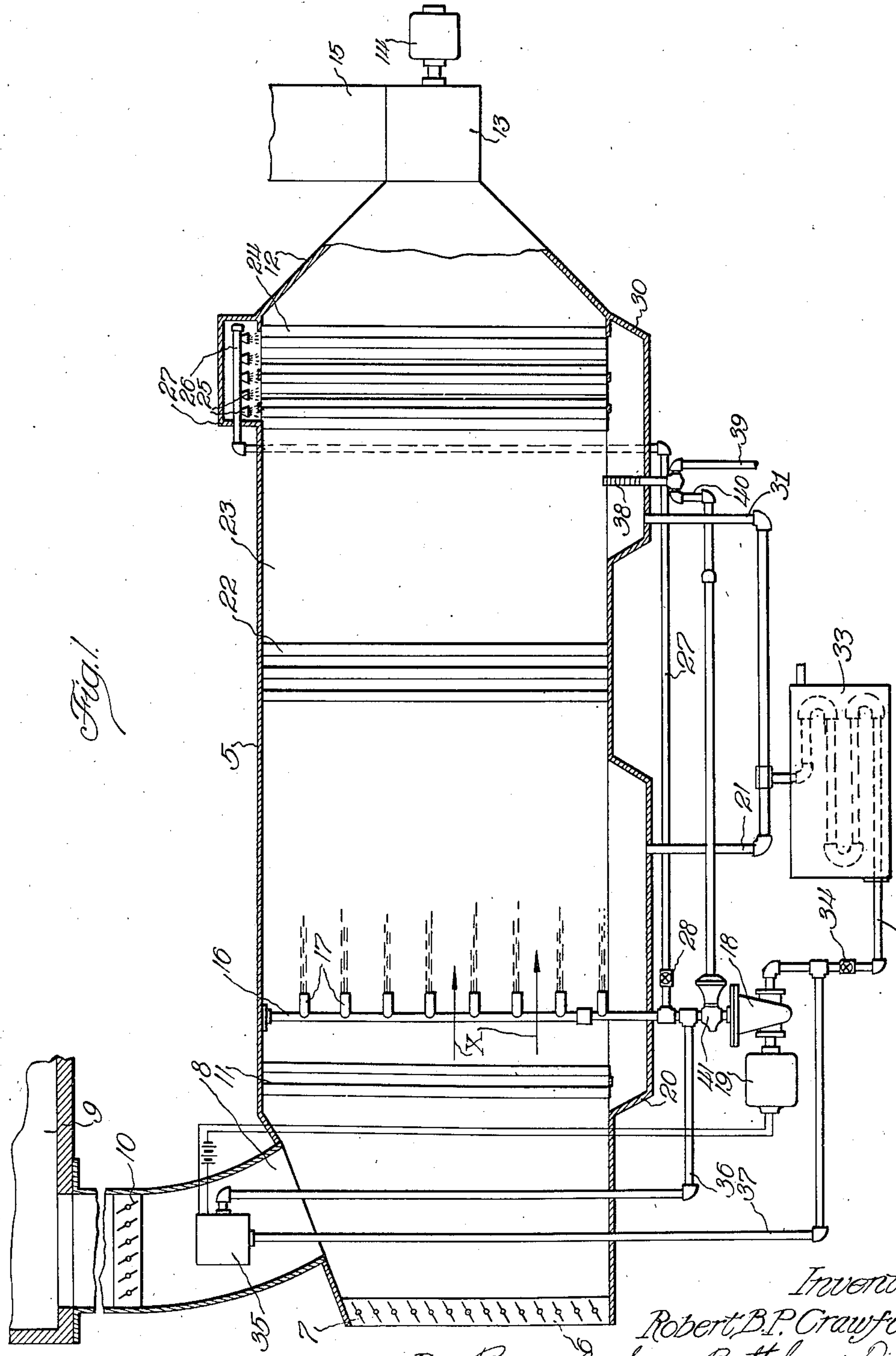
March 8, 1938. R. B. P. CRAWFORD 2,110,203

AIR CONDITIONING SYSTEM

Filed April 7, 1932 6 Sheets-Sheet 1



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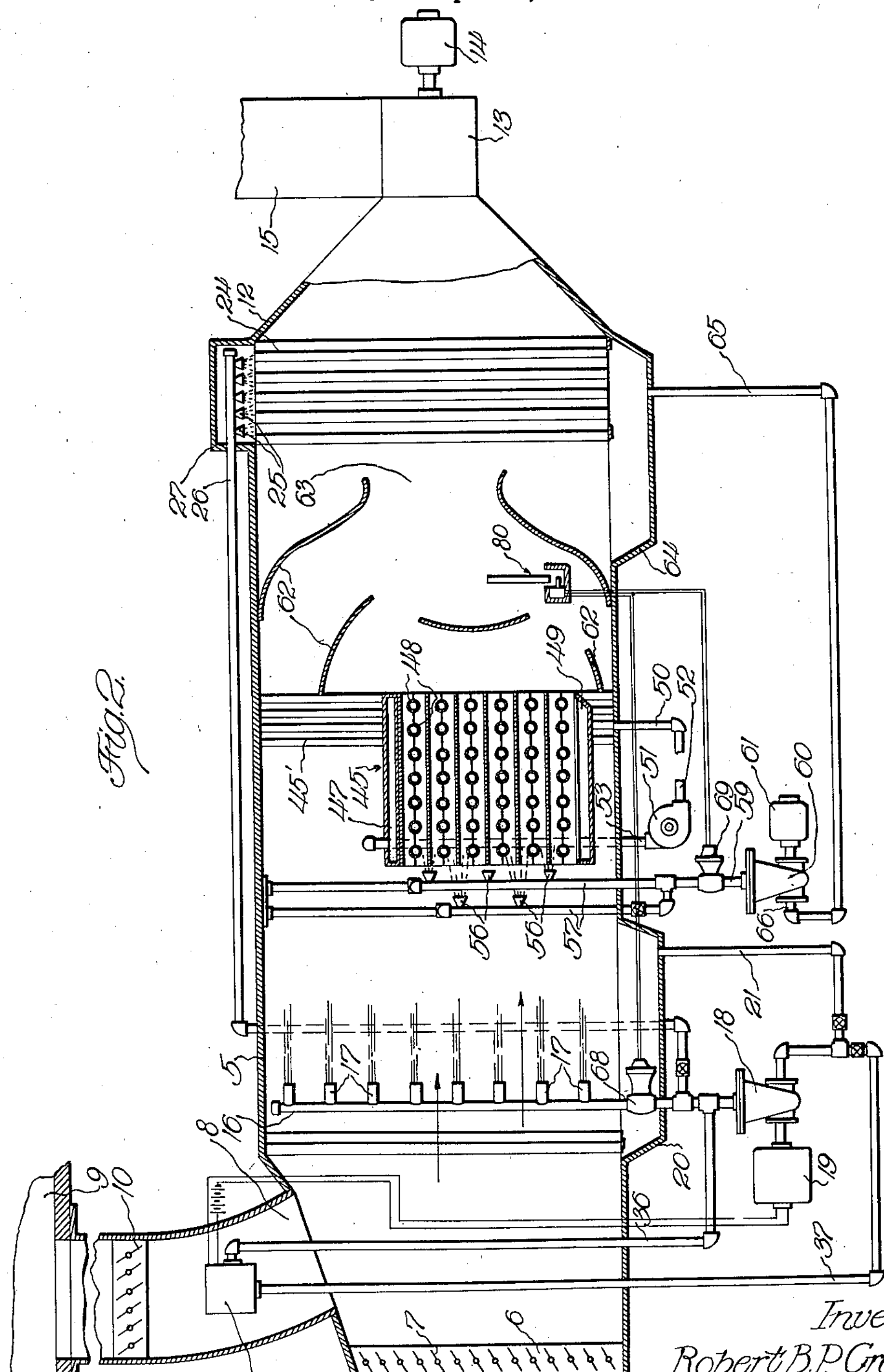
AIR CONDITIONING SYSTEM

