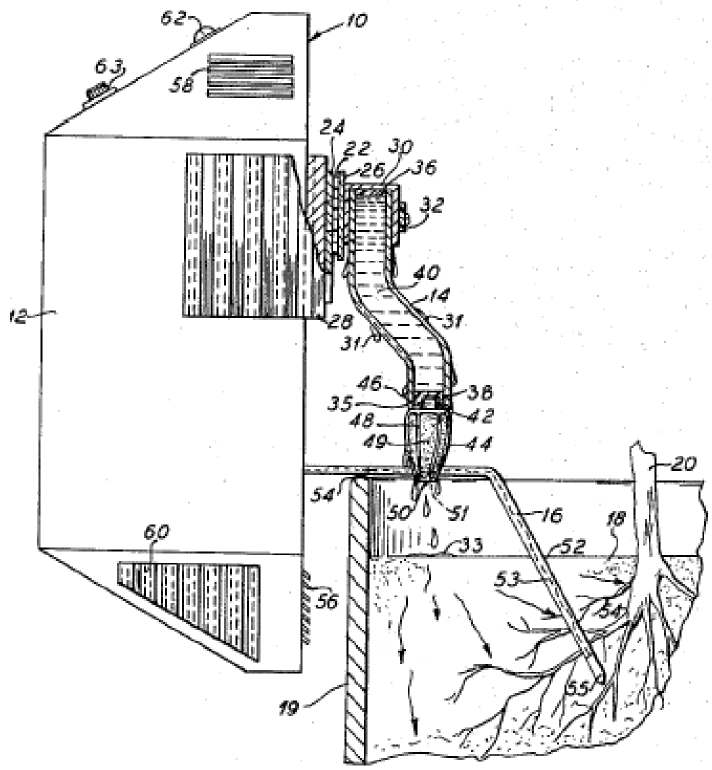
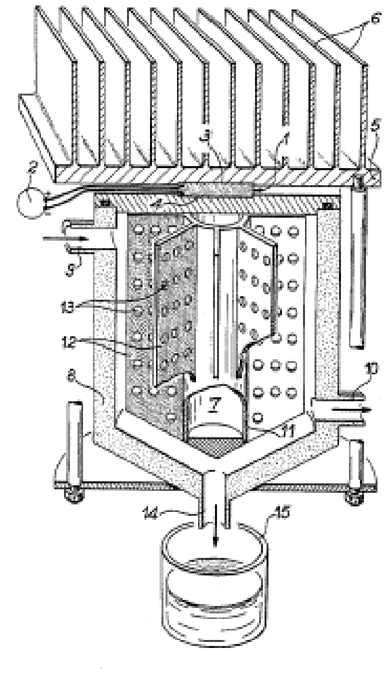


Figure 36 ~ USP # 4,506,510



Another promising method to collect atmospheric humidity makes use of hygroscopic dessicants such as silica gel or zeolite. The dessicant is regenerated by heating and the water vapor is condensed. The considerable energy requirements for such systems can be ameliorated by solar-heated intermittent absorption or zeolite refrigeration systems such as have been developed in recent years. Several patents have been granted for various embodiments of this technique (www.rexresearch.com/airwell2/airwell2.htm and .../interefr/patents.htm): US Patent # 2,138,689 ~ # 2,462,952 ~ # 3,400,515 ~ # 4,146,372 ~ # 4,219,341 ~ # 4,242,112 ~ # 4,285,702 ~ # 4,304,577 ~ # 4,342,569 ~ # 4,345,917 ~ # 5,846,296, etc. (Figures 37, 38)

Figure 37 ~ US Patent # 3,400,515:

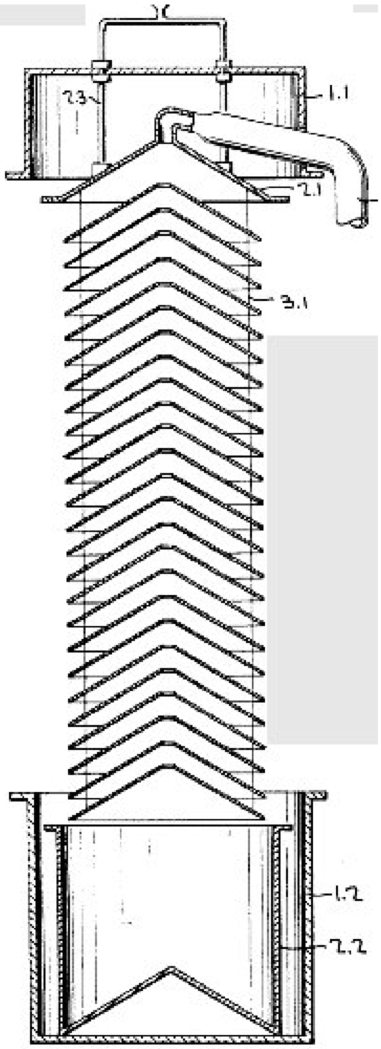


Figure 38 ~ US Patent # 5,846,296:

