May 17, 1938. F. R. ERBACH ET AL 2,117,410

PORTABLE AIR CONDITIONER

Filed July 1, 1937 2 Sheets-Sheet 1

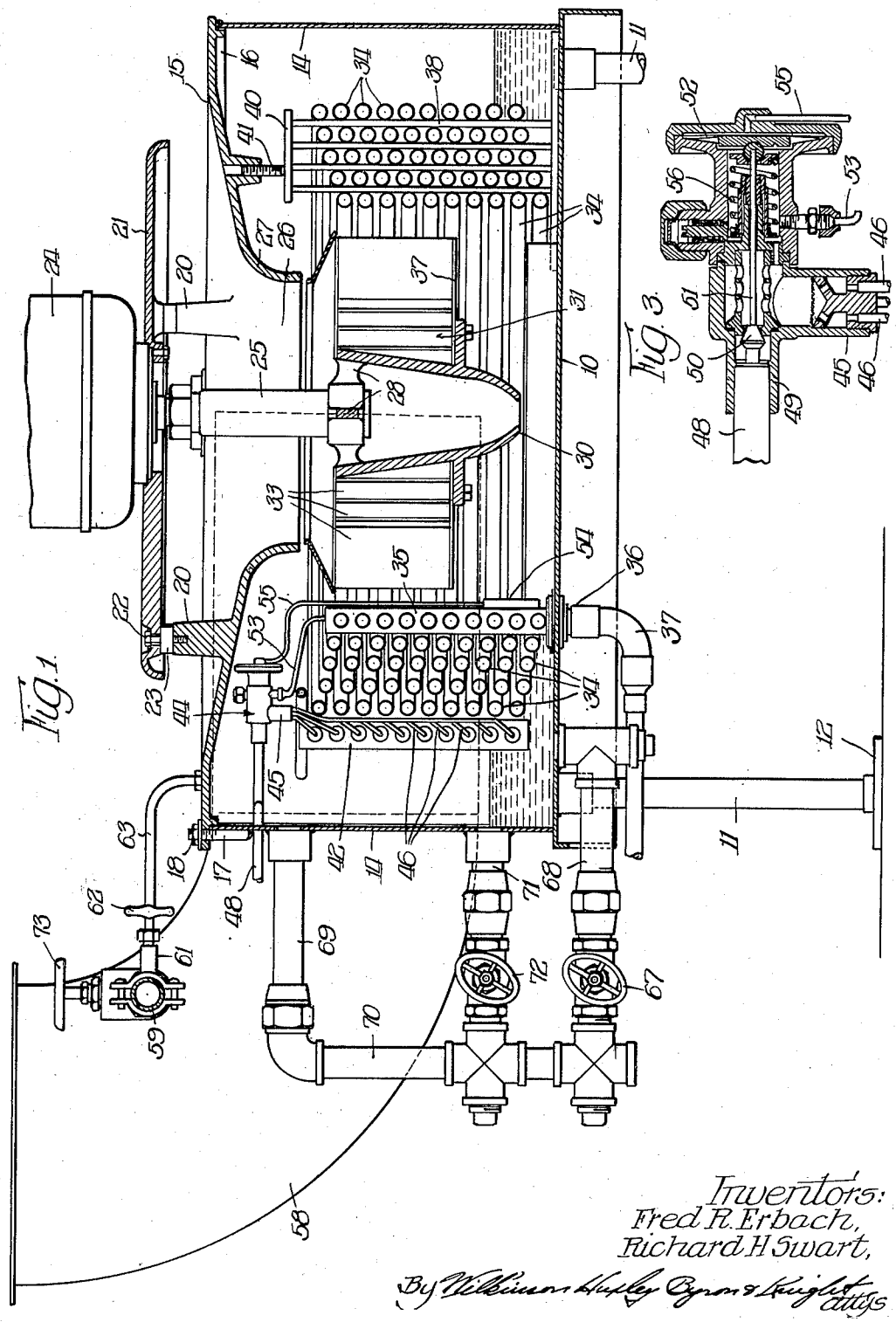


Fig. 1.

