Nov. 22, 1932. S. M. ANDERSON 1,888,844

AIR CONDITIONING APPARATUS

Filed June 24, 1929 3 Sheets-Sheet 1

Fig. 1

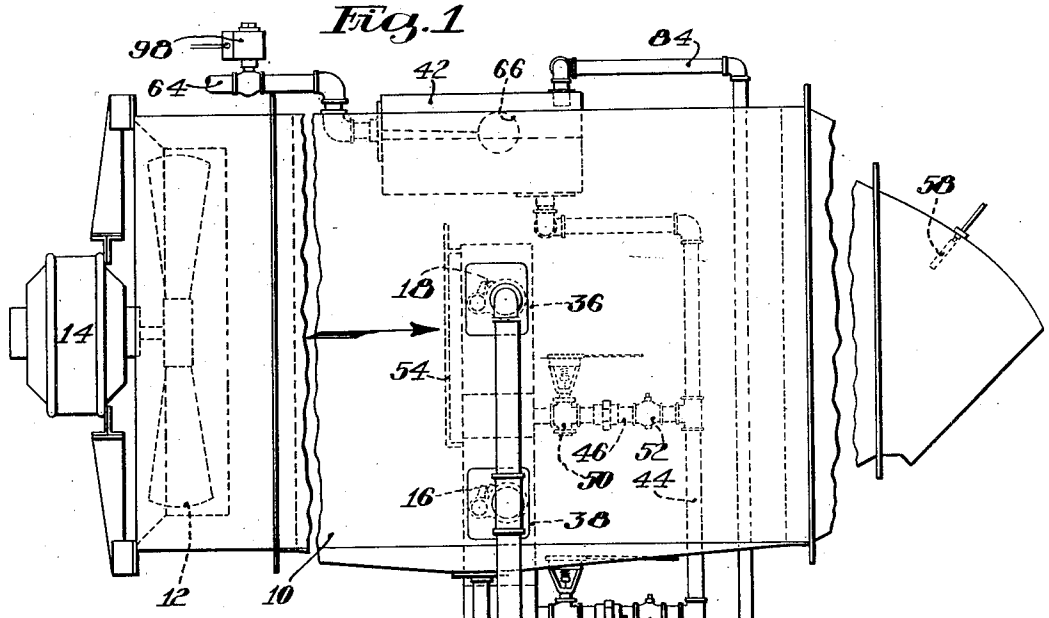
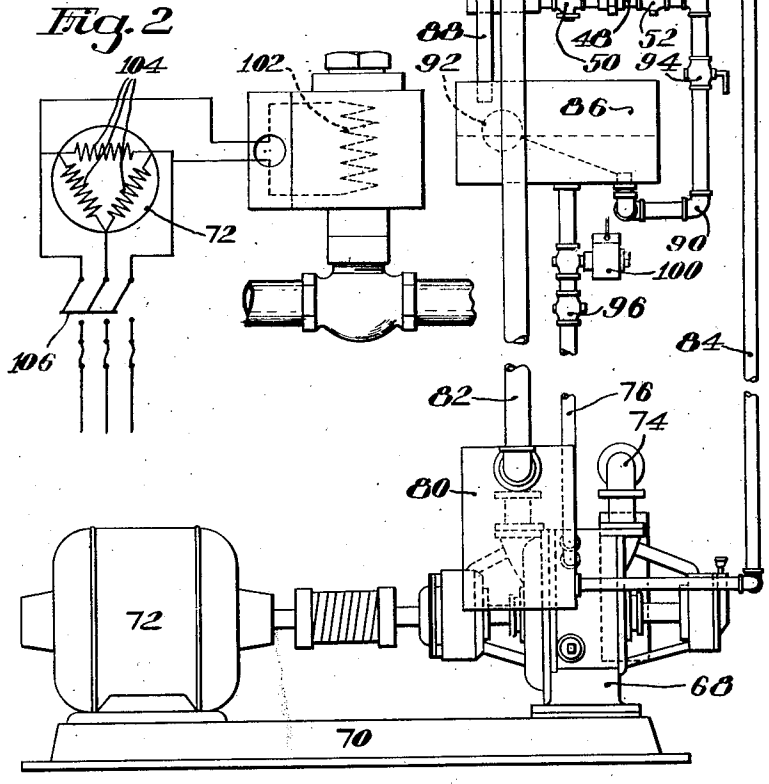


