June 13, 1939. F. A. WHITELEY 2,162,394

AIR-CONDITIONING APPLIANCE

Filed Jan. 21, 1937 6 Sheets-Sheet 1

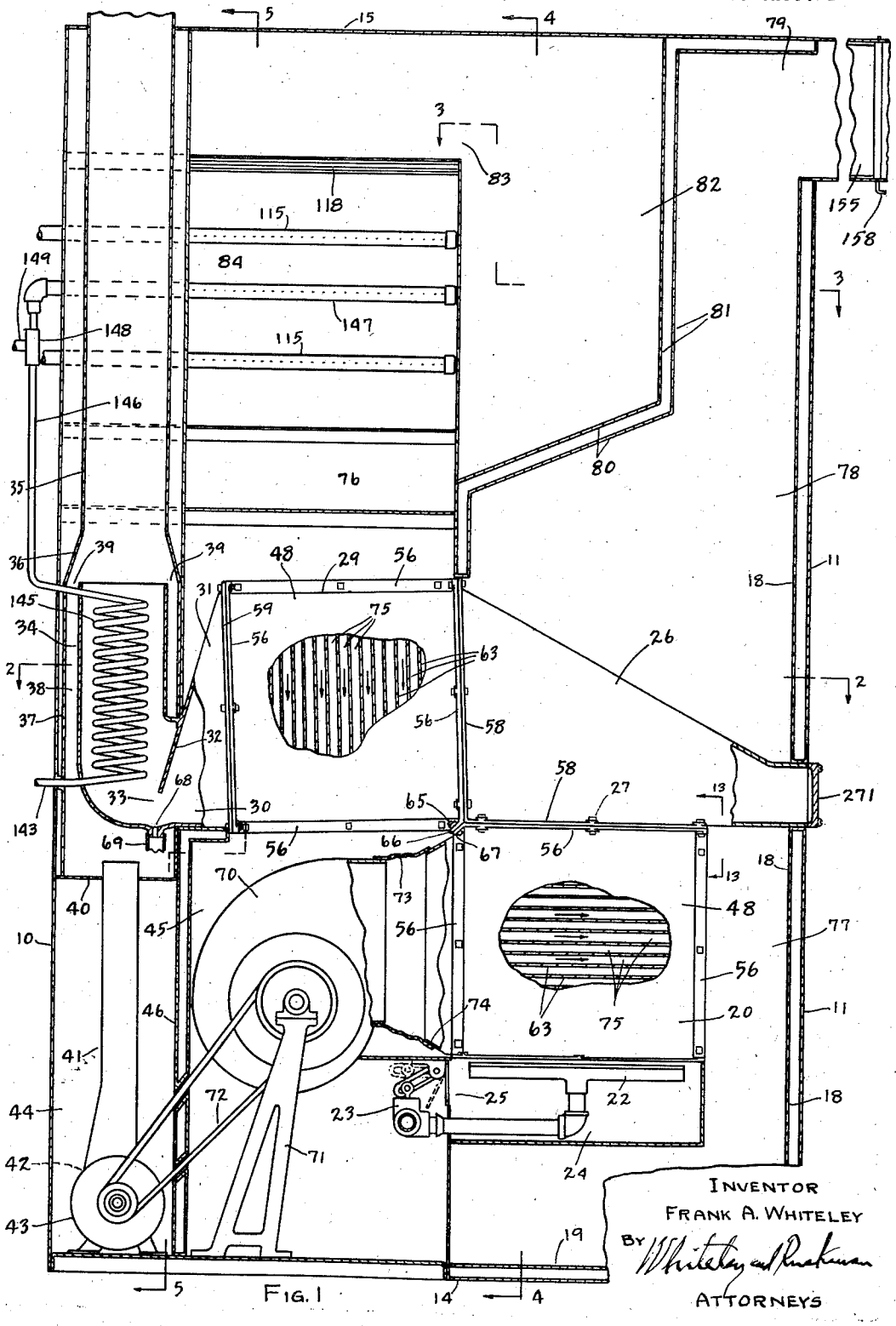


FIG. 1

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AIR-CONDITIONING APPLIANCE

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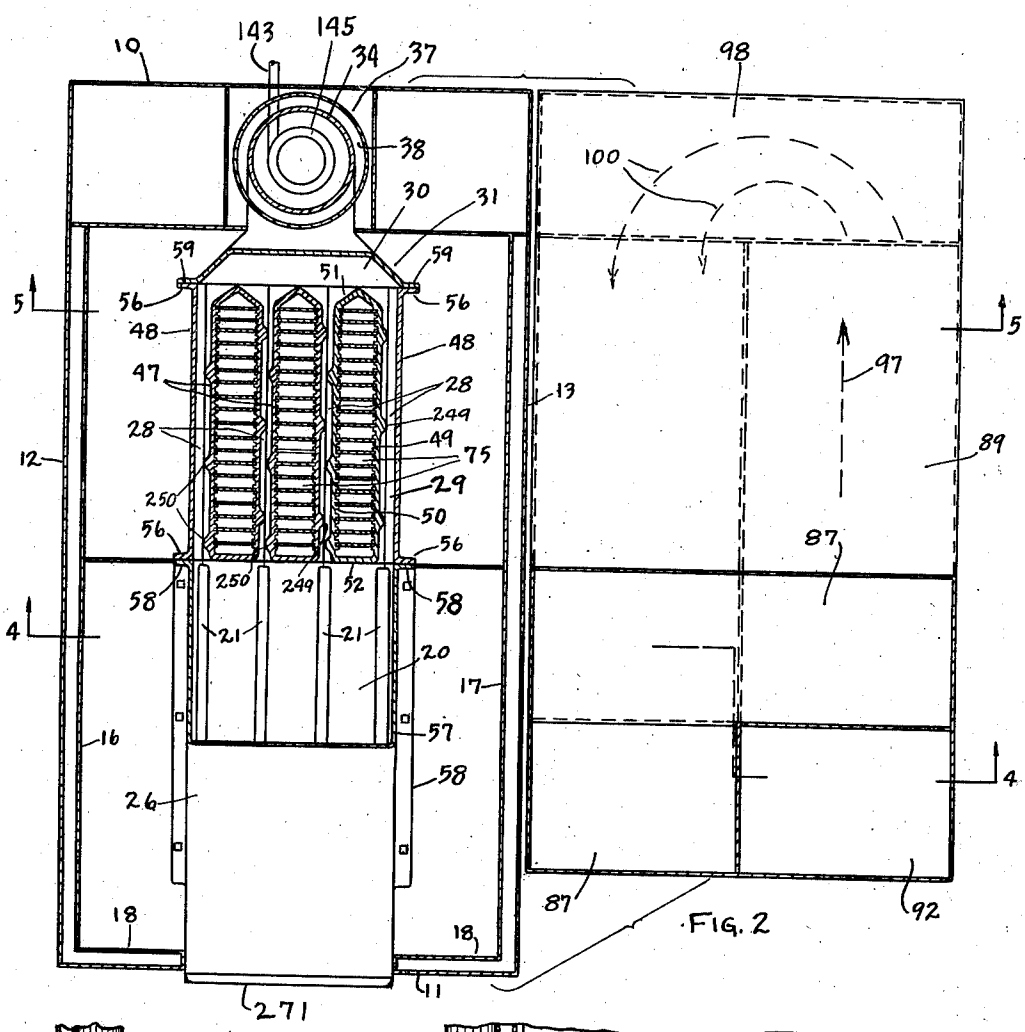