Fig. 3.

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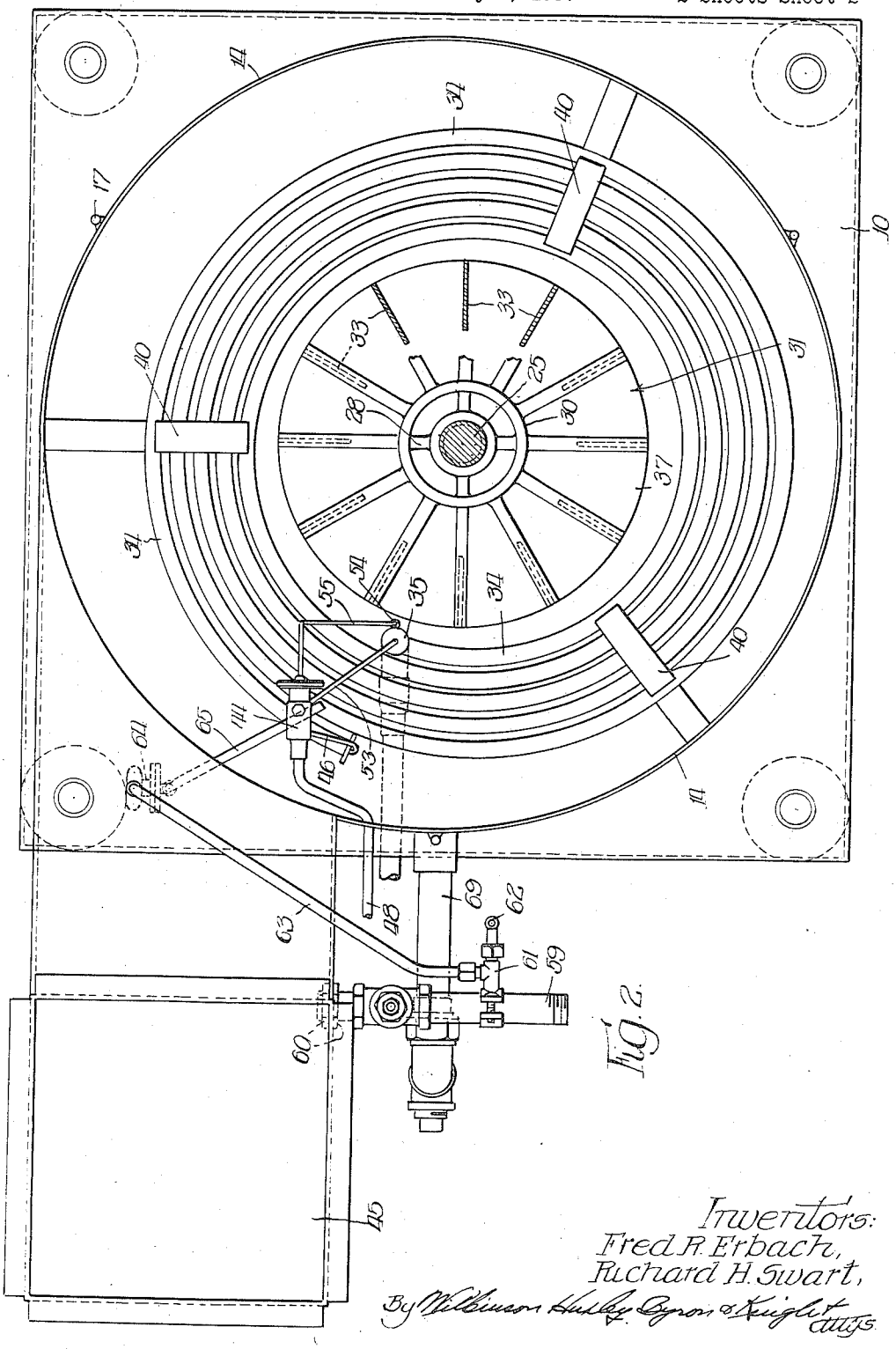


Fig. 2.