Fig. 2



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AIR CONDITIONING APPARATUS

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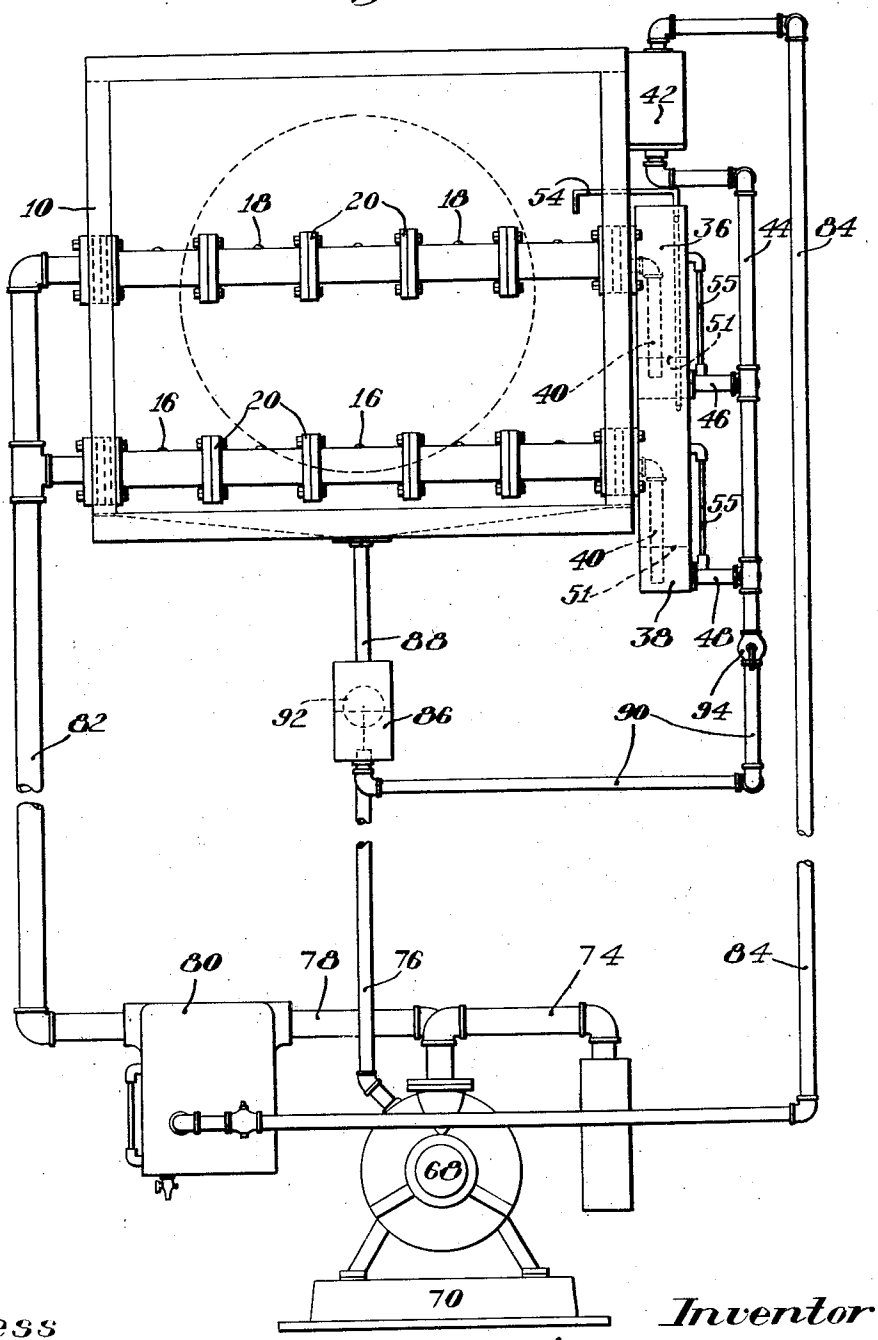
Fig. 3