FIG. 2

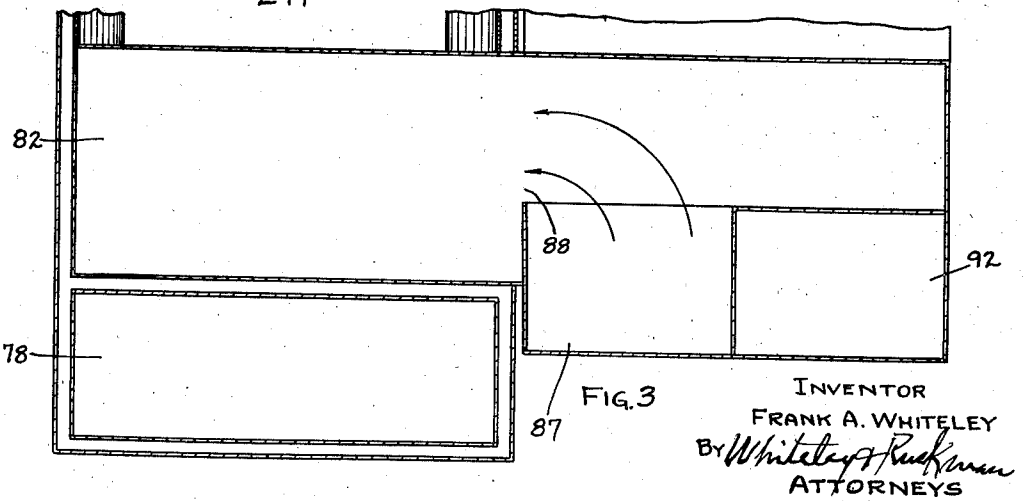


FIG. 3

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AIR-CONDITIONING APPLIANCE

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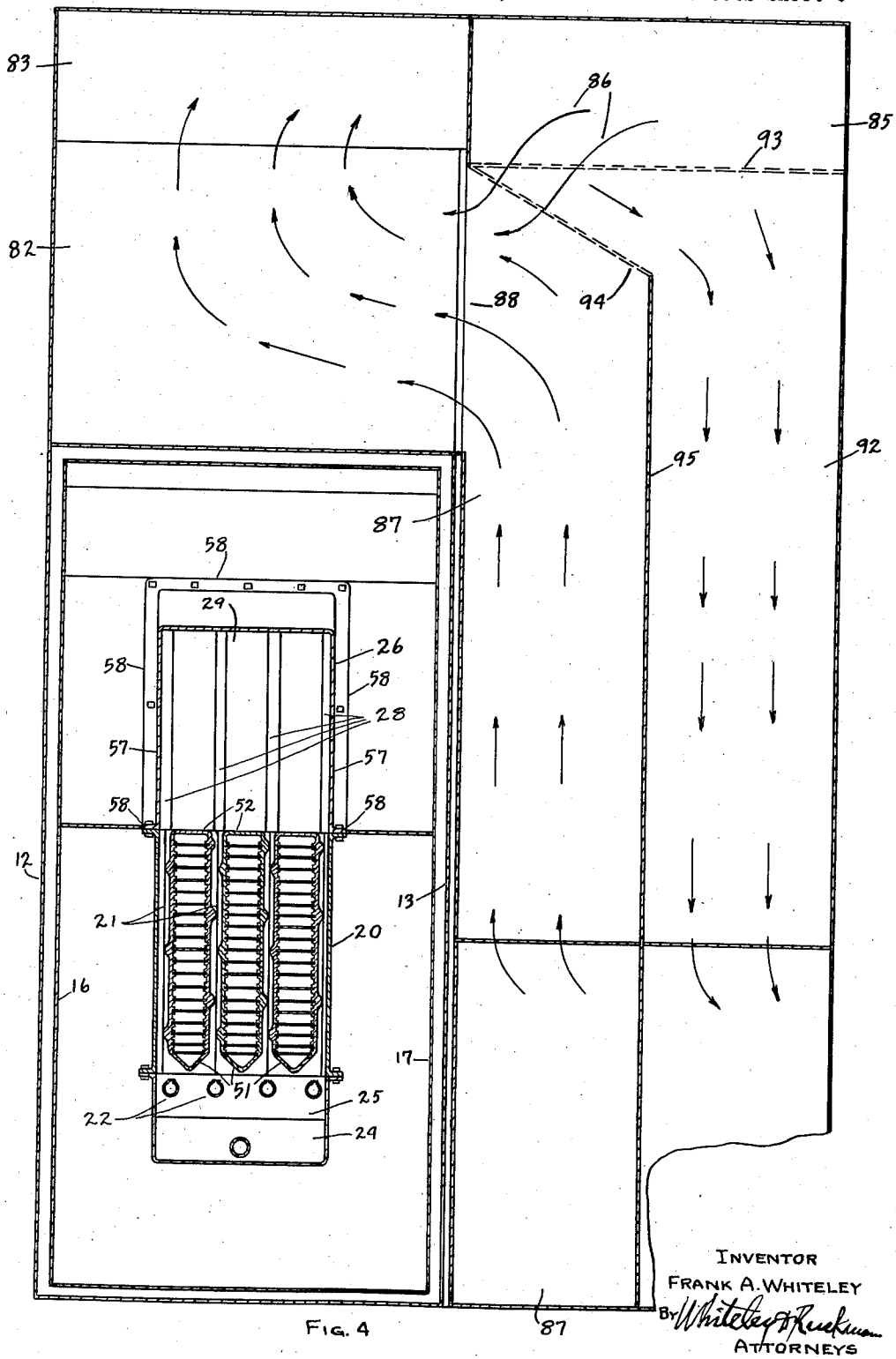