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PORTABLE AIR CONDITIONER

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7 Claims. (Cl. 261—91)

The invention relates to portable air conditioning equipment and has more particular reference to an air conditioner having combined washing and surface cooling features.

The air conditioner of the invention makes use of the combined action of water and cooling coils to remove heat from the air to be conditioned which is first washed by said water and then passed over said cooling coils. An object of the invention therefore is to provide an improved apparatus for conditioning air which will have increased efficiency attained by thoroughly washing the air with finely divided water particles and properly distributing the mixture over the surface of cooling coils having a refrigerant medium flowing therethrough.

Another object of the invention is to provide air conditioning equipment wherein the motor for operating the fan and water pump is mounted vertically above the tank, thereby eliminating packing boxes, bearings and fittings below the water level in the tank which might leak or be the cause of serious trouble.

Another object of the invention is to provide an air conditioner having a pump of the simplest rotative cone design and in which water enters at the bottom inlet of the cone and is deflected upwardly until it reaches the mouth of the cone, whereupon it is discharged by centrifugal force across the air stream entering the fan. By this arrangement thorough washing of the air as it passes into the fan is secured.

Another object of the invention is to provide an improved arrangement of cooling coils each consisting of a flat spiral of copper tubing and each forming a complete evaporator having an inlet for the liquid refrigerant at the outside thereof and being joined to a suction header at the inside of the coil. According to the invention the spirals have a downward pitch as they progress toward the center of the coil, thereby permitting the liquid refrigerant admitted to the outside coil of the spiral to drain inward toward the suction header. The arrangement also results in accomplishing the counter-flow principle in heat exchange. The liquid refrigerant is fed in at the outside of the evaporator coils and expansion takes place as it progresses toward the center, producing the well known cooling effect. Thus, the air as it passes over the evaporator coils, being discharged from the inside outwardly thereof, is gradually cooled and the discharged air from the outlet has the lowest temperature possible.

The invention is also concerned with the provision of air conditioning equipment as above described, wherein the cooling surfaces can be readily cleaned to remove deposits of dust and dirt, and the like, which might adhere thereto as a result of the continual discharge of air over said coils and the spraying of water thereon. In the operation of the air conditioner the water may cause an encrustation over the surface of the cooling coils, which in the present air conditioning equipment are mounted in a tank that can be flooded to submerge the coils in a cleaning solution of the proper chemical analysis for dissolving the particular type of mineral deposits left on the coils by their contact with the conditioned air and washing water.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention and wherein like reference characters are used to designate like parts—

Figure 1 is a vertical elevational view showing the internal construction of an air conditioner embodying the featuures of the invention;

Figure 2 is a top plan view of the air conditioner of Figure 1 with the cover plate for the tank and motor removed; and

Figure 3 is a sectional view showing in detail the internal construction of the expansion valve for uniformly feeding liquid refrigerant to a plurality of cooling coils.

Referring to the drawings, the operative parts of the present air conditioner are shown as supported upon a table having a top 10 substantially rectangular in plane and which is suported on any suitable foundation by means of the uprights 11 having circular foot rests 12. The top plate 10 comprises the bottom of the tank which is formed by the cylindrical side wall 14 welded to said top plate so as to make a liquid-tight connection therewith. The top member of the tank comprises a removable cover 15 having a depending flange 16 adapted to fit within the cylindrical walls 14 of the tank and thus the same properly positions the cover thereon. Suitably secured to the exterior of the cylindrical wall 14 of the tank are upwardly projecting pins 17 adapted to pass through openings formed in the cover and receive screws 18, thereby releasably securing the cover in place. Said cover has formed integral therewith upwardly extending lugs 20 which form supports for plate member 21, the same being re-

leasably secured thereto by the threaded screws 22. The rubber inserts 23 are interposed therebetween in order to cushion the vibrations of the motor 24 supported by said plate member. The rotor shaft 25 of said motor extends centrally through opening 26 in the cover 15 formed by the downwardly curved walls 27. Attached to the lower end of said rotor shaft by the connecting webs 28 is a pump tube formed by the inverted cone 30. Said pump tube carries a centrifugal fan designated generally in Figure 1 by numeral 31 and which consists of a base member 32 supporting a plurality of radial plates or blades 33.