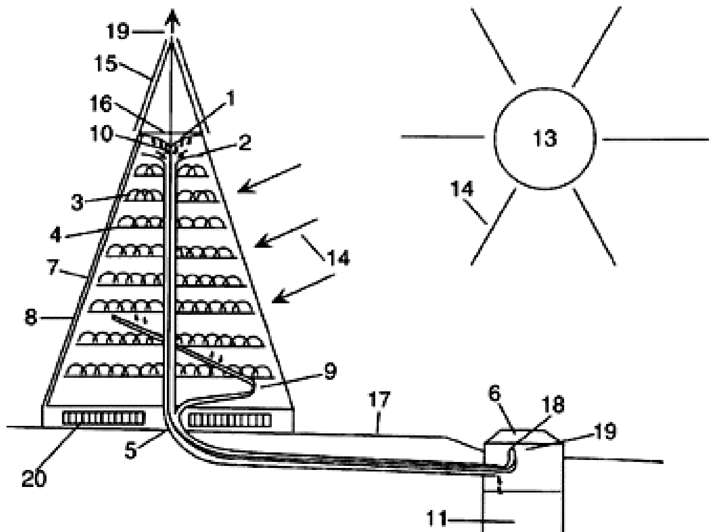
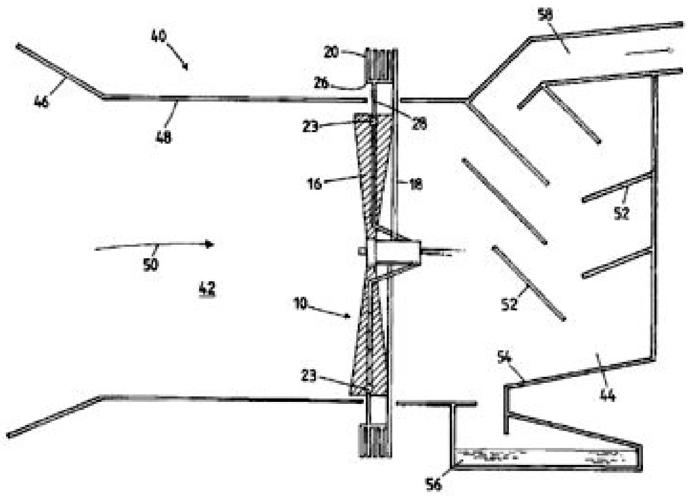


FIG. 3

The method and apparatus developed by Max Whisson is of particular interest. A windmill (which also serves to generate electricity) pushes air through a set of baffles and a compressor unit, according to his patents (WO2007009184 -- Gust Water Trap Apparatus, and WO2006017888 -- Apparatus & Method for Cooling of Air):

Figure 38-B



Dew Ponds ~

The water collectors known as "dew ponds" were invented in prehistoric times, but the technology is nearly forgotten today. A few functional dew ponds can still be found on the highest ridges of England's bleak Sussex Downs and on the Marlborough and Wiltshire Hills, and connected to castle walls. They always contain some water that apparently condenses from the air during the night. Gilbert White described a dew pond at Selbourne (south of London), only 3 feet deep and 30 feet in diameter, that contained some 15,000 gallons of water which supplied 300 sheep and cattle every day without fail.

Investigations by UNEP (1982) and by Pacey and Cullis (1986) determined that the ponds do not catch significant amounts of dew, but actually were filled mainly by rainfall. Pacey and Cullis may, however, have confused dew precipitation with rainfall --- two different processes. The ponds may also collect fog. (Ref 18)

Edward A. Martin proved that dew ponds are not filled by precipitated dew because the water usually is warmer than the air, so no dew could be deposited. He concluded that mist condenses on the water already in the pond, or else the grass collects dew which gravitates to the bottom and forms a pond. Both mechanisms probably are active.

The ancient question, "Does dew rises from the soil by evaporation or precipitates by condensation from the air?" first was posed by Aristotle. John Aitken proved in 1885 that dew rises or falls as conditions allow. He also determined the favorable conditions for the formation of dew: (1) a radiating surface, (2) still air, and (3) moist, warm earth. The ability of materials to capture dew depends on their specific heats. The best material is swan's down, followed by flax or cotton, silk, paper, straw, wool, earth, charcoal, silica sand, and powdered chalk.

Arthur J. Hubbard described a dew pond in his book *Neolithic Dew-Ponds and Cattleways* (1907):

"There is [in England] at least one wandering gang of men... who will construct for the modern farmer a pond which, in any suitable situation in a sufficiently dry soil, will always contains water. The water is not derived from springs or rainfall, and is speedily lost if even the smallest rivulet is allowed to flow into the pond.