FIG. 4

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AIR-CONDITIONING APPLIANCE

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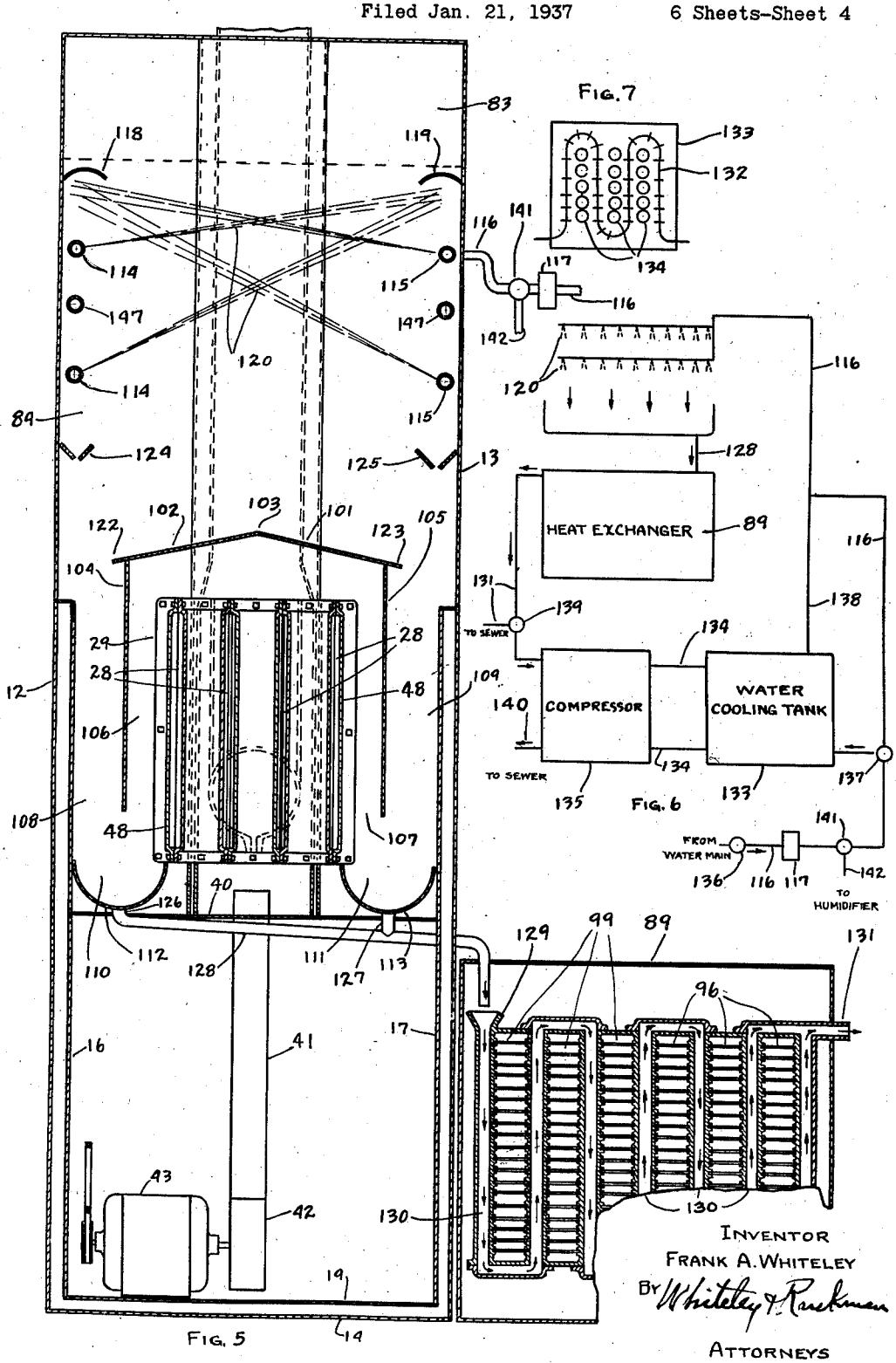


FIG. 7

FIG. 6

FIG. 5

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AIR-CONDITIONING APPLIANCE

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FIG. 10

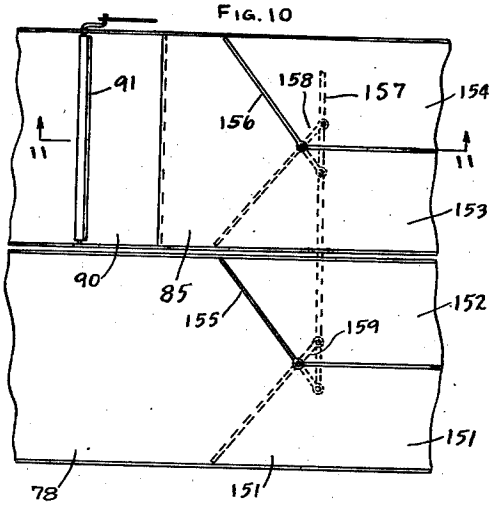


FIG. 9

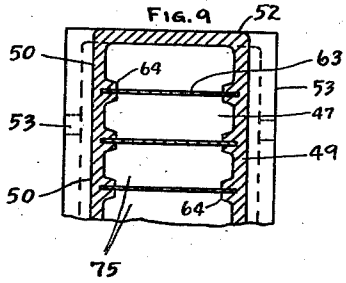


FIG. 11

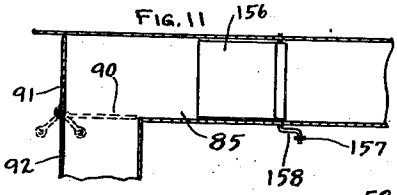


FIG. 8

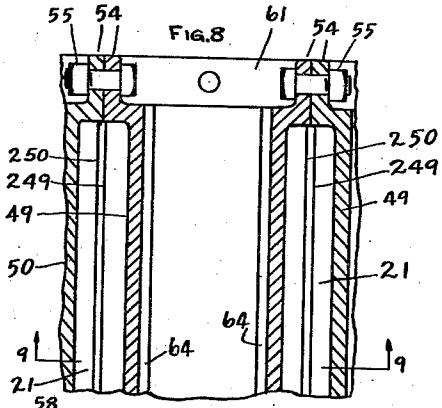


FIG. 12

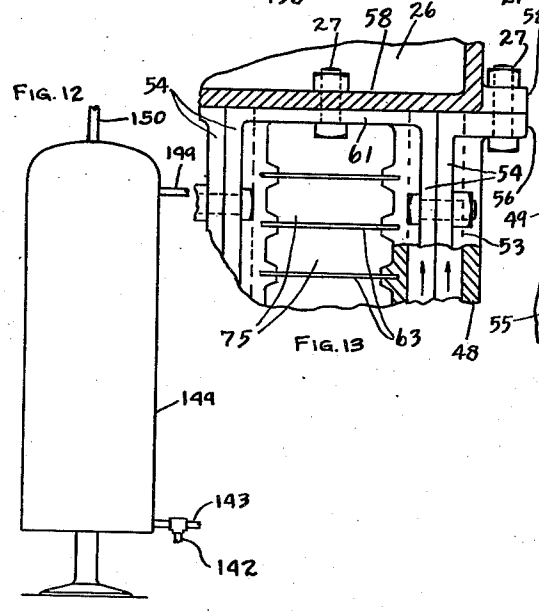
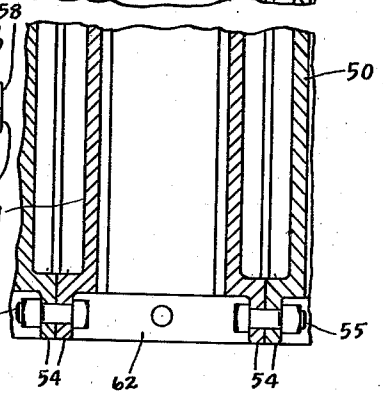


FIG. 13



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AIR-CONDITIONING APPLIANCE

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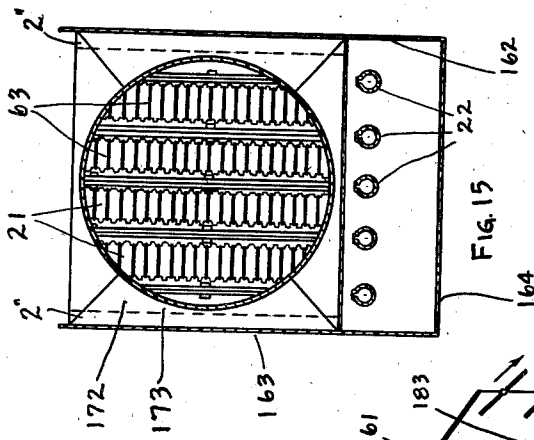