Filed April 7, 1932 6 Sheets-Sheet 2



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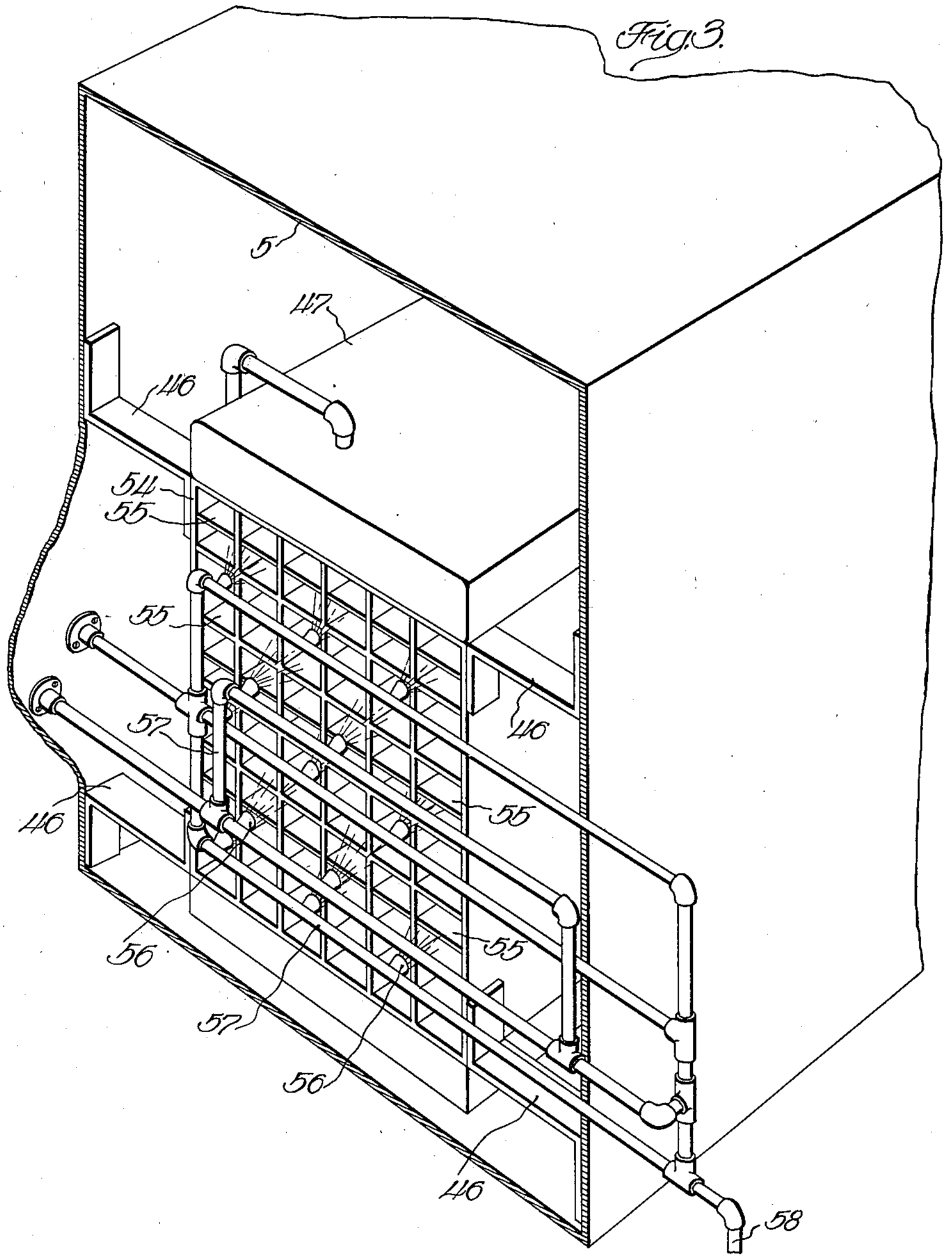
AIR CONDITIONING SYSTEM

Filed April 7, 1932 6 Sheets-Sheet 3



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AIR CONDITIONING SYSTEM

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Fig. 4.

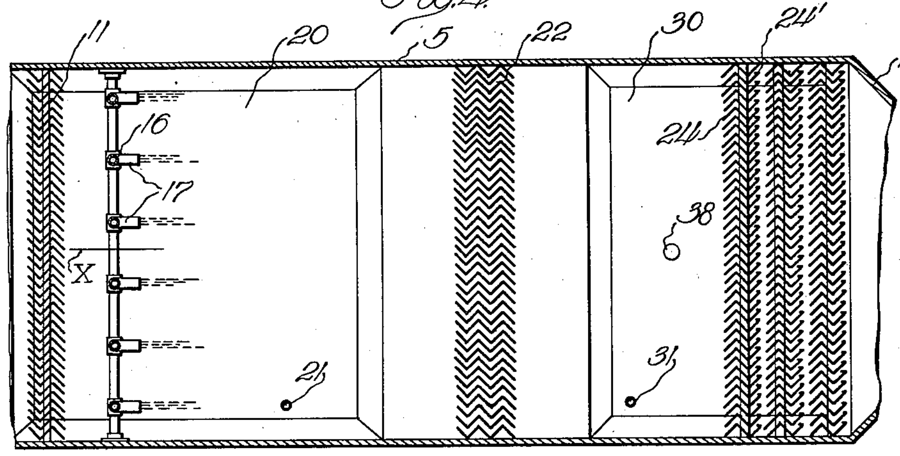


Fig. 6.

