

Dec. 24, 1940.

F. E. PERNOT ET AL

2,225,795

AIR CONDITIONING APPARATUS

Original Filed June 26, 1937

5 Sheets-Sheet 1

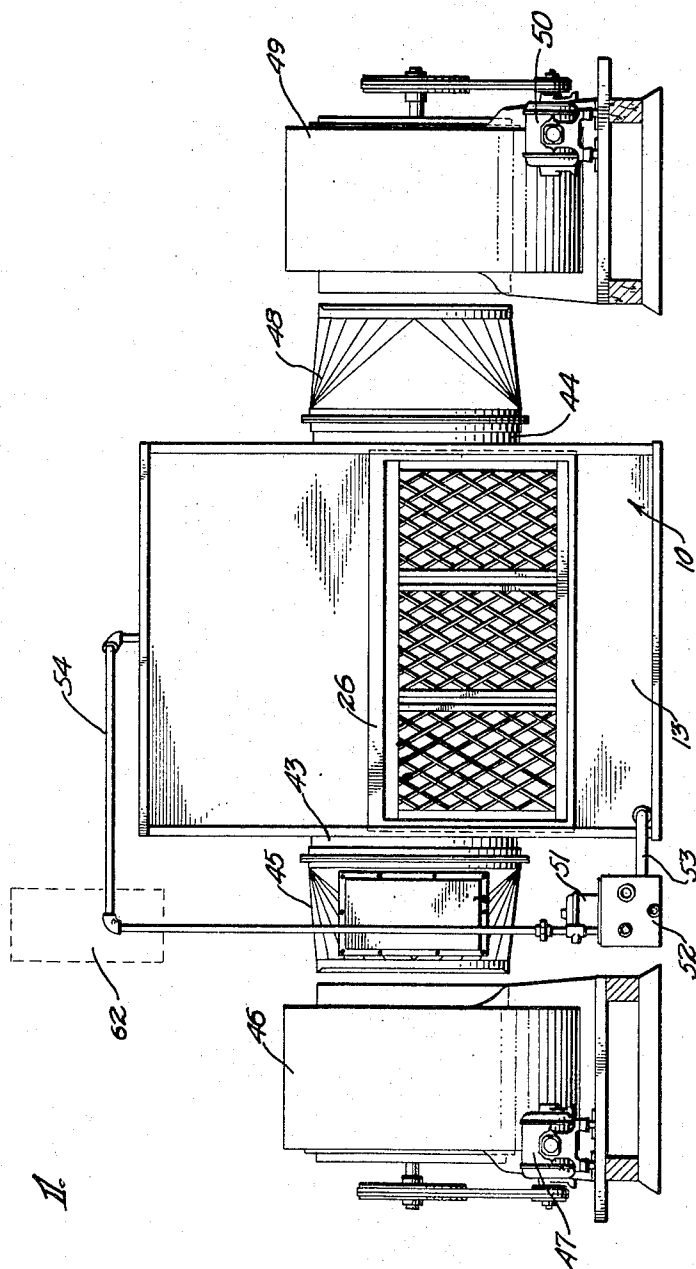


Fig. 1

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5 Sheets-Sheet 2

