

Dec. 3, 1935.

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AIR HEATING AND CONDITIONING DEVICE

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2 Sheets-Sheet 1

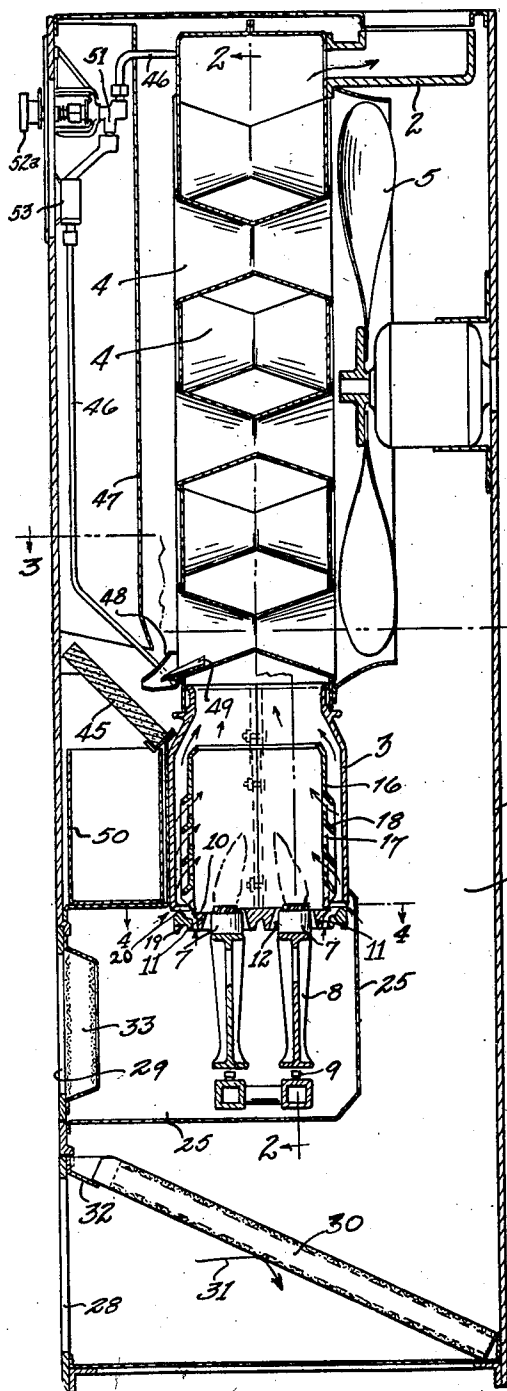


Fig. 1.

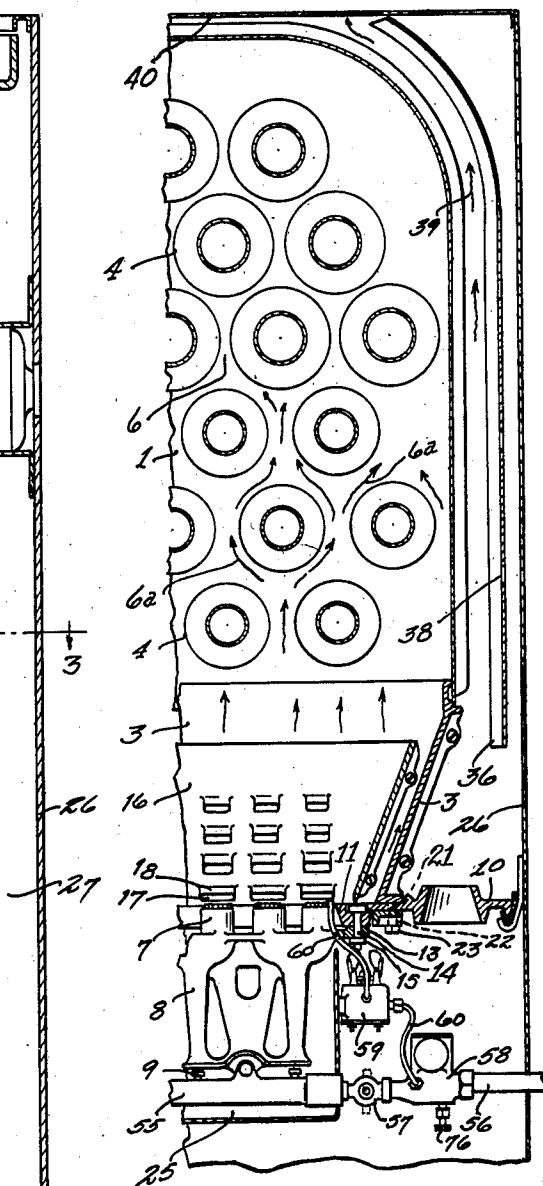


Fig. 2.

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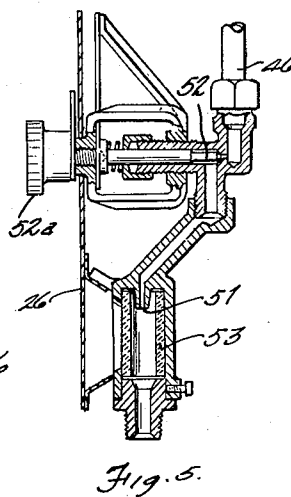
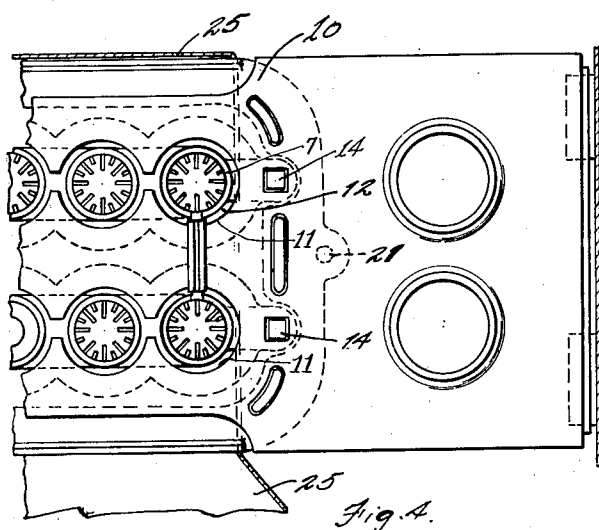
