May 18, 1937. R. T. BRIZZOLARA 2,080,998

AIR CONDITIONING APPARATUS

Filed Sept. 6, 1935 3 Sheets-Sheet 1

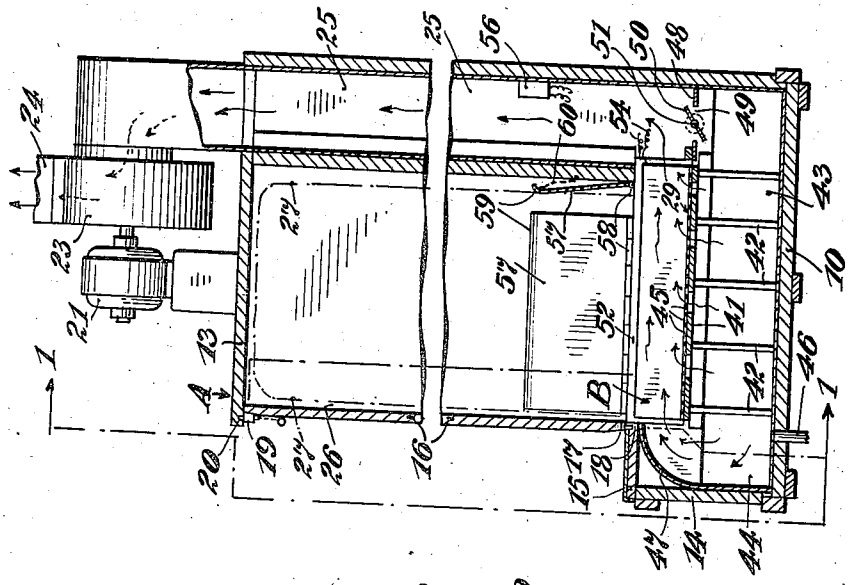


Fig. 2.

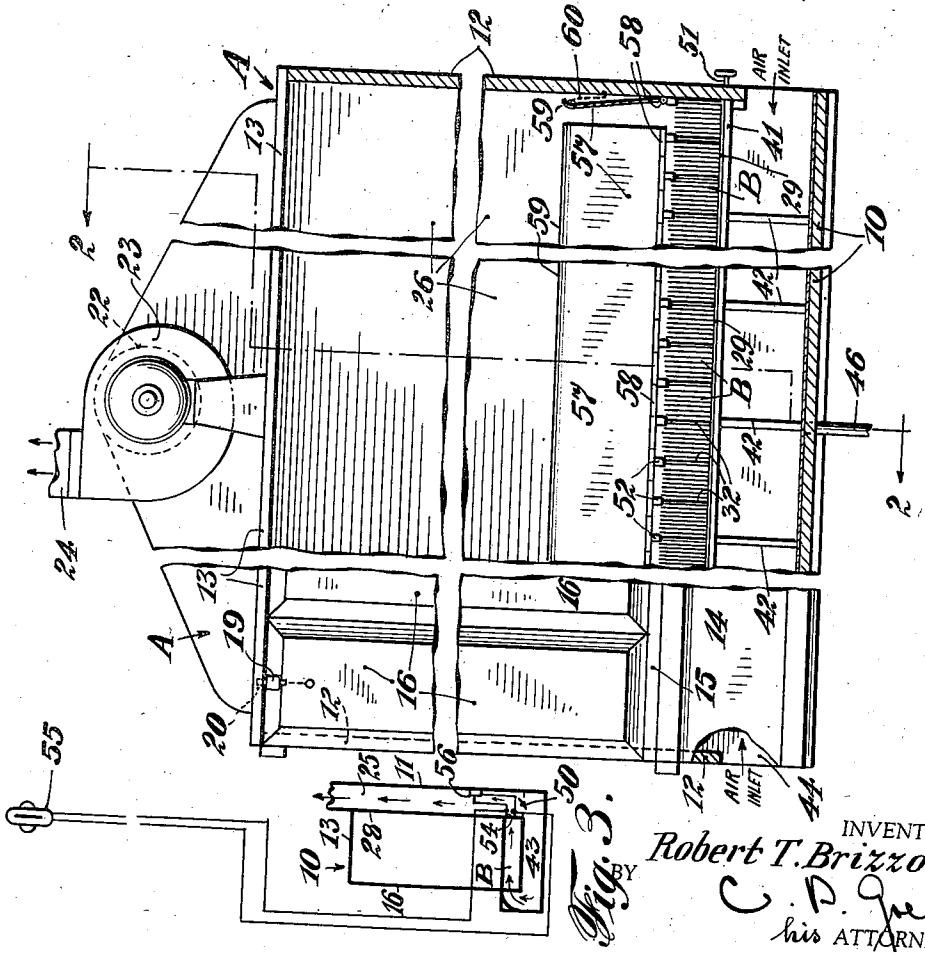


Fig. 1.