Fig. 15

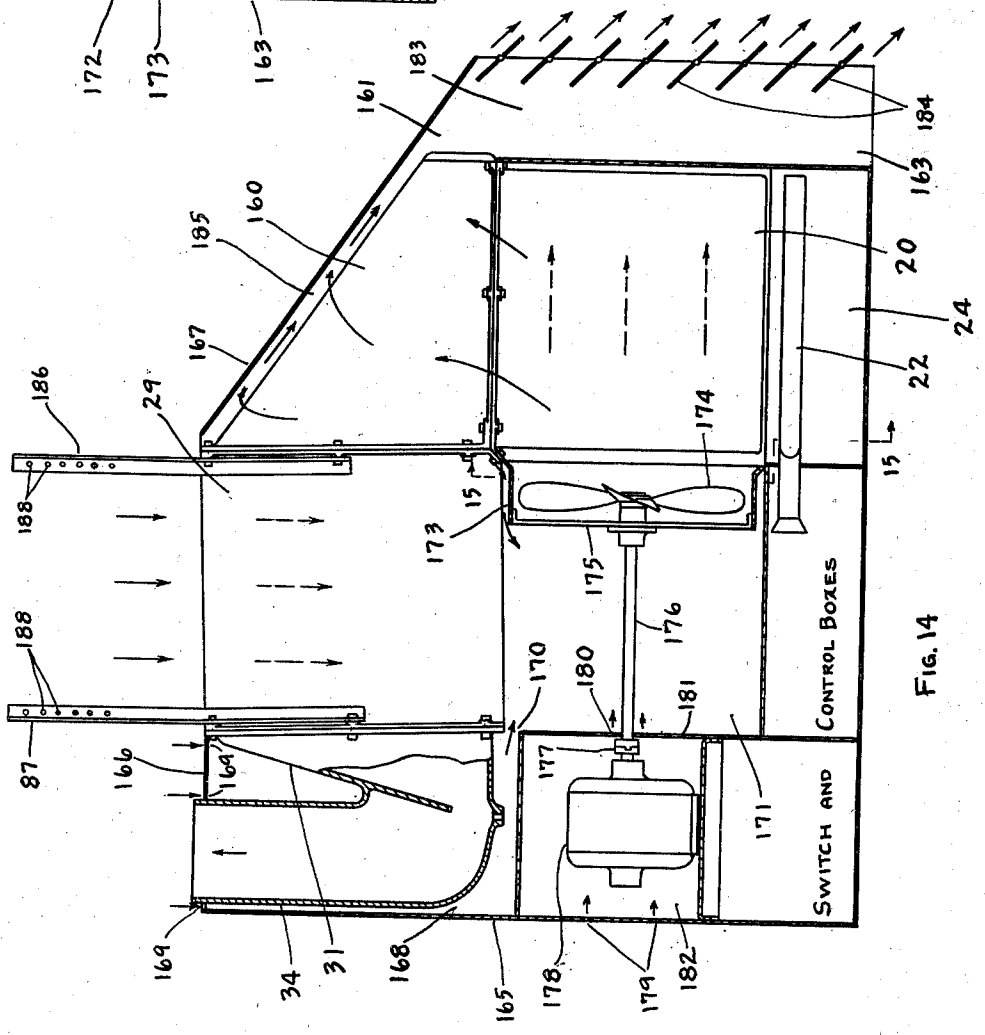


Fig. 14

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UNITED STATES PATENT OFFICE

2,162,394

AIR-CONDITIONING APPLIANCE

Frank A. Whiteley, Covington, Ky.

Application January 21, 1937, Serial No. 121,518

16 Claims. (Cl. 126—116)

My invention relates to air-conditioning appliances, and has for its object to provide a compact and simple mechanism occupying substantially the space usually occupied by the ordinary hot air furnace which will induce and control currents of air drawn through returns from a room or rooms or enclosure or enclosures in which the air is to be conditioned and cause it to move through and be subject to instrumentalities which during that movement will heat the air, impart moisture to it and take from the air the dust and dirt which it carries.

It is a further object of my invention to provide for use in either heating or cooling the air a heat exchanger comprising a hollow air-leg or air-carrying member having cast metal walls, said member being divided into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls.

It is a further object of my invention to provide for heating or cooling the air a plurality of said air legs or air-carrying members each divided into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, said members being secured together so as to provide between pairs of said members extensive passageways of small depth for conveying the medium (either heat as flame and gas, or cold as cold water) along said cast metal walls to effect heat exchange to the air going through said air legs, and providing means for securing said air leg members together.

It is a further object of my invention to provide an air-inlet chamber having therein a secondary heat exchanger through which the smoke or gases of combustion when the appliance is used for heating go from said enclosure or enclosures to and through the appliance and to form this heat exchanger of the same elements as are provided for the primary heat exchanger directly associated with the combustion chamber as above recited.

It is a further object of my invention to provide means in the main casing of the appliance for causing the gases of combustion when the appliance is used for heating to be positively moved through the primary and secondary heat exchanger and to and through the stack.

This application is a continuation in part of my application heretofore filed Serial Number 513,513 for hot-air heating, moistening and cleaning means. It embodies, however, specific means for constructing the several air-legs making up the heat exchangers so that they may readily be united together in any desired number and detailed improvements in the heat exchanger arrangement in the air-inlet chamber and in the means for controlling the air going to and coming from the enclosure or enclosures to be air-conditioned and in the type of air-moistening and cleaning devices.

The full objects and advantages of my invention will appear in connection with the detailed description thereof, and its novel features are particularly pointed out in the claims.

In the drawings, illustrating an application of my invention in one form,

Fig. 1 is a longitudinal sectional elevation view through the main air-conditioning appliance. Fig. 2 is a part sectional plan view taken on line 2—2 of Fig. 1. Fig. 3 is a part sectional plan view taken on line 3—3 of Fig. 1. Fig. 4 is a transverse sectional elevation view taken on line 4—4 of Figs. 1 and 2. Fig. 5 is a transverse sectional elevation view taken on line 5—5 of Fig. 1 and Fig. 2. Fig. 6 is a diagram showing the course of travel of the water when the appliance is used for cooling. Fig. 7 is a schematic diagram indicating the flow of water through pipes immersed in a bath cooled by a compressor operative in connection with the cooling features of the appliance. Fig. 8 is an enlarged view in section of the heat exchanger units showing their formation and manner of uniting to form complete heat exchangers, either primary or secondary. Fig. 9 is a fragmentary sectional view of the top of one of said heat exchanger units. Fig. 10 is a plan view with the top casing removed showing a valve mechanism for controlling movement of air to and from selected groups of rooms. Fig. 11 is a sectional view taken on line 11—11 of Fig. 10. Fig. 12 illustrates the manner of connecting a hot water tank in the water line which furnishes warmed spraying water for humidifying the air during winter air-conditioning. Fig. 13 is a fragmentary part sectional detail taken on line 13—13 of Fig. 1 and on an enlarged scale. Fig. 14 is a longitudinal part sectional side elevation view showing the application of my invention to what is known as a unit heater. Fig. 15 is a sectional view taken on line 15—15 of Fig. 14.