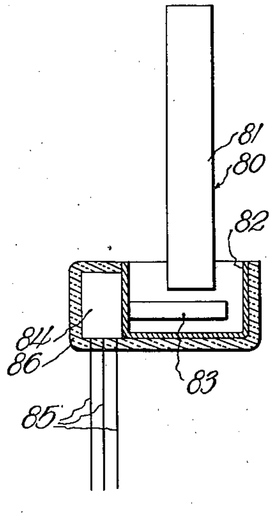
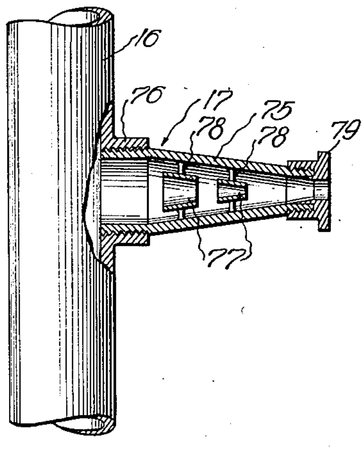


Fig. 5.



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AIR CONDITIONING SYSTEM

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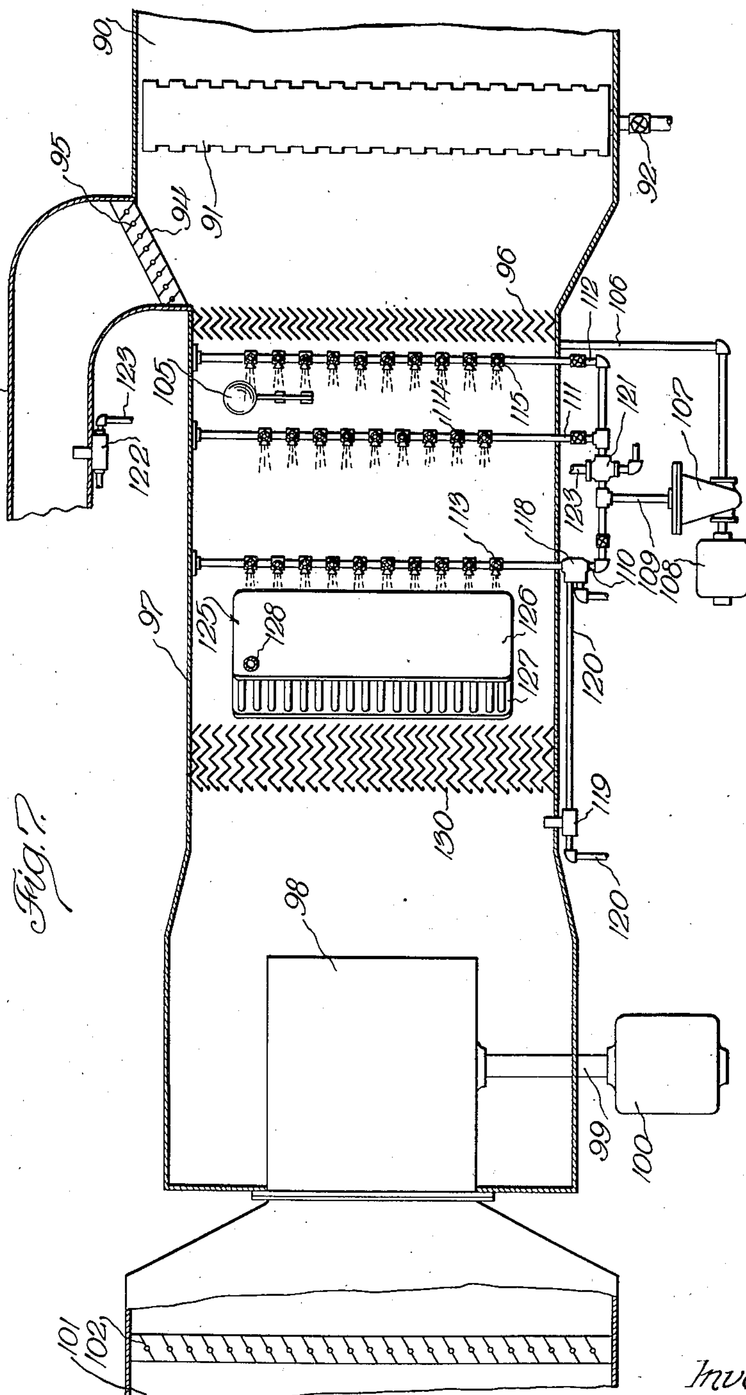

Fig. 7.

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AIR CONDITIONING SYSTEM

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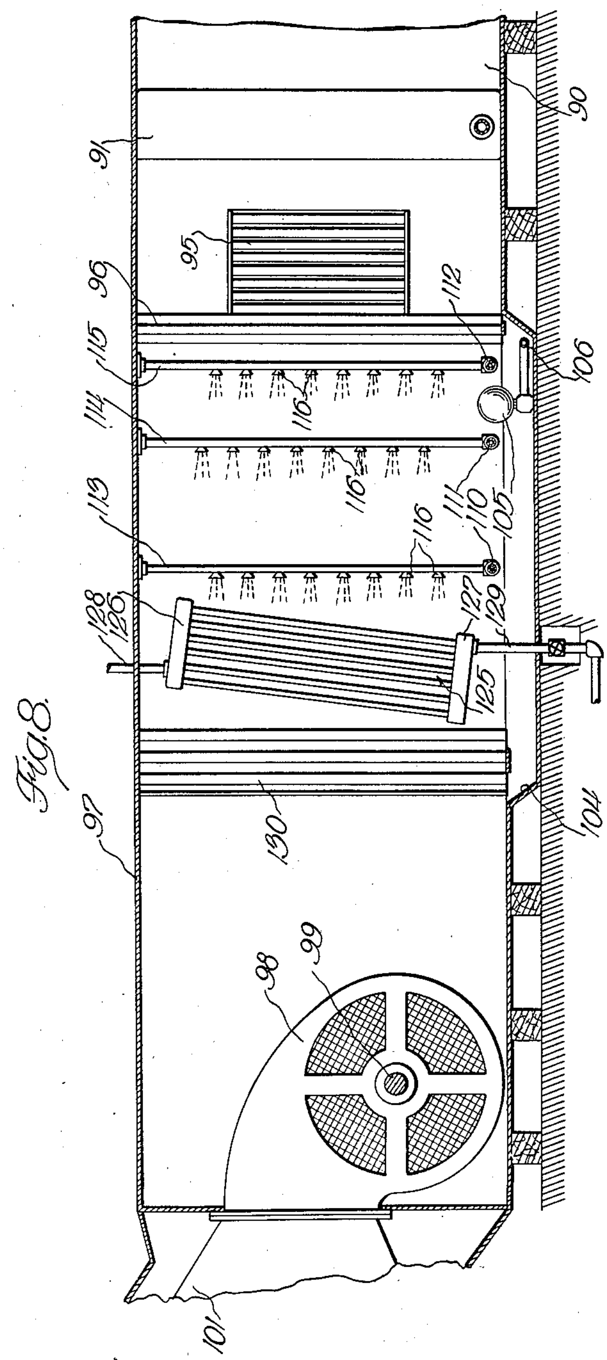

