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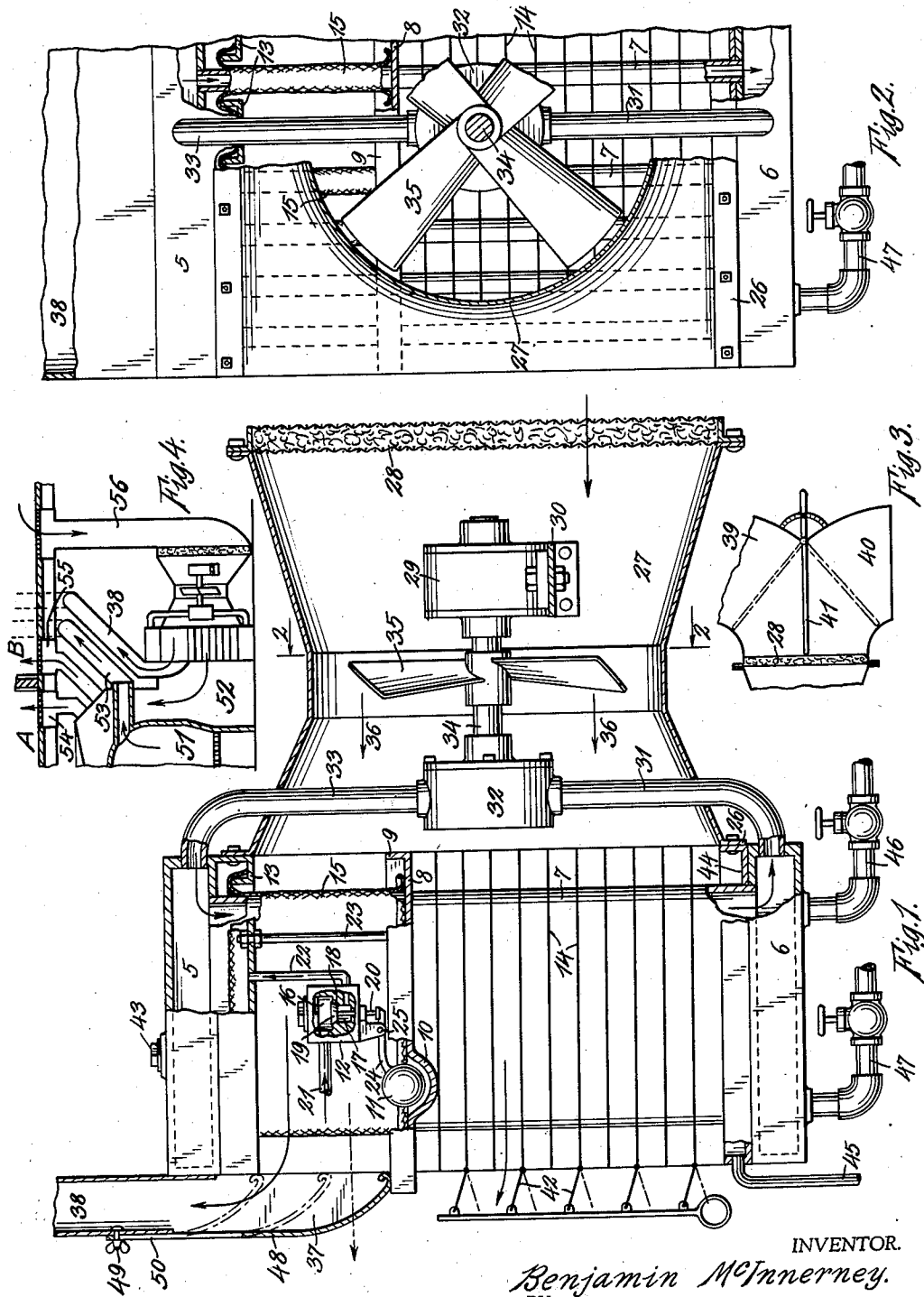
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AIR CONDITIONING APPARATUS