The heating appliance proper comprises a main casing having end walls 10 and 11, side walls 12 and 13, a bottom wall 14 and a top wall 15, all as clearly shown in Figs. 1, 2 and 5. Inner casing side walls 16 and 17, inner end wall 18 and inner bottom wall 19 may be provided suitably spaced from side walls 12, 13, end wall 11 and bottom wall 14, and this space either

may be filled with insulating material such as mineral wool, or it may be open to circulation therethrough of return air in a well-known way.

Within the main casing, as clearly shown in Fig. 1, is positioned a primary heat exchanger 20 formed with a multiplicity of gas-carrying passages 21, Figs. 3 and 8, which receive at their bottoms flame and gases of combustion from burners 22 supplied with fuel gas from valve mechanism controls of well-known construction indicated at 23, burners 22 being located in a combustion chamber 24 which receives the necessary secondary air through a suitable opening such as is shown at 25, Fig. 1. The gases of combustion go from vertical passageways 21 into a chamber formed by a preferably cast casing 26 provided with a clean-out door 271 and secured in gas-tight relation to the primary heat exchanger 20 by flange and bolt connections indicated at 27, in Fig. 1. The gases of combustion reverberate within the casing 26 and go through substantially horizontal passageways 28 in a secondary heat exchanger 29, and from these passages 28 go into a chamber 30 within a smoke hood 31. From the chamber 30 the gases of combustion are constrained to move to its bottom by means of a baffle 32. They pass through opening 33 under baffle 32 and go through a vertical pipe 34. From pipe 34 they go into smoke pipe 35 which leads the gases of combustion to the stack. The smoke pipe 35 is carried by means of a funnel-shaped expander 36 into a pipe 37 which surrounds and is spaced from pipe 34 so as to leave an annular passageway 38, Figs. 1 and 2, about pipe 34. This annular passageway discharges at 39 about the end of pipe 34 and immediately below the funnel 36, which forms a restriction above said annular opening 39 thereto. The pipe 37 has its bottom closed by a wall 40 into which discharges a conduit 41 connected with a small blower 42 which may operate from the shaft of the main blower motor 43. The blower 42 and motor 43 are located within a chamber 44 separated from the main blower chamber 45 by a preferably-insulated partition 46. This arrangement provides a blast of air positively moved by blower 42 which issuing at 39 under the restriction of the conical casing 36 engages the gases of combustion issuing from the end of pipe 34 and frictionally moves them upward into pipe 35, which tends to produce a vacuum within pipe 34 and chamber 30 and thus positively moves the gases of combustion through the primary heat exchanger passages 21, the reverberating chamber in 26, the secondary heat exchanger passages 28 and the chamber 30 and pipe 34 to and through pipe 35 and to and out of the stack.

The primary heat exchanger 20 and the secondary heat exchanger 29 are each formed of identical air-legs 47 shown in detail in Figs. 2, 8 and 9 and side plates 48 shown in Fig. 2. Each of these air legs or air-carrying members comprises a hollow body open at both ends with relatively large extent in two dimensions and small extent in the third dimension, formed of cast metal side walls 49 and 50, and cast end walls 51 and 52, Figs. 2 and 4, the end walls 51 preferably being V-shaped to form flaring openings to the combustion gas passageways 21 as shown in Fig. 4. Walls 49 and 50 are formed on their outside with cast ribs 249 and 250, which, as shown in Figs. 2 and 4, are positioned relatively across the walls 49 and 50 so as to make the passageways 21 and 28 somewhat zigzagged in cross-section for causing turbulence and a wiping action on the walls of the flames and gases going through said passageways. Walls 49 and 50 are also formed at their edges with offset portions or lips 53, as well shown in Fig. 8. And from these lips extend flanges 54 parallel with the walls 49 and 50. By means of bolts 55 extending through the flanges 54 groups of air-legs 47 may be united together, furnace cement being applied to the adjusting faces whereby the combustion gas passage 21 (or 28) are formed along pairs of walls 49 and 50, as clearly shown in Fig. 8. Any number of air-legs 47 may be thus secured together to form heat exchangers of any desired width. The heat exchanger is finished at the sides by means of side plates 48 which are formed with offset portions 53 and flanges 54 in exactly the same manner as the side walls of the air-legs. The plates 48 are also provided with flanges 56 extending outwardly, see Fig. 1 and Fig. 2, which are adapted to form unions with corresponding flanges 58 on hood casting 26 and with flanges 59 on smoke hood 31. The air-legs are also provided with end flange members 61 and 62 corresponding in all particulars with the flange members 54 for similarly forming unions with the casting 26 and the smoke hood 30, as shown in Figs. 8 and 13.

Within the chamber formed by the side walls 49 and 50 of the air-leg members 47 and integrally cast therewith along their sides are a multiplicity of thin plates 63, which may be formed or fabricated in any desired manner, and which are united with the side walls 49 and 50 at the time that the air-legs in their entirety are cast. These plates 63 will preferably be of the same or similar metal as the main walls 49, 50, 51, 52 of the air-legs. When used for heat exchange in heating, a desirable metal for the air-legs is iron, since cast iron exposed to the hot gases of combustion from burning fuel gases or other fuel is resistant to corrosive effects of such gases. When, however, the air-leg is employed for heat exchange in cold air-conditioning, where the walls in practice will usually be exposed to moving water, brass or copper is a desirable metal, since water does not seriously corrode this metal and it has characteristics of rapid heat transfer. In practice the plates employed may be sheet metal such as sheet iron or sheet copper, and will be held in position in molds so when the hot metal for the wall and ends of the air-leg is poured it will envelop the edges of the plates 63 and said edges will be fused into the body of hot metal which will ultimately form the walls of the air-legs. I have found it advantageous to cast ribs of metal 64 along the edges of the plates, as shown in Fig. 9, whereby a little larger body of molten metal surrounds said edges and the fusing of the edges is made more effective and complete.

The arrangement here shown wherein the smoke or gases of combustion pass through the several channels 21 into the reverberating chamber formed by casting 26 through the secondary heat exchanger passages 28 into the smoke heat chamber 30 and thence through pipes 34 and 35 to the stack is such that, until the gases of combustion leave pipe 34 they will contact nothing but cast metal walls such as cast iron, thus insuring a long life. In going through these passages the heat of the combustion gases will be largely absorbed from the heat exchangers by the air being passed through the appliance, so that the moisture carried by the combustion

gases will largely be precipitated in secondary heat exchanger 29 and hood chamber 30. For this reason the heat exchanger 29 is positioned at a slight angle, as clearly shown in Fig. 1, being secured along its bottom edge adjacent the primary heat exchanger 20 by means of bolts 65 going through angularly-disposed flange 66 on secondary heat exchanger 29 and angularly-disposed flange 67 on heat exchanger 20. Because of this dipping downward of secondary heat exchanger 29 the water precipitated as above noted will gravitate into hood chamber 30 and to outlet aperture 68, from which it goes through pipe 69 to the sewer. In order to insure the travel of combustion gases through the above-noted passageways, and to the stack, at their reduced temperatures, as above pointed out the forced draft mechanism heretofore described is employed.