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Patented Mar. 8, 1938

2,110,203

UNITED STATES PATENT OFFICE

2,110,203

AIR CONDITIONING SYSTEM

Robert B. P. Crawford, Brooklyn, N. Y., assignor, by mesne assignments, to Auditorium Conditioning Corporation, Jersey City, N. J.

Application April 7, 1932, Serial No. 603,711

11 Claims. (Cl. 261—26)

This invention relates to air conditioning systems and more particularly to air conditioning systems in which controlling the spray is one of the regulating factors of the system.

This application is a continuation, in part, of my copending application, Serial No. 375,952, filed July 5, 1929, and is directed specifically to controlling the spray of water in the dehumidifying chamber.

In such systems, it is well known that the air, to be properly conditioned, must be unsaturated, and this unsaturated condition is ordinarily obtained by either condensing out the water vapor contained in the air stream, or by absorbing this water vapor through the use of a dehydrating agent. It has been customary, in air conditioning systems, drying systems, and similar apparatus, to dehumidify the air by passing it over refrigerating coils placed in the path of the air stream before it enters the delivery duct. This method necessarily requires the use of a refrigerating system, including coils, compressors, motors, and associated apparatus, in addition to the provision of sluicing water for defrosting and removing the water condensed out of the air that is being conditioned. Also, the use of such refrigerating means, under cool weather conditions, will still further decrease the temperature of the incoming fresh air, and will necessitate the provision of some suitable type of heating means for bringing the air up to the proper temperature desired in the system.

In the preferred embodiment of my invention, I disclose a method of conditioning air in which the dehumidification is accomplished without the use of refrigerating systems or dehydrating solutions.

According to my invention, I first form a mixture of fresh and return air, the proportions of which may be either manually or automatically controlled, and pass this mixture through a spaced set of directional spray nozzles. This forms an air stream having certain portions thereof with a relatively high dewpoint temperature and other portions with a relatively low dry bulb temperature. Intimate commingling of this air stream results in the formation of a fine mist or fog, due to the condensation of moisture from that portion of the stream having a relatively high dewpoint temperature. The air stream is then passed through proper eliminator baffles to remove the fog, or condensation, and the conditioned air is passed to the delivery system. Such a method of dehumidifying the air provides a mixture having a higher dry bulb temperature and a lower dewpoint temperature than is obtainable by simply mixing the two air streams. The lower dewpoint temperature means that the unsaturation in the air mixture has been increased, without the use of refrigeration or dehydration.

The method described above may be carried out in several different ways, and I have illustrated in the accompanying drawings several types of apparatus which may be employed for this purpose. It is to be understood, however, that the method is not restricted to the particular type of apparatus disclosed, but may be utilized in any apparatus which is capable of intimately mixing the two portions of the air stream for producing the fog or mist.

In one embodiment of my invention, I pass the air stream through the conditioning unit in such a manner that a small portion of the air stream is directly contacted by a cold spray of water. The major portion of the air stream has a relatively high dewpoint, whereas the portion contacting the spray of cold water has a relatively low dry bulb temperature. These two streams are brought into intimate contact with each other by a series of baffles which provide a very thorough mixing of the two streams. The cold particles or portion of the mixture, in contacting with the major portion of the air which is at a relatively high dewpoint, will cause the vapor carried by this portion of the air to be condensed, forming a fine fog or mist. All of the fog or mist is then removed, and the conditioned dehumidified air is passed to the delivery duct.

In the other modification, the air stream is first passed through a set of sprays, and a restricted portion thereof is then additionally passed over a set of cold water coils or refrigerating coils for the purpose of producing in that portion of the air a low dry bulb temperature. This portion of the air, having the low dry bulb temperature, is then mixed by means of a plurality of baffles, with the major portion of the air, which possesses a relatively high dewpoint. The condensation is removed in the same manner as described above, and the air is then led to the delivery duct.

In connection with these systems, I provide suitable control devices for regulating the quantity of water supplied to the spray nozzles, and for also regulating this quantity in accordance with the temperature produced in the mixing chamber. The temperature of the water used in the spray is preferably regulated in conjunction with the size of the individual particles of water that are discharged by the spray, the surface area of these drops determining to a large extent the condition produced in the air passing through the spray chamber. The area of these drops can be controlled, as disclosed, by the pressure of the spray water, by the size of the jets, or in any other suitable manner. In addition, I contemplate the provision of a suitable humidistat responsive to the humidity in the return air stream for controlling the quantity of spray water. It is to be understood, however, that any suitable control means may be employed for the purpose of regulating the amount of water, and also the temperature thereof, which is supplied to the conditioning unit.

Other features and advantages will appear more fully from the following detailed description, which, taken in connection with the accompanying drawings, will disclose to those skilled in the art the particular construction and mode of operation of a preferred embodiment of my invention.

In the drawings:

Figure 1 is a sectional view of a conditioning unit, showing a simplified method of producing the mist or condensation desired;

Figure 2 is a modified form of device for accomplishing the same result;

Figure 3 is a perspective sectional view showing in detail the apparatus used for producing the low dry bulb temperature in a restricted portion of the air stream;

Figure 4 is a sectional plan of the conditioning unit shown in Figure 1;

Figure 5 is a detail sectional view of one of the directional spray nozzles;

Figure 6 is a detail sectional view of the fog sensing device shown in Figure 2;

Figure 7 is a plan view of a modified form of conditioning system; and

Figure 8 is a side elevation of the system shown in Figure 7.