Filed Nov. 3, 1937

2 Sheets-Sheet 1



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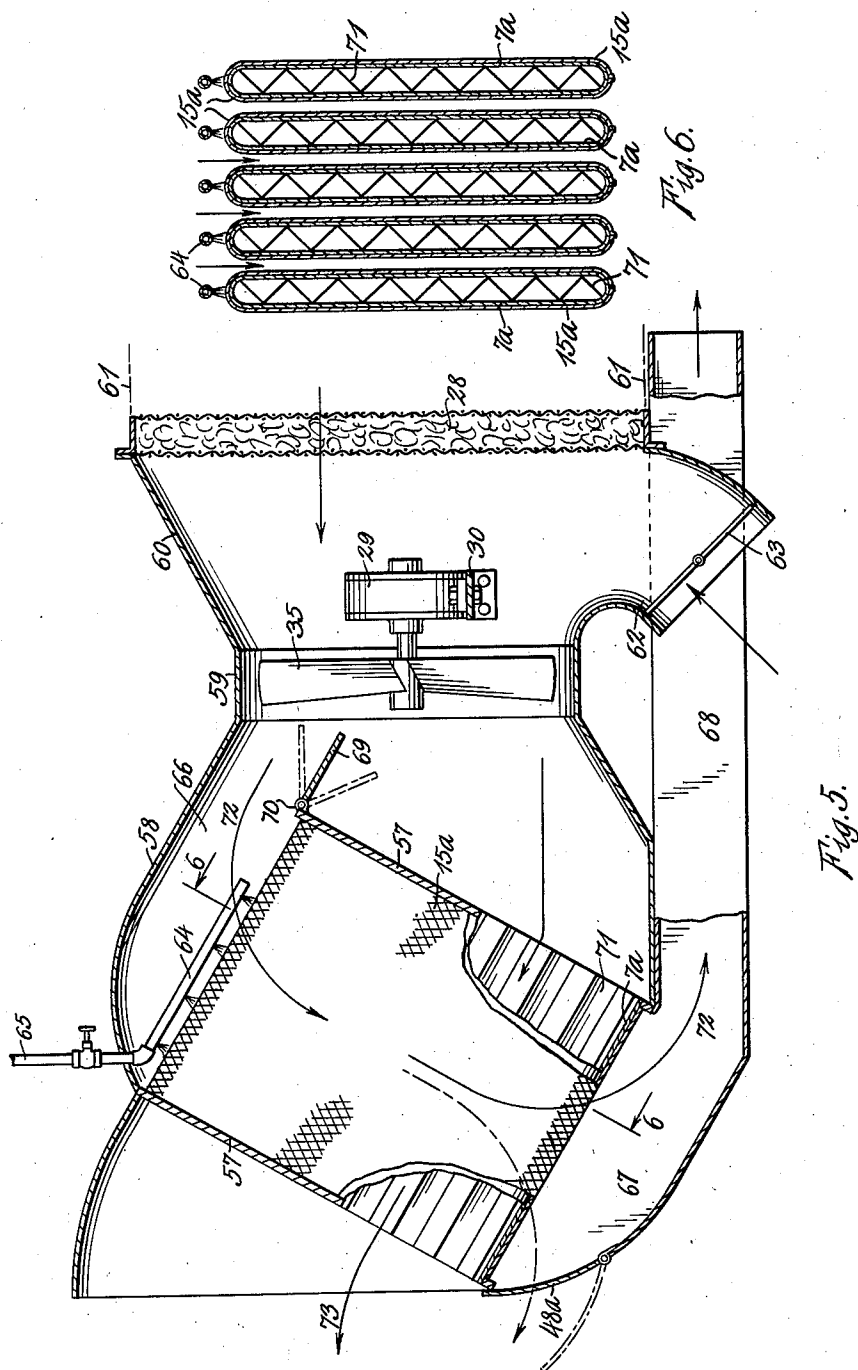
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AIR CONDITIONING APPARATUS

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10 Claims. (Cl. 62-139)

This invention relates to improvements in air conditioning devices.

It is well understood that our modern dwellings, offices, restaurants and shops can be made more comfortable both in summer and in winter by conditioning the air with respect to temperature and moisture content.