Referring now to the air travel from the room or rooms, or enclosure or enclosures, to be air-conditioned, a blower 70 of standard construction is positioned within chamber 45 heretofore described, said blower being mounted upon standards 71 and driven by motor 43 through belt 72. The blower 70 has connection by means of a union 73 and funnel member 74, Fig. 1, with air passages 75 formed in the air-legs between plates 63 and portions of walls 49, 50. The air is drawn through passages 75 in the secondary heat exchanger 29 from the air intake chamber 76 and goes through passages 75 in the primary heat exchanger 20 to a passage or chamber 77 adjacent end casing walls 11, 18. From there it passes under and around the heat chamber formed by combustion chamber 24, the primary heat exchanger 20 and the top casting chamber 26 to the air-delivery chamber 78 and thence to the hot air-delivery duct 79, see Figs. 1 and 10, from which the hot air is distributed to the different rooms or enclosures to be air-conditioned in a well-known way. The air-delivery chamber 78 is formed by end walls 11, 18 and by preferably insulated partition 80, 81 forming a chamber 82 which discharges through a large opening 83 into the top of an intake chamber 84, as clearly shown in Figs. 1, 4 and 5, from which the air passes first through one or the other of the sprays hereinafter to be described and thence through the secondary heat exchanger back to the blower.

The return air duct for conveying the air from the rooms or enclosures to be air-conditioned is indicated at 85 in Figs. 4 and 10. The return air from duct 85 may go directly, as indicated by arrows 86, Fig. 4, into a vertical passageway 87 and thence through an opening 88 into chamber 82 and from there through opening 83 to air-intake chamber 84, and this arrangement for direct travel of the return air may be employed when the appliance is used for heating. When, however, the appliance is used for cooling, or for heating when it is desired to recover heat otherwise lost from the spray water for moistening, the air will be by-passed through a secondary cooling heat exchanger 89 by the following means: An opening 90, Figs. 10 and 11, is formed across the bottom of return air duct 85. This opening is controlled by a damper valve 91 which in the up position of Figs. 10 and 11 blocks direct flow of return air as indicated by arrows 86 in Fig. 4 and opens the flow of return air to a vertical duct 92. In the down position of damper valve 91, shown in dotted lines in Fig. 11, the vertical duct 92 is closed off and return air from return pipe 85 goes directly to the air-inlet chamber following the course of arrows 86.

As indicated in dotted lines at 93, the duct 92 is expanded by an angularly-disposed partition 94 for the whole width of the air-inlet pipe 85, but is contracted by partition 95 joining 94 to about half that width.

Referring to Fig. 2, the heat exchanger 89 is shown in plan in dotted lines and the travel of the air is there indicated as follows: From vertical duct 92 the air goes through heat exchanger passages 96 in heat exchanger 89, Fig. 5, of substantially the same construction as primary heat exchanger 20 and secondary heat exchanger 29 used for heat, excepting that the air-legs of heat exchanger 89 will preferably be formed of brass and copper or other water-resisting and quick heat transfer material. The air passes through heat exchanger passageways 96 as indicated by the dotted-line arrow 97, Fig. 2, into an end chamber 98 from which it passes back through heat exchanger passageways 99, Fig. 5, following the course of dotted-line arrows 100. From heat exchanger passages 99 the return air goes to vertical air-leg 87, through which it travels to opening 88, chamber 82, through opening 83 and to the air-inlet chamber 84, as heretofore described.

The air-inlet chamber 84 provides in effect a spray tower above the secondary heat exchanger 29. A pair of sloping partitions 101, 102, Fig. 5, meet at 103, the center longitudinally of air-inlet chamber 84, and are united short of their ends with vertical partitions 104 and 105, which form sets of parallel vertical passageways 106, 108 and 107, 109, as clearly shown in Fig. 5. Passageways 106, 108 enter and leave a lower chamber 110 formed by a semicircular bottom wall 112, and passageways 107, 109 similarly empty into a chamber 111 formed by a semicircular bottom wall 113.

A multiplicity of water pipes 114 on one side of inlet chamber or spray tower 84 and 115 on the other side have connection with the water system through pipe 116 and intermediate automatic water valve 117 operated by well-known means to admit water under pressure to pipes 114 and 115 when blower 70 begins operation, and terminate said water flow when the blower ceases operation. Baffles 118, 119 of suitable shape and size are secured to side walls 12 and 13 for restraining upward movement of water along said side walls and causing it to spray back into the air-inlet and spraying chamber 84. When the water is being delivered under pressure two sheets of spray, indicated at 120, move entirely across the chamber 84 in the above directions and the inlet-air moving to the blower is caused to pass through these sheets of spray and move down through outer passages 108, 109 and thence reverse sharply into passages 106, 107, whereby free water will be thrown out by gravity action. The air cooled by contact with cold water from the system and which air is preliminarily cooled as hereinafter pointed out, then goes to chamber 121 above secondary heat exchanger 29 and thence through the heat exchanger passages 75 therein to the blower and to be distributed to the rooms. The water drips from eaves 122 and 123 of top plates 101 and 102, and also from suitably constructed baffles 124, 125, and gravitates to the troughs formed by curved partitions 112, 113. The water from troughs 110, 111 goes through pipes 126 and 127 to a manifold pipe 128 which discharges to re-

celving funnel 129 from which the water travels through the heat exchanger passageways 130 in the heat exchanger 89, finally discharging at the top through pipe 131 which leads to the sewer.

The water may be supplied directly from the city mains, and where its temperature is not higher and preferably lower than 70° F. it will provide effective cooling of the enclosures to be air-conditioned. Where, however, tap water is delivered at too high temperatures it may be cooled, as indicated diagrammatically in Fig. 7, by passing it through an extensive length of fin tubing 132 in a tank 133 containing a heat exchange liquid cooled by evaporator coils 134 from compressor mechanism indicated diagrammatically at 135. The course of water travel through the system is illustrated diagrammatically in Fig. 6. Pipe 116 leads to the water main, being controlled by cut-out valve 136. Pipe 116 passes through automatic valve 117 electrically operated in unison with the blower 70 as hereinbefore pointed out. Pipe 116 then may deliver directly to the sprays 120 and from there excess water delivers through pipe 128 to the heat exchanger 89, and from heat exchanger 89 the water may go through pipe 131 direct to the sewer. In this form of circulation for the cold-conditioning sprays no compressor or preliminary cooling of the water is employed. Where this is done a three-way valve 137 by-passes the water through the cooling tank 133, from which it passes through pipe 138 to pipe 116 and the sprays. Similarly a three-way valve 139 by-passes the water from pipe 131 through the compressor 135 for cooling the compressor and then to waste through pipe 140 to the sewer.