"The gang of dew-pond makers commence operations by hollowing out the earth for a space far in excess of the apparent requirements of the proposed pond. They then thickly cover the whole of the hollow with a coating of dry straw. The straw in turn is covered by a layer of well-chosen, finely puddled clay, and the upper surface of the clay is then closely strewn with stones. Care has to be taken that the margin of the straw is effectively protected by clay. The pond will eventually become filled with water, the more rapidly the larger it is, even though no rain may fall. If such a structure is situated on the summit of a down, during the warmth of a summer day the earth will have stored a considerable amount of heat, while the pond, protected from this heat by the non-conductivity of the straw, is at the same time chilled by the process of evaporation from the puddled clay. The consequence is that during the night the warm air is condensed on the surface of the cold clay. As the condensation during the night is in excess of the evaporation during the day, the pond becomes, night by night, gradually filled. Theoretically, we may observe that during the day, the air being comparatively charged with moisture, evaporation is necessarily less than the precipitation during the night. In practice it is found that the pond will constantly yield a supply of the purest water.

"The dew pond will cease to attract the dew if the layer of straw should get wet, as it then becomes of the same temperature as the surrounding earth, and ceases to be a non-conductor of heat. This practically always occurs if a spring is allowed to flow into the pond, or if the layer of clay (technically called the 'crust') is pierced."

Additional construction details were explained in *Scientific American* (May 1934):

"An essential feature of the dew-pond is its impervious bottom, enabling it to retain all the water it gathers, except what is lost by evaporation, drunk by cattle, or withdrawn by man. The mode of construction varies in some details. The bottom commonly consists of a layer of puddled chalk or clay, over which is strewn a layer of rubble to prevent perforation by the hoofs of animals. A layer of straw is often added, above or below the chalk or clay. The ponds may measure from 30 to 70 feet across, and the depth does not exceed three or four feet." (Figures 39 & 40)(Ref. 19)

Figure 39 ~ Dew Pond:

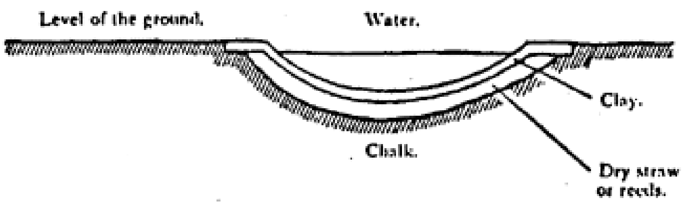


Figure 40 ~ Dew Pond (Oxteddle Bottom, Sussex):

(Photo: Chris Drury)

Edward A. Martin also described their construction in his book *Dew Ponds* (London, 1917). In particular, he notes that in order to ram the clay and puddle the surface, horses are driven round and through the pond for several hours. The base of the pond is planted with grass; without grass, the pond dries up. Trees and brush are planted around the pond to provide shade.

The simplest form of dew pond is used in Cornwall, where areas of about 40 square feet are prepared on mountain slopes by coating the ground with clay and surrounding it with a small wall. The clay is covered with a thick layer of straw that collects dew during the night. Straw is said to be more effective than grass for the purpose. Since the straw is moist both day and night, it rots quickly and must be replaced frequently.(Ref. 20)

In his book, *The Naturalist on the Thames*, published circa 1900, C. J. Cornish gave a description of British dew ponds, excerpted here:

“The dew ponds, so called because they are believed to be fed by dew and vapours, and not by rain, have kept their water, while the deeper ponds in the valleys have often failed. The shepherds on the downs are careful observers of these ponds, because if they run dry they have to take their sheep to a distance or draw water for them from very deep wells. They maintain that there are on the downs some dew ponds which have never been known to run dry. Others which do run dry do so because the bottom is injured by driving sheep into them and so perforating the bed when the water is shallow, and not from the failure of the invisible means of supply. There seem to be two sources whence these ponds draw water, the dew and the fogs...

“The fogs will draw up the hollows towards the ponds, and hang densely round them. Fog and dew may or may not come together; but generally there is a heavy dew deposit on the grass when a fog lies on the hills. After such fogs, though rain may not have fallen for a month, and there is no water channel or spring near the dew pond, the water in it rises prodigiously...

“The shepherds say that it is always well to have one or two trees hanging over the pond, for that these distil the water from the fog. This is certainly the case. The drops may be heard raining on to the surface in heavy mists.”

Cornish quoted Gilbert White’s *Journal* of May, 1775:“’[I]t appears that the small and even the considerable ponds in the vales are now dried up, but the small ponds on the very tops of the hills are but little affected’. Can this difference be accounted for by evaporation alone, which is certainly more prevalent in the bottoms? Or, rather, have not these elevated pools some unnoticed recruits, which in the night time counterbalance the waste of the day? " These unnoticed recruits, though it is now certain that they come in the form of those swimming vapours from which little moisture seems to fall, are enlisted by means still not certainly known. The common explanation was that the cool surface of the water condensed the dew, just as the surface of a glass of iced water condenses moisture. The ponds are always made artificially in the first instance, and puddled with clay and chalk.

“Mr. Clement Reid… notes his own experiences of the best sites for dew ponds. They should, he thinks, be sheltered on the south-west by an overhanging tree. In those he is acquainted with the tree is often only a stunted, ivy-covered thorn or oak, or a bush of holly, or else the southern bank is high enough to give shadow. ‘When one of these ponds is examined in the middle of a hot summer's day’, he adds, ‘it would appear that the few inches of water in it could only last a week. But in early morning, or towards evening, or whenever a sea-mist drifts in, there is a continuous drip from the smooth leaves of the overhanging tree. There appears also to be a considerable amount of condensation on the surface of the water itself, though the roads may be quite dry and dusty. In fact, whenever there is dew on the grass the pond is receiving moisture’.