Referring now in more detail to Figure 1, I have disclosed the air conditioning unit which is indicated generally by the reference numeral 5. This unit comprises the fresh air inlet 6, which is controlled by means of suitable dampers or louvres 7, and the return air inlet 8, through which the return air from the room 9 is admitted by means of the dampers or louvres 10.

Suitable baffles 11 are provided for the purpose of mixing the return and the unconditioned fresh air before it is admitted to the main portion of the air conditioning unit 5. It is to be understood that suitable control means, operable either by humidity or temperature control, may be utilized for regulating the relative proportions of fresh and return air admitted into the conditioning unit, this control being effected through the operation of the dampers 7 and 10.

The other end of the conditioning unit is provided with the tapered portion 12, leading to a suitable blower housed in the end thereof, as indicated by the numeral 13, which blower is operated by means of an electric motor 14 or the like. From here the air is conducted through the delivery duct 15 to the room 9, or to any suitable elevator shaft, or the like for the purpose of delivering the conditioned air to the ventilating system of the building.

Disposed within the conditioning unit 5 are a plurality of pipes 16, which extend practically throughout the cross-section of the conditioning unit, and are provided with the directional spray nozzles 17, these nozzles 17 being disposed at certain definite intervals along the pipes 16. As shown in Figure 5, each of these nozzles 17 comprise the body portion 75, which is threaded into a suitable nipple 76 secured to pipe 16. A plurality of directional cones 77 are concentrically mounted in the body portion 75 of the nozzle, as by means of the spider members 78. The outer end of the body portion 75 has threaded thereto a tip member 79, which is provided for the purpose of assuring that no outward flaring of the discharge will occur.

The pipes 16 are connected to a suitable pump 18 which is driven from an electrical motor 19 or similar device. A sump 20 is provided in the lower portion of the conditioning unit 5, and is adapted to collect the water discharged from the nozzles 17.

Posterior to the spray nozzles 17 and extending practically throughout the entire cross-section of the conditioning unit 5, I have provided a plurality of irregularly shaped baffles indicated at 22, these baffles being so disposed as to effect a thorough mixing of the air passing therethrough. The air passing through the baffles 22 is intimately mixed in the mixing chamber 23, and from the mixing chamber is conducted past the eliminator baffles 24 to the tapered portion 12 of the conditioning unit, from which it is delivered to the delivery duct 15.

I have provided a sluicing spray, comprising the spray nozzles 25 carried by the spray pipe 26 and disposed within the projecting portion 27 of the conditioning unit 5. The pipe 26 is connected through the pipe 27 to the outlet side of the pump 18, and a suitable valve 28 is provided for the purpose of controlling the quantity of water discharged by the nozzles 25.

This water sluices down over the baffles 24 and is collected in a suitable sump 30 disposed below the baffles. A drain pipe 31 is connected at the lower portion of the sump 30 for the purpose of draining away the water collected therein. The water from the sumps 20 and 30 is conducted into a cooling chamber 33 by means of drain pipes 21 and 31. In this chamber, a constant flow of refrigerant around the coils serves to impart to the return water flowing therethrough, a predetermined temperature. From the cooling chamber 33, the cooled water is conducted through pipes 32 to the inlet side of pump 18, a suitable valve 34 being provided to control the flow through the return pipe. The chamber 33 is maintained at any desired predetermined temperature by providing continuous flow of a suitable refrigerant therethrough, which absorbs heat from the return water circulating through the coils disposed in this chamber.

Disposed within the return air conduit, and preferably near the inlet 8 thereof which leads to the conditioning unit, I provide a suitable humidity controlling device, such as a humidistat, indicated by the reference numeral 35. As an example of this type of device, reference may be had to the diffostat disclosed in the copending application of Otto A. Labus and myself, Serial No. 319,764, filed November 16, 1928. This device may be connected in the circulating system of the pump 18, having the inlet pipe 36 leading thereto from the outlet side of the pump 18, and being provided with the return pipe 37 leading to the inlet side of the pump. The device 35 may operate through the influence of the humidity in the air returning from the room 9, or may be of such character as to be controlled by the difference between the wet and dry bulb temperatures of the air, or by the difference between the dry bulb temperature and dewpoint temperature of the return air. Suitable electrical means are actuated by the device **35**, for varying the speed of the motor **19** in accordance with the sensings of the control device.

Disposed within the sump **30** is a suitable thermally responsive device **38**, which is connected through the inlet pipe **39** and outlet pipe **40**, with a suitable source of fluid pressure, such as compressed air. This device **38** is adapted to respond to the temperatures existing within the mixing chamber **23** for the purpose of controlling the flow of water to the spray pipes **16**, by regulating the pressure diaphragm valve indicated at **41**. This valve may be of any suitable type, and the entire control system may be varied, to accommodate it to different types of systems, but, in general, the system includes a temperature responsive device adapted to control the rate of flow to the spray nozzles.

In the operation of this system, suitable proportions of fresh and return air are admitted to the air conditioning unit **5**. These portions are first intimately mixed by means of the baffles **11** and are then forced through the main portion of the unit, certain portions of the air stream coming into intimate contact with the spray of water directed out of the directional spray nozzles **17**. However, these nozzles are so arranged that a considerable part of the air passes therebetween, as indicated by the arrows X, and only a small portion has its dry bulb temperature lowered by contact with the cold water being sprayed therefrom. The remainder of the air stream has a relatively high dewpoint with respect to the low dry bulb temperature of the contacted portion, and these two streams of air pass through the baffles **22** and are intimately mixed in the chamber **23**, the cold portions of the stream, upon coming into contact with the relatively high dewpoint temperature existing in the major portion of the stream, causes condensation in the unsprayed portion of the air and the formation of a fine mist or fog in this chamber. The fog or mist settles to the bottom and is collected in the sump **30**, and the air stream is conducted past the baffles **24**, where any entrained fog or mist particles are removed, and the water discharged from the flushing spray nozzles **25** effectively causes this fog or mist to be forced downwardly into the sump **30**. The conditioned dehumidified air is then passed through the blower **13** to the delivery duct **15**. The superficial area of the flushing water is maintained at a low value so that the condition of the air passing is not materially changed thereby.

The fundamental differences between this type of spray control for dehumidification purposes and former types are as follows:

Firstly, in the present device the temperature of the water discharged from the directional nozzles **17** must be kept constant. Further, two portions of the air stream are formed, one having a relatively low dry bulb temperature relative the high dewpoint temperature of the other. These two portions are so intimately commingled by the use of baffles that fog will form. The supplementary eliminators are of such a design that the fine fog will be entirely eliminated before the conditioned air reaches the delivery duct.

