

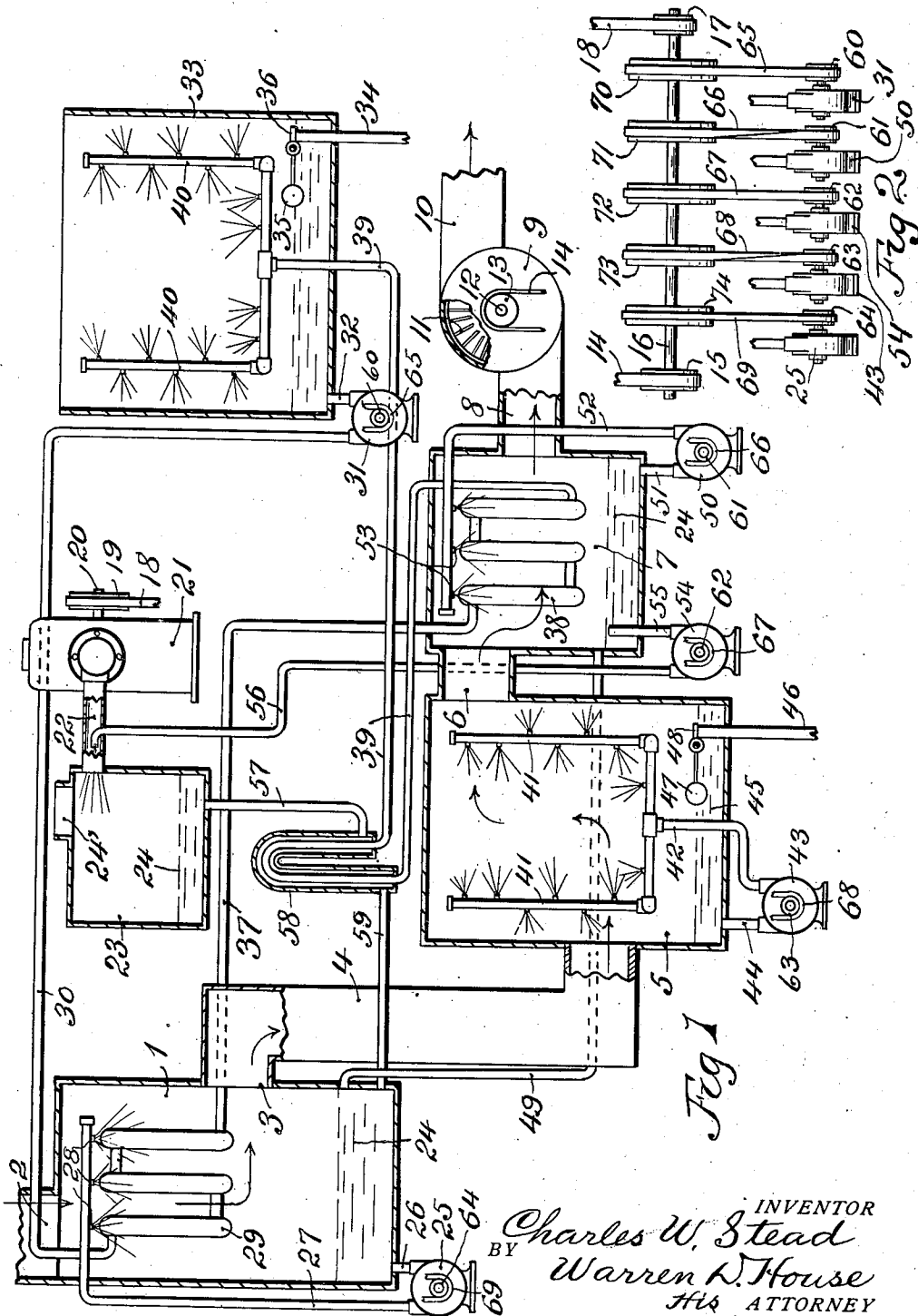
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METHOD OF AND APPARATUS FOR CONDITIONING AIR

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METHOD OF AND APPARATUS FOR
CONDITIONING AIR

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My invention relates to improvements in methods of and apparatus for conditioning air. It relates particularly to a method of air conditioning in which the air is washed to cool it and then is partially dehumidified by contacting it with a dehydrating agent, such as calcium chloride.