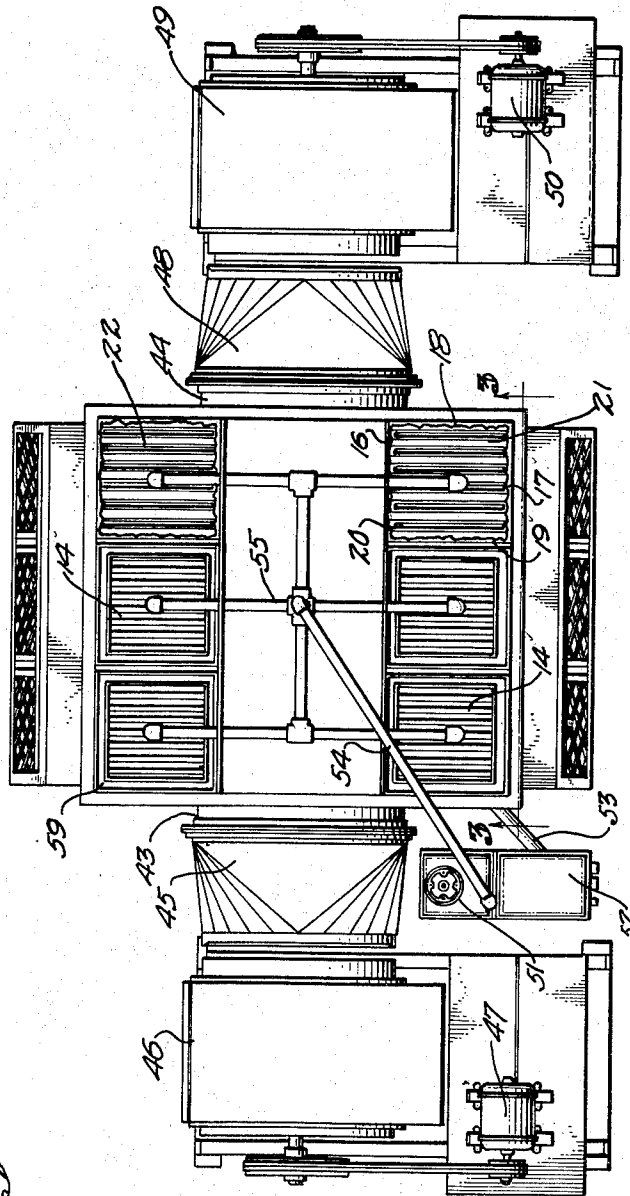


Fig. 2.

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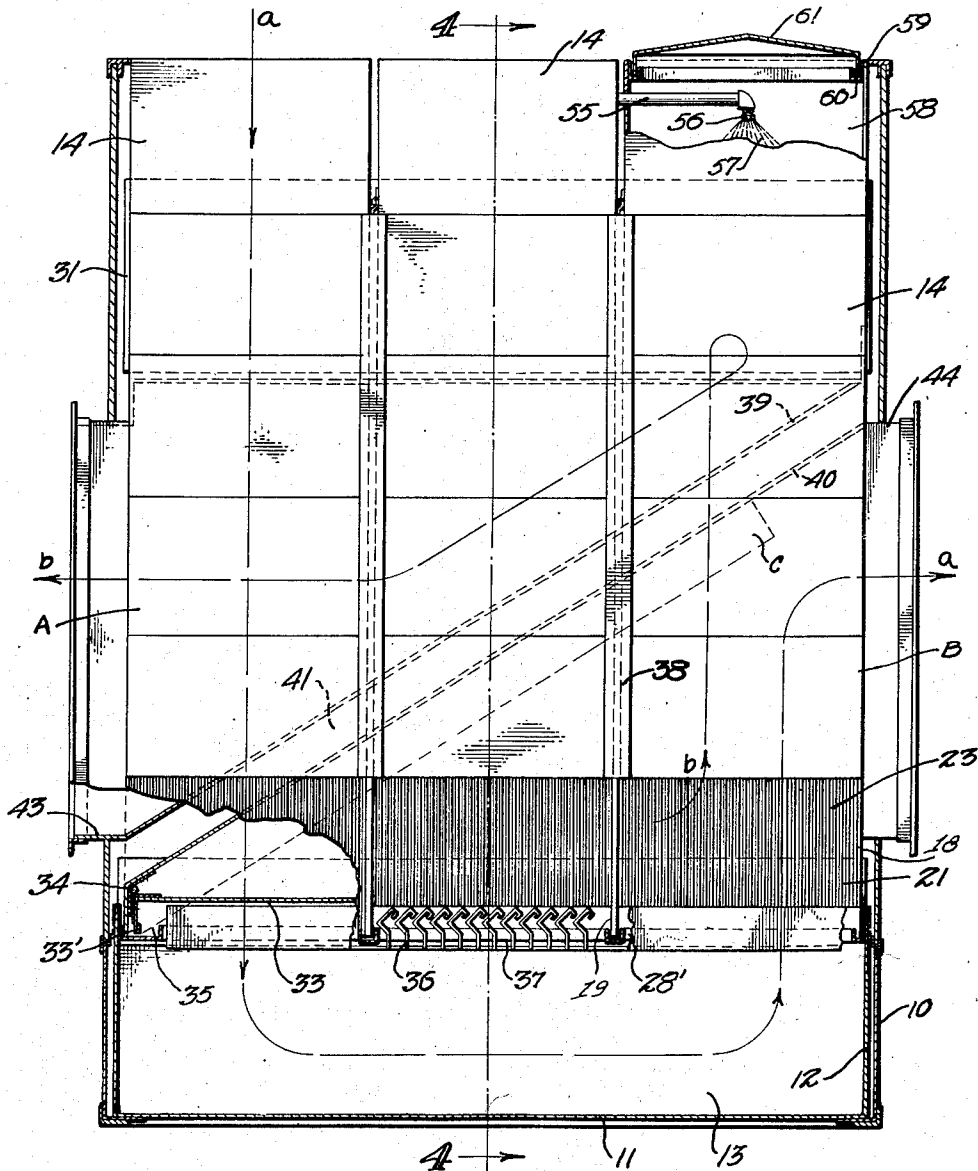
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Fig. 3.