In parts of our country where the air is moist and hot in summer, living conditions are very unpleasant for several months each year, and in such places air conditioning is essential to comfort.

It is now quite common to subject the air in buildings, such as residences, hotels and theaters to a treatment that reduces its temperature and modifies its moisture content. In some instances this temperature reduction is effected by means of refrigerating units such as those employed with the ordinary power operated refrigerators. In other cases with ice or cold water and in other cases the air is merely driven through moist screens or through a water spray where the temperature is reduced by the evaporative action of the air and the water.

The last method is usually the simplest and the cheapest but its action is more or less illusory due to the fact that the latent heat of vaporization that is absorbed by the water during its vaporization is returned when the vapor condenses with the result that the total amount of heat in a room subjected to this kind of air conditioning is in reality increased by the energy expended in operating the apparatus, and in moist climates the vapor which has been added to the air tends to increase physical discomfort.

The apparatus to which this invention relates is of the type in which the heat absorptive action of evaporation is employed to reduce the temperature of a radiator and in which air is then passed through the radiator for the purpose of cooling it. The air that is used for effecting the evaporation is conducted to the outside of the room to be cooled and the air that is cooled by passing through the radiator is directed into the room and in this way the heat abstracted from the liquid during the evaporation will not be redelivered to the air of the room.

Having thus described the invention in a general way, the same will now be described in detail and for this purpose reference will be had to the accompanying drawings in which one form of the invention has been illustrated and in which:

Figure 1 is a vertical section through a unit

embodying the invention, parts being broken away to better disclose the construction.

Figure 2 is a fragmentary section taken on line 2-2 Fig. 1.

Figure 3 is a detail showing one arrangement of proportioning valve;

Figure 4 is a view showing how the device can be associated with an ordinary hot air heating system.

Figure 5 is a longitudinal section similar to Fig. 1 and shows a modified form of the invention; and

Figure 6 is a partial section taken on line 6-6 Fig. 5.

In the drawings reference numerals 5 and 6 represent respectively the top and the bottom tank of a radiator and are connected by flattened tubular members 7. The number, size and shape of the tubular members can be varied to suit conditions but for the purpose of illustration the tubes 7 have been shown as few in number and comparatively large. A partition 8, having a vertical wall 9, is positioned at some point between the two tanks, the exact point being determined by the average temperature and humidity of the air to be conditioned. The partition has an opening for each tube and the latter are joined to the partition by solder so that a water tight pan or reservoir is formed at this point. At one point the bottom of the pan, or partition, is provided with a sump 10 in which is positioned a hollow float 11 that controls the action of a valve mechanism 12, which will be more fully described hereinafter. Pans 13 surround the tubes 7 directly below tank 5 but are not attached to the tubes for reasons that will be obvious as the description proceeds. Radiating fins are attached to the tubes below the partition and serve to facilitate radiation or heat interchange in the usual manner. Those portions of the tubes 7 that are positioned between the two pans 8 and 13 are covered by an absorptive fabric 15 that may be made from wool, linen, cotton or any other suitable material that has the property of conducting a liquid by capillary action; these coverings will be referred to hereinafter as "wicks". It is evident that a spray or other equivalent means may be used to moisten the wicks, but I prefer the method shown, in which the lower ends of the wicks extend to the bottom of pan 8 and the upper ends are curved outwardly and downwardly and project into the pans 13. When pans 8 and 13 contain water, or other liquid, this will travel upwardly from pan 8 and downwardly from pan 13, thus keeping the wicks moist. The

pans 8 and 13 are kept supplied with water by means of a valve mechanism 12 which comprises a valve body having a cylindrical chamber 16 whose lower end terminates in a smaller cylindrical opening 17. The wall at the intersection of chamber 16 and opening 17 is chamfered so as to form a valve seat 18 that cooperates with a poppet valve 19 whose stem 20 projects through the bottom of the valve body. Chamber 16 is placed in communication with a source of water under pressure by means of a pipe 21 that may be part of the domestic water supply installation. A discharge pipe 22 communicates with pan 13. Adjustably secured to the pan 13 is an overflow pipe 23 that determines the level to which the liquid can rise. The overflow is discharged into pan 8 and controls the float 11. It will be observed that float 11 is attached to one end of a lever 24 that is pivoted at 25 to lugs that are integral with or secured to the valve body. When the level of the water in pan 8 sinks below a predetermined point the upward push that is exerted on the valve stem by the lever 24 unseats valve 19 and permits water to flow into pan 13 and overflow from it into pan 8 until it reaches a predetermined level and in this manner pans 8 and 13 are constantly supplied with water.

