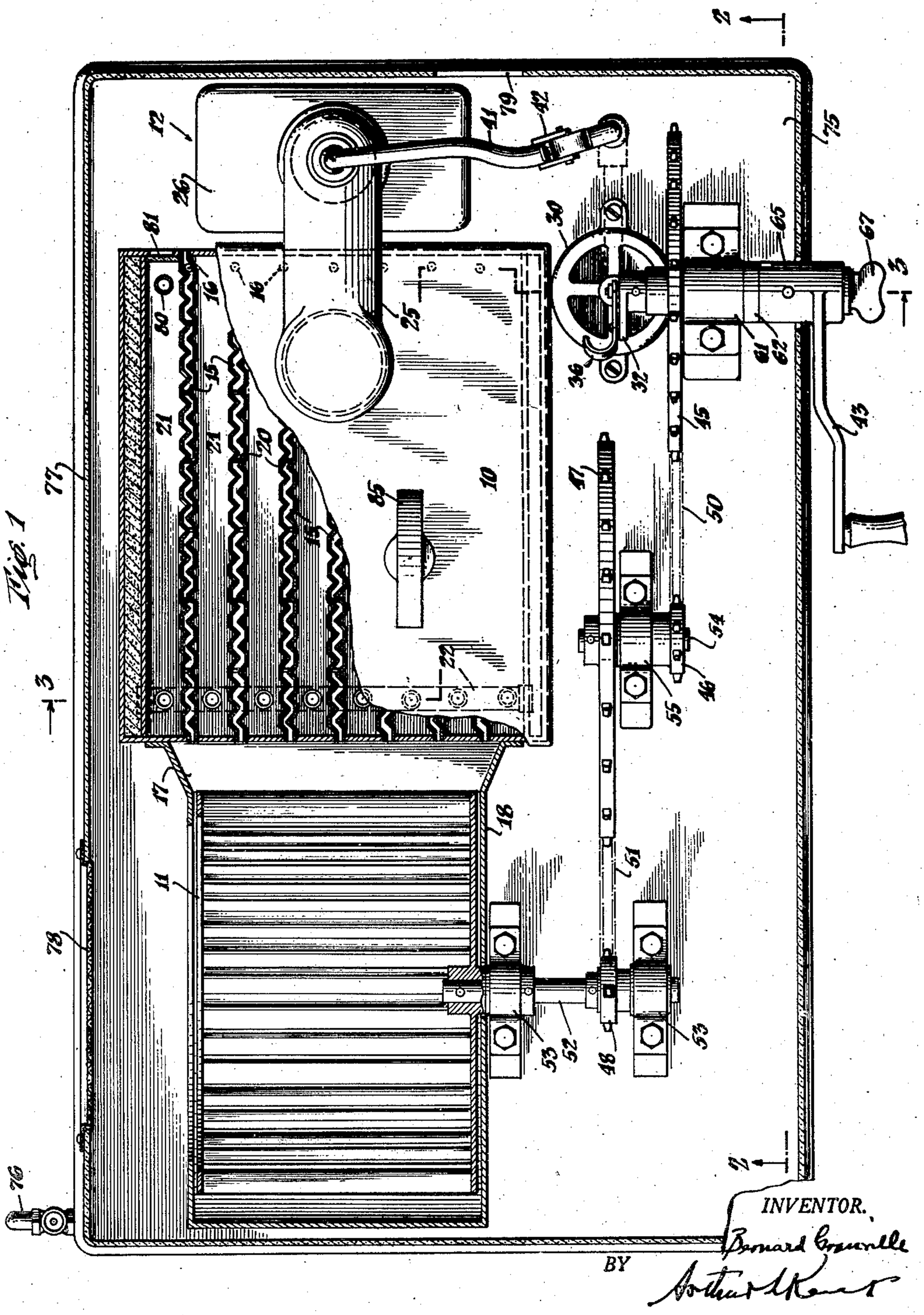
Oct. 22, 1946. B. GRANVILLE 2,409,624

APPARATUS FOR EXTRACTING WATER FROM ATMOSPHERIC AIR

Filed July 20, 1943 3 Sheets-Sheet 1