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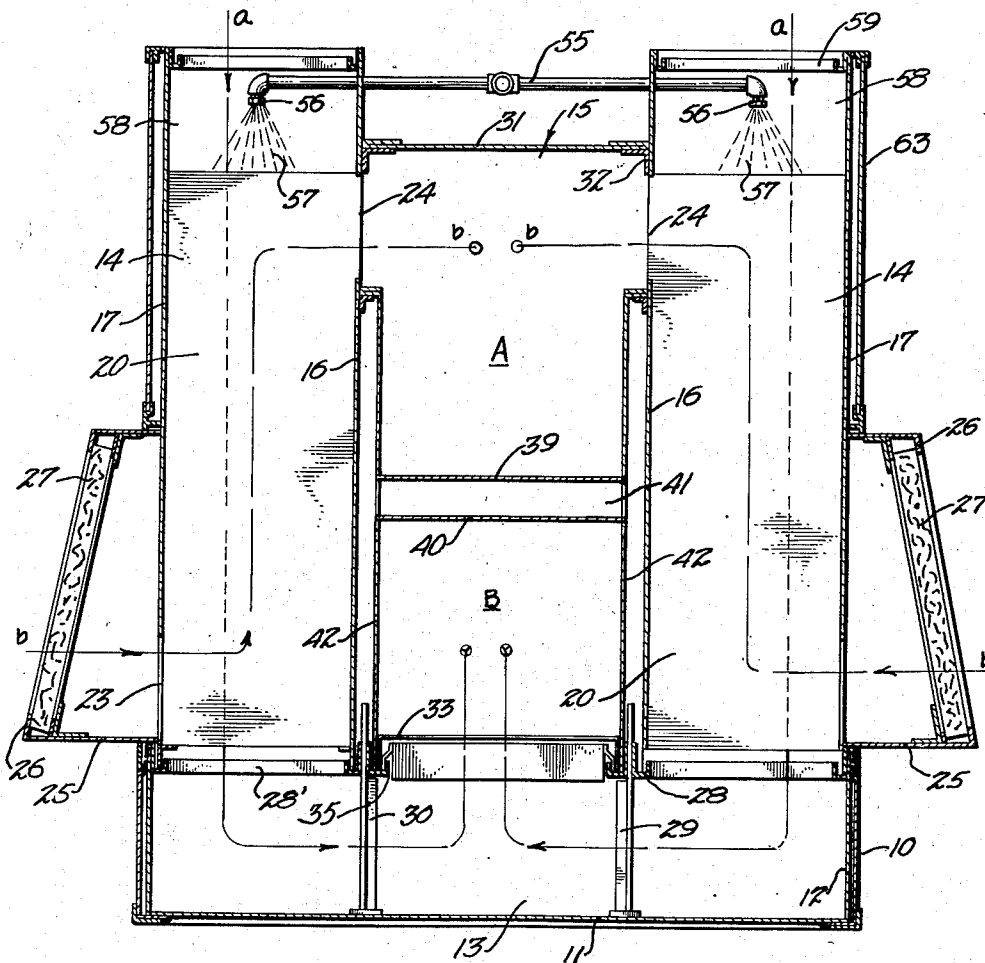
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Fig. 4