The radiator is enclosed in a housing that has been designated by reference numeral 26. The front of the housing is connected with a tubular chamber 27 that has been shown as of somewhat smaller diameter at its center than at its ends. A filter screen 28 closes the front end of chamber 27 and a motor 29 is supported in the housing on a shelf 30.

A pipe 31 connects the bottom tank 6 with the intake port of a rotary pump 32 and a pipe 33 connects the delivery port of the pump with tank 5. Shaft 34 connects the motor and the pump. A fan 35 is carried by the shaft 34 and when the motor is in operation the pump transfers liquid from the lower to the upper tank and the fan produces a movement of the air in the direction of arrows 36.

A portion of the air flows through the radiator between pans 8 and 13 and produces rapid evaporation of the liquid in the wicks; this air flows into the chamber 37 and out through the flue 38. The air that flows through the radiator below pan 8 is cooled by contact with the tubes 7 and flows into the room. By directing that portion of the air that has absorbed heat, due to the evaporation, to a point outside of the room, it cannot return this heat to the room with the result that heat is being constantly removed by what may be termed a thermal pump action similar to that of a mechanical refrigerator. Particular attention is called to the feature just mentioned because the very erroneous idea is quite prevalent that it is possible to reduce the temperature of a closed room by circulating the air over moist surfaces or through a water spray.

It is evident that at first more heat will be abstracted from the liquid in the tubes by the evaporation than will be returned to it by the air that flows through the radiator and into the room and as a result the liquid is gradually reduced in temperature until a point of equilibrium is established.

Owing to the difference in temperature and consequent difference in density of the water at the top and at the bottom of the radiator, it is theoretically possible to dispense with the pump 32 and still obtain some circulation but the use of a pump is desirable.

In Fig. 3, means has been illustrated for connecting the intake of the fan chamber 27 at will with the outside or with the room itself or partly with the outside and partly with the inside. A split conduit comprising branches 39 and 40 is connected with the wall of chamber 27 and has a movable damper 41 that can occupy any position between the two extreme positions indicated by dotted lines. The branch 39 may be considered as extending to the outside of the room and branch 40 as communicating with the room. When the damper is in the full line position the air is taken in equal amounts from the outside and inside.

The outlet for the air that passes through the refrigerator below the partition or pan 8 is provided with a plurality of interconnected pivoted louvers 42 that may be adjusted to any desired angle and are usually so adjusted that, while used for cooling, the air is directed upwardly. Tank 5 is provided with a fill opening that is normally closed by means of a removable plug 43. The lower ends of tubes 7 are surrounded by a pan 44 that catches any water of condensation or leakage and this overflows through pipe 45.

In winter and during those parts of the year when it is necessary to heat a room or a building instead of cooling it, the apparatus that has just been described can be used for this purpose and it may then be connected with a suitable steam boiler by means of pipes 46 and 47, one of which supplies the steam and the other of which serves as a return for the water of condensation; these pipes are provided with suitable valves. Instead of steam hot water may be circulated in which case the supply pipe may be connected with tank 5. When steam or hot water is used the pump may be disconnected but the fan is used in the usual manner.

In cold weather it is often desirable to add moisture to the air and this is effected by sliding member 48 upwardly so as to uncover some or all of the opening through which the moistened air emerges. Member 48 is clamped in adjusted position by a screw 49 that passes through a slot 50. By adjusting the position of member 48 the proportion of the moist air that flows into the room and into flue 38 can be determined.