“Though this is evidently the case, no one has explained how it comes about that the pond surface receives so very much more moisture than the grass. The heaviest dew or fog would not deposit an inch, or even two inches, of water over an area of grass equal to that of the pond. None of the current theories of dew deposits quite explain this very interesting question. Two lines of inquiry seem to be suggested, which might be pursued side by side. These are the quantities distilled or condensed on the ponds, and the means by which it is done; and secondly, the kind of tree which, in Gilbert White's phrase, forms the best "alembic" for distilling water from fog at all times of the year. It seems certain that the tree is an important piece of machinery in aid of such ponds, though many remain well supplied without one.”

An improved form of traditional dew pond was invneteded by A.J. Hubbard, *et al*., and granted British Patent # 13,039 (1 March 1905), "Improvements in Reservoirs for Collecting Dew". The complete specification is as follows:

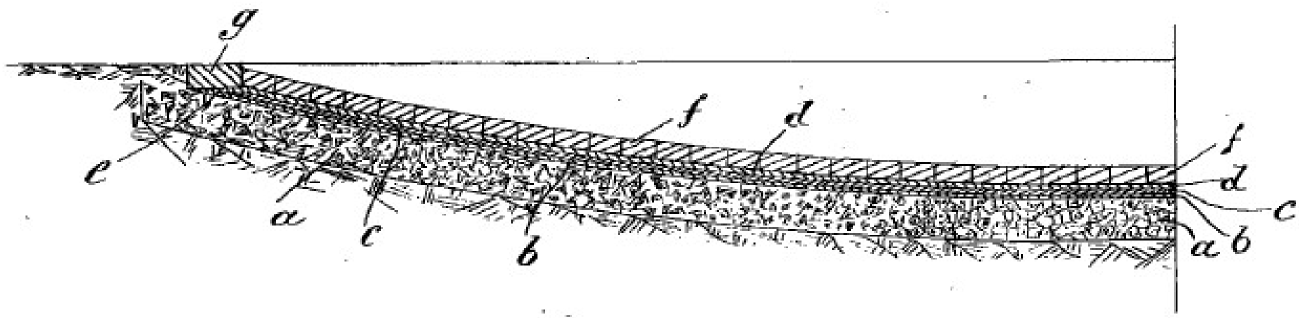
"For the purpose of securing water supply in the absence of rainfall, springs, or streams, reservoirs adapted to collect dew have been constructed by excavating the ground over an area and to a depth sufficient to form a basin of adequate capacity and providing the same with a compound lining comprising a bed of straw as a non-conductor and a superimposed water-tight layer of clay.

"The action of such a reservoir depends on the fact that the non-conducting layer of straw prevents the tendency to the equalization of temperature of the clay layer and water to that of the earth. The water, cooled by radiation, consequently retains the coldness so caused, and the temperature of the air in contact with it is reduced below the dew point. Consequently the water vapour in the air condenses and collects in the reservoir. Such reservoirs as heretofore constructed, however, have been comparatively inefficient, and, unless on chalk, liable to destruction by moisture, worms, or other causes, disadvantages which it is an object of this invention to obviate, for which purpose, according thereto the basin is provided with a lining possessing both impermeable and non-conducting properties. In practice this can be advantageously effected by the use of a compound lining comprising two layers of impermeable material with interposed material that is non-conducting or is a bad conductor of heat. In order that the non-conducting property of the lining be not impaired it is necessary that the lining should be so formed that the non-conducting material cannot become wet. For this reason when absorbent non-conducting material is interposed between two layers of impermeable material, the two layers of impermeable material are continuously joined a the edges in a watertight manner. For the purpose of increasing the evaporation and consequently reducing the temperature of the surface upon which the water vapour is to be condensed, a water-retaining cover is preferably superimposed upon the upper layer of impermeable material. Where necessary owing to the character of the soil, a solid foundation is formed in the basin upon which the lower layer of impermeable material is laid.

"The drawing shows, diagrammatically, in vertical section, by way of example, a reservoir for dew according to this invention, in which *a* is a concrete foundation, *b* a layer of asphalt, *c* a layer of asbestos, *d* a second layer of asphalt having its edge joined to that of the lower layer *b* as at *e* so as to completely enclose the asbestos *c*, and thus prevent it becoming wet and its non-conducting property becoming impaired; *f* is a layer of bricks of a porous nature which are rapidly cooled to a low temperature owing to the evaporation of the water absorbed by them; *g* is a stone curb which serves to prevent the edges of the lining being damaged.

"In some cases the concrete foundation a may be dispensed with, as also the porous bricks *f*."