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AIR CONDITIONING APPARATUS

Filed June 24, 1929 3 Sheets-Sheet 3

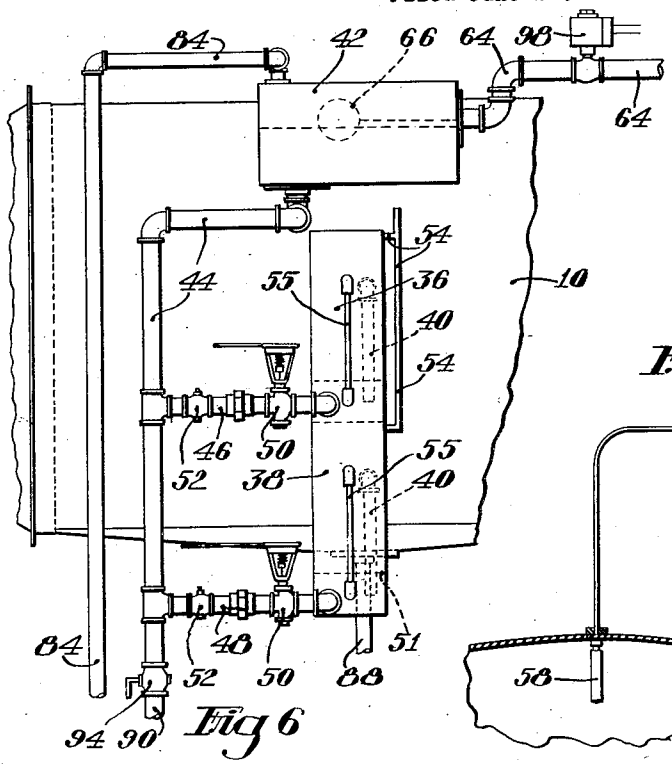


Fig. 4

Fig 6

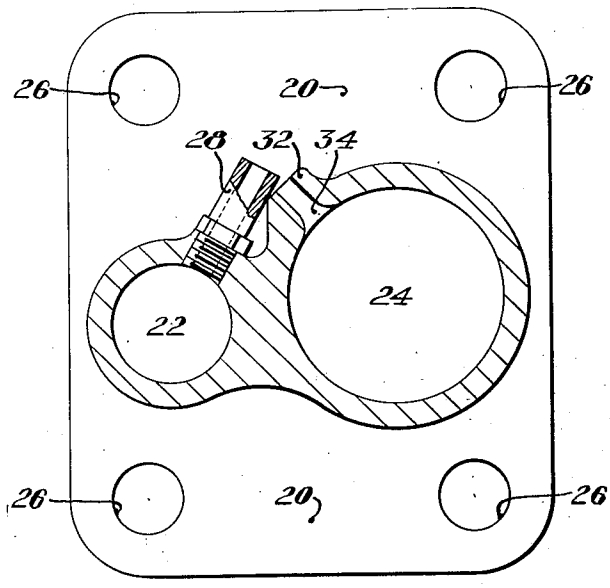
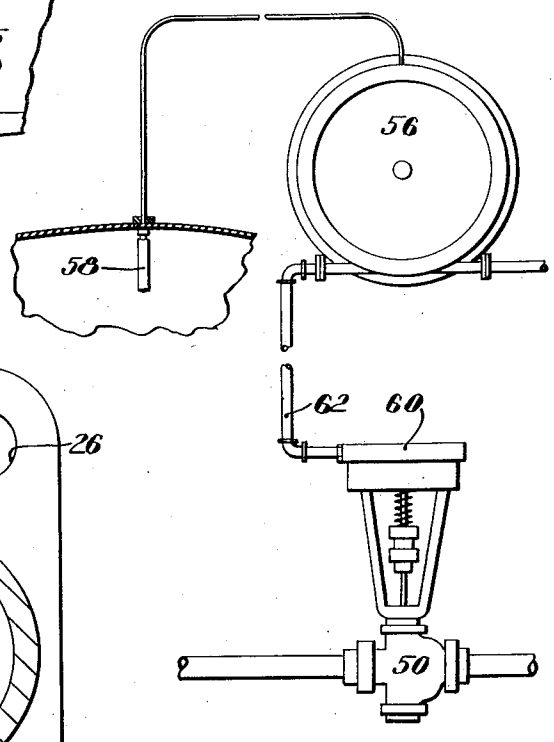


Fig 5



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Patented Nov. 22, 1932 1,888,844

UNITED STATES PATENT OFFICE

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AIR CONDITIONING APPARATUS

Application filed June 24, 1929. Serial No. 373,414.