By means of the damper 41, the proportion of fresh air that is added can be controlled and on very cold days it may be necessary to close the fresh air intake and depend entirely on the leakage for air dilution. The amount of water evaporated by the device when used as a heater may be controlled by a valve in pipe 21 or by adjusting overflow 23 and float 11.

Air conditioners of the type described can be very easily installed in stores, restaurants and also in offices and private dwellings, and may be auxiliary to the ordinary heating system or may constitute the only heating system.

In Fig. 4, the device has been shown as incorporated in an ordinary hot air heating plant. Numeral 51 designates the fire box of a furnace and 52 the jacket, while 53 designates the flue for the combustion gases. Two ducts 54 and 55 have been shown as connecting the hot air space of the furnace with rooms A and B. The duct 38 connects the evaporation cooler with the outside and return flue 56 conducts air from the rooms above to the air conditioner. In summer the whole house may be air conditioned by this means and in winter the air may be moistened thereby.

As already stated, the size and the shape of the

parts including tubes 7 can be varied to suit the particular conditions and the embodiment shown can be departed from to such extent as may be permissible within the scope of the appended claims.

In Figs. 5 and 6, a modified form of the invention has been shown. In this embodiment the liquid employed to transfer heat from the cooling means to those parts of the tubes that come into contact with the circulating air from the room has been omitted together with pump 32. In the embodiment illustrated in Fig. 5, the tubes 7a are made larger than the corresponding tubes 7 in Fig. 1, and the air that passes into the room is passed through the tubes and supplies heat to the tubes which are cooled by the evaporative refrigerator device.

In order to more clearly describe the construction and operation of the device shown in Fig. 5, reference will now be had to the drawing in which reference numeral 7a designates wide thin tubes of copper or other good heat conducting metal. These tubes are assembled between the end plates 57 and the assembly is positioned in a housing that has been designated in its entirety by reference numeral 58. The housing extends rearwardly and connects with a cylindrical section 59 in which is positioned a fan 35 that is driven by a motor 29 supported on a shelf 30. From section 59 an outwardly flaring housing 60 extends rearwardly and terminates in screen 28. A conduit 61, shown dotted, extends from the screen to the outside of the room that is to be air conditioned. The wall of section 60 has an opening 62 that communicates with the room and which is provided with a damper 63 which can be opened if for any reason it is found desirable to recirculate the air from the room through the air conditioner. The extent to which the damper 63 is opened determines the proportion of fresh and old air that is employed. Tubes 7a are arranged with their flat sides parallel and in vertical planes in the manner shown in Fig. 6 and above each tube is positioned a perforated pipe 64. These pipes are connected with a source of water supply 65 through a valve and serve to spray water onto the tubes for the purpose of keeping their outer surfaces moist. It is believed that the tubes should have a covering of absorbent fibrous material 15a that corresponds to the wicks 15 of Fig. 1. The absorbent coverings are maintained moist by the spray.

The housing 58 is so designed that it forms a chamber 66 that is in communication with the spaces between the tubes and the housing in like manner provides a chamber 67 that is in communication with the spaces between the tubes. A conduit 68 connects the chamber 67 with the outside of the room that is being air conditioned. A damper 69 is hinged at 70 and serves by its position to proportion the air that goes into chamber 66, thence through conduit 68 with respect to the air that flows through the interior of the tubes and enters the room.

Tubes 7a are open at both ends and are provided on their interiors with zigzag plates 71 that have their apexes soldered to the insides of the tubes. The air that passes through the tubes comes into heat conductive contact with the metal surfaces of the tubes and of the plates 71 and if these are cooler than the air, heat will pass from the latter to the tubes. The wall of chamber 67 is provided with a hinged door 48a that can be opened to any extent desired to per-

mit some of the moist air from chamber 67 to enter the room.

We will now assume that the apparatus illustrated in Figs. 5 and 6 is positioned in a room to be air conditioned and that conduits 61 and 68 are in communication with the atmosphere outside of the room. The air that passes into chamber 66 follows the path of arrow 72 and in passing over the moistened surfaces of the absorbent coverings 15a, it produces rapid evaporation, which in turn cools the tubes and the plates 71. The air that passes from the fan below damper 69 flows through the interiors of the tubes and emerges into the room as indicated by arrow 73.