Fig. 3.

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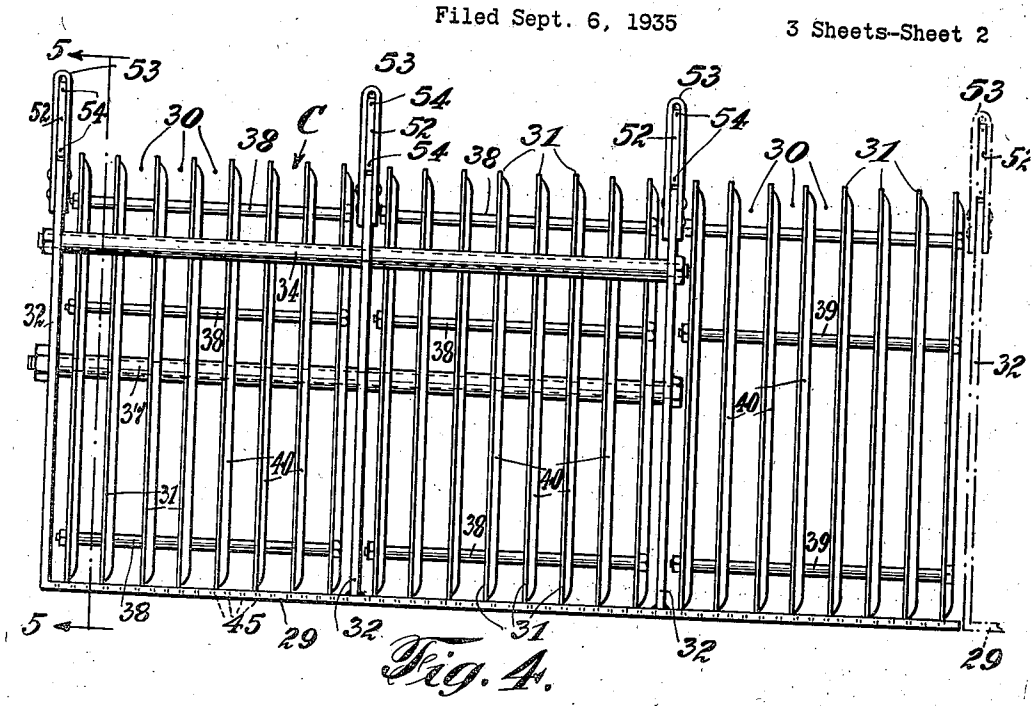


Fig. 4.

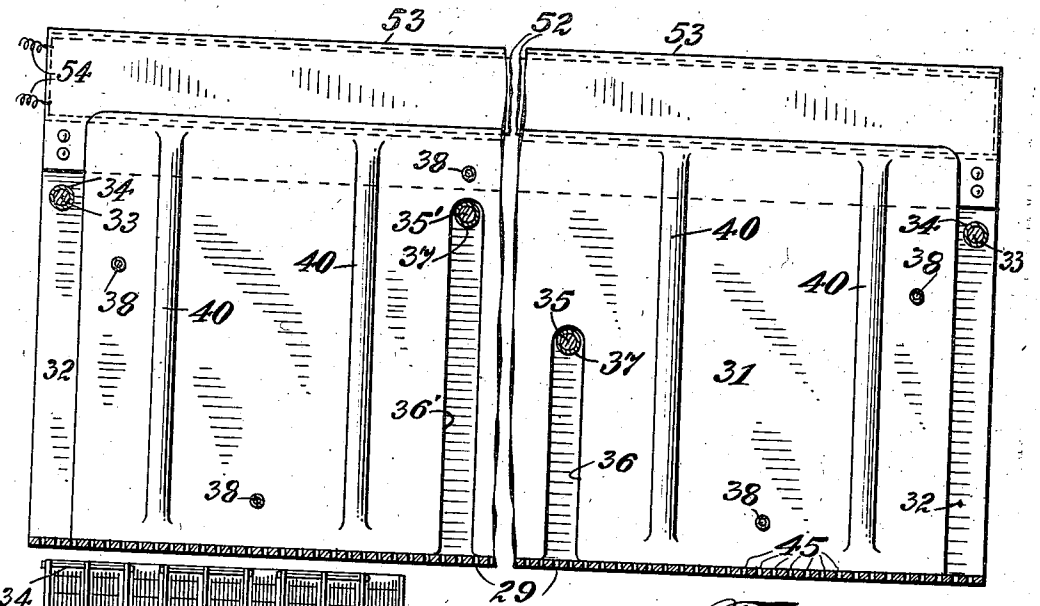


Fig. 5.