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5 Sheets-Sheet 5

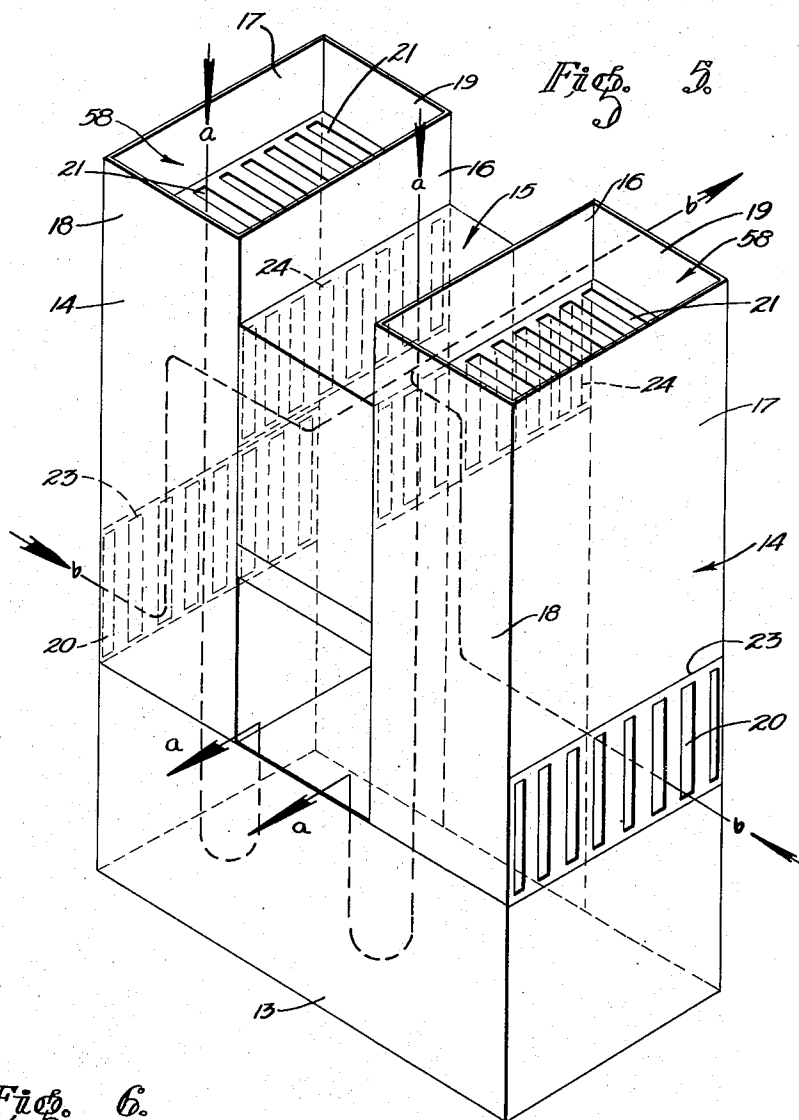
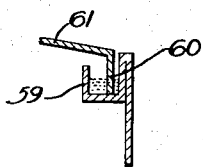


Fig. 6.



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AIR CONDITIONING APPARATUS

Frederick E. Pernot and Lester J. Rich,
Los Angeles, Calif.Application June 26, 1937, Serial No. 150,552
Renewed June 22, 1940

8 Claims. (Cl. 261-9)

This invention relates to means for changing the temperature of air, and particularly pertains to air conditioning apparatus.

At the present time considerable attention is being given to the problems of air treatment in buildings and dwellings, and particularly in connection with the control of temperature and humidity of air in winter and summer, so that the variable temperature range within a room or building will be relatively small and so that living conditions will be comfortable at all times, irrespective of temperature and weather conditions generally. It is the principal object of the present invention therefore to provide a compact air conditioning unit of selected capacity and which unit may be operated to reduce the temperature of air passing through it or may be optionally arranged to increase the temperature of the air passing through it.