Figure 40-A



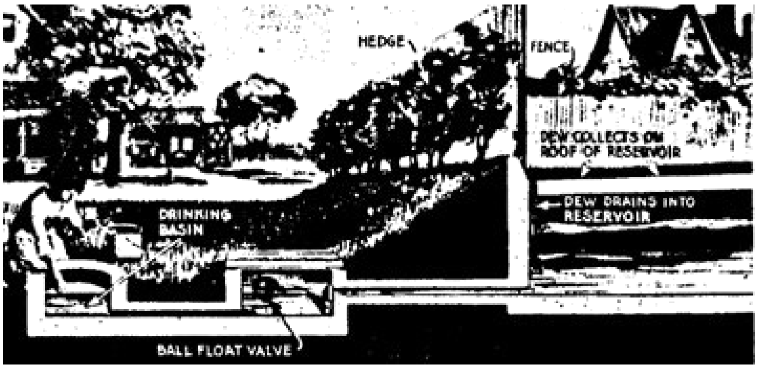
Another form of dew pond was invented by S.B. Russell in the 1920s. According to the description in *Popular Science* (September 1922), "A dew reservoir 30 feet square will collect 24,000 gallons of water in a year, or an average of 120 gallons daily during the hot summer months and 50 gallons daily for the remainder of the year...

"The Russell reservoir consists of a concrete cistern about 5 feet deep, with sloping concrete roof, above which is a protective fence of corrugated iron which aids in collecting and condensing vapor on the roof and prevents evaporation by the wind. The floor of the cistern is flush with the ground, while sloping banks of earth around the sides lead up to the roof.

"Moisture draining into the reservoir from the low side of the roof maintains the roof at a lower temperature than the atmosphere, thus assuring continuous condensation.

"At one side of the reservoir is a concrete basin set in the ground. By means of a ball valve, this basin is automatically kept full of water drawn from the reservoir." (Figure 41)(Ref 21)

Figure 41 ~ Russell's Dew Pond:

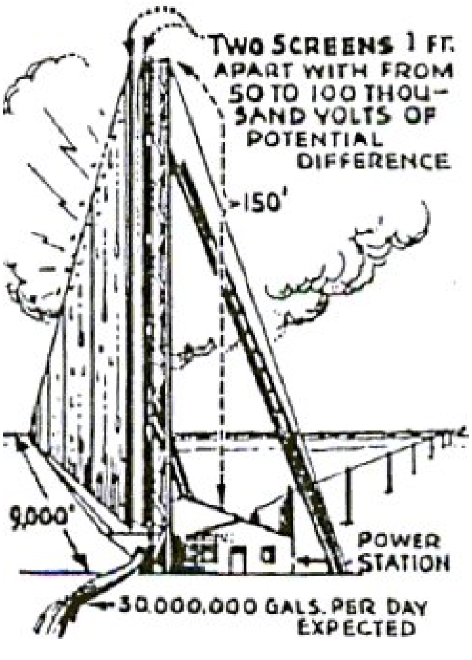


Fog Fences ~

The Roman author Pliny the Elder mentioned the Holy Fountain Tree, growing on the island of El Hierro in the Canary Islands. For thousands of years (until about 100 years ago), the people there obtained most of their water from the trees, the leaves of which captured fog.

In 1945, South Africa's chief meteorologist, Theodore Schumann, proposed the construction of a unique cloud-condenser on top of Table Mountain on the south side of Capetown. Schumann designed two large parallel wire screens, one insulated and one grounded, charged with a potential difference of 50-100 KV. The wire screens were to be about 150-ft. high, 9,000 ft. long, and 1 foot apart. He estimated that the electrified fence would condense as much as 30,000,000 gallons daily from "The Cloth", a perpetual cloud that crowns the 3,000 ft peak. The fence was never built. (Figure 42)

Figure 42 ~ Schumann's Fog Fence:



Alvin Marks invented the "Power Fence" (USP # 4,206,396) to generate electricity from the wind by means of a charged aerosol which was dispersed from microscopic holes in the tubing of the fence. Marks calculated that if the wind averaged 25 mph, a mile of fence would generate about 40 megawatts. The towers would be 500 feet high, strung with a grid of steel bars in a rectangular array, subdivided into a lattice of 4-inch squares. The squares are divided by a mesh of perforated tubules through which the water flows. Marks' patent also claims that the system can be used to modify weather and to clear fog in the same manner that Schumann proposed.. (Figure 43 & 44) (Ref. 22)

Figure 43 ~ Mark's Power Fence:

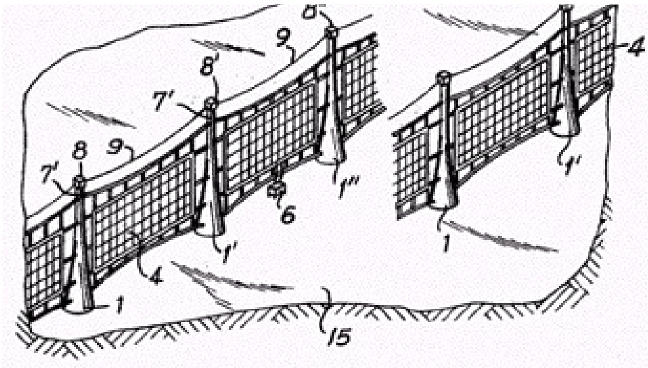
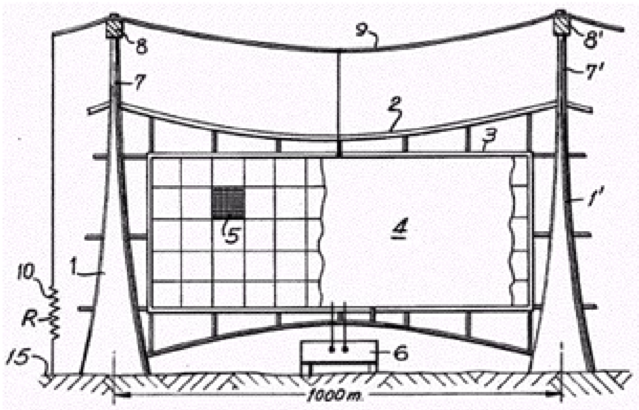
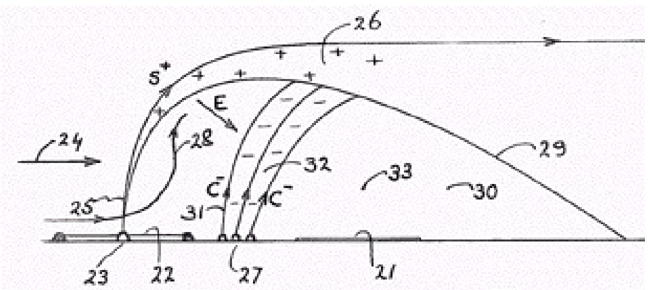


Figure 44 ~ Mark's Power Fence:



The EGD Fog Dispersal System invented by Meredith Gourdine (USP # 4,671,807) has been used at Los Angeles and Ontario International Airports and by the Air Force since 1986. The system sprays an electrified mist into the fog over the runways, thus clearing them for landing. A similar system was invented by Hendricus Loos (USP 4,475,927). (Figure 45) (Ref 23)

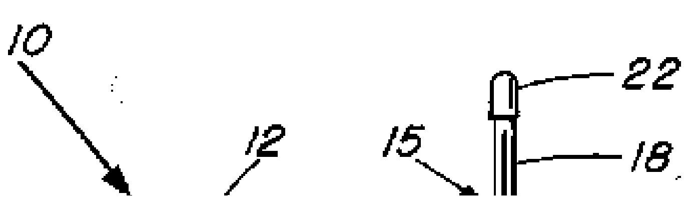
Figure 45 ~ Loos' USP # 4,475,927:

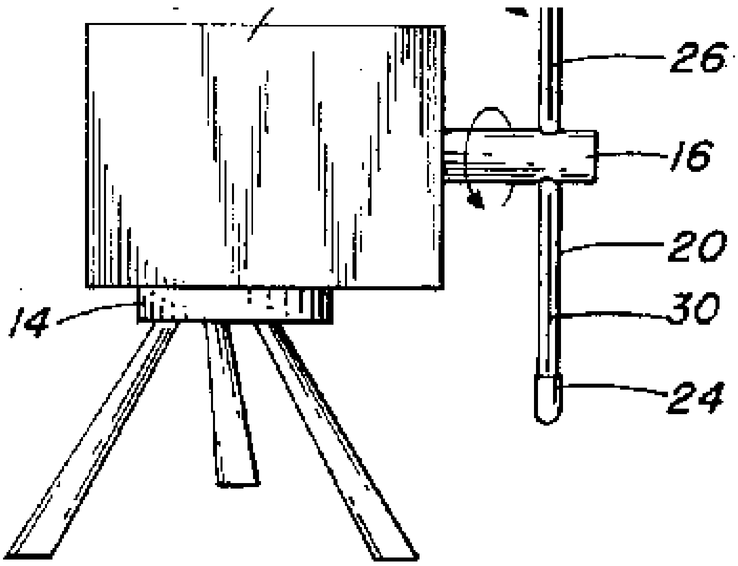


Alekseevich, *et al.*, used high voltage direct current to perform mist-clearing; thus, "electric force lines are directed upward in the air... producing charged particles based on corona discharge... The charged particles absorb water in the air, condensing and binding into water, and dispersing the fog", according to USP # 6,152,378.

The "Fog Water Collector" patented by Roland Pilie and Eugene Mack (USP # 3,889,532) "consists of a slotted seainless steel rotatable tube. The tube is rotated and fog droplets are collected by impaction on the tube. Centrifugal force causes the water toflow outward towards the ends of the tube where it is collected..." (Figure 46)