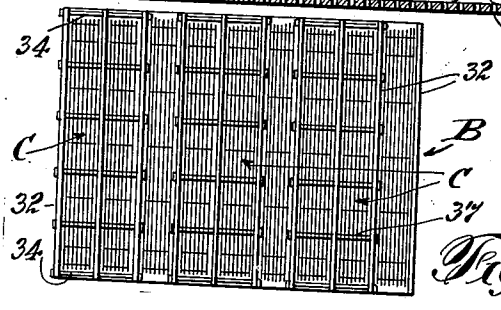


Fig. 6.

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AIR CONDITIONING APPARATUS

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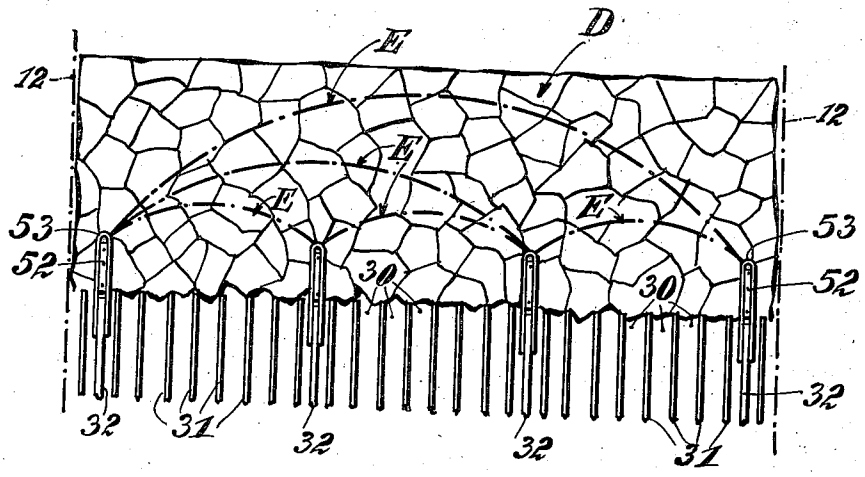


Fig. 7.

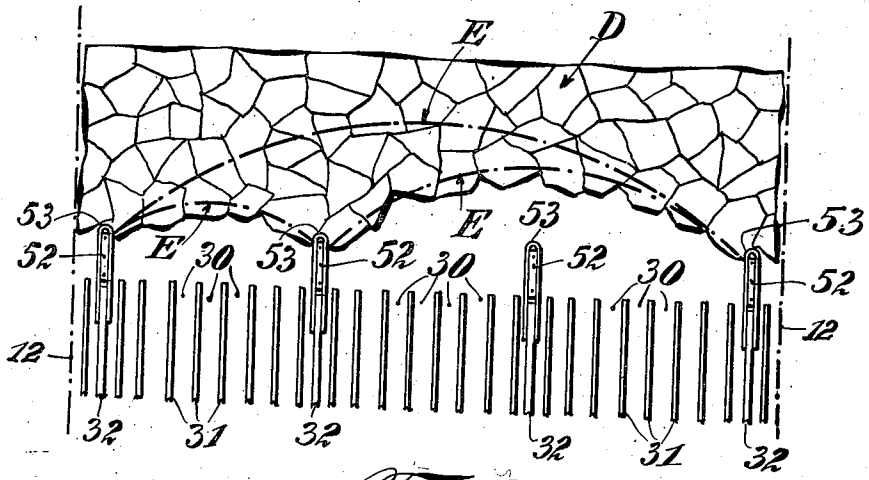


Fig. 8.

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UNITED STATES PATENT OFFICE

2,080,998

AIR CONDITIONING APPARATUS

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Application September 6, 1935, Serial No. 39,430

19 Claims. (Cl. 62—133)

My present invention relates to an air conditioner for use in rooms, apartments, stores, assembly halls, hospitals, and the like, and involves certain improvements upon the invention disclosed in by Letters Patent No. 1,952,414, dated March 27, 1934, for Method and apparatus for cooling air.

In its broad aspect, by present invention has for its object to provide an improved apparatus having improved means whereby to supply cooled, cleansed, and invigorating air, and in connection therewith to provide for controlling the operation of the apparatus in such manner and automatically that the temperature of the air in the room will not, within suitable or desirable limits, become either too cool or too warm.