One of the objects of my invention is the provision of a novel method of treating the air by which a maximum cooling of the air may be obtained with a minimum amount of the dehumidifying agent.

A further object of my invention is the provision of a novel method of partially dehumidifying the dehydrating agent after it has been used for dehumidifying the air, which method effects evaporation of water from the dehydrating agent through the intermediacy of heat developed in the operation of an engine employed to circulate the air that is being cooled and conditioned.

Still another object of my invention is the provision of a novel apparatus for carrying into effect my improved method, which apparatus is simple, cheap to install and operate, which is durable, not likely to get out of order, and which is efficient in its operation.

The novel features of my invention are hereinafter fully described and claimed.

In the accompanying drawing,

Fig. 1 is a diagrammatic view of my improved apparatus which carries into effect my improved method.

Fig. 2 is a side elevation of the countershaft, pumps operated thereby and parts connected therewith, enlarged.

Similar characters of reference designate similar parts in the different views.

In carrying my improved method into effect the air to be conditioned is forced by power obtained from an engine through a conduit to its place of use, and in passing through the conduit it is first contacted with a dehumidifying agent, such as a concentrated solution of calcium chloride, and subjected to cooling. The air is then washed by spraying with water, whereby it absorbs a large amount of water and has its temperature thereby reduced. The air is then again contacted with the dehumidifying agent (that was first used for dehumidifying the air), and cooled and forced to its place of use.

The dehumidifying agent that was thus used the second time for contacting with the air is subjected to the heat and evaporating effect of the engine which is employed for forcing the air through the conduit and for pumping the water

used in washing and cooling the air as it passes through the conduit.

The dehumidifying agent which is subjected to the heating effect of the operating engine, preferably of the internal combustion type, is discharged into the exhaust of the engine and has a large amount of its absorbed water released and discharged to the air with the heated gaseous products of combustion. The resulting condensed dehumidifying solution is then cooled and returned to its original location in the conduit, thereby completing a cycle. The returned cooled condensed humidifying solution is then again contacted with fresh incoming air, thereby taking the first step in a similar cycle which forms part of a continuous operation carried on in the manner just described.

The conduit through which the air to be conditioned is forced comprises in my improved apparatus a first chamber 1 having an inlet 2 for air from the outside atmosphere, and having an outlet 3 which discharges into a pipe 4 that discharges into a chamber 5.

In the first chamber 1 the atmospheric air entering through the air inlet 2 is cooled and dehumidified.

In the chamber 5 the air is washed and then discharged through a pipe 6 which connects the chamber 5 with a third chamber 7, in which the washed air is again dehumidified by the dehydrating agent which was used in the first chamber 1 in the first dehumidifying operation on the air.

After the second dehumidification, the air passes from the chamber 7 by a pipe 8 connecting the chamber 7 with the casing 9 of a blower which discharges into a pipe 10 that is the outlet of the conduit, and which carries the conditioned air to its places of use.

The blower has in the casing 9 revolving vanes 11 which force the air in the direction indicated by the arrows in Fig. 1. The vanes are revolved by a rotary shaft 12 of the blower, which shaft has secured upon it a pulley 13, connected by a belt 14 with a pulley 15 secured upon a countershaft 16, that is revolved by a pulley 17 mounted on the countershaft and connected by a belt 18 to a pulley 19, fastened upon the rotary drive shaft 20 of an internal combustion engine 21.

The engine 20 has its exhaust pipe 22 discharging into a condensing chamber 23, provided with an outlet 24 communicating with the atmosphere.

The chambers 1, 7, and 23 are adapted to hold a dehydrating solution, as a solution of calcium

chloride 24, which is used in condensed form in the chamber 1 for contacting with the incoming air, for preliminarily dehumidifying the air.