Since the transfer of heat from the air to the tubes is not sufficient in the beginning to return as much heat as was abstracted by the evaporation of the liquid, the temperature of the metal parts will continue to decrease until an equilibrium is reached.

It will be observed that this device operates in substantially the same way as the device illustrated in Fig. 1, but cannot be used as a heater. It does, however, function to abstract heat from the room and remove it to a place outside thereof.

While my tests indicate that the forms shown are most efficient, it is evident that special installations may require changes in the construction. The wick section may be placed at the bottom of the tubes in case it is desired to conduct the heat outside from that point or any desired number of the tubes at either side may be completely covered with wicking, and flue 38 located adjacent thereto thus providing a side outlet for the heat, while the entire length of the remaining tubes are used for cooling the air without departing from the principles of my invention.

Having described the invention what is claimed as new is:

1. An air conditioning and heat interchange device for cooling a room, comprising in combination, a plurality of tubular heat conducting members having exposed surfaces, means for maintaining a portion of the surfaces moist by applying to them a vaporizable liquid, means comprising a fan for flowing air over the moist surfaces whereby evaporation is effected and heat abstracted from the tubular members, means comprising a conduit for conducting the moistened air to a position outside of the room, means including the fan for flowing air over and in thermal conductive contact with the unmoistened surfaces of the tubular members and into the room whereby the air is cooled for abstracting heat from the air in the room, the wall of the conduit for the moistened air having an opening in direct communication with the interior of the room for sending air directly from the conduit into the room, and means comprising a movable damper for regulating the effective area of the opening whereby any desired proportion of the moistened air can be directed into the room.

2. An air conditioning and heat interchange device for cooling a room, comprising in combination, a plurality of heat conducting members having exposed surfaces, a portion of the surfaces having a covering of fibrous absorbent material, means for supplying an evaporatable liquid to the absorbent material, means comprising a fan for flowing a stream of air over the moistened absorbent material whereby evaporation takes place and the temperature of the heat conductive members is lowered, means comprising a conduit for conducting the air from the absorbent members to a position outside of the room, means com-

prising the fan for flowing air in thermal conductive contact with the heat conductive members into the room, whereby heat is abstracted from the last named air stream and the temperature of the room lowered, the conduit having an opening in direct communication with the interior of the room whereby air from the absorbent members may be passed directly into the room without first mixing with the cooled air, and a damper for controlling the effective area of the opening, whereby the proportion of moistened air diverted directly to the room can be varied.

3. An air conditioning and heat interchange device for modifying the temperature of a room, comprising a radiator having vertically spaced tanks connected by a plurality of tubes, a liquid filling the radiator, means separate from the tubes for circulating the liquid in the radiator, an absorbent material surrounding the upper portions of the tubes, means for supplying water to the absorbent material whereby it will be maintained moist, and means comprising a fan for passing a stream of air over the moist absorbent material, whereby the water will be evaporated, thereby abstracting heat from the liquid in the tubes, means conducting the stream of air to a point outside the room, means including the fan for circulating the air for the room through the remaining portion of the radiator tube, whereby heat will be removed from the room by a thermal pump action.

4. An air conditioning device, comprising in combination, a liquid containing radiator having spaced tanks connected by a plurality of tubes, a pipe, separate from the tubes, joining the tanks, a pump operatively associated with the pipe, said pump when operating serving to circulate the liquid in the radiator, an absorbent material covering a portion of the tubes, means for maintaining the absorbent material moist, a partition extending transversely of the tubes adjacent the absorbent material, means comprising a fan for directing a flow of air through the radiator on both sides of the partition, and means for separating the two air streams from each other after they have passed through the radiator.

5. An air conditioner and heat interchange device comprising a radiator having an upper tank and a lower tank for containing water, connected by a plurality of tubes, and means separate from the tubes for returning water from the lower to the upper tank, a partition extending transversely of the tubes between the tanks, means associated with each tube, in the space above the partition for effecting a rapid evaporation of water in contact with the tubes to abstract heat from the water in the tubes, means comprising a fan for circulating air through the radiator spaces above and below the partition, and means on the discharge side of the upper radiator space for conducting any desired portion of the emerging air to a distant point.