Located within the tank 14 and positioned concentric with the centrifugal fan are a plurality of cooling coils 34, each in the form of a flat spiral disposed so as to give each spiral a downward pitch as the same progresses from the outer coil thereof to the inner coil. Each spiral has connection at its inner end to a suction header 35 which extends through the base 10 of the tank and has connection at 36 with the suction line 37 of the refrigerating system which returns the refrigerant gas to the compressor. The spaced vertical rods 38 maintain the spiral coils in proper superposed relation. Three sets of these rods are used, each set being retained in spaced relation by the top member 40 which is held against the rods by the screws 41 having threaded connection with cover 15.

The outer end of each spiral coil is supported by member 42 which maintains said end of the coil in proper spaced relation. Liquid refrigerant is supplied to each coil by the expansion valve, designated in its entirety by numeral 44, said valve being suitably supported in the upper part of the tank immediately below the cover 15 and to the side thereof substantially directly over the member 42. From the outlet fitting 45 of the valve a plurality of tubes 46 lead to the spiral coils, each coil having connection with a tube whereby liquid refrigerant is delivered thereto.

As more particularly shown in Figure 3, the expansion valve 44 may be a conventional thermostatic expansion valve having an inlet tube 48 connecting with the inlet fitting 49 for supplying liquid refrigerant to said valve. The conical valve member 50 formed on the end of rod 51 controls the flow of liquid refrigerant to the outlet fitting 45 above described and which connects with the capillary tubes 46, each tube leading to the inlet end of a cooling coil 34. The expansion valve is also provided with a pressure responsive diaphragm 52 which has connection with the wave member 50 through rod 51. Said diaphragm is biased toward the right, that is, in a valve closing direction, by the pressure of the evaporated refrigerant gas within the suction header 35, which pressure is communicated from said header through the tube 53 to the space on the underside of the diaphragm. The diaphragm is also biased toward the left, or in a valve opening direction, by the pressure produced by the thermostatic bulb 54, which pressure is communicated through tube 55 to the space on the upper side of the diaphragm. It will be observed that the thermostatic bulb 54 is clamped to the suction header 35 and thus the average discharge temperature of the refrigerant gas leaving the plurality of cooling coils 34 influences the thermostatic fluid in said bulb to produce corresponding variations in pressure on the upper side of the diaphragm. The pressure produced by the thermostatic bulb is a function of the average temperature of the returning refrigerant gas. Inasmuch as the pressure within the suction header 35 is a function of the saturation temperature of the refrigerant gas, the difference in pressure imposed on the diaphragm will be a function of the superheat of the refrigerant leaving the series of cooling coils. The coil spring 56 yieldingly forces the valve member 50 in a closing direction in opposition to the pressure difference on the diaphragm which tends to open the valve.

The space between the cover 15 and the plate member 21 forms the air inlet for the centrifugal fan, air being drawn through said space and through the central opening 26 in said cover and being delivered thereby to the fan 31. The duct 58, substantially rectangular in cross section, comprises the air outlet for said tank, said duct having a tangential connection therewith, as will be clearly understood by reference to Figure 2. Water is supplied to said tank by the water pipe 59 which passes through the side wall of the duct 58 so as to discharge within said duct. The said discharge end of the pipe is secured to the wall by nuts 60. Joined to the water main 59 is a valved connection 61 having handle 62 and provided with tube 63 connecting with a magnetic valve 64 suitably located within the tank. The oulet end 65 from said valve, as shown in Figure 2, terminates over the spiral cooling coils 34. In an air conditioner of this type it is advisable to supply a small amount of fresh water to the tank periodically to thereby prevent the accumulation of foul odors in the water tank. The magnetic valve which may be arranged to supply water when the conditioner is running would meet the above requirements. For draining said tank it is only necessary to open the valve 67 located in the water drain 68 which has connection with the bottom 10 of the tank.