An object of the invention is to provide a construction in which blocks, bodies or masses of fragmentary ice may be employed as the refrigerant and in which grid plates or fins of high conductivity may be used as the means by which to abstract the heat from the air that is being cooled. Under the arrangement, the blocks, bodies, masses or the like, of ice may find their support upon the grid plates to produce in the air channels between such plates, melting ice fins with which the air will come into direct contact for quick cooling. The grid plates or fins are kept cool by the ice and the ice water or moisture which drips from the melting of the ice. Such drippings with the moisture given off thereby are used to pre-cool, de-humidify and cleanse the air prior to contact of the air with the cooling grid plates. The channels or passages for the air are so arranged that, besides permitting the accomplishment of the above operations, the partly treated incoming air may, when desired, be mixed with the cooled air prior to the exhausting of the supply from the conditioner.

Another object of the invention is to provide in connection with and above the grid plates an arrangement of electric heating elements upon which the ice bodies or masses are placed for their support and which, when operated, will rapidly melt away the ice therearound, permitting the bodies thereby to descend by gravitational action for contact with and to find their support upon the grid plates, with the result that sheets of ice will be formed in the passages between the grid plates.

With this arrangement the ice can be melted rapidly and the temperature of the room quickly lowered whenever prevailing conditions require it in order to maintain the desired temperature within the room. When the room temperature drops and nears the condition that may be considered undesirable or as "too cool", the current to the heating elements can be regulated or cut off entirely, whereupon the ice bodies continuing to melt, though at a much less rapid rate, will soon again find themselves wholly supported upon the heating elements and they will entirely melt away from any direct contact with the grid plates. The current supply for the heating elements may be controlled by thermostats.

With the foregoing and other objects in view, the invention consists in the construction and relative arrangement of the parts so associated as to coact and cooperate with each other in the accomplishment of the results herein contemplated, and comprises in its present evolvement the simple and practical example illustrated in the accompanying drawings, wherein similar reference characters designate corresponding parts throughout the several views and in which:—

Figure 1 represents a fragmentary front elevation and section, taken approximately on the lines 1—1 of Fig. 2, of an air conditioner made in accordance with my present invention;

Fig. 2 is a vertical sectional view taken through the device from front to rear on the line 2—2 of Fig. 1;

Fig. 3 is a diagram showing the thermostatic controls and wiring connections for the heating elements;

Fig. 4 is a front elevational view showing a section of the grid plates with their electric heating elements;

Fig. 5 is a cross section, partly broken away, taken on the line 5—5 of Fig. 4;

Fig. 6 is a top plan view of a plurality of grid plate sections with their electric heating elements;

Fig. 7 is a fragmentary elevation, illustrating diagrammatically the formation of ice arches upon the ice supporting means when the ice chamber is supplied with refrigerant comprising a mass of fragmentary ice; and

Fig. 8 is a similar view but showing the ice melted entirely away from the grid plates and supported by ice arches upon the electric heating elements.

Referring now to the accompanying drawings, the refrigerator box or housing which is denoted herein in general by the reference character A may be made of any suitable or approved materials and in such size that it will have capacity adequate and sufficient to meet the air conditioning requirements of any particular room or in-

door space in connection with which the apparatus is to be employed.

In the present embodiment, the box or housing is illustrated as having a bottom wall 10, a back wall 11, opposite end walls 12, 12, and a top wall 13. The box is of elongated form, its elongated length dimension being between the opposite ends 12, 12. Along its front side adjacent the bottom thereof there is a forwardly projecting extension 14 the top 15 of which provides a deck or ledge upon which conveniently to dispose cakes or blocks of ice during the process of filling the ice chamber within the box. The front of the box above the plane or level of the deck 15 includes a series of demountable doors or panels 16. The lower end edges 17 of these doors are fashioned to removably fit within a groove 18 provided for the purpose along the inner edge of the deck 15. The outer faces of these doors adjacent the top ends thereof are furnished with latch devices 19 adapted releasably to interlock with suitable keeper openings 20 provided in the underside of the overhanging top wall 13.

In the present instance, I show suitably mounted upon the top of the box an electric motor 21 carrying an exhaust fan 22 operating in a casing 23 having a discharge outlet 24. This exhaust fan has for its purpose to draw the air through the various air-conducting channels in the box and finally up through the air-conducting exhaust channel 25 for discharge into the room through the discharge outlet or pipe 24. 26 denotes the ice chamber in which the cakes or blocks of ice as indicated at 27 in dash-dot outline are disposed, and this chamber extends throughout the length of the box behind the series of demountable doors. This chamber is separated from the air-conducting exhaust channel by a partition 28.