In the ordinary type of throttled spray air washer the refrigeration does not stay constant because as the contact with the water becomes less the refrigeration load becomes less. The present system avoids this by having the system capable of handling the maximum refrigeration load with the maximum unsaturation and with the coarsest spray. The use of intermediate baffles of such design as to provide intimate contact between the two portions of the air stream and the provision of a relatively large chamber for the fog to form in are features of the present invention that provide for an efficient and positive dehumidification. As I have pointed out, I find that such a method of spray control produces a higher dry bulb temperature in the mixed air, this temperature being higher, and the dewpoint of the air being lower than is possible by a simple mixing of the two streams.

The fog produced by the intimate mixing of the two air streams is such that it cannot be removed by any of the standard eliminators that are now on the market. The eliminators used must be of a type having close centers, at least of the character of one inch, and having a large number of short breaks, at least one every two inches in an eliminator occupying a width of 24 inches in the conditioning unit.

As shown in Figure 4, the eliminators **24** have angularly disposed edge portions or tips **24'** which are provided to catch any fog or condensate contained in the air passing therethrough. This assures that the air passing to the delivery duct will have all of its entrained moisture or condensate removed.

If it is desired to produce more unsaturation in the system, the spray is throttled and the air stream which comes in contact with the water spray from the directional jets **17** becomes much colder and of less quantity with respect to the whole portion of the air. This colder stream will produce a lower dewpoint in the mixture after the fog has been removed because the colder temperature thereof causes more condensation. Likewise, the greater quantity of condensation and the greater percentage of the major portion of the air stream having a high dewpoint when it entered the system, will result in the conditioned air having a higher dry bulb temperature. The wet bulb temperature of the air remains constant throughout the entire conditioning operation, since the refrigeration load is kept constant. This throttling of the spray may be controlled by either the temperature in the condensation of mixing chamber **23**, or by the humidistat or control device positioned in the path of the return air being led to the conditioning unit. For instance, if the control device or thermostat **38** is subjected to a temperature higher than that desired, it will operate to produce an increased flow to the spray nozzles **17**, which will result in less condensation, and therefore a lower dry bulb temperature of the air passing to the delivery duct **15**, since a greater proportion of the air will be subjected to the water discharged from the nozzles, and will thus have its dry bulb temperature lowered. If, on the other hand, the control device **38** is subjected to a temperature lower than that for which it is set, it will function to throttle the flow of water to the nozzles **17**, and thus a greater proportion of the air stream will not be contacted by the water discharged therefrom, and the condensation formed in the mixing chamber **23** will be at a lower temperature, resulting in the conditioned air having a higher dry bulb temperature as it is delivered to the duct **15**, but having a lower dewpoint than would be the case if the device **38** was subjected to a temperature higher than that for which it is set.

Similarly, if the humidity in the return air is such that it is desirable to supply a drier air to the room, the control device 35 will function to throttle or slow down the motor 19, thus throttling the discharge of water from the nozzle 17, which will result in a colder temperature existing in that portion of the air stream being contacted, but a relatively smaller quantity of the air stream will be so contacted, and the dry bulb temperature of the final conditioned air will be increased, but the dewpoint will be lowered considerably.

Thus it is apparent that the water discharged from the nozzles 17 may be so throttled as to give a final condition of air wherein the air will have a high dry bulb temperature at a relatively low dewpoint, or a lower dry bulb temperature at a higher dewpoint. The control devices may be regulated so as to give any desired condition of air in the system.

Considering now in more detail the embodiment disclosed in Figure 2, the system in general is the same, and the same reference numerals will apply to those parts which have not been changed. It is to be understood that the cooling chamber 33 of Figure 1 may be applied to the embodiment of Figure 2 in order to maintain the spray water projected through the nozzle 17 at a constant predetermined temperature.

In this embodiment, I have disclosed, in addition to the structure shown in Figure 1, a set of refrigerating coils, indicated in their entirety by the reference numeral 45. This refrigerating unit 45 comprises the box-like structure shown in detail in Figure 3, which is supported in the path of the air stream by means of suitable brackets 46 which are secured to the side walls of the unit 5. These brackets 46 are adapted to support the unit 45 in such position that it will be interposed in the path of the air stream, the unit 45 being of such size as to affect only a portion of the total air stream.

This unit comprises the header 47, the set of coils 48, and the lower collecting chamber 49, which is suitably connected through the pipe 50 to the return section of a refrigerating system. A suitable pump 51 is provided which has its inlet side 52 connected to the refrigerating system, and which has the outlet connection 53 to the header 47 for supplying the refrigerating fluid to the coils 48. The coils 48 are supported in a suitable housing or case indicated at 54, which has the lateral partitions 55 adapted to be joined to the respective coils of pipe 48 and positioned between these coils of pipe for the purpose of providing an extended refrigerating surface over which the air will pass.

Disposed in front of the unit 45 are a plurality of spray nozzles 56, which are adapted to direct streams of slucing water over the coils to remove the condensed vapor formed thereon. These spray nozzles are carried by the pipes 57, which are supported in position within the unit 5 and which have their inlet side 58 connected to the outlet side 59 of a pump 60. The pump 60 is driven by a suitable electrical motor or similar power device 61.

Positioned posterior to the unit 45, and placed in the path of the air stream are suitable baffles 45′, which are adapted to intimately commingle the relatively large portion of the air stream which does not pass through the unit 45, and the relatively small portion which passes therethrough. If desired, additional curved baffle members 62 may be provided for mixing said stream more intimately, and for causing said stream to pass adjacent to and in contact with a fog temperature sensing device 80, shown more in detail in Figure 6.

This devi e comprises a set of vertically extending baffles 81, which have their lower ends received in a receptacle 82, adapted to receive condensate dripping from the baffles 81. In the receptacle 82 I provide a thermal sensitive member 83, which is connected to a suitable control box 84 for varying the current passing through the conductors 85, in accordance with variations in the temperature of the liquid in the receptacle 82. The entire unit is enclosed by a suitable insulating cover 86.

The mixing chamber is indicated by the numeral 63, in which mixing chamber a fine fog or mist is produced by the contact between the relatively small portion of the air stream which has a relatively low dry bulb temperature, and the major portion of the air stream which has a relatively high dewpoint temperature with respect to the other portion of the stream. This fog or mist collects in the sump 64, and is conducted by means of the drain 65, to the inlet side 66 of the pump 60. The eliminators 24 are provided for the purpose of removing the mist or fog from the conditioned air stream, and have the spray nozzles 25 positioned thereabove for discharging sluicing water down over these eliminators. The conditioned air is then led through the blower 13 to the delivery duct 15.