The present invention relates to air conditioning apparatus of the general type commonly known as air washers employed for changing the moisture content and temperature conditions of atmospheric air, at the same time removing the dust and other impurities.

A primary object of the present invention is to provide a novel and improved air conditioning apparatus which will be more compact and efficient than apparatus of this description previously developed, will be more economical in the amount of water consumed, and will permit of a more efficient use of the power required both to supply the requisite amount of compressed air for the operation of the apparatus and to return the waste water in the system to active use.

A further object of the invention is to provide an air conditioning apparatus of this description adapted for use as a complete unit which will be more fully automatic in operation than apparatus previously developed and will require less attention by the operator both in starting the unit and shutting it down.

The several features of invention herein disclosed as embodied in an air conditioning apparatus consist in certain devices and arrangements of parts which are particularly adapted for use with the spraying or atomizing mechanism disclosed in the inventor's pending application Serial No. 323,951, filed December 5, 1928, for injecting finely divided particles of water vapor into a current of air. A spraying device of this description, as more fully set forth in the above-mentioned application, comprises a water tube across the end of which a blast of air is directed to draw water out of the tube and break it up into the small particles required for the humidifying process. An adjustment of the volume of spray produced with a consequent control of the degree of saturation of the conditioned air is readily secured by varying the head of water in the water tube which will in turn determine the rate at which water is drawn out of the tube in the vacuum formed by the air blast. As more fully pointed out in the application above referred to, a very finely divided spray is produced which is almost wholly taken up by the passing current of air so that there is very little waste water to be taken care of.

One feature of the present invention consists in the provision in an air conditioning apparatus of this general description which includes a compressed air atomizing nozzle, of an air and water pump which is adapted to supply compressed air to the nozzles and will also act to return the waste water in the system to active circulation.

Other features of the invention consist in the devices, combinations, and arrangement of parts hereinafter described and claimed which, together with the advantages to be obtained thereby, will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings in which Fig. 1 is a view in side elevation of an air conditioning apparatus embodying the several features of the present invention; Fig. 2 is a detailed view of the automatic water shut-off valve showing the connection with the motor in a conventional manner; Fig. 3 is a view taken from the right of the apparatus shown in Fig. 1; Fig. 4 is a detailed view showing the water tanks and connections for maintaining the desired head of water in the water tube; Fig. 5 is a somewhat diagrammatic view of the automatic control mechanism for varying the level of the water in the water tanks to regulate the humidity of the conditioned air; and Fig. 6 is a detailed sectional view of one of the spraying units showing the relationship of the compressed air and water tube nozzles.

The air conditioning apparatus herein disclosed as embodying the several features of the present invention comprises the casing 10 which forms a part of the air duct through which the atmospheric air is caused to flow in the direction of the arrow in Fig. 1 by a suitable fan indicated at 12 which is driven from a motor 14. The casing includes one or more sets of spray devices indicated as two sets at 16 and 18, the former for promoting contact of water with the air in the lower part of the duct, and the latter with the air in the upper part.

Each of the sets 16 and 18 comprises a plurality of sections as shown in Fig. 3, and more fully described in the applicant's pending application above referred to. Each section has two flanges 20 on opposite ends which are connected by a water pipe 22 and compressed air pipe 24, the flanges and the two pipes of each section being cast integrally, as shown in Fig. 6. The sections are bolted together through bolt holes 26 in the flanges and as many sections may be used as are necessary to fill the width of the casing. When bolted together, the pipe sections 22 and 24 form respectively continuous water and air pipes extending completely across the casing.

A water tube or nozzle 28 is screwed into the middle of each water pipe section. Each compressed air section 24 is formed with an air nozzle 32 having a rounded inlet 34. The mouth of the water nozzle 28 terminates in the air blast delivered by the air nozzle 32. It will be seen that the current of air blowing with high velocity across the mouth of the water tube produces a vacuum which creates conditions of turbulent water flow in the tube, breaking up the water into minute particles, and causing them to be expelled as a fine mist into the chamber.