The means for supporting the blocks of ice in the ice chamber comprises a metallic grid structure denoted in general by the reference character B and composed of metal for transferring or exchanging heat so as to abstract the heat from the air, the grid structure being so designed and arranged that it will be kept cool by the ice and the cold drippings and moisture given off thereby. In the present instance the grid structure which constitutes the bottom for the ice chamber is represented as comprising a series of identical grid sections C, each including a horizontal bottom plate 29 upon which is mounted a series of vertically disposed longitudinally extending grid plates of high conductivity. These plates extend in spaced-apart parallel relation so as to provide air lanes 30 between them. The plates include relatively thin members 31 connected together in groups and which are supported upon and between relatively thick members 32 the lower ends of which are rigidly secured by spot-welding or the like to the plate 29. As shown in Figs. 4 and 5, the members 32 extend beyond the opposite ends of the members 31 and are rigidly connected by bolt elements 33 carrying spacers 34 whereby to reinforce and maintain the elements 32 in proper spaced relation. The elements 32 are also connected by bolt elements 35 and 35' upon which the plates 31 are mounted, said plates 31 being provided with slots 36 and 36' extending upwardly from the bottom edges thereof for receiving the bolts 35 and 35' respectively. Suitable spacers 37 for properly spacing the plates 31 are provided upon the bolts 35 and 35'. Each group of the plates 31 which is mounted between two plates 32 is also connected by bolts 38. By this arrangement, each group of plates 31 may as a unit be readily applied for its support upon the bolts 35 and 35', and also may be as readily removed. Each grid section may also include at one side thereof, as shown at the right hand end of Fig. 4 and as also shown in Fig. 6, a group of similar plates 31 which are disposed for their support upon the bottom plate 29 and which are connected at suitable intervals by spacer bolts 39. The relatively thin metallic plates 31 of high conductivity are preferably made with vertically extending reinforcing ribs 40 which project into the air lanes 30 from one side thereof, and these projecting ribs in addition to reinforcing and stiffening these thin plates also serve as baffles against which the air passing through the air lanes between the plates will contact whereby to break up any smooth flowing of the air and cause all parts of the air stream in passing through the narrow lanes to contact directly with the plates for rapid extraction of the heat from the air.

The grid structure which may be composed of several grid sections as above described, is so disposed for the support of the ice in the ice chamber that the plates, as shown in Figs. 1 and 2, will extend from the front to the rear of the box for directing the air which passes through the lanes 30 into the air-conducting exhaust channel 25. The bottom plates of the grid structure are disposed upon spaced-apart parallel sill plates 41 which extend in the direction of the length of the box and are supported upon post elements 42 the lower ends of which are secured to the bottom wall of the box. The sill plates 41 are relatively wide and are movably disposed upon the post elements for adjusting the spaces between the plates. These plates may also be exchanged for other plates having a different width whereby to vary the spaces between them. The bottom plates 29 separate the air lanes 30 from an air-conducting inlet channel or chamber 43 into which the air flows through openings 44 provided in the opposite ends of the box adjacent the rear wall 11 thereof. Said plates 29 are provided throughout with perforations or openings 45 through which the drippings and moisture from the melting ice, after having passed downwardly through the air lanes, will descend through the air-conducting chamber 43 to the bottom of the box, thence to be drained away through suitable drain piping 46. At the front of the box below the deck 15 and within the extension 14 there is provided a return wall 47 by means of which the air which passes to the front end of the box through the air-conducting channel 43, will be diverted upwardly and into the air lanes 30. Air from the air-conducting channel 43 will also be drawn upwardly into the lanes 30 through the apertures 45 in the bottom plates 29, and the air which ascends through said apertures 45 will of course be brought into direct contact with the ice, ice water drippings and moisture in process of descending through said openings. At the rear of the bottom plates, the air-conducting chamber 43 is separated from the air-conducting exhaust channel 25 by a partition 48. In this partition is provided a central opening 49 and this opening is normally closed by means of a damper or valve 50 swingably mounted intermediate its length upon a supporting rod 51. By means of this damper, air from the air-conducting intake channel 43 may be permitted to pass directly into the air-conducting exhaust channel 25, so that at any time, if the air which is being discharged through the channel 25 is too cold, this condition

may be immediately remedied by mixing with the cold air in the channel 25 the moderately cooled air from the inlet chamber 43.