Oct. 22, 1946. B. GRANVILLE 2,409,624

APPARATUS FOR EXTRACTING WATER FROM ATMOSPHERIC AIR

Filed July 20, 1943 3 Sheets-Sheet 2

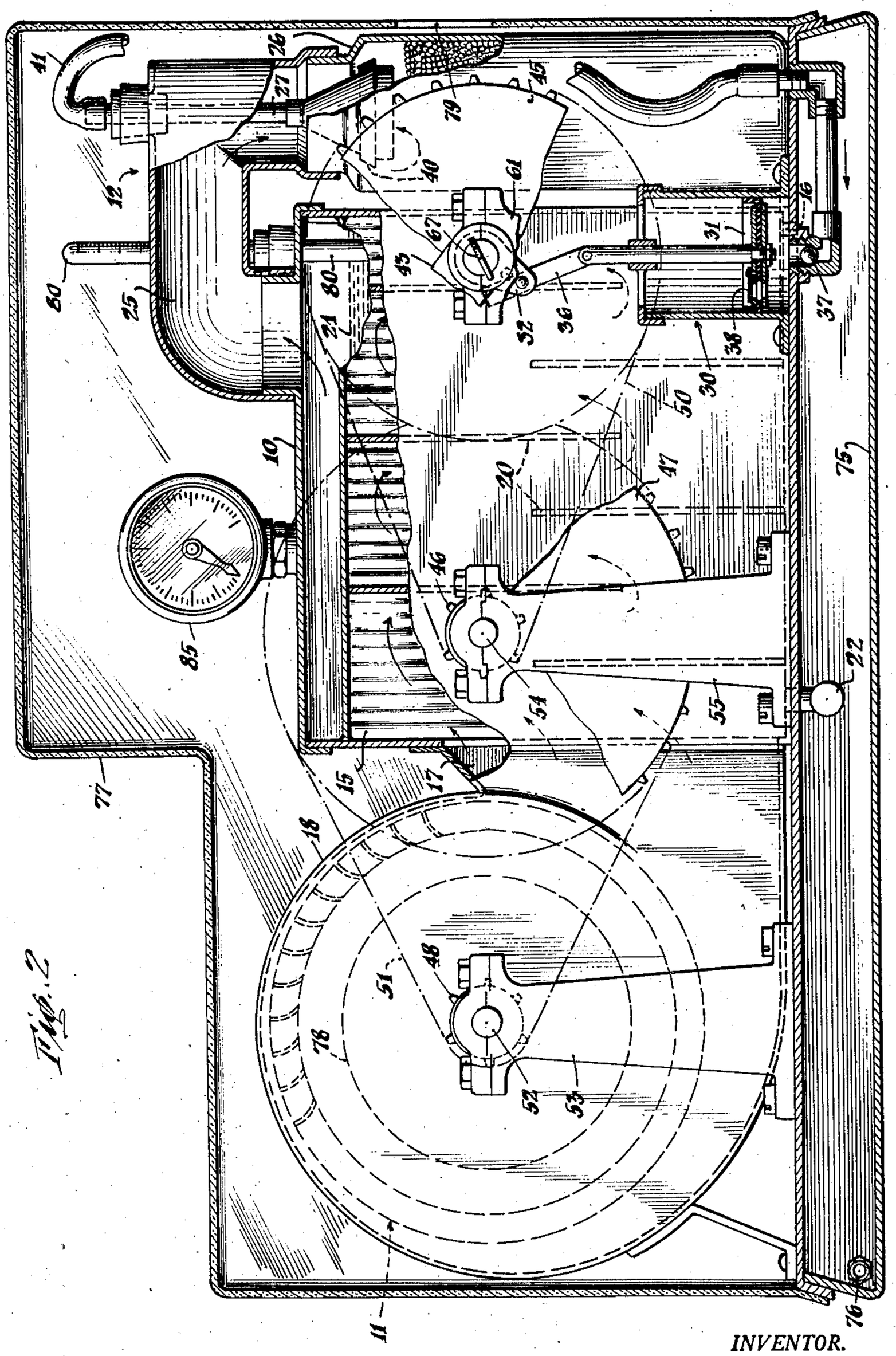


Fig. 2

INVENTOR.