The connections for supplying water to the water tube 28 comprise two closed tanks 36 and 38 which are supported by the sides of the casing, each adapted to contain a supply of water maintained at a constant head with respect to the mouths of the spray devices. A downwardly extending pipe 40 connects the water pipe sections 22 of each set of nozzles with the water supply in the tank. These supply tanks 36 and 38 contain water which is maintained at a suitable level by means of a reservoir or feed tank 42 connected by a pipe 44 with horizontal branch pipes 46 and 48, each leading to one of the supply tanks and each including a regulating or throttling valve 50 and a check valve 52. The top of each tank is connected through the equalizing pipes 54 with the interior of the chamber 10. The purpose of this is to maintain the water in the supply tanks under the same pressure or vacuum as the chamber 10, so that variations in the pressure in the chamber will have no tendency to cause variations in the rate of discharge of the water from the water nozzles. The gage glasses 55 afford a convenient means for indicating visibly to the operator the head of the water for the nozzles, and to a somewhat rough degree, the humidity secured.

In operation, the water level in each of the supply tanks 36 and 38 is maintained at a definite value relative to the position of the mouth of the water tube 28. The amount of water which each nozzle supplies in the form of spray is dependent upon the head of the water in the supply tanks 36 and 38, and also upon the velocity of the compressed air which in the apparatus herein disclosed is held constant. The head of water on the nozzles as measured by the level in the tanks 36 and 38 may be varied over a wide range to give either a positive or a negative head to control the amount of spray formed by the blast of compressed air. In the drawings, a negative head is shown by the water line 51. After each setting of the throttle valve 50, the water in the tanks 36 and 38 will find a level which will represent an equilibrium between the rate at which water is being withdrawn by the action of the blast of compressed air under the head of water determined by the level in the tanks and the rate at which water is brought into the tanks from the reservoir 42 through the throttle valves 50. If, for instance, the valve 50 is opened wider to permit a freer flow of water into the tanks, the level will tend to rise increasing the head (or diminishing the negative head) to the nozzles 28 and thus greatly increasing the rate at which the water is drawn out by the blast of compressed air. The water in the tanks will rise in the tanks until a level is reached which will represent a new equilibrium between the ingo and out-go of water from the tanks.

One feature of the present invention contemplates the provision of means for automatically controlling the operation of the throttle valves 50 to vary the volume of spray to secure a predetermined degree of moisture in the conditioned air. To this end, a humidity recorder-controller is provided which may be of any well-known construction as indicated at 56, and is provided with a tube or member 58 which is placed in the outlet through which the conditioned air flows and is sensitive to the amount of moisture in the conditioned air. In order to adjust the throttle valves 50 in accordance with the reading of the humidity controller, compressed air valves 60 are connected to the throttle valves 50 and are controlled from the humidity controller 56 through a compressed air line 62, as shown in Fig. 5, supplied from the pump or otherwise.

In order to secure a satisfactory automatic control of the operation of the apparatus herein disclosed, it has been found necessary to insure a sluggish action of the automatic humidity controller to vary the level of water in the tanks 36 and 38 and so to prevent any wide oscillations in the amount of moisture injected into the current of air. With the present construction, the desired result is obtained by supplying water to the valves 50 at a low pressure from the reservoir 42 so that comparatively wide changes in the setting of the valves 50 by the automatic humidity controller will produce only slight variations in the flow of water into the tanks.

Water is supplied to the valves 50 at low head from the reservoir 42 which is maintained at all times at a predetermined level

to insure a sufficient supply of water in the system by means of a water inlet pipe 64 which is provided with an inlet valve controlled by a float 66. Since with the construction shown in Figs. 1, 3 and 4 of the drawings, the supply tanks 36 and 38 are on different levels, corresponding adjustments must be made in the valves 50 to compensate for the difference in the head of water from the reservoir 42 at these valves.