The present invention contemplates the provision of heat exchange units through which air may pass and within which the air may be cooled by evaporation of moisture in a stream of air flowing through the unit to heat exchange relationship to the air being treated, the structure providing means whereby the temperature of the air being treated may be raised if desired.

The invention is illustrated by way of example in the accompanying drawings in which:

Figure 1 is a view in end elevation showing a structure embodying the principles of the present invention.

Fig. 2 is a view in plan showing the structure with parts broken away to disclose the arrangement of the heat exchange units.

Fig. 3 is a view in vertical section as seen on the line 3-3 of Fig. 2 showing the air flow arrangement.

Fig. 4 is a view in vertical section, as seen on the line 4-4 of Fig. 3 and as disclosing the paths of travel of the two air streams of the device.

Fig. 5 is an isometric drawing indicating the air flow through the structure in diagram.

Fig. 6 is an enlarged fragmentary view showing one of the liquid sealed joints of the apparatus.

Referring more particularly to the drawings 10 indicates a base structure which is formed with a bottom floor 11 of desired dimensions and connected with which, along the perimeter of the floor, are vertical side walls 12. These form a water sump 13 for a purpose to be hereinafter described. It is to be understood that the present invention contemplates variation in capacity of air conditioning apparatus by varying the number of heat exchange units 14 which are incorpo-

rated in the apparatus when manufactured. The heat exchange units are of the general construction shown in a co-pending application of Frederick E. Pernot, filed May 11, 1936, entitled improvements in Heat Interchangers, and bearing Serial No. 78,972. These exchangers are made in separate units and are supported upon the base structure 10 in a manner to be hereinafter set forth.

Referring more particularly to Fig. 4 of the drawings, it will be seen that the heat exchangers 14 are arranged in horizontally spaced relation to each other to form an intermediate compartment 15 to be hereinafter described, and by reference to Fig. 3 it will be seen that a plurality of these heat exchangers may be disposed in each of the rows occurring upon opposite sides of the intermediate compartment 15. The heat exchangers include vertical side walls 16 and 17 and vertical end walls 18 and 19. Interposed between the end walls 18 and 19 are vertical air ducts 20 which are spaced from each other to form intermediate passageways 21 as well as the air duct passageways 20. It is preferable that the air ducts 20 shall be defined at opposite sides by flat plates 22 which are parallel to the end walls 18 and 19. The air ducts 20 are closed at their sides by the side walls 16 and 17 with the exception of the fact that at the lower portion of the outer side walls 17 an opening 23 occurs and extends entirely across the wall sections 17. The innermost side walls 16 are formed with an opening 24 adjacent the upper edge which openings communicate with the upper end of the compartment 15. Thus in the spaces represented by the openings the passageways 21 which occur between the ducts 20 will be in communication with the exterior of the exchangers and as particularly shown in Fig. 4 of the drawings will communicate with an induction throat 25, one of which is disposed on each of the outer sides of the two rows of interchangers 14. Mounted over the opened mouth of each duct is a filter frame 26 carrying a suitable air filter material 27. The lower edges of the vertical walls 16 and 17 of all the heat exchanger units 14 rests in parallel channel-shaped troughs 28 which are disposed horizontally across the top of the base structure 10. These troughs also have portions 28' which extend transversely and receive the lower ends of the wall sections 18 and 19. Liquid accumulates in these troughs and forms an air seal so that no packing means is necessary between the base and the circumscribing walls of the several heat exchange units 14. Extending longitudinally of