BY Bernard Granville

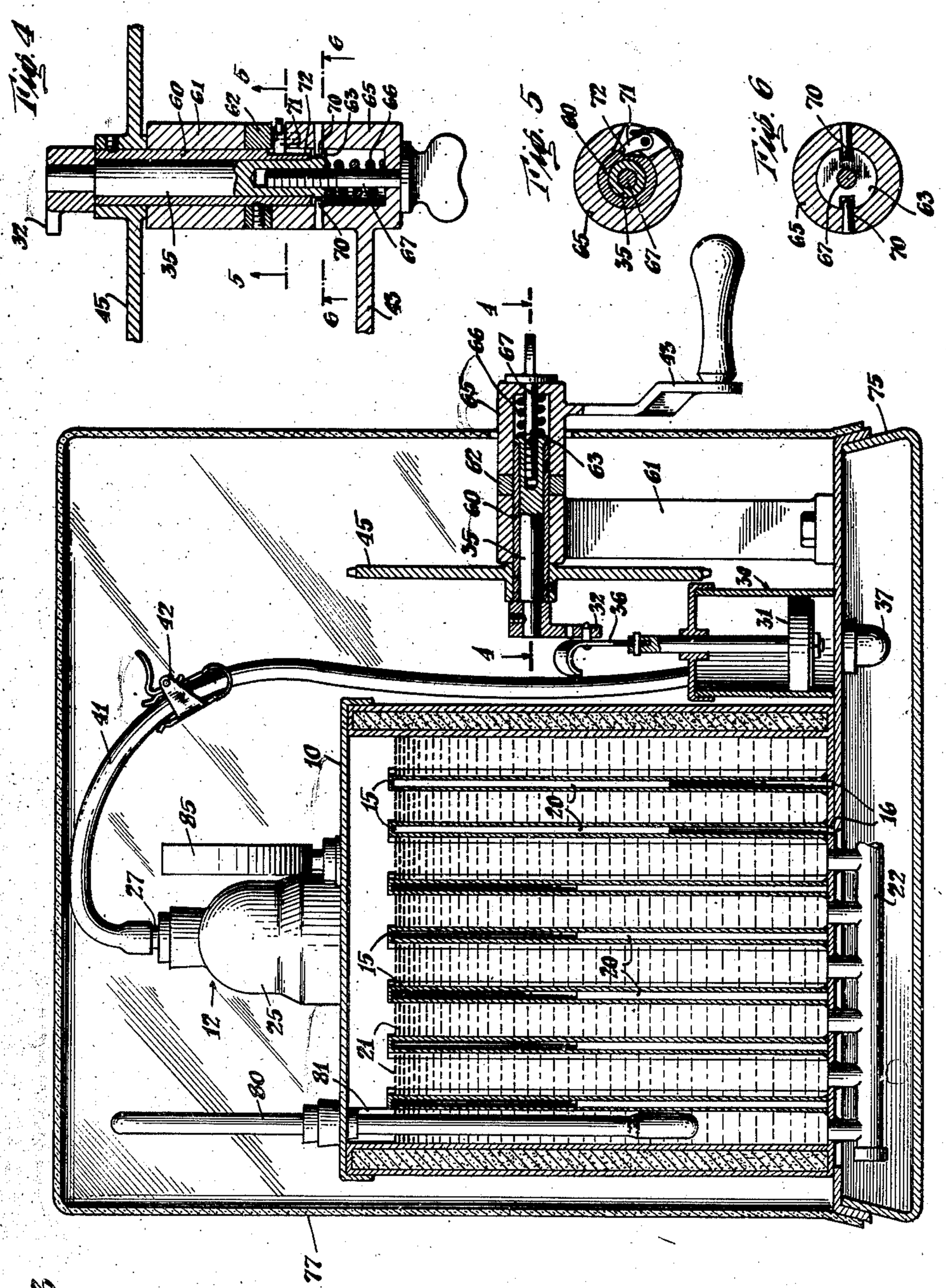
Arthur D. Hall

his ATTORNEY

Oct. 22, 1946. B. GRANVILLE 2,409,624

APPARATUS FOR EXTRACTING WATER FROM ATMOSPHERIC AIR

Filed July 20, 1943 3 Sheets-Sheet 3



Patented Oct. 22, 1946 2,409,624

UNITED STATES PATENT OFFICE

2,409,624

APPARATUS FOR EXTRACTING WATER FROM ATMOSPHERIC AIR

Bernard Granville, Los Angeles, Calif.

Application July 20, 1943, Serial No. 495,452

6 Claims. (Cl. 62—140)

1

This invention relates to an apparatus for extracting water from atmospheric air. An object of the invention is to provide means for obtaining water, for drinking or other purpose, directly from atmospheric air, and another object is to provide means for reducing the moisture content of air drawn from the atmosphere.

The invention comprises an apparatus wherein a heat-conducting surface is cooled to a temperature below the dew point temperature of the surrounding atmosphere, and air from the surrounding atmosphere is caused to flow past such cooled surface, with the result that the air is cooled and the excess water vapor in such of the air as is cooled to a temperature below its dew point liquefies in the air flow passages and is drained off; all as more fully hereinafter set forth and as claimed. The invention includes apparatus for practicing the method.

A full understanding of the invention can best be given by a detailed description of an apparatus of approved form suitable for practicing the method and embodying the apparatus features of the invention, and such a description will now be given in connection with the accompanying drawings illustrating such an apparatus. In said drawings:

Fig. 1 is a plan view of the apparatus with certain parts of the apparatus, including the outer casing, shown in section;

Fig. 2 is a view taken on line 2—2 of Fig. 1 with parts broken away to show other parts in section;

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is an enlarged detail sectional view taken on line 4—4 of Fig. 3; and