The humidity responsive device 35, or a similar control device, positioned in the return air inlet to the conditioning unit, is adapted to control the speed of the motor 19 for controlling the quantity of spray water discharged by the nozzle 17, this control being such that the final condition of the air can be controlled thereby. This control is similar to the control effected by the control device 35 described in connection with the embodiment disclosed in Figure 1. The control 80 is adapted to control the flow of water both to the directional spray nozzles 17 and to the spray pipes 57. As shown, if the temperature of the fog or mist reaches a certain preselected minimum temperature, the control will function to operate the electrically controlled diaphragm valve 68 to throttle the spray discharged from the jets 17. If the temperature continues to lower, the device operates the valve 69 to throttle the flow to the spray pipes 57. As the temperature increases, these valves are successively opened to allow full flow therethrough.

As pointed out in connection with the embodiment disclosed in Figure 1, the operation of the system is such that the spray discharge from the nozzle 17 may be throttled in accordance with the conditions existing in the return air from the room 9, this spray being throttled down to produce an air having a relatively high dry bulb temperature and a relatively low dewpoint, or being increased to provide air having a low dry bulb temperature and a higher dewpoint. The member 80 is adapted to control the portion of the air passing through the unit 45 in order to produce greater or lesser condensation in the fog or mixing chamber 63, and thus to control the temperature existing in the conditioned air.

Referring now in detail to Figures 7 and 8, I have disclosed a modified form of air conditioning system, in which the temperature and humidity of the air is controlled through the use of a plurality of spray pipes, the spray discharged therefrom being regulated by both temperature and humidity controlling devices. The fresh air inlet to this system is indicated by the reference numeral 90, and the air passing through the inlet comes into contact with the tempering coil or radiator 91, which is supplied with a heating medium through the valve 92.

A recirculation duct 93 is adapted to open into the main fresh air inlet duct at 94, the relative portions of the two air streams being controlled by means of the louvres or dampers 95. A set of baffles 96 are positioned in the open end of the main air conditioning duct 97, and serve to provide an intimate commingling of the recirculated air and the fresh air, and the mixed air is delivered as a homogeneous stream into the conditioning duct 97.

The duct 97 is provided with a blower fan 98 positioned at its opposite end, the fan 98 being actuated through shaft 99 coupled to the motor 100. The fan draws air from the conditioning duct 97 and forces it into the circulating duct 101, the quantity of air being controlled by means of the dampers 102.

Considering now in detail the duct 97, it will be noted from Figure 8 that the duct is provided with a sump 104, having a float valve 105 controlling a suitable outlet 106. The outlet 106 leads to the suction side of a pump 107, which is operated by motor 108. The outlet of the pump 107 is connected through pipe 109 to the conduits 110, 111 and 112, leading to the three sections of spray pipes 113, 114 and 115.

Suitable valves are provided between the connection 109 and the spray connections 110, 111 and 112, in order to shut off flow thereto, as desired. Each of the spray sections 113, 114 and 115 comprises a plurality of vertically extending pipes, provided with a plurality of spray nozzles, or discharge jets 116. As shown, these jets are positioned to discharge in the direction of motion of the stream of air, but, if desired, the jets may be turned to discharge against the stream of air. The spray section 113 is provided with a diaphragm or other suitable type of control valve 118, which control valve is regulated by means of the temperature sensitive control indicated at 119. This temperature sensitive control extends within the duct 97, and is adapted to regulate the flow of pressure through a suitable pressure line 120 to control the valve 118, thus regulating the quantity of water admitted to the last spray section 113.

Similarly, the spray sections 114 and 115 are controlled through a control valve 121, which is actuated by means of a suitable humidity testing device 122 positioned in the recirculation duct 93. This humidity testing device may be of the relay type, for controlling the flow of pressure through a pressure line 123 leading to the control valve 121.

Positioned adjacent the first spray section 113, is a cooling or refrigerating coil 125. The coil 125 is positioned, as shown in Figure 8, at an angle with respect to the duct 97, and, in a preferred embodiment, is provided with a plurality of laterally extending fin sections for providing intimate contact between the individual coils of the refrigerating unit and the water sprayed from the jets 116 carried by the spray section 113. The coil is provided with upper and lower headers 126 and 127 respectively, the header 126 having an inlet 128 leading to, and an outlet 129 leading from the header 127.

The temperature of the coolant circulating in the coils 125 may be accurately maintained at any desired value, and this temperature is transmitted to the spray water discharged in the duct by the contact of the spray water upon the cooling coils, and therefore the temperature of the spray water passing through the spray sections 113, 114 and 115 may be accurately controlled within any desired value.

Thus it is apparent that both the size of the individual spray particles discharged from the spray section, and also the temperature of the particles, may be controlled, the size of the particles being controlled by the pressure controlled valves 118 and 121, responsive to the temperature of the conditioned air and the humidity of the recirculated air, respectively, and the temperature being controlled by controlling the temperature existing in the cooling coils 125.

Disposed posterior to the cooling coils 125, and extending the full width of the air duct 27, is a set of eliminator baffles indicated at 130, these baffles being of the same type as the baffles 24 shown in Figure 1. In this system, the mixed recirculated air and fresh air passes through the spray chamber, and is subjected to the discharge from the jets 116 carried by the spray sections 113, 114 and 115.

Since the temperature of the water discharged from the jets, and also the superficial area of the drops or particles, can be controlled, it is obvious that portions of the air will be cooled to a temperature such that moisture is condensed therefrom, while other portions of the air will be cooled to a lesser extent, depending upon the quantity of air which receives the spray. However, the total cooling effect will be insufficient to bring the average air stream temperature down to the saturation value, and the degree of the humidification obtained in this chamber may be controlled by varying the pressure for regulating the quantity of water passing through the spray section, which, in turn, varies the surface area of the liquid particles being discharged into the air stream, and thus controls the relative proportions of air which are cooled below the condensation temperature and which are cooled to a lesser extent. The conditioned air, after passing the coil 125, passes through the baffles 130, where all entrained moisture is removed, and from there passes through the fan 98 to the delivery duct 101.