For so contacting the air with the calcium chloride solution 24, there is provided a pump 25 having its inlet connected by a pipe 26 with the chamber 1 at the bottom thereof. The outlet of the pump 25 is connected to a pipe 27 which enters the chamber 1 above the outlet 3 and is closed at its adjacent end. The pipe 27 in the chamber 1 is provided with means for spraying the calcium chloride solution in said chamber, such as nozzles 28.

The nozzles 28 are, preferably, so disposed as to spray the solution upon a radiator 29 in the chamber 1, which radiator is connected by a cold water supply pipe 30 with the outlet of a pump 31, the inlet of which is connected by a pipe 32 with the interior and lower portion of a cooling tank 33, into which water is fed from a water service pipe 34, the discharge from which is controlled by a float 35, which is lifted by water in the tank 33 so as to close a valve 36 arranged to shut off the flow of water from the pipe 34 when the water level in the tank 33 reaches a predetermined level.

The radiator 29 has connected to it a discharge pipe 37, which is connected to a radiator 38 in the chamber 7. The radiator 38 has connected to it a pipe 39 which enters the tank 33 and has therein two perforated branches 40, closed at their ends, and which spray through their perforations the water to be cooled by contact with the outside air entering the tank. The water thus cooled is circulated by the pump 31 from the tank 33, through the pipe 32, pipe 30, radiator 29, pipe 37, radiator 38, pipe 39 and its branches 40 back into the tank 33.

The air entering the chamber 1 is dehumidified by the solution 24, and the air and solution are cooled by contacting with the radiator 29.

The air thus treated passes through the pipe 4 into the chamber 5 in which it is washed with water sprayed into the chamber from two branches 41 of a pipe 42 connected with the outlet of a pump 43 the intake of which is connected by a pipe 44 with the interior and lower part of the chamber 5, in which is held water 45 fed into the chamber from a water service pipe 46, the flow therefrom of which is controlled by a float 47, which is lifted by the water in the chamber to close the valve 48 that shuts off the flow from the pipe 46 when a predetermined depth of water is reached in the chamber 5.

The air being thus washed in the chamber 5 is cooled by the water. The water saturated air then passes through the pipe 6 into the chamber 7 where it is again dehumidified by contact with the calcium chloride solution 24 which was used in the chamber 1, and which is conveyed therefrom by gravity through a pipe 49 which connects the chambers 1 and 7, the discharge end of the pipe 49 being lower than its intake end at the chamber 1.

The solution 24 in the chamber 7 is drawn therefrom by a pump 50, through a pipe 51 connected with the inlet of the pump and the interior and lower part of the chamber 7. The water is discharged from the pump 50 through a pipe 52 connected with the outlet of the pump 50, and which in the chamber 7 is provided with vents 53 which spray the solution over the radiator 38, which cools the solution and also the air in the chamber 7.

By reason of the air being first dehumidified with the solution 24 in the chamber 1 and then saturated with water in the chamber 5, the air

in chamber 5 will be able to absorb a much larger amount of water than it could were the air not first dehumidified in the chamber 1. With such treatment a larger amount of sensible heat is transformed into latent heat in chamber 5 than would be were the air not first dehumidified in chamber 1.

As is well known, a hygrometric solution, as a calcium chloride solution, absorbs moisture from the air at a rate proportionate to the relative humidity of the air. The air leaving chamber 5 is, ordinarily, more highly saturated with moisture than it is when it enters chamber 1. The solution 24 which has been so diluted in chamber 1 that it will not readily absorb moisture from air having a degree of moisture corresponding to that of the air entering chamber 1, contacts in chamber 7 air having a much higher moisture content than it possessed when entering chamber 1. The diluted solution 24 in chamber 7 will absorb considerable additional moisture from the highly saturated air in chamber 7 even after it has lost its efficiency to absorb moisture from air having the relative humidity normally present in it when it enters chamber 1.

Thus, by humidifying the air between dehumidifications, a maximum amount of heat is transformed and concentrated in the hydrating solution from which it is transferred through the radiators 29 and 38 to the water circulating there-through, from which the heat is dissipated to the atmosphere by evaporation of the water in the cooling tank 33, with the use of a minimum of dehumidifying solution.