Figs. 5 and 6 are sectional views taken on lines 5—5 and 6—6, respectively, of Fig. 4.

Referring to the drawings, the apparatus shown comprises a closed tank 10 which in the use of the apparatus is nearly but not quite filled with water or other suitable liquid and which has a plurality of air flow passages extending therethrough; a fan or blower 11 for causing air from the surrounding atmosphere to flow through said air passages; and refrigerating means 12 for cooling the water or other liquid in the tank. The air flow passages 15 are formed most desirably by closely spaced thin metal plates extending between and opening through the end walls of the tank and extending from the bottom of the tank to near the top thereof, the passages being closed at the top and bottom except that

2

each passage has a bottom opening 16 near its outlet end for outflow of condensate.

The fan or blower 11 may be of any suitable kind which will supply air in sufficient volume, the discharge conduit 17 or end of the blower casing 18 being connected to the end of the tank about the intake ends of the air flow passages. A sirocco blower, as shown, is preferred for a hand-operated machine such as the one illustrated.

To increase the length of the flow paths of the air through the passages 15, the passages have alternating upper and lower baffles 20 therein, and the walls of the passages are most desirably corrugated so that the flow paths shall be of serpentine form in the direction of the length of the tank, this being for the purpose of reducing stratification of the flowing air and causing a more general contact of the air with the passage walls.

The water spaces 21 in the tank between the air passages should be considerably wider than the air passages, and for equalizing the water level in the water spaces they are connected, as by the pipe 22. For the small hand-operated machine shown, which may be something less than two feet long, the water spaces in a tank of the construction shown are most desirably about ¾'' wide and the air passages not more than about ¼'' wide.