the base structure and in spaced relation to each other between the rows of heat exchange units 14 are vertically disposed stiffening plates 29 and 30. Each one of these plates carries a trough 28 and when the heat exchange units are disposed therein cooperate with the wall sections 12 in supporting the units. The compartment 15 is formed by the opposed side walls 16 of the heat exchangers 14 and is provided at its top with a sealing plate 31 which is secured to the opposing walls 16 by angles 32 extending horizontally above the openings 24 in said walls. A vertically swinging floor 33 is pivoted upon a hinge 34 at an end of the compartment 15 and may be disposed horizontally over the central portion of the sump 13 to cover and seal the same, or at an upwardly swung position which will uncover the sump. Mounted around the marginal edge of the portion of the sump occurring between the stiffening plates 29 and 30 is a channel trough 35 which receives a downwardly extending marginal flange 33' occurring entirely around the rectangular perimeter of the floor section 33. Disposed in the space bounded by the trough 35 is a spray eliminator structure comprising a plurality of plates 36 spaced from each other horizontally to form sinuous vertical passageways 37 along which spray from the sump will be entrapped and condensed so that its heavy particles will not be carried by the air passing through the apparatus. The vertical edges of the sides 16 and 17 of the heat exchangers are sealed by vertical strips 38. Thus a rectangular compartment occurs between the two sets of heat exchangers 14. This compartment is divided diagonally by sloping wall members 39 and 40. These members as shown in Fig. 4 of the drawings are spaced apart and form an intermediate air space 41. Supplementary side walls 42 are interposed between the edges of the members 39 and 40 and the interchanger side walls 16. These accommodate the upwardly extending edges of the stiffening plates 29 and 30. By reference to Fig. 3 of the drawings it will be seen that the upper partition member 39 extends diagonally from the lower end of a service air eduction throat 43 to a point upwardly and diagonally across all of the heat exchangers and that the partition member 40 extends from the upper end of a cooling air eduction throat 44 downwardly to a point adjacent to the hinge 34 above the swinging floor 33. This divides the compartment 15 into an air duct A which communicates with the passageways 24 from the various heat exchangers 14 and an air duct B which communicates with the sump 13 when the floor member 33 has been swung upwardly to the dotted line position indicated in Fig. 3 of the drawings. The duct A communicates with the service outlet member 43 and the duct B communicates with the outlet 44. As shown in Fig. 1, the member 43 is shown in communication with a service air conduit 45 which establishes communication with a blower 46 driven by a suitable motor 47. The member 44 is in communication with a conduit 48 which establishes communication with a blower 49 driven by a motor 50. The blower 46 communicates with the service air ducts leading to the building into which the air is to be delivered. The blower 49 draws off moist air and may deliver it to the attic of the residence in which the structure is being used or to some other point of exhaust.

The conditioning of the air passing through the service duct of the apparatus is brought about by an interchange of heat. When air is to be

cooled water is delivered from a pump 51 having a sump 52 in communication with the sump 13 by a conduit 53. An overhead delivery pipe 54 connects the pump with distributor pipes 55 one of which leads into the top of each of the interchangers 14 and at a point above the upper edges of the air ducts 20. At the ends of the pipe 55 spray nozzles 56 are provided to produce a jet of water spray 57 in the upper compartments 58 of each of the heat exchangers. This water passes downwardly through the members 20 into the sump 13 after which it may be recirculated. The tops of each of the compartments 58 of the heat exchangers are formed with channel troughs 59 into which the marginal edges 60 of cover lids 61 rest. These troughs are constructed in the same manner and for the same purpose as troughs 28 and receive an accumulation of water to form an air seal as particularly shown in Fig. 6. In the event that the apparatus is to be used for heating the service air rather than cooling it the water from the pump 52 is passed through a heater 62 indicated by dotted lines in Fig. 1. It will be understood that this water will raise the temperature of the air passing through the heat exchangers, and in such operation it is understood that the blower 49 is not run and accordingly air is not drawn through the wetted passages 20.

In the operation of the present invention the air capacity required for a given room space and a given temperature change will be computed and the desired number of heat exchange units 14 will be selected for the computed capacity. The base structure 10 will of course be of a size to exactly accommodate the heat exchangers of the capacity required and will permit the lower edges of the walls 16, 17, 18 and 19 to properly seat within the troughs 28 and 28' of the base. The result will be that these edges will be submerged in the accumulated water of the troughs and will be sealed against the passage of air therearound without requiring any packing or sealing gaskets or the use of any fastening bolts. These last named elements will be eliminated due to the fact that the weight of the sheet metal heat exchanger units will hold the units solidly in place in cooperation with the vertical strips 38. It will be seen that a unitary base and sump will be provided and that when desired the heat exchangers may be interchangeably mounted thereon. Under conditions when air is to be cooled the covers 61 are removed from the tops of the heat exchangers so that cooling air may pass in the direction of the arrows *a* as indicated in Figs. 3, 4, and 5 of the drawings, and will pass downwardly through the tubes 20 into the sump 13 beneath the heat exchangers. This air will then travel horizontally in the sump and will pass upwardly into the duct B while flowing over the top of the accumulated liquid within the sump 13 and flowing through the passageways 37 between the spray eliminator plates 36. The air thus flowing will receive water from jets 56 while passing through the upper compartments 58 of the heat exchangers and thus when passing downwardly through the tube spaces 20 will carry the suspended moisture so that evaporation will take place within the tube spaces 20 to produce a desired heat exchange relationship with the air passing through the spaces 21 between the tubes of the heat exchangers to flow to the room. The cooling air is normally discharged through the conduit 48 as drawn by the suction fan 49 and may be delivered to any desired point of ex- 75