Another feature of the present invention consists in the provision of a compact and efficient pumping unit for maintaining a supply of compressed air during the operation of the apparatus and for returning the excess water used in the spray into circulation. This unit comprises an air and water pump such as that indicated at 68 in Figs. 1 and 3 of the drawings, which is of a well-known construction, being of the type illustrated in Letters Patent to I. C. Jennings No. 1,297,692 dated March 18, 1919. This pump is mounted on a foundation 70 and is driven directly from the three-phase, constant speed motor 72. In a pump of this description, water is utilized as a seal for the air compressor to prevent leakage of air around the ends of the blades. The air intake for the pump is indicated at 74 and the water inlet at 76. Air and water are forced out of the pump through a pipe 78 to a separating chamber 80 for separating the water from the compressed air. The compressed air is carried directly from the separating chamber 80 to the compressed air nozzles on the air pipes 24 by means of a connecting pipe 82 which enters the upper portion of the chamber 80. A water pipe connection 84 is provided through which the excess water in the chamber is returned to the reservoir 42 under the pressure maintained in the chamber 80 by the operation of the pump.

It will be seen that the reservoir 42 is thus made to perform two useful functions, first, in providing a low pressure head to the valves 50 to insure a satisfactory action of the valves to change gradually the amount of the inflow of water into the tanks 36 and 38; and secondly, in providing a way to return the excess water from the spray to the system with the expenditure of a minimum amount of power from the air and water pump. Since a relatively low pressure of compressed air is sufficient for the proper operation of the spray nozzles, it is required only to maintain a sufficient air pressure in the separating chamber 80 to lift the water contained therein to the level of the reservoir 42. Where this elevation is less than seven feet, an air pressure as low as three pounds per square inch may be employed.

Water is supplied to operate the pump by means of a drainage tank 86 which is mounted directly above the pump and is connected to the water inlet pipe 76. With the construction herein disclosed, the excess water which is collected in the mixing chamber 10 is permitted to flow out through a drain 88 into the drainage tank 86 so that this water is permitted to pass through the pump and is again transferred through the pipe 84 to the reservoir 42 to circulate again through the system. In order to insure an adequate supply of water to operate the pump, a pipe connection is provided from the reservoir 42 to the drainage tank 86 which comprises an extension 90 of the pipe 44 which enters the bottom of the drainage tank 86 and is provided with an inlet valve controlled by a float 92 to maintain a constant level of water at all times in the tank 86. A manually operated shut-off valve 94 is provided in the pipe 90.

Inasmuch as the amount of water required to operate the pump remains constant under operating conditions, a throttle valve 96 is provided in the inlet pipe 76 to the pump and acts in conjunction with the constant head of water provided from the drainage tank 86 to insure an even flow of water into the pump. A final adjustment of the throttle valve 96 is made upon installing the apparatus.

In the operation of air conditioning apparatus of the type herein described, it is necessary when the apparatus is stopped to shut off the water supply to prevent flooding of the pump with a consequent delay and inconvenience in starting the apparatus again. Another feature of the present invention contemplates the provision of automatic means for controlling the water supply which comprises an automatic shut-off valve 98 which is provided in the inlet pipe 64 for the water supply. In order to prevent all the water in the reservoir 42 and in the drainage tank 86 from draining into and flooding the pump when the apparatus is shut down, a second automatic shut-off valve 100 is placed in the inlet pipe 76 for the pump.

A device for automatically operating the shut-off valves is conventionally illustrated in Fig. 2 and comprises a solenoid for each valve as indicated at 102 which is magnetized to hold the valve open while the motor 72 is running, by connections across two of the phases 104 of the motor. When the motor switch 106 is thrown to the open position shown in Fig. 2, the solenoid connected with each valve is de-magnetized, allowing the valves to close, shutting off the water supply. A similar action occurs upon failure of the power, thus automatically preventing the flooding of the apparatus.

With the present construction and arrangement of the parts, an air chamber in which the air is forced upwardly in a vertical direction through the spray may be utilized to advantage. In air conditioning apparatus as heretofore developed, it has been found impractical to force the air vertically upward through a spray because of the difficulty in taking care of the comparatively large vol-

ume of waste water from the spray nozzles. With the compressed air atomizing nozzles utilized in carrying out the present invention, the amount of water which is not taken up by the current of air and tends to drain to the bottom of the chamber is reduced to such an extent that comparatively little difficulty is experienced in preventing moisture from passing down the air ducts. The advantages of a vertical chamber consist in the more compact form of the apparatus and also in the fact that where a number of sets of spray nozzles are utilized, these will be situated at the same level so that only one pressure tank is required to maintain the proper head of water for each of the nozzles.