The relatively heavy plates 32 of the grid structure have secured thereto at the top ends thereof elongated electric heating elements 52 having rounded tips or top ends 53. The ice cakes when loaded in the ice chamber are disposed upon these electric heating elements which rise well above the grid sections for the support of the ice cakes above the grid sections and out of contact with the relatively thin plates 31. These electric heating elements may be of any suitable type or construction well known in the art and as illustrated in Fig. 5 they preferably extend along the entire length of the top ends of the elements 32. With each of the heating elements there is of course provided circuit connections or wires 54 which lead to any suitable source of electricity for supplying current to the resistance coils (not shown) which are of course provided in the heating elements for heating the same. With a block of ice disposed upon the heating elements and with the latter being operated, ice portions of the block surrounding and adjacent to the heating elements will rapidly melt away so that the ice block will gradually descend by its weight until it finds its support upon the relatively thin plates 31, in which position the heating elements 52 will be within the block of ice. When the ice cake rests upon the plates 31, continued melting of the ice will result in the formation of ice fins in the upper portions of the lanes 39, so that the air flowing through said lanes will come into direct contact with the ice fins formed therein for rapid cooling, as will more fully and particularly appear from the disclosure of my said prior Patent No. 1,952,414, dated March 27, 1934. Through the operation of the heating elements, the ice will be rapidly melted for quickly cooling the grid plates and hence the air which flows through the air lanes 39. Moreover, under this arrangement, due to the rapid melting of the ice, copious drippings of ice water and moisture will descend through the lanes of air and through the apertures 45 and thence into the incoming air in the air-conducting chamber 43 whereby preliminarily to cool the air in this chamber. In this way the temperature of the air can be rapidly lowered so as to correct excess humidity since air lowered in temperature is relieved of excess moisture. By this arrangement, also, when the temperature of the air in the room has been sufficiently lowered through the introduction of the cooling air from my apparatus, the current may be shut off from the heating elements, and in this case after a time through continued melting of the ice, the ice cake will again cease to have direct contact with the plates 31 and will be wholly supported upon the heating elements 53.

For automatically controlling the operation of the heating elements in accordance with the temperature of the room or in-door space in connection with which my improved apparatus is employed, I utilize a thermostat 55 which may be located within the room or in-door space in any suitable location therein and connected with the circuit connections 54 of the heating elements. This thermostat, being self-acting in response to the temperature of the air within the room or in-door space, controls and regulates the operation of the heating elements in a manner well understood in the art. If desired, another thermostat 56 may be employed and located, as shown in Fig. 2, within the air-conducting exhaust channel 25 and connected with the usual circuit connections with the electric heating elements whereby to regulate and control the heating elements in accordance with the temperature of the air passing upwardly in the air-conducting channel 25.

In order to obstruct the passage of air into the ice chamber 26 from around the ice cakes, I may provide suitable obstructing plates 57 mounted at their lower edges to the defining walls of the chamber by means of hinges 58 or the like. These air-obstructing plates have the top ends thereof curved as at 59 toward the walls so that these plates will normally tend to fall by their weight inwardly into the interior of the ice chamber for maintaining constant contact with the sides of the cakes of ice irrespective of the melting away of the ice. The inward movement of the obstructing plates 57 may be suitably limited by means of flexible chains 60 or the like which are connected between the outer portions of the obstructing plates and the adjacent walls.

Referring to the sill plates 41 on which the perforated bottom plates 29 are supported, said sill plates may be varied in width or in the spaced-apart relation thereof, to suit the conditions as may be required of a greater or less supply of air ascending from the air inlet chamber into the air lanes. By varying the relative positions of the movable sill plates, or the spaces between them, or by the substitution of other plates differing in width, the places through which ascending air will pass into the air lanes through the apertured bottom plate can be changed as to location and as to extent of area.

Ice in the condition commonly known as crushed, shaved, flaked or broken ice, may be loaded into the ice chamber and disposed for its support upon the heating elements and grid plates as shown in Fig. 7. Owing to the natural cohesiveness which subsists in a mass D of fragments of such ice and to the gravitational wedging action thereof when confined in a chamber, numerous ice arches as E will in various combinations form upon and between the electric heating elements in conjunction with the walls defining the sides of the ice chamber. Upon supplying current to the electric heating elements, the anchorages of the ice arches E or the basis thereof, which find their support upon the heating elements in conjunction with the side walls, will melt away permitting the arches thereby to collapse upon the grid plates. Then when current is shut off from the heating elements, the ice will again form its own supporting arches upon the elements and/or in conjunction with the side walls as illustrated in Fig. 8. Thus, with the use of a mass of crushed ice or a mass of similar fragmentary ice bodies, the same results can be obtained as with the use of the solid block or cake form of ice.

It is desired to point out here that when it is intended that a mass of crushed or similar fragmentary ice is to be used as the refrigerant, the box or casing should be provided in its top end or in the upper portion of a side wall with a suitable opening or inlet channel through which the crushed or similar fragmentary ice can be introduced into the ice chamber. In such case, the ice may be passed through the filling opening by hand, or, if desired, it can be charged into the ice chamber by any pump, stoking or charging device or method of known character.