To partially dehumidify the solution 24 which is deposited in the chamber 7, and thereby condense the solution for use again in the chamber 1, the solution 24 in the chamber 7 is pumped therefrom by a pump 54 through a pipe 55 which extends into the chamber 7 and is connected to the intake of the pump 54. The pump 54 pumps the solution through a pipe 56 connected with the outlet of the pump and the discharge end of which extends into the exhaust pipe 22 of the engine 21.

The solution is intermixed with the hot gaseous products of combustion of the exhaust, whereby a large amount of the water in the solution is evaporated therefrom and released in the condensing chamber 23 and escapes therefrom to the air with the exhaust gases through the outlet 24'. The condensed solution 24 is then conveyed through a pipe 57, connected with the bottom of chamber 23, and discharged into one end of a U shaped radiator 58 with which the pipe 57 connects. The water pipe 39 extends through the radiator 58, from the walls of which it is spaced, and absorbs heat from the solution 24 which envelops the pipe 39 in the radiator 58. The cooled solution then passes back into the chamber 1 through a pipe 59 connected with the radiator 58 and the chamber 1. The chamber 23 is disposed at a height such that the inlet end of the pipe 57 is higher than the discharge end of the pipe 59, so that the condensed solution 24 will flow by gravity from the chamber 23 through the pipe 57 radiator 58 and pipe 59 into the chamber 1.

The pumps 31, 50, 54, 43, and 25 are respectively provided with driven pulleys 60, 61, 62, 63, and 64 respectively connected by belts 65, 66, 67, 68, and 69 with pulleys 70, 71, 72, 73, and 74 which are fastened on and revoluble with the countershaft 16.

The engine 21 thus serves the functions of forcing the air through the conduit, operating

the pumps 31, 50, 54, 43, and 25, and with its exhaust evaporating the excess of moisture from the used hydrating solution 24, so that the latter may be in continuous use during the operation of the apparatus.

Modifications of my invention, within the scope of the appended claims may be made without departing from its spirit.

What I claim is:—

1. The method of air conditioning consisting in contacting atmospheric air with a dehydrating agent, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with the agent used in the first step of dehydration, and cooling said agent and the air during one of said dehydrating steps.

2. The method of air conditioning consisting in contacting atmospheric air with a dehydrating agent, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with the agent used in the first step of dehydration, then partially dehumidifying said agent, thereby completing a cycle, then contacting fresh atmospheric air with said partially dehumidified agent, thereby taking the first step of a second similar cycle, and cooling said agent and the air during one of said dehydrating steps.

3. The method of air conditioning consisting in contacting atmospheric air with a dehydrating agent, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with the agent used in the first step of dehydration, and cooling the air and the dehydrating agent during the two steps of dehydration.

4. The method of air conditioning consisting in contacting atmospheric air with a dehydrating agent, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with the agent used in the first step of dehydration, then partially dehumidifying and cooling said agent, cooling the air and the dehydrating agent during the two steps of dehydration of the air, thereby completing a cycle, and then contacting fresh atmospheric air with the cooled partially dehumidified agent, thereby taking the first step of a second similar cycle.

5. The method of air conditioning consisting in contacting atmospheric air with a calcium chloride solution, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with said solution used in the first step, and cooling said solution and the air during one of said dehydrating steps.

6. The method of air conditioning consisting in contacting atmospheric air with a calcium chloride solution, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with said solution used in the first step, then partially dehumidifying said solution, thereby completing a cycle, then contacting fresh atmospheric air with said partially dehumidified solution, thereby taking the first step of a similar cycle, and cooling said solution and the air during one of said dehydrating steps.

7. The method of air conditioning consisting in contacting atmospheric air with a calcium chloride solution, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with said solu-

tion used in the first step, and cooling the air and said solution during the two steps of contacting the air with said solution.

8. The method of air conditioning consisting in contacting atmospheric air with a calcium chloride solution, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with said solution used in the first step, then partially dehumidifying and cooling said solution, cooling the air and said solution during the two steps of contacting the air with said solution, thereby completing a cycle, and then contacting fresh atmospheric air with said cooled and partially dehumidified solution, thereby taking the first step of a similar cycle.