For winter air-conditioning a three-way valve 141 by-passes the water through pipe 142 to where it joins a pipe 143 which at one end enters a hot water tank 144, Fig. 12, and at the other end goes through a heating coil 145, Fig. 1. From the heating coil 145 the water goes to pipe 146 and thence to spray tubes 147, Figs. 1 and 5, where the water is sprayed into the air-inlet chamber 84 for the purpose of moistening and cleaning the air in the wintertime. Excess water flows out of the system through drain pipe 128 and into the heat exchanger 89 in the same manner as when the appliance is used for cold-conditioning. To the extent, therefore, that the water escaping through pipe 128 is heated by passing through the heating coil 145 and adjacent the secondary heat exchanger 29, over and above the heat that the water loses in humidifying the air being conditioned, this heat will be recovered by the incoming air passing through the heat exchanger 89, and in this manner practically all of the heat generated by the burning gas will be recovered and utilized.

Pipe 146 has incorporated in it a three-way solenoid controlled valve 148, of well-known construction, which is normally open to spray pipes 147 and which will automatically be shifted to by-pass the water through pipe 149 to hot water tank 144 by means of a humidostat of well-known construction, not shown, whenever the air in the rooms is sufficiently humidified and to prevent over humidification. In this position the water heated in coil 145 will move into the hot water tank 144 and be withdrawn therefrom through pipe 150, all in a customary way.

In heat exchange for cold air-conditioning a larger volume of air relative to the space being air-conditioned is requisite than in heat air-conditioning. It is also true that in cold air-conditioning the normal living quarters, such as living room, dining room, kitchen and the like is used and occupied during waking hours, while the sleeping quarters, such as bedrooms, are occupied during and just preceding and following the sleeping period. It follows that cold air-conditioning may be effectively carried on by providing means for causing the discharge of the entire volume of air moved by the blower 70 to one or the other of these groups of rooms, thus to the living quarters in the daytime and earlier part of the evening, and to the sleeping quarters in the later part of the evening and the nighttime. This volume of air being sufficient to supply the heating requirements for the entire space of both sets of rooms will relatively greatly increase the volume of air going to either one or the other of said sets of rooms in relation to the total space of such set of rooms. Practically to effect such a distribution I divide the air-delivery passageway 78, Fig. 10, into two parallel passageways 151 and 152, of which passageway 151 will lead to one group of rooms only and passageway 152 to the other group of rooms. Similarly I divide the air-return passageway 85 into passageways 153 and 154, of which passageway 153 will return the air from the same group of rooms to which the air is delivered by passageway 151, and passageway 152 will return the air from the other group of rooms.

Damper valves 155 in air-delivery passageway 78 and 156 in air-return passageway 85 are adapted to simultaneously operate through a link 157 connected with an arm 158 rigid with the damper 156, and a second arm 159 rigid with the damper 155. When the damper is in the full-line position of Fig. 10 all the air delivered from the appliance will go through duct 151 to one group of rooms and all the air returning to the appliance will be drawn through duct 153 from the same group of rooms. When the damper 156 is taken into the dotted-line positions of Fig. 10 all the air delivered by the appliance will go through duct 152 to a second group of rooms, and all of the air drawn from those rooms will go through duct 154 and back to the appliance. It will be obvious that when the damper valve occupies the intermediate position, as it usually will during heating in winter, the full volume of air will be distributed through both groups of rooms.

In Figs. 14 and 15 I have shown a heating assemblage specifically disclosed in Figs. 1 to 5 inclusive in a normal heated air air-conditioner, as applied to a unit heater construction adapted to be suspended in factories, warehouses and the like for giving direct gas-fired heat. In this construction the primary heat exchanger 20, secondary heat exchanger 29, smoke hood 31, discharge pipe 32 and burners 22 are, or may be, the same as shown in the aforesaid Figs. 1 to 5. A reverberating chamber is formed by casting 160 of a modified form provided with a clean-out door 161. A special type of casing is provided comprising parallel side walls 162, 163 and bottom wall 164 and end wall 165, a partial top wall 166 and a sloping top wall 167 above casting 160. The smoke hood 31 and smoke flue 34 are housed in a chamber 168 which admits air through top apertures 169 and discharges through a bottom aperture 170 into a blower chamber 171. Only a small amount of air passes through this portion of the system, enough to

drain away the heat from hood 31 and pipe 34. As shown in Figs. 14 and 15, an adapter 172 embodies a cylindrical extension 173 which forms a housing for the fan or blower 174. A bar 175 across the cylindrical housing 173 forms a support for a drive shaft 176 which is connected by suitable universal joint 177 with driving motor 178. Apertures 179 in end wall 165 and 180 about shaft 176 and inner casing wall 181 permit air to flow through the motor chamber 182 to cool the motor.

The side wall 163 projects somewhat beyond the end of heat exchanger 20, as indicated at 183, and has supported therein a series of damper plates 184 which may be made adjustable for deflecting the heated air downwardly. In operation the air is moved by the fan 174 through secondary heat exchanger 29 and flue chamber 168 to discharge to primary heat exchanger 20 (going through the passageways 21 as indicated in Fig. 15). Some of the air travels about the outside of the heat exchangers and the casting 160 through passageways such as indicated at 185 in Fig. 14, and all of the heated air is caused to move downwardly toward the floor by deflectors 184. For hanging the unit heater suitable members such as the angle iron bars 186, 187 are secured to the secondary heat exchanger 29 and are each furnished with a multiplicity of holes 188 adapted for adjusting a position of the unit heater. It will be obvious that so far as the heating features may go the unit heater of Figs. 14 and 15 will operate to heat the air in the same way and by the same means as the heater arrangement of the hot air furnace shown in other relations.

The advantages of my invention have been very well given in connection with the preceding description. Generally speaking these advantages include a single unit appliance of the general character of a hot air furnace or forced-air air-conditioner in which inexpensive and efficient means for conditioning air for whatever circumstances of use may be required are provided, and which are adaptable for the varying different seasons of the year. For heat conditioning the composite unit air-leg heat exchanger provides a very large area of heat exchange surface and carries the gases of combustion through in contact only with cast iron surfaces, thus adapting it for gas as a fuel. The heat exchange surface is highly efficient in a primary heat exchanger being located entirely close to the gas flame or source of heat, and the secondary heat exchanger receives the cooling gases of combustion and is subject to contact with the cooler incoming air, which may be additionally cooled by being washed and humidified in a water spray. It is further a great advantage in the use of the appliance for heating, either as a home forced-air air-conditioner or as a unit heater for factory use, that both primary and secondary heat exchangers are formed of the same air-leg sections and that the use of such sections makes it simple and easily practicable to have the heat exchangers of any desired width simply by employing a greater or less number of the individual air-legs.

The entire organization to whatever use it may be put, is not only compact and cheap to construct, but extraordinarily efficient relative to its weight and cubical contents.

I claim:

1. A hot-air heating plant comprising a casing forming a fire chamber, an air-carrying member extending across said fire chamber having cast iron walls, said member being divided into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, an air-intake chamber, an air-delivery chamber, and means for positively moving the air to be heated from the air-intake chamber through said air passageways and to the air-delivery chamber.

2. A hot-air heating plant comprising a casing forming a central fire chamber and air chambers at the ends thereof, a multiplicity of air-carrying members extending across said fire chamber between said last-named chambers, each having cast iron walls spaced from one another and from the walls of the fire chamber, each of said members being divided into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, and means for positively moving the air to be heated from one of said chambers to the other.