haust. This path of travel is diagrammatically indicated in Fig. 5 of the drawings. The service air which is to be delivered to the room to be cooled travels in the direction of the arrows *b* in Figs. 3, 4, and 5 of the drawings, and is drawn inwardly through the filters 27 to the induction throats 25 after which the air passes through the openings 23 and between the tube structures 20, thereafter passing upwardly in the direction of the arrows *b* and outwardly through the openings 24 in the upper portion of the walls 16 of the heat exchangers. The air is then conducted into the service air duct A from which it is drawn through the conduit 45 by action of the suction blower 46. In following these air streams it will be seen that the cooling air stream is initially saturated with moisture and then drawn downwardly into the heat exchanger through the sump and afterwards upwardly into the air duct B while the service air is drawn upwardly in counter-flow to the cooling air and then is drawn outwardly through the duct A in counterflow to the air in duct B, thus insuring that a maximum exchange of heat will take place in a structure of minimum size and contents. The service air is filtered through the filters 27 and is thus in a desirable condition when cooled and delivered to the room. Attention is directed to the fact that due to the arrangement of the diagonal partition walls 39 and 40 between the ducts A and B the capacity of these ducts will progress from their inner ends outwardly and as they pass along the sets of heat exchangers whereby the progressively increased volume of air to and from the exchangers will be accommodated in progressively larger ducts A and B at their discharge ends. When it is desired to use the device for a heater the water supply is continued through the spray system and nozzles 56 and on its way from the pump passes through a water heater 62. The swinging floor 33 which for cooling purposes has been held in the elevated position indicated by dotted lines at *c* in Fig. 3 will be lowered to its solid line position in the same figure. This will seal the sump so that moisture will not escape via the passageway B and the idle blower 49. The lids 61 are then placed over the upper ends of the compartments 58 of the heat exchangers to close the same, after which a supply of hot water is delivered through the pipes 54 and 55 and through a heater 62. This hot water will have heat exchange relationship with the service air passing in the direction of the arrow *b* in the drawings, and will heat this service air to a desired temperature. The hot water may be circulated through the sump 13 and the pump 51.

It is to be understood that in any event when the joints between the assembled parts are to be sealed water is allowed to accumulate in the various sealing troughs 28, 28' and 59, and when thus sealed the structure will be hermetically tight. Attention is further directed to the fact that an outer cover or shell 63 is provided which, while having some heat insulation effect, will primarily cover and trim the apparatus so that it will be sightly in appearance. Furthermore attention is drawn to the fact that by the arrangement of a structure having spaced heat exchangers with intermediate air ducts drawing and discharging air oppositely from opposite sides of the ducts, a very compact air conditioning structure will be provided.

While we have shown the preferred form of our invention, as now known to use, it will be understood that various changes might be made

in the combination, construction and arrangement of parts by those skilled in the art, without departing from the spirit of the invention.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. An air conditioning device comprising a pair of heat exchangers spaced from each other, a pair of ducts disposed between the spaced heat exchangers, a flow of air passing through the heat exchangers and one of the ducts in one direction, and a counterflow of air passing through the heat exchangers and the other duct, spray chambers at the upper ends of the heat exchangers, and water spray jets in said chambers for supplying moisture to the air passing therethrough, and a sump at the opposite ends of said exchangers establishing communication between the bottoms of the exchangers and the air duct through which the moisture-laden air passes.