Means according to any suitable refrigerating system may be employed for cooling the water or other liquid in the tank 10. The well known sulphuric acid system is preferred as most suitable for a small hand-operated apparatus, and refrigerating means according to this system is shown in the drawings. This system operates by absorbing water vapor from the gases above a body of water thereby causing evaporation of a part of such body of water with consequent abstraction of heat from such body equivalent to the heat of vaporization of the water so evaporated.

From the space in the top of the tank 10 above the level of the liquid therein a passage 25 leads to the top of a sulphuric acid container 26 and from a point within the container 26 a suction tube 27 leads to a suction pump 30. The intake end of the suction tube should be slightly above the surface of the acid in the container so that the vapor and any other gases from the space above the liquid in tank 10 sucked out through passage 25 to the acid container and thence through the tube 27 to the vacuum pump will have to flow in contact with the acid and thereby

have the water vapor therein largely removed by the acid before entering the intake end of the suction tube. The suction tube has most desirably at its intake end an end piece of inverted funnel shape to provide a comparatively large intake opening directly over the surface of the acid.

The vacuum pump **30** may be of any suitable form, such as the single acting piston pump shown mounted on the base of the apparatus, its piston **31** being reciprocated by a crank **32** on a shaft **35** through a pitman **36** connected to the upper end of the piston rod. The pump will have in the usual manner a check valve **37** in its intake from the suction tube and a check valve **38** in its piston **31**.

In order to seal the acid container when the apparatus is not in use, the suction tube **27**, which extends upward from the acid container and through the upper wall of the passage **25**, is slidably mounted in the upper wall of the passage and the conically extended intake end of the suction tube is provided with a packing ring **40** of suitable material which when the intake end of the tube is drawn upward seats against the shoulder at the neck of the acid container to make a tight closure. To permit the intake end portion of the suction tube to be moved up and down, a part **41** of the tube is formed of flexible tubing of rubber or other suitable material. A suitable valve is provided for closing the suction tube when the apparatus is not in use, such as the pinch clip **42** on the part **41**.

All parts of the apparatus with which the acid is normally, or may be, in contact, or which may be subject to attack by fumes of the acid, are made of glass or rubber or other suitable material resistant to sulphuric acid.

Crankshaft **35** is turned for operating the vacuum pump by means of a handcrank **43**. The blower **11** is also driven by means of the handcrank **43** through a speed-increasing train of sprocket wheels **45**, **46**, **47** and **48** and chains **50** and **51**, or other suitable speed-up gear train. The blower shaft **52** carries sprocket wheel **48**, and is journaled in bearings carried by standards **53** extending upward from the machine base, and the sprocket wheels **47** and **46** are fast on a short shaft **54** mounted in a bearing carried by a standard **55**. Crankshaft **35** is journaled in a hollow shaft **60** which carries fast thereon the sprocket wheel **45** and is mounted in a bearing carried by a standard **61**, being held against endwise movement in this bearing by the sprocket wheel at one end of the bearing and by a collar **62** secured to the shaft at the other end of the bearing. Shaft **35** has a flange **63** at its outer end, and is held against endwise movement in shaft **60** by this flange and the crank **32**.

The shafts **35** and **60** are both turned by means of the handcrank **43**, which extends from a hollow hub **65** mounted with a sliding fit on the end of the shaft **60** and held against the pressure of a spring **66** by a thumb screw **67** which screws into a threaded bore in the end of the shaft **35**. When the hub **65** is in the position shown in Fig. 3, lugs **70** extend from the hub into recesses in the flange **63** of shaft **35**, which is thereby held to turn with the hub. When screw **67** is unscrewed, the hub is moved outward by spring **66**, the lugs **70** being thereby withdrawn from the flange recesses and shaft **35** being released from the hub. A pawl **71** on the inner end of the hub **65**, by engaging in a notch **72** in shaft **60**, acts as a one-way clutch whereby