While the present invention has been illustrated and described as embodied in a particular form of invention, it is to be understood that the invention is not limited to such construction but may be embodied in other forms and arrangements.

The invention having been thus described, what is claimed is:

1. Air conditioning apparatus comprising a chamber through which the air being conditioned flows, a water tube, a tank for supplying water to the tube, means for atomizing the water as it leaves the tube, an indicator mechanism for determining the humidity of the conditioned air, and mechanism for controlling automatically the level of the water in the tank to maintain a predetermined degree of humidification of the conditioned air.

2. Air conditioning apparatus comprising a chamber, a water tube in the chamber, means for directing a blast of air across the mouth of the water tube, means for maintaining a head of water with respect to the mouth of the water tube, and means for automatically varying the head independently of the air blast for regulating the volume of spray.

3. Air conditioning apparatus comprising a chamber, a water tube in the chamber, means for directing a blast of air across the mouth of the water tube, means for maintaining a head of water with respect to the mouth of the water tube, an indicator for measuring the humidity of the conditioned air, and means controlled by said indicator for varying the head independently of the air blast for regulating the volume of spray.

4. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a water tube in the chamber, a compressed air nozzle for blowing a blast of air across the mouth of the tube, means for supplying water to the water tube including a reservoir and a water inlet to the reservoir controlled to maintain the reservoir at a constant level, a drain in the chamber to collect the excess water in the conditioning process, a combination air and water pump, air connections from the pump to the compressed air nozzle, water connections from the pump to return the water in the drain to the reservoir, and connections for supplying water from the reservoir to the pump.

5. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the current of air, means for supplying water to the nozzle, and a combination air and water pump, connections for delivering the waste water to the pump for cooling and sealing, and connections for supplying compressed air to the nozzle.

6. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, means for supplying water to the nozzle, and a combined rotary air and water pump for supplying compressed air to the nozzle, the pump compressing the air in contact with water and delivering the water to the nozzle supply.

7. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a compressed air atomizing nozzle, means for supplying water to the nozzle including a reservoir and a water inlet to the reservoir controlled to maintain the reservoir at a constant level, an air and water pump for supplying compressed air to the nozzle, and connections for delivering the waste water to the pump to seal and cool the same and for returning the waste water to the reservoir.

8. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, means for supplying water to the nozzle, a drainage tank for collecting waste water from the nozzle, a water inlet for the drainage tank controlled to maintain the tank at a constant level, an air and water pump, connections including a throttle valve from the drainage tank to the pump, connections from the pump to the compressed air nozzle, and connections from the pump for returning water discharged therefrom to the nozzle.

9. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a water tube in the chamber, a compressed air nozzle for directing a blast of air across the mouth of the tube, means for supplying water to the tube including a water tank connected with the tube, a reservoir, connections from the reservoir to the water tank including a throttle valve to regulate the level of the water in the tank with relation to the mouth of the water tube, a water inlet to the reservoir controlled to maintain the reservoir at a constant level, an air and water pump to provide compressed air for the apparatus and to return excess water to

the reservoir, a motor for operating the pump, and means rendered operative upon stopping the motor to shut off the water inlet to the reservoir.

10. Air conditioning apparatus comprising a chamber, a water tube in the chamber, a compressed air nozzle for blowing a blast of air across the mouth of the tube, means for maintaining a head of water with respect to the mouth of the water tube, a reservoir for supplying water to the water tube, a water inlet to the reservoir controlled to maintain the reservoir at a constant level, an air and water pump, connections from the pump to the compressed air nozzle, a drainage tank placed above the pump to receive the excess water used in the conditioning process, a pipe connection from the reservoir to the drainage tank, an inlet valve for said connection to maintain the water level in the drainage tank constant, connections including a throttle valve from the drainage tank to the pump, and a pipe connection from the pump to the reservoir.