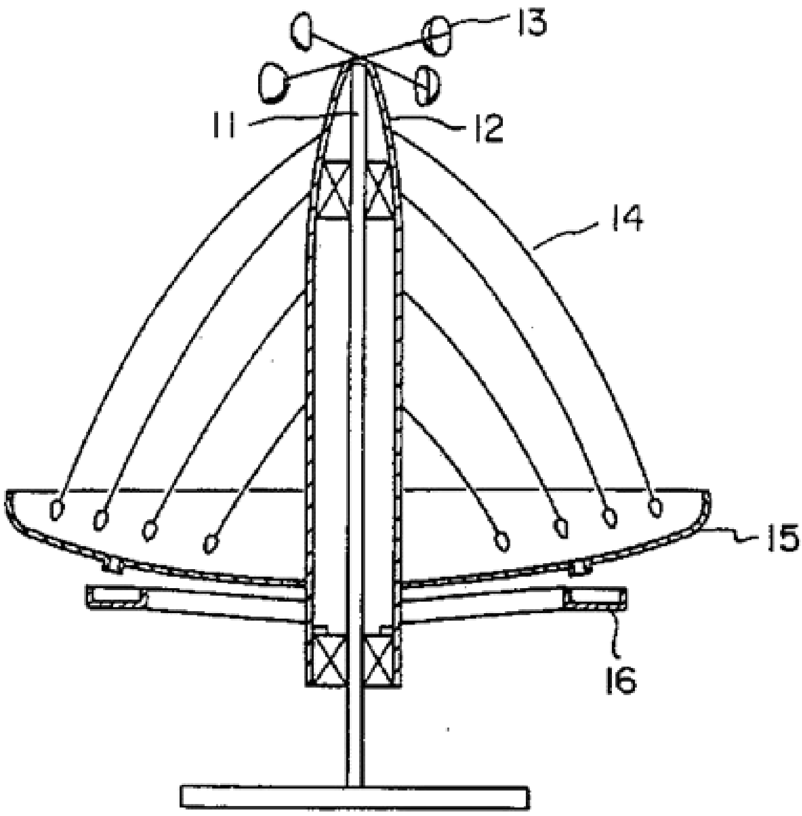
Figure 46 ~ Pilie/Mack's USP # 3,889,532:





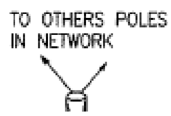
"The "Fog Water Collecting System" invented by Yoshio Usui (USP # 5,275,643) resembles a windmill with flexible rods that capture fog droplets which accumulate, condense and drain off. (Figure 47)

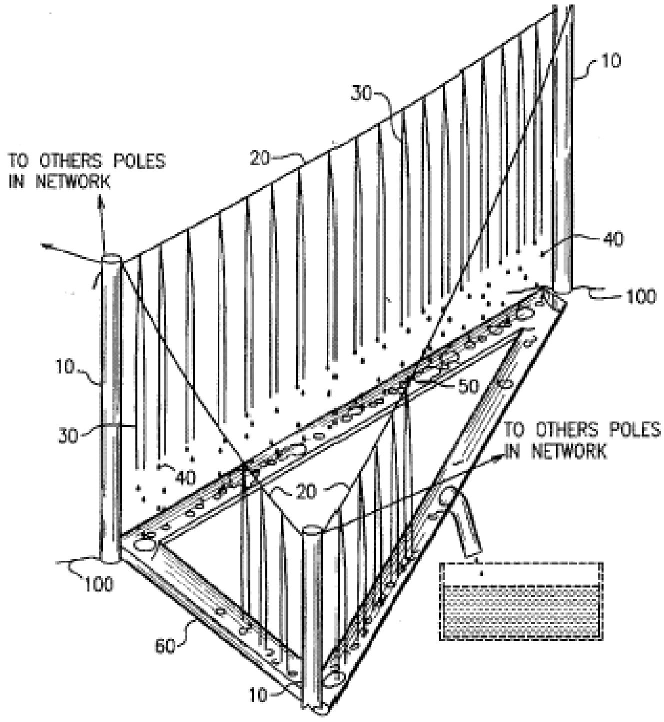
Figure 47 ~ Usui's USP # 5,275,643:



Kuntz' US patent for a "Rain-Making System" (USP # 5,626,290) uses dangling filaments as condensation collectors (Figure 48). This design works only when no clouds block the heat radiation of the earth. The US Geological Survey uses a similar design as a standard fog collector to make surveys of potential fog-collection sites.

Figure 48 ~ Kuntz's "Rain-Making System (US Patent # 5,626,290):





Since the late 1980s there has been considerable research and development of fog collectors around the world, pioneered by Dr Robert Schemenauer and Prof. Pilar Cereceda (Univ. of Chile). The Canadian organization FogQuest (www.fogquest.org) is the international leader in this admirable effort; Dr Schemenauer now serves as a research scientist with the organization. (Refs. 24-26)

Fog contains from 0.05 gram of water per cubic meter, up to 3 grams. The droplets are 1 to 40 microns in diameter. Fog has a very low settling rate, and it is carried by the wind wherever it may go. Fog collectors therefore require a vertical screen surface positioned at right angles to the prevailing wind. The collector must be a mesh because wind will flow around a solid wall and take the fog with it. A fog collector captures about half of the water passing through it. The efficiency of fog collectors depends on the size of fog droplets, wind speed, and the size of mesh (about 1 mm is optimal), which should fill up to 70% of the area. Two layers of ultraviolet-protected mesh, erected so as to rub together, cause the minute droplets to join and drain into PVC pipes attached to the bottom of the nets. The lifetime of the mesh is about 10 years. It costs about 25 cents or more per square meter.