From what has been said it will be understood that my improved air conditioner comprises a self-acting apparatus for effective control of the

temperature, humidity, and purity of in-door air. Assuming that the apparatus is in operation with the cakes of ice upon the heating elements and with the exhaust fan turned on, when the temperature rises to the maximum range as determined by the thermostat control, the current will be automatically turned on and the heating elements will quickly melt the adjacent ice permitting the cake to descend and to find its support upon the grid plates for producing the fins of ice between the plates. As soon as the temperature is lowered to the minimum of the range permitted and as determined by the thermostat, the current supply will be shut off, whereupon continued melting of the ice will cause the ice block to melt away entirely from contact with the grid plates and to be again supported entirely upon the electric heating elements. In this case the temperature of the grid plates will rise and less heat will be abstracted from the air passing through the lanes so that the temperature in the room will again rise. This may be facilitated by opening the damper so that warm air from the inlet chamber will rise directly into the exhaust channels to there be mixed with the air issuing from the air lanes.

It is to be understood that I have employed the terms or expressions "ice" and "bodies of ice" as terms of description and not of limitation, and that by the use of such terms and expressions, I intend to mean and embrace cakes, blocks, bodies or masses of crushed, broken, flaked or briquetted ice.

While the invention has been illustrated and described with a considerable degree of particularity, it will be recognized that in practice various changes and alterations may be made in the construction illustrated. It has been sought herein to illustrate only such an embodiment as will suffice to exhibit the character of my present invention. Reservation is, therefore, made to the right and privilege of changing the form of the details of construction or otherwise altering the arrangement of the parts without departing from the spirit or scope of the invention or the scope of the appended claims.

I claim:—

1. An air conditioning apparatus having means forming a chamber for containing ice bodies, means to transfer and conduct heat through metal elements disposed to support the ice bodies and comprising upwardly directed heating elements and a grid composed of spaced-apart plates forming lanes in which ice fins may form for contact by air passing along the lanes, said heating elements being effective, when operated, to melt supported ice therearound and permit same to descend to find support upon said plates.

2. An air conditioning apparatus having means forming a chamber for containing ice bodies, means disposed to support the ice bodies comprising upwardly directed heating elements adapted on their operation to melt adjacent ice portions so as to permit the ice thereby to descend therearound, a grid disposed below the elements for receiving thereon and supporting thereby the ice that descends and forming air conducting channels in which ice fins may be formed on supported ice, and means responsive to temperature for controlling the action of the heating elements.

3. In an air conditioning apparatus and in combination, a chamber, substantially vertically disposed heating elements for supporting ice in the chamber and adapted on operation to melt adjacent ice portions permitting the ice thereby to descend around the elements, a grid disposed to receive thereon and support thereby the ice that descends, said grid being connected with said elements and comprising plates to transfer and conduct heat and forming air-circulating channels in which ice fins may be formed on supported ice, and means for controlling the operation of the heating elements.

4. An air conditioning apparatus having, in combination, a refrigerator box having an upper chamber, substantially vertically disposed heating elements for supporting ice in the chamber and adapted on operation to melt adjacent ice portions permitting the ice thereby to descend around the elements, a grid supporting said elements and disposed to receive thereon and support thereby the ice that descends, said grid having plates comprising means to transfer a temperature and forming between them air-conducting lanes, a perforated bottom for the grid forming an air-inlet chamber below it and positioned by spaced upright members which are supported upon the bottom of the box, means forming with said air-inlet chamber an air-conducting channel to said lanes at one end of the grid, and an air-conditioning outlet channel leading from the opposite end of the grid.

5. An air conditioning apparatus which includes means forming a chamber for containing ice, means to transfer a temperature disposed to support the ice in the chamber and comprising upwardly directed electric heating elements and a grid composed of spaced-apart plates forming lanes through which air may flow along the plates and down through which drip may descend, said heating elements having circuit connections connected therewith whereby to be operated and being effective, when operated, to melt away adjacent ice portions and permit the ice to descend and find its support upon said plates, and means automatically responsive to temperature connected with the circuit connections for controlling the action of the heating elements.

6. Heat conducting and transfer means for an air conditioning apparatus which has an ice chamber and separately therefrom air-conditioning inlet and outlet channels, said means comprising a grid having plates forming air lanes between the inlet and outlet channels and disposed to support ice within the ice chamber, electric heating elements rising above said grid for supporting ice thereon and adapted, when operated, to rapidly melt adjacent portions of the ice and permit descent of the ice to find its support upon said plates for slow melting thereon and the production of ice fins within the air lanes, and means for controlling the operation of said electric heating elements.

7. In an air conditioning apparatus which includes an ice chamber, an air-conducting inlet channel, an air-conducting outlet channel, heat conducting and transfer means comprising a grid the plates of which form air lanes between the inlet and outlet channels and are disposed to support ice within the ice chamber, electric heating elements supported by and rising above said grid for supporting ice thereabove and adapted, when operated, to melt portions of the ice around such elements and permit descent of the ice to find its support upon said plates, means forming a by-pass through which air may pass directly from the inlet to the outlet channel and

having a control valve, and means for controlling the operation of said electric heating elements.