If desired, the spray jets 116 provided in the spraying section 113 may be so proportioned as to provide coarser particles of water than the spray discharged from the jets of sections 114 and 115. The coarser spray will result in a lesser quantity of air being subjected to the spraying action, but the portion of air that is thus subjected will be cooled to a lower temperature. The throttling of the spray in the spraying sections 113, 114 and 115 by the humidity control in the recirculated air duct, and the temperature control in the conditioned air duct, determines the final condition of air passing through the system. For example, a relatively coarse spray, with but a small portion of the air stream being so contacted by the spray, will result in a relatively high temperature in the final conditioned air, with a relatively low humidity. On the other hand, a relatively fine spray, which contacts the major portion of the air stream, will result in a final condition of air having a low temperature with reference to the humidity thereof. Thus, by properly proportioning the various controls, both as to the temperature of the spray and the size of the discharge, the final condition of the air can be properly determined and maintained.

Wherever the term "psychrometric condition" is used in the appended claims, it is intended that a temperature and/or humidity condition be defined.

Thus it is apparent that this controlled throttling of the spray is effective to determine the final condition of air which it is desired to maintain, and that the conditioning system may be so regulated as to produce any desired condition in the air.

I do not intend to be limited to the exact details shown and described in connection with the accompanying drawings, but only insofar as defined by the scope and spirit of the appended claims.

I claim:

1. The method of conditioning air which comprises forming a mixture of fresh and return air, passing said mixture through a spray chamber, controlling the spray in said spray chamber in response to the humidity of said return air, said mixture after passing through said chamber comprising two portions, one having a high dewpoint temperature and the other having a low dry bulb temperature relative thereto, intimately mixing said two portions, controlling the relative proportions of said two portions in accordance with the temperature of said mixture, and passing said mixed air stream through an eliminator.

2. The method of conditioning air which comprises forming a mixture of fresh and return air, passing said mixture through a spray chamber, controlling the spray in said spray chamber in response to the humidity of said return air, passing a portion of said mixtue over sprayed refrigerating coils, intimately mixing all portions of said air stream in a mixing air chamber, sensing the temperature existing in said mixing chamber and controlling the sprayed refrigerating means in accordance therewith, and passing said mixed air stream through an eliminator.

3. A control of the class described comprising a fresh air inlet, a return air inlet, a spraying chamber, means for spraying a portion of the air passing through said chamber, humidity testing means disposed in said return air inlet for controlling said spraying means, secondary means for spraying a restricted portion of said air, means for intimately mixing said secondary sprayed portion, said sprayed portion and the unsprayed portion of said air to produce a fog, means for sensing the temperature of said mixture for controlling said secondary spraying means, and means for removing said fog.

4. In an air conditioning system, the method of dehumidifying air which comprises passing a stream of air through an unobstructed passageway, projecting individual spaced jets of water into said stream to contact a predetermined portion thereof, intimately mixing the sprayed and unsprayed portions of said stream posterior to said passageway, said sprayed portion condensing moisture out of said unsprayed portion to lower the dewpoint temperature thereof, controlling the pressure of the water projected in accordance with the humidity of a portion of the entering air, controlling the quantity of water projected in accordance with the temperature of the condensate, and removing the condensation before delivery of said air to said system.

5. In an air conditioning system, the method of dehumidifying air which comprises passing a stream of air through an unobstructed passageway, projecting individual spaced jets of water into said air stream to contact a predetermined portion thereof, intimately mixing said sprayed and unsprayed portions of said stream posterior to said passageway to condense moisture out of said unsprayed portion, and controlling the portion of air sprayed in accordance with the humidity of the entering air and the temperature of the condensate.

6. In an air conditioning system, the method of dehumidifying air which comprises passing a stream of air through an unobstructed passageway, projecting individual spaced jets of water into said air stream to contact a predetermined portion thereof, maintaining the temperature of said water constant, intimately mixing said sprayed and unsprayed portions of said stream posterior to said passageway to condense moisture out of the unsprayed portion, and controlling the portion of air sprayed in accordance with the humidity of the entering air and the temperature of the condensate.

7. In an air conditioning system, the method of dehumidifying air which comprises passing a mixture of fresh and return air through an unobstructed passage, treating one portion of said air in said passage to impart a low dry bulb temperature thereto, passing the remainder of said air through said passage at a high dewpoint temperature, intimately mixing said treated and untreated portions of said air posterior to said passage to condense moisture from said untreated portion by contact with said treated portion, and controlling the treating of said one portion in accordance with the humidity of said return air and the temperature of said condensate.

8. In an air conditioning system, a conditioning unit comprising an air inlet, a spray chamber, and a fog chamber, means for drawing a mixture of fresh and return air through said inlet into said spray chamber, a plurality of spaced directional spray nozzles disposed in said spray chamber, means for supplying water to said nozzles to spray only a predetermined portion of said air, means disposed between said spray chamber and said fog chamber for intimately mixing said sprayed and unsprayed portions of said air to form a fog, and means disposed in said fog chamber responsive to the temperature of said chamber coacting with humidity responsive means disposed adjacent said inlet for controlling the projected spray area.

9. In an air conditioning system, a conditioning unit comprising an air inlet, a spray chamber, and a fog chamber, means for drawing a mixture of fresh and return air through said inlet into said spray chamber, a plurality of spaced directional spray nozzles disposed in said spray chamber, means for supplying water to said nozzles to spray only a predetermined portion of said air, means for maintaining the water supplied to said nozzles at a predetermined temperature, means disposed between said spray chamber and said fog chamber for intimately mixing said sprayed and unsprayed portions of said air to form a fog, and means disposed in said fog chamber responsive to the temperature of said chamber coacting with humidity responsive means disposed adjacent said inlet for controlling the projected spray area.

10. An air conditioning system comprising a conditioning unit, a spray chamber in said unit, a plurality of spaced directional spray nozzles disposed in said chamber, means for projecting jets of water from said nozzles to contact a predetermined portion of the air passing through said chamber, heat transfer means disposed in said chamber, means for spraying said heat transfer means, a plurality of curved baffles at

the outlet end of said spray chamber for intimately mixing sprayed air, cooled air and unsprayed air to cause condensation of moisture from said air, baffle means for removing entrained condensation particles from said air, and thermally responsive means adjacent said curved baffles for successively controlling the size of the water particles projected from said nozzles and from said heat transfer spraying means in accordance with the temperature of said condensate.

11. The method of conditioning air comprising passing a stream of air through a water spray, controlling said spray in accordance with a psychrometric condition of said stream of air prior to its passage through said spray, passing a second stream of air through a water spray and then in psychrometric affecting relation with a tempering zone, mixing said streams of air and controlling said tempering zone in accordance with the psychrometric condition of said mixture.

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