The ideal location for fog collecters are arid or semi-arid coastal regions with cold offshore currents and a mountain range within 15 miles of the coast, rising 1,500 to 3,000 feet above sea level. Collection varies with the topography and the density of the fog. Ocean or lowland fog usually lacks sufficient water or wind speed to yield a substantial amount of water, so careful evaluation studies must be made to determine the suitability of any particular microclimate. This is done by monitoring a number of 1 m^2 collectors for a period of months.

Fog fences have the advantages of being passive, requiring no artificial energy input for operation. They are simple to design and can be constructed quickly and easily with little skill. The system is modular, easy to maintain, and can be expanded as demand increases or money allows. Investment costs are low --- much less than conventional sources in the areas where this technology can be applied. The water quality usually is good, though some treatment may be necessary for human consumption.

Mesh fog collectors are limited by the local conditions of climate and topography. The yield is affected by season and weather, included macro-systems such as El Nino and La Nina. Dust can cause high levels of metals and low pH. High humidity can promote the growth of microflora, and other sources of contamination (i.e., insects and birds) must be considered. Unless the collectors are close to the consumers, the system requires uneconomical pipelines that also present hydraulic problems. The site must be easily accessable and have clear ownership. Site security also may be an issue. Management of the water distribution must be fair, efficient, and self-sufficient. (Ref 27)

A very successful pilot project was established at Chungungo, Chile in 1987. Over a period of 5 years, 94 fog collectors were constructed atop 2,600 ft. El Tofo Mountain, collecting up to 2,000 gallons daily (mean yield: 3 liters/m^2/day). The villagers call it "harvesting the clouds". Walter Canto, regional director of Chile's National Forest Corporation, said:

"We're not only giving Chungongo all the water it needs, but we have enough water to start forests around the area that within 5 or 6 years will be totally self-sustaining." (Figure 49)

Figure 49 ~ Fog Fences (El Tofu Mountain):

(Photo source: www.fogquest.org)

The fog collectors on El Tofo have fallen into a sad state of disrepair. In 2002, only 9 collectors remained of the 94 that once shrouded the mountaintop. (Figure 50)

Figure 50 ~ El Tofo Mountain (2002):

The success of the fog collectors at Chungongo actually contributed to the failure of the project. The new supply of water stimulated local development that tripled the population to 900 inhabitants while reducing the amount of water available to each family. It would have been a simple matter to increase the number of fog collectors, but a political decision was made to construct a pipeline (costing ~ US$1M) to bring water from Los Choros. Dr Schemenauer, who directed the original project, said that 400 collectors (many more than enough to meet the need) could be built on the mountain at a much lower cost than that of the pipeline. But the villagers were not significantly involved in the original project, so they had little understanding of water economics and what was required to maintain the collectors over a period of years; they were taken for granted.

The International Development Research Center (IDRC) that sponsored the original project reported that local officials "regard water from fog as an unreliable, irregular, and insufficient source for providing drinking water for Chungongo".

Dr Schemenauer maintains that the original project was not designed to supply water to the community. It was intended to perfect the technology and use the water for a reforestation project on the mountain. The local community lobbied to divert water to the village instead, and it was done. The obvious lesson is that the local people must be involved and committed to long-term maintainance and development, adding more fog collectors if the need arises.

Another 21 sites (1,000 acres total) in Chile and on the Pacific coast of Latin America also have fog collectors that continue to provide water for agricultural and forestry projects. Some of the locations have become self-sufficient because the trees have become large enough to collect fog for themselves, just as the ecosystem did before settlers disrupted it. Precarious "lomas" fog-forest ecosystems survive on droplets of water collected by their leaves. Some such forests, surrounded by deserts, have been sustained by fog for millenia. Very little cutting is necessary to initiate gradual but complete destruction.

In the past few years, FogQuest has conducted several successful projects in Yemen, Guatemala (Lake Atitlan), and Haiti (Salignac Plateau). More are being planned in the Sultinate of Oman, Ethiopia, and Nepal. The Yemen project is in the mountains near Hajja, where there is virtually no rainfall in the winter months. There is, however, sufficient fog to justify the construction of large fog collectors. The best sites produce about 4.5 liters/m^2/day. The yield at the best sites in Haiti is about 5.5 liters/m^2day. In other words, each square meter of mesh produces about 165 liters/month. A large collector (50 m^2) would produce about 175 liters daily, which is sufficient to supply the needs of nine people..

Fog collectors in the Sultanate of Oman have yielded as much as 70 liters/sq meter/day! A 48 m^2 collector there yields over 3000 liters/day. Each village requires 30 to 80 collectors (cost: ~ US$400 each) to provide its needs.

The many forms of atmospheric dehumidifiers offer real hope for thirsty humanity. Countless lives can be saved and improved by this elegant technology. The quantity of water thus produced may even meet the needs of large-scale agriculture if used in a conservative manner, such as drip-feeding.

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