9. The method of air conditioning consisting in contacting atmospheric air with a dehydrating solution, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with said solution used in the first step, cooling the air and said solution during one of said dehydrating steps, then evaporating water from and thus concentrating said solution, then cooling said solution, thereby completing a cycle, and then contacting fresh atmospheric air with said cooled concentrated solution, thereby taking the first step of a similar cycle.

10. The method of air conditioning consisting in contacting atmospheric air with a dehydrating solution, then saturating by washing with water the air so treated, cooling the air and said solution during one of said dehydrating steps, then contacting and dehydrating said washed air with said solution used in the first step, then partially dehumidifying said solution by contacting it with heated gaseous products of combustion and releasing the water vapor, then cooling said solution, thereby completing a cycle, and then contacting fresh atmospheric air with said concentrated solution, thereby taking the first step of a similar cycle.

11. The method of air conditioning consisting in contacting atmospheric air with a dehydrating solution, then saturating by washing with water the air so treated, then contacting and dehydrating said washed air with said solution used in the first step, then partially dehumidifying said solution by contacting it with heated gaseous products of combustion and releasing the water vapor, then cooling said partially dehumidified solution, cooling the air and said solution during the two steps of contacting the air with said solution, and then contacting said cooled and concentrated solution with fresh atmospheric air, thereby taking the first step of a similar cycle.

12. In an air conditioning apparatus, a conduit including a chamber having an air inlet, a chamber having an air outlet and an intermediate chamber, means for forcing air through said conduit from said air inlet to said air outlet, means for saturating with water the air as it passes through said intermediate chamber, means for contacting and dehydrating air entering the first named chamber with a dehydrating solution, means for conveying said solution from said first named chamber to said chamber having said outlet, means for conducting said solution from the chamber having the outlet to the first named chamber, means for cooling said solution during such conduction means for contacting and dehydrating the air in said chamber having the outlet with said solution, and means for

cooling the air and said solution between said inlet and said outlet.

13. In an air conditioning apparatus, a conduit including a first chamber having an air inlet, a chamber having an air outlet, and an intermediate chamber, means for forcing air through said conduit from said inlet to said outlet, means for saturating with water air passing through said intermediate chamber, means for contacting and dehydrating air entering said first chamber through said inlet with a dehydrating solution, means for conveying said first chamber to said chamber having said outlet, means in the last named chamber for contacting and dehydrating air therein with said dehydrating solution, means for partially dehumidifying and concentrating said solution taken from said last named chamber and discharging the concentrated solution in said first named chamber, and means for cooling the air and said solution in said first chamber and said chamber having said outlet.

14. In an air conditioning apparatus, a conduit including an inlet and an outlet for air, a heat producing engine, means actuated by said engine for forcing air through said conduit from said inlet to said outlet, means actuated by said engine for saturating with water air passing through said conduit, means actuated by said engine for contacting a dehydrating solution with and dehydrating the air passing through said conduit, means actuated by said engine for effecting cooling of the air and of said solution in said conduit, and means by which the heat

of said engine is employed to partially dehumidify said solution after the latter has been used for dehydrating the air.

15. In an air conditioning apparatus, a conduit including an inlet and an outlet for air, an internal combustion engine, means actuated by said engine for forcing air through said conduit from said inlet to said outlet, a dehydrating solution in said conduit, means for contacting and dehydrating air passing through said conduit with said solution, means for taking said solution after it has been used to dehydrate the air and subjecting it to the heat and evaporating effect of the exhaust of said engine to partially dehumidify and concentrate said solution, and means by which the said concentrated solution is discharged into said conduit for further use in dehydrating incoming air.

16. In an air conditioning apparatus, a conduit having an inlet and an outlet for air, an internal combustion engine, means for forcing air through said conduit from said inlet to said outlet, means for contacting and dehydrating air passing through said conduit with a dehydrating solution therein, means for withdrawing from said conduit said solution after such use and mixing it with the hot gaseous products of combustion of the exhaust of said engine whereby a portion of the water is evaporated from said solution so as to concentrate the latter, and means for discharging said concentrated solution into said conduit for further use in dehydrating incoming air.

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