when the hub is turned in one direction shaft **60** is turned and when the hub is turned in the other direction shaft **60** is not turned. The notch **72** extends lengthwise of shaft **60** for a distance sufficient so that it may be engaged by the pawl whether the hub is in position for clutching or for releasing shaft **35**. Therefore, when the hub is in the position shown in Fig. 3, the vacuum pump and the blower may both be operated by turning the handle in one direction, or the pump alone may be operated by turning the handle in the other direction; and by adjusting the hub outward to release shaft **35** and then turning the handle in the first mentioned direction, the blower alone may be operated.

As shown, the machine has a hollow base **75** which serves as a tank to receive the water from the openings **16**, and there is a valved outlet **76** from one lower corner of this tank. An open-bottomed casing **77** for enclosing all the machine parts excepting the operating handcrank **43** fits onto the base **75** so as to be readily removable, suitable means being provided for releasably securing the casing to the base. The casing has a screened air intake opening **78** opposite the intake opening of the blower casing, and has a suitably located air outlet opening **79**. The outside walls of tank **10**, and especially the two side walls as shown, are most desirably suitably heat insulated.

In operation.—The tank **10** being filled with water or other suitable liquid to about the top of the air-flow passages and the container **26** having sulphuric acid therein up to near the intake of suction tube **27** and the handcrank hub **65** being in the position shown in Fig. 3, the handcrank is turned until the liquid in tank **10** has been cooled to a temperature below the dew point temperature of the surrounding atmosphere. During this preliminary cooling of the tank liquid, the handle is most desirably turned in the direction not to operate the blower. Then, when the tank liquid has been sufficiently cooled, the blower is operated, by turning the crank in the other direction, to cause air from the surrounding atmosphere to flow through the air passages **15**, and the air flowing past and in contact with the relatively cold walls of the passages is cooled, and when so cooled below its dew point some of the water vapor in the air is condensed in the air passages and escapes through the outlet openings **16** into the base tank **75** and may be withdrawn through the valved outlet **76**.

The required degree of cooling of the tank liquid will depend upon the temperature and humidity of the surrounding air. The greater the percentage of humidity in the air, the less the drop in temperature required to bring the air to the point of saturation, that is, dew point, and therefore the less the drop in temperature required to cause condensation of some of the water vapor in the air, and, therefore, the less the required lowering of the temperature of the tank liquid in order to effect the necessary cooling of the air going through the air passages. The amount of water obtained from air of any given degree of humidity, however, will depend on the degree to which the air is cooled below its dew point. It is desirable, therefore, that the tank liquid should be cooled to a suitably low temperature, and for best results the cooling of the tank water or other liquid may be carried to the point where it becomes frozen, whatever the freezing temperature of the liquid may be. After the tank liquid has been frozen or cooled to a suitably low

temperature, the handcrank hub **65** may be adjusted outward to release the pump-operating shaft **35**, and the handcrank then turned to operate the blower alone until the temperature of the tank liquid rises to a point too close to the dew point temperature of the surrounding air; or, after cooling the water by turning the handcrank in a direction to operate the suction pump alone, the handle, with its hub remaining in the position of Fig. 3, may be turned in the opposite direction to operate the blower and at the same time to continue operation of the suction pump.

When both the vacuum pump and the blower are being operated after the tank liquid has been cooled to a desired temperature, it will not usually be necessary in order to maintain the liquid at the desired low temperature to have the pump operated so forcefully as when reducing the temperatures of the liquid. Provision is made, therefore, for reducing the stroke of the pump by reducing the effective length of the crank **32**. For this purpose two or more pivot openings are provided in the crank at different distances from the shaft axis, in each of which the pivot pin for connecting the pitman **36** may be entered.

If the air which has passed through the air passages **15**, from which air water has been extracted and its moisture content thus reduced, is warmed to the temperature of the ingoing air, its humidity, that is, the amount of moisture it contains as compared with that required to saturate it at that temperature, will then be lower than that of the ingoing air.