11. Air conditioning apparatus comprising a chamber, a water tube in the chamber, a compressed air nozzle for blowing a blast of air across the mouth of the tube, means for supplying water to the water tube including a water tank connected to the tube, a reservoir situated above the tank, pipe connections from the reservoir to the tank, a throttle valve in said connections for regulating the flow of water from the reservoir and so to regulate the water level in the tank with relation to the mouth of the water tube, an air and water pump, connections for supplying water to the pump including a drainage tank and a throttle valve, a drain for draining the excess water used in the conditioning process into the drainage tank, connections from the reservoir to the drainage tank including an inlet valve to maintain a predetermined water level in the drainage tank, water supply connections for the reservoir including an inlet valve to maintain a predetermined water level in the reservoir, pipe connections from the pump to the reservoir, and connections from the pump to the compressed air nozzle.

12. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, an air and water pump for supplying compressed air to the nozzle, a water supply for the nozzle, means for supplying water to the pump, and devices for automatically cutting off the water supply for the nozzle and the pump when the pump is thrown out of operation.

13. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, an air and water pump for supplying compressed air to the nozzle, a water supply for the pump, and devices for automatically turning on and cutting off the water supply for the pump when the pump is thrown into and out of operation, respectively.

14. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, a pump for supplying compressed air to the nozzle, a water supply for the nozzle, an electrically controlled cut-off valve for the said water supply, an electric motor for driving the pump, an electric circuit for the motor, and a motor switch, the valve being located in the motor circuit whereby the valve is controlled by the motor switch.

15. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, a main supply tank, means for maintaining a constant head of water in the tank, an auxiliary tank for the nozzle, and means controlled by the humidity of the conditioned air for regulating the rate of flow from the main to the auxiliary tank to vary the level in the latter.

16. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle, an air and water pump, a constant speed motor for driving the pump, and means for supplying water to the pump at a constant rate including a drain for conveying waste water from the nozzle to the pump, and connections for supplying additional water from the supply to furnish the required amount of water for the pump.

17. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle, a pump, means independent of the pump for supplying water for the nozzle and means independent of the nozzle for supplying water for the pump, and means for maintaining constant heads of water for the nozzle and for the pump respectively.

18. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle, a pump, a source of water supply, connections from the water supply to the nozzle, connections for conveying waste water from the nozzle to the pump, connections for supplying water from the supply directly to the pump, and return connections for returning water from the pump to the supply.

19. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle, an air and water pump for supplying

compressed air to the nozzle, connections for conveying waste water from the nozzle to the pump, and connections from the water supply to supplement the waste water from the nozzle to maintain a uniform flow to the pump.

20. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, a water supply for the nozzle, an air and water pump for supplying a constant flow of air to the nozzle and a constant flow of water circulating through the pump and returned to the supply.

21. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, an air and water pump for supplying a constant flow of air to the nozzle, a water supply for the nozzle, means for conveying waste water from the nozzle to the pump, and means for varying the water supply to the nozzle while maintaining constant the flow of water to the pump.

22. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle, an air pump, a water supply for the nozzle, a throttle valve for the water supply, pneumatic means for actuating said valve, and connections between the pump and said means.

23. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, means for producing a finely divided water spray in the air current, an air compressor for supplying air to said means, connections for supplying water to the pump to absorb the heat of compression, and connections for delivering such water to the spray means.

24. Air conditioning apparatus comprising a chamber through which the air to be conditioned flows, a water tube, a compressed air nozzle for blowing a blast of air across the mouth of the tube, means for supplying water to the water tube including a water tank connected with the tube, and means for regulating the level of the water in the tank to vary the head with respect to the mouth of the water tube and so to control the volume of spray, said means comprising a supply reservoir at an appreciably higher level than the tank and connections situated to supply water to the tank at low pressure, and a throttle valve to restrict the flow of water to the tank.

25. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, a water supply for the nozzle, a pump for supplying compressed air to the nozzle, and devices for simultaneously cutting off the water supply and throwing the pump out of operation.

26. Air conditioning apparatus comprising a chamber through which air to be conditioned flows, a compressed air atomizing nozzle for producing a finely divided spray in the air current, a water supply for the nozzle, a pump for supplying compressed air to the nozzle, and commonly controlled devices for cutting off the water supply and throwing the pump out of operation.

In testimony whereof I have signed my name to this specification.

SAMUEL M. ANDERSON.