2. An air conditioning device comprising a pair of heat exchangers spaced from each other, a pair of ducts disposed between the spaced heat exchangers, a flow of air passing through the heat exchangers and one of the ducts in one direction, and a counterflow of air passing through the heat exchangers and the other duct, spray chambers at the upper ends of the heat exchangers, and water spray jets in said chambers for supplying moisture to the air passing therethrough, and a sump at the opposite ends of said exchangers establishing communication between the bottoms of the exchangers and the air duct through which the moisture-laden air passes, and means for circulating the water from the sump to the jets.

3. An air conditioning device comprising a unitary base forming a sump, heat exchanger units resting upon said base and in communication with its sump, a cooling air duct disposed between the heat exchanger units and in communication with the sump whereby cooling air may pass downwardly through the heat exchanger units into the sump and then outwardly through said duct, means for supplying moisture to said cooling air, means for establishing a counterflow of air to be cooled through the heat exchanger units, and an upper air duct between the heat exchanger units through which said cooled air passes.

4. An air conditioning device comprising a unitary base forming a sump, heat exchanger units resting upon said base and in communication with its sump, a cooling air duct disposed in communication with the sump whereby cooling air may pass through the heat exchanger units into the sump and then through said duct, means for supplying moisture to said cooling air, means for establishing a counterflow of air to be cooled through the heat exchanger units, and an air duct between the heat exchanger units through which said cooled air passes.

5. An air conditioning device comprising a unitary base forming a sump, heat exchanger units resting upon said base and in communication with its sump, a cooling air duct disposed between the heat exchanger units and in communication with the sump whereby cooling air may pass downwardly through the heat exchanger units into the sump and then outwardly through said duct, means for supplying moisture to said cooling air, means for establishing a counterflow of air to be cooled through the heat exchanger units, an upper air duct between the heat exchanger units through which said cooled air passes, the intermediate ducts for the cooling air and the

cooled air progressing in capacity from one end of the heat exchanger units to the other whereby the increasing volume of air delivered by the heat exchanger units to the ducts will be accommodated.

5 6. An air conditioning device comprising a unitary base forming a sump, heat exchanger units resting upon said base and in communication with its sump, a cooling air duct disposed between
10 the heat exchanger units and in communication with the sump whereby cooling air may pass downwardly through the heat exchanger units into the sump and then outwardly through said duct, means for supplying moisture to said cooling
15 air, means for establishing a counterflow of air to be cooled through the heat exchanger units, an upper air duct between the heat exchanger units through which said cooled air passes, and air filters disposed in the path of travel of the
20 air to be cooled as it passes through the apparatus.

7. An air conditioning device comprising a plurality of heat exchanger sections arranged in
25 parallel horizontal rows, said sections being characterized as having opened top and bottom ends with intermediate air passageways through which air may flow from the top to the bottom of each unit and intermediate passageways through which
30 another stream of air may flow in counter current upwardly through the heat exchange sections, an eduction air duct in communication with the bottoms of the heat exchanger sections and through which air may draw therefrom, a second eduction air duct in communication with
35 the heat exchangers adjacent to their upper end

and drawing the counterflowing air therefrom, means interposed in the path of travel of said counterflowing air to filter the same, means interposed in the path of travel of the first named
5 stream of air by which hot water may be introduced therinto, and a damper for interrupting the flow of air from the lower ends of the heat exchangers to the eduction duct with which they normally communicate.

8. An air conditioning device comprising a plurality of heat exchanger sections arranged in
10 parallel horizontal rows, said sections being characterized as having opened top and bottom ends with intermediate air passageways through which air may flow from the top to the bottom of each
15 unit and intermediate passageways through which another stream of air may flow in counter current upwardly through the heat exchange sections, an eduction air duct in communication with the bottoms of the heat exchanger sections
20 and through which air may be drawn therefrom, a second eduction air duct in communication with the heat exchangers adjacent to their upper end and drawing the counterflowing air therefrom, means interposed in the path of travel of
25 said counterflowing air to filter the same, means interposed in the path of travel of the first named stream of air by which hot water may be introduced therinto, and a damper for interrupting the flow of air from the lower ends of the heat
30 exchangers to the eduction duct with which they normally communicate and covers for the upper ends of the heat exchange units.

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