The cooling coils of the present air conditioner can be submerged by substantially filling the tank with water and for this reason the present tank is constructed so that the air inlet and the air outlet will be above the water level in the tank during the operation of submerging the coils for cleaning purposes. The flood level of the water is determined by the overflow connection 69 joined by pipe 70 to connection 71. Connection 71 is provided with a valve 72 and by means of said valve the normal level of the water within the tank during operation of the air conditioner is determined. It is to be noted that a number of the cooling coils are located below the normal level of the water. Thus the coils are submerged during operation of the air conditioner and their effect is to cool the water in the tank which thereby materially increases the efficiency of the air conditioner.

In operation of the air conditioner above described the pump 30 will dip into the water in the bottom of the tank since the normal water level determined by outlet 71 will be, as shown in Figure 1, slightly above the lower end of said pipe tube. When the motor 24 is started, causing rotation of the fan, water is caused to flow up the pump tube 31 and to be discharged radially in a fine spray from the upper end of said pump tube. Accordingly, fine water sprays are directed across the path of the air being delivered to the fan. The pumping action of the inverted cone 30 is dependent on skin friction and the centrifugal force of the water on the interior wall of the inverted cone. Water escapes from the end of said pump tube in a substantially horizontal spray and moisture, together with air, is accordingly delivered to the blades of the fan. In this manner

the air prior to being delivered to the cooling coils **34** is washed by a water spray in the form of finely divided particles. The discharge from the fan is directed into contact with the series of superposed cooling coils **34**, each coil comprising an independent evaporator having a capillary tube **46** delivering liquid refrigerant thereto and having connection at its opposite end with the suction header **35**. The washing of the air with water having a relatively low temperature considerably reduces the temperature of the air, which, however, is further cooled due to surface contact with the cooling coils **34**. The coils remove considerable moisture from the air which drips from said coils and in this manner is returned to the reservoir in the bottom of the tank. The method of conditioning the air by first water washing the air and subsequently passing the washed air over cooling coils is very effective and has the further advantage of economy in operation.

The liquid refrigerant delivered by the inlet **48** to the expansion valve is distributed uniformly by the outlet fitting **45** to the plurality of capillary tubes **46** which have connection respectively with a cooling coil. By controlling the flow of refrigerant in accordance with the superheat the cooling coils are supplied with a quantity of refrigerant that can be completely evaporated thereby.

Another feature of the present air conditioner resides in the downward pitch of the spiral coils as they progress toward the suction header **35**. This facilitates the flow of the liquid refrigerant toward the suction header.

An air conditioner of the above type presents a serious problem in that the surfaces of the cooling coils become coated with deposits left by the water continually brought in contact therewith. In the present structure the tank can be flooded to submerge the coils in a cleaning solution of the proper chemical analysis to dissolve the particular type of mineral deposit left in the coils. This flooding is made possible by locating the air inlet opening and air discharge opening above the upper level of the coils. For the cleaning operation the motor **26** is stopped and the valve **72** is closed. Water from the water main **58** is then admitted to the tank by opening the valve controlled by the handle **73**. Water will fill the tank to a level determined by the overflow connection **69**. The proper quantity of cleaning solution is added to the water in the tank after the coils are submerged. During the cleaning operation the solution may be stirred occasionally. At the end of the cleaning operation the drain **68** is opened to completely drain the solution from the tank.