For showing the temperature of the tank liquid, a thermometer **80** is desirably provided and may be an ordinary transparent tube thermometer, as shown, extending from the top wall of the tank down into one of the liquid spaces near one of the end walls of the tank, which has a glass-covered sight window **81** through which the scale on the thermometer tube may be viewed. A vacuum gauge **85** is also desirably provided for showing the degree of vacuum, or negative pressure, in the space in the tank below the liquid level.

The apparatus shown and to which the description has been largely confined is designed for small readily portable units intended to be used for obtaining water, and is to be taken as an illustrative embodiment of the apparatus features of the invention, and it is to be understood that apparatus embodying apparatus features of the invention and for practicing the method may differ widely in construction and arrangement of parts and in the character of parts thereof without departing from the invention as defined in the claims.

What is claimed is:

1. Apparatus for obtaining water from atmospheric air, comprising in combination a tank for containing water, means providing a plurality of tortuous air flow passages extending through said tank having walls of heat-conducting material, means for vaporizing part of the water in said tank to cool the remaining water in said tank to a temperature below the dew point temperature of the surrounding atmosphere, means for forcing air from the surrounding atmosphere through said air passages, and means for collecting the water which is condensed from the cool flowing air.

2. Apparatus for obtaining water from atmospheric air, comprising in combination a tank for containing water, means providing a plurality of air flow passages extending through said tank

having walls of heat-conducting material, means for vaporizing part of the water in said tank to cool the remaining water in said tank to a temperature below the dew point temperature of the surrounding atmosphere, means for forcing air from the surrounding atmosphere through said air passages, means for baffling the air flowing through said passages, and means for collecting the water which is condensed from the cooled flowing air.

3. Apparatus for extracting water from atmospheric air, comprising in combination a closed tank for containing liquid, means providing a plurality of air flow passages extending through said tank having walls of heat-conducting material, refrigerating means for cooling liquid in said tank to a temperature below the dew point temperature of the surrounding atmosphere, said refrigerating means including a vacuum pump, a blower for forcing air from the surrounding atmosphere through said air passages, and driving connections for operating the pump and the blower whereby the pump and the blower may be operated together or either one alone.

4. Apparatus for extracting water from atmospheric air, comprising in combination a closed tank for containing liquid, means providing a plurality of air flow passages extending through said tank having walls of heat-conducting material, refrigerating means for cooling liquid in said tank to a temperature below the dew point temperature of the surrounding atmosphere, said refrigerating means including a vacuum pump, a blower for forcing air from the surrounding atmosphere through said air passages, and driving connections for operating the pump and the blower whereby the pump and the blower may be operated together or either one alone, said connections including means for changing the length of stroke of the pump.

5. Apparatus for extracting water from atmospheric air, comprising in combination a tank for containing liquid having a plurality of air flow passages extending between and opening through its end walls, said passages being formed each by two closely spaced thin plates of heat-conducting material transversely corrugated to provide a passage of serpentine form and the passages being baffled to increase the length of the air flow paths, refrigerating means for cooling liquid in said tank to a temperature below the dew point temperature of the surrounding atmosphere, means for forcing air from the surrounding atmosphere through said passages, and means for collecting the water which is condensed from the cooled flowing air.

6. Apparatus for extracting water from atmospheric air, comprising in combination a closed tank for containing water, means providing a plurality of air flow passages extending through said tank having walls of heat-conducting material, refrigerating means for cooling the water in said tank to a temperature below the dew point temperature of the surrounding atmosphere, said refrigerating means including a vacuum pump to reduce the pressure above the water in said tank and thereby cause part of said water to vaporize with abstraction of heat from the remainder thereof, a blower for passing air from the surrounding atmosphere through said air passages and driving connections for operating the pump and the blower whereby the pump and the blower may be operated together or either one alone.

BERNARD GRANVILLE.