6. An air conditioning and heat interchange device comprising two vertically spaced tanks connected by tubular members, a liquid in the tanks and tubular members, means for effecting a circulation of the liquid from the upper tank through the tubes into the lower tank and then returning the liquid to the upper tank, a water supply pan positioned in close proximity to the tubes directly below the upper tank, a second water supply pan surrounding the tubes at a point below the upper pan, means for supplying water to the pans, an absorptive fibrous material surrounding each tube between the pans, the ends of the absorptive material projecting into

the pans whereby it will be kept moist by capillary action, means comprising a fan for flowing an air stream through the tube assembly between the pans whereby evaporation is effected and heat abstracted from the liquid in the tubes, means for conducting the air and discharging it at a point separated from the air intake of the fan by a wall, and means comprising the fan for moving a stream of air around and about the tubes between the lower pan and the lower tank whereby a heat interchange is effected.

7. An air conditioning device, comprising in combination, a liquid containing radiator having two vertically spaced tanks connected by a plurality of tubes, a pipe, separate from the tubes, joining the two tanks, a pump operatively associated with the pipe, said pump when operating serving to transfer liquid from the lower to the upper tank, a water supply pan positioned directly below the upper tank, adjacent the tubes, an absorbent material covering the upper ends of the tubes, the upper end of the absorbent material dipping into the pan, a pan extending transversely of the tubes below the absorbent material, means for supplying water to the upper pan, means for overflowing water from the upper pan to the lower pan, a valve in the water supply means, a float responsive to the water level in the lower pan for controlling the opening and the closing of the valve, means for producing a flow of air through the radiator, the air that flows between the two pans producing evaporation whereby heat is abstracted from the liquid in the tubes, and means for directing this air into a conduit for removal to a predetermined place, the air that flows through the radiator below the lower pan and the lower tank giving up heat to the liquid in the tubes whereby its temperature is lowered.

8. In an evaporative refrigerator an upwardly ranging tubular member, a covering of absorbent material in heat conductive contact therewith, a pan positioned adjacent the upper end of the tube, spaced from but in close proximity thereto, the upper end of the absorbent covering extending over the edge and into the pan whereby liquid will be conducted from the pan by capillary action to maintain the absorbent material moist, means for maintaining a predetermined liquid level in the pan, a pan surrounding the tubular member some distance below the upper pan, the lower end of the absorbent material extending into the lower pan, means for supplying a liquid to the upper pan, means for overflowing liquid from the upper pan into the lower pan, and means controlled by the level of the liquid in the lower pan for controlling the flow of liquid to the upper pan.

9. An air conditioning and heat interchange device comprising, a heat conducting medium, two separate air spaces associated therewith, one of said spaces including means for effecting rapid evaporation of a liquid in contact with the included surface of said medium, the other space including another portion of the surface of said medium and serving to conduct air into contact with the included surface of the medium and thence into a room to be cooled, means comprising a fan for circulating air through both spaces, means comprising a conduit at the discharge end of the first mentioned space for conducting the air discharged therefrom to a distant point, said conduit having an opening in direct communication with the room, and means for varying the effective area of the opening whereby any desired portion of the air passing through

the conduit can be discharged directly into the room.

10. An air conditioning apparatus, comprising in combination, a radiator having a plurality of tubular members open at both ends and spaced
5 apart by heads which divide the spaces outside of the tubes from the spaces within the tubes, the spaces within the tubes being in communication with a room to be cooled, a single means, com-
10 prising a fan, for circulating air through both spaces, means within the space surrounding and

in communication with the outside of the tubes, comprising a moist surface, for effecting a cooling of the tubes by means of rapid evaporation, means comprising a conduit located on the discharge side of the last mentioned space for conducting any desired portion of the air from said
5 space to a distant point, and for discharging the remainder directly into the room being cooled without first mixing it with air from the first space.

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