During operation of the present air conditioner it is possible to add chemicals to the water in the tank to assist in the purification of the air or to add chemicals to impart a pleasing and characteristic odor to the conditioned air.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. Apparatus for washing and cooling air, in combination, a tank providing a reservoir for water, a centrifugal fan mounted for rotation on a vertical axis and located in the upper part of said tank, means rotating with the fan for drawing water from said reservoir and discharging the same radially from the center of said fan in the form of finely divided sprays, whereby air entering the fan is washed by contact with said water sprays, and a plurality of cooling coils each in the form of a substantially flat spiral encircling said fan and located in the path of the air discharged thereby, an expansion valve for uniformly delivering liquid refrigerant to said coils, and means maintaining said reservoir at a constant water level during operation.

2. Apparatus for washing and cooling air, in combination, a tank providing a reservoir for water, a centrifugal fan mounted for rotation on a vertical axis and located in the upper part of said tank, a pump tube depending from the center of said fan and dipping into said reservoir, said pump tube drawing water therefrom and discharging the same radially from the center of said fan in the form of finely divided sprays, whereby air entering said fan is washed by said water sprays, a plurality of superposed cooling coils encircling said fan and located in the path of the air discharged thereby, an expansion valve for uniformly delivering liquid refrigerant to said coils, and an outlet for the washed and cooled air located above the level of said cooling coils, whereby said tank may be substantially filled with water to submerge the cooling coils in order to clean said coils.

3. In an air conditioner, the combination with a tank forming a reservoir for water, of a plurality of cooling coils supported within said tank, a motor operated fan positioned centrally of said coils and operating to discharge a water and air mixture over said coils, an air supply inlet located above the fan, an air discharge outlet located above the level of the cooling coils whereby said tank may be substantially filled with water to submerge said cooling coils for the purpose of cleaning the same, and means for completely draining said tank.

4. In an air conditioner, the combination with a tank forming a reservoir for water, of a plurality of superposed cooling coils each in the form of a substantially flat spiral supported within said tank, a motor operated fan positioned centrally of said coils and operating to discharge a water and air mixture over said coils, an air supply inlet positioned above said fan, an air discharge outlet located above the level of said cooling coils whereby said tank may be substantially filled with water for submerging said cooling coils, an overflow connection for said tank determining the level of the water when said coils are submerged, and means for completely draining said tank.

5. Apparatus for washing and cooling air, in combination, a tank providing a reservoir for water, a centrifugal fan mounted for rotation on a vertical axis and located in the upper part of said tank, means rotating with the fan for drawing water from said reservoir and discharging the same radially in the form of finely divided sprays from the center of said fan and in a direction substantially horizontal, whereby said water sprays traverse the air streams entering said fan to wash the air, and a plurality of cooling coils within said tank, said coils comprising substantially flat spirals encircling the fan and located in the path of the air discharged thereby.

6. Apparatus for washing and cooling air, in combination, a tank providing a reservoir for water, a centrifugal fan mounted for rotation

on a vertical axis and located in the upper part of said tank, means rotating with the fan for drawing water from said reservoir and discharging the same radially in the form of finely divided sprays from the center of said fan and in a direction substantially horizontal, whereby said water sprays traverse the air streams entering said fan to wash the air, a plurality of cooling coils within said tank, said coils comprising substantially flat spirals each having a downward pitch as it progresses toward its inner end and having connection at said end with a suction header, and an expansion valve delivering liquid refrigerant to the outer end of each of said cooling coils.

7. Apparatus for washing and cooling air, in combination, a tank providing a reservoir for water, a centrifugal fan mounted for rotation on a vertical axis and located in the upper part of said tank, means rotating with the fan for drawing water from said reservoir and discharging the same radially in the form of finely divided sprays from the center of said fan and in a direction substantially horizontal, whereby said water sprays traverse the air streams entering said fan to wash the air, and a plurality of cooling coils within said tank, said coils comprising substantially flat spirals encircling the fan and located in the path of the air discharged thereby, and certain of said coils being submerged by the water in the tank, thereby cooling the water and materially increasing the efficiency of the apparatus.

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