8. An air conditioning apparatus having heat conducting and transfer means for supporting ice in an air chamber and comprising heating elements which control the down feeding of ice to the heat conducting grids supported by and above a grid the plates of which form air lanes, means forming an air-conducting inlet channel having openings through which air passes into the grid lanes, means forming an air-conducting exhaust channel having connection with the exhaust end of the grid lanes, means forming a by-pass air-conducting channel between the air-inlet and exhaust channels, a fan motor arranged to operate in said exhaust channel, and a valve for opening and closing said by-pass channel.

9. An air conditioning apparatus having heat conducting and transfer means for supporting ice in an air chamber and comprising heating elements which control the down feeding of ice to the heat conducting grids supported by and above a grid the plates of which form air lanes, a supporting structure for said grid forming an air-conducting inlet chamber extending substantially throughout the area below said lanes, the top of said structure having openings through which air may ascend from said chamber into said lanes, said chamber also having at one end a return extension through which ascending air may pass into the lanes at one end thereof, an air-conducting exhaust channel for receiving air from the opposite end of said lanes, power-operated means in the exhaust channel for exhausting air, and means included in said grid supporting structure for varyingly covering portions of said top and the openings therein.

10. In an air conditioning apparatus and in combination, a chamber, substantially vertically disposed heating elements for supporting ice in the chamber and adapted on operation to melt adjacent ice portions permitting the ice thereby to descend around the elements, a grid disposed to receive thereon and support thereby the ice that descends and comprising plates to transfer a temperature and forming air conducting lanes, and movable means for obstructing air from said lanes from ascending around the ice into said chamber, said means being effective to maintain an engagement with the ice.

11. Air obstructing means for an ice chamber which has a side wall and a grid bottom on which the ice is supported, said means comprising a movable plate movable to close the space between the side wall and the ice and to maintain an engagement with the ice during the melting thereof.

12. In an air conditioning apparatus, the combination with an ice chamber and a grid for supporting ice in the chamber, of electric heating elements rising in the chamber above the top of the grid for supporting ice above the top of the grid, said elements being effective when heated to melt adjacent ice portions and being shaped to permit the ice to descend therearound to find its support upon the grid and with said elements extending into the ice.

13. The combination with a grid having spaced plates to transfer and conduct heat of electric heating elements superimposed upon and connected with the grid to exchange temperature therewith, said elements being shaped to support ice above and out of contact with said plates while the elements are unheated, and, when heated, to melt into and penetrate the ice so that the latter will descend to find its support upon said plates.

14. The combination with a grid having parallel spaced-apart vertically-disposed plates, of electric heating elements secured to certain of said plates, extending longitudinally thereof in parallel relation, said elements extending upwardly above the top edges of the other of the plates.

15. The combination with a grid having parallel spaced-apart vertically-disposed plates, of electric heating elements secured to certain of said plates, extending longitudinally thereof in parallel relation, said elements extending upwardly above the top edges of the other of the plates for the support of ice above said edges.

16. In cooling apparatus for cooling air which includes an ice chamber and an air channel therebelow, means in the air channel for abstracting heat from the air and adapted to support ice, an arrangement of electric heating elements for supporting ice in the ice chamber above the top of said heat abstracting means and having top portions, the elements and top portions being shaped so that when the elements are not heated the ice will be supported upon the top portion and when the elements are heated the ice will thereby be melted away from said parts permitting it to descend therearound so as to find its support directly upon the heat abstracting means.

17. In cooling apparatus for cooling air, the combination with an ice chamber and an air channel therebelow, means for supporting ice in the chamber including a grid forming air lanes, a bottom plate for the grid between the air lanes thereof and the channel below the same and having perforations therein, and means for covering portions of the plate to change the locality and amount of apertures through which air can pass from the air channel into the air lanes.

18. In cooling apparatus for cooling air which includes an ice chamber, an air inlet channel and an air exhaust channel, means for supporting ice in the ice chamber including a grid forming air lanes for conducting air from the inlet channel to the exhaust channel, a bottom plate for the grid disposed between the inlet channel and air lanes and having perforations throughout the areas of the air lanes for admitting air into the lanes from the inlet channel, and means for variously covering over portions of said plate to variously change the locality and amount of apertures through which air is admitted from said inlet channel.

19. In an air conditioning apparatus, a cold air conduit, means for drawing air through said conduit, an ice chamber outside of the air conduit, grids extending between the conduit and the chamber for contact with the ice and to provide air lanes for air cooled by the ice, and heating means for the ice to melt the same and increase the cooling action of the air passing from the chamber between the grids and into the air duct.

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