3. A hot-air heating plant comprising a casing forming a central fire chamber, an air-delivery chamber above, an air-intake chamber and a transfer chamber at the ends thereof, a multiplicity of air-carrying members extending across said fire chamber between said last-named chambers each having cast iron walls spaced from one another and from the walls of the fire chamber, each of said members being divided into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, means for positively moving the air to be heated from one of said chambers to the other and from there to the air-delivery chamber, and a gas burner positioned to direct flame and gases of combustion through said spaces.

4. In a hot-air heating plant comprising a casing forming a central fire chamber, air chambers at the ends and embodying a fan for moving the air, a heat exchanger comprising a multiplicity of air-carrying members each embodying a multiplicity of substantially rectangular ducts arranged in a vertical series and extending across said fire chamber between the end chambers and conjointly dividing the fire chamber into upper and lower compartments, each member having cast iron walls spaced from one another and from the walls of the fire chamber to form horizontally-elongated relatively narrow vertical passageways between said upper and lower compartments, and gas burners positioned to direct flame and combustion gases through said passageways.

5. In a hot-air heating plant comprising a casing forming a central fire chamber, air chambers at the ends and embodying a fan for moving the air, a heat exchanger comprising a multiplicity of air-carrying members extending across said fire chamber between said end chambers, each member having cast iron walls spaced from one another and from the walls of the fire chamber to form elongated, relatively narrow vertical passageways, each of said members being divided into a multiplicity of shallow broad air ducts by thin plates integrally cast at their sides in the cast metal walls, and gas burners positioned to direct flame and combustion gases through said passageways.

6. In a hot-air heating plant comprising a casing forming a central fire chamber, air chambers at the ends and embodying a fan for moving the air, a heat exchanger comprising a multiplicity of air-carrying members extending across said fire chamber between said end chambers, each member having cast iron walls spaced from one another and from the walls of the fire

chamber to form elongated relatively narrow vertical passageways, gas burners positioned to direct flame and combustion gases through said passageways, and a secondary heat exchanger in one of said end chambers for thereafter conveying gases of combustion from the heat chamber to the stack.

7. In a hot-air heating plant comprising a casing forming a central fire chamber, air chambers at the ends and embodying a fan for moving the air, a heat exchanger comprising a multiplicity of air-carrying members extending across said fire chamber between said end chambers, each member having cast iron walls spaced from one another and from the walls of the fire chamber to form elongated relatively narrow vertical passageways, said vertical passageways having projections to cause the gases passing through them to move in an irregular path and impinge alternately upon said walls, and gas burners positioned to direct flame and combustion gases through said passageways.

8. A hot-air heating plant comprising a casing forming a central fire chamber and air chambers at the ends thereof, an air-carrying member extending across said fire chamber and opening into the end chambers having cast iron walls subject to the gas and flame in the fire chamber and being divided into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, and means for positively moving the air to be heated through said air passageways from one of said chambers to the other.

9. A gas furnace comprising a casing forming a central fire chamber with air chambers on each side thereof, a plurality of hollow rectangularly-elongated metal heat exchangers extending directly across the fire chamber, said heat exchangers having cast metal walls spaced apart so as to form narrow substantially horizontal passageways extending across the fire chamber and opening into the air chambers from top to bottom thereof and forming substantially vertical passageways between adjacent pairs of heat exchangers, a multiplicity of metal plates having their edges cast into said cast metal walls which divide the horizontal passageways into numerous smaller horizontal passageways, a gas burner below and close to the lower opening of each vertical passageway to cause flame and gases of combustion to heat said walls and plates, and means to move air from one air chamber through all said horizontal passageways to the other air chamber.

10. In air-conditioning appliances, a heat exchanger comprising a cast metal open-ended air-leg having spaced side walls, said air-leg being divided within said walls into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, and means adapted to be attached to said air-leg to form open-ended passageways on the outsides of said walls for constraining a heat exchange medium to move in contact therewith.

11. In air-conditioning appliances, a heat exchanger comprising a cast metal open-ended air-leg having spaced side walls, said air-leg being divided within said walls into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, and means adapted to be attached to said air-leg to form open-ended passageways on the outsides of said walls for constraining a heat exchange medium to move in contact therewith, said last-named passageways extending along said walls in a direction at right angles to the first-named passageways.

12. In air-conditioning appliances, a heat exchanger comprising a cast metal open-ended air-leg having spaced side walls, said air-leg being divided within said walls into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, and means on said walls whereby a plurality of said air-legs may be attached together to form open-ended passageways between pairs of air-legs for constraining a heat exchange medium to move in contact with the walls thereof.

13. In air-conditioning appliances, a heat exchanger comprising a cast metal open-ended air-leg having spaced side walls, said air-leg being divided within said walls into a multiplicity of air passageways by thin plates integrally cast at their sides in the cast metal walls, and flanged ribs formed at the margins of said walls and extending at right angles to said air passageways with faces parallel to the walls for securing a plurality of said air-legs together to form open-ended passageways on the outsides of said walls for constraining a heat exchange medium to move in contact therewith.

14. In air-conditioning appliances, a casing forming a fire chamber, an air-inlet chamber and an air-delivery chamber, an air-carrying member extending across said fire chamber having cast metal walls, subject to the heat generated in the fire chamber, said member being divided into a multiplicity of air-passageways by thin plates integrally cast at their side edges in the cast metal walls, an air-carrying member extending across the air-inlet chamber having cast metal walls also subject to the heat generated in the fire chamber, said member being divided into a multiplicity of substantially vertical air-passageways by thin plates integrally cast at their side edges in the cast metal walls, and means for positively moving the air to be heated through all said air-passageways, about the heat chamber and to the air-delivery chamber.

15. A heat exchanger system comprising a casing forming a central chamber with end chambers on each side thereof, a plurality of hollow rectangularly elongated metal heat exchangers extending directly across the central chamber, said heat exchangers having cast metal walls spaced apart so as to form narrow, substantially-horizontal passageways extending across the central chamber and opening into the end chambers from top to bottom thereof and forming vertical passageways between adjacent pairs of heat exchangers, a multiplicity of metal plates having their edges cast into said cast metal walls which divide the horizontal passageways into numerous smaller horizontal passageways, means to move an exchange medium through the vertical passageways to temper said walls and plates, and means to move air from one end chamber through all said horizontal passageways to the other end chamber.

16. In air-conditioning appliances, a casing formed with air-inlet and air-outlet parts, a blower in the air-inlet part for moving air through the air-inlet part and into and out of the air-outlet part, a primary heat exchanger in the air-outlet part comprising vertical combustion gas passageways and intermediate horizontal air passageways, a secondary heat exchanger in the air-inlet part comprising horizontal combustion gas passageways and intermediate ver-

tical air passageways, said heat exchangers positioned adjacent each other at an upper corner of one and a lower corner of the other, respectively, and all said combustion gas passageways being of cast metal, and a cast metal hollow member having side walls at right angles to each other united with walls of the said heat exchanger and forming a chamber for receiving combustion gases from the primary heat exchanger and conducting said gases to the secondary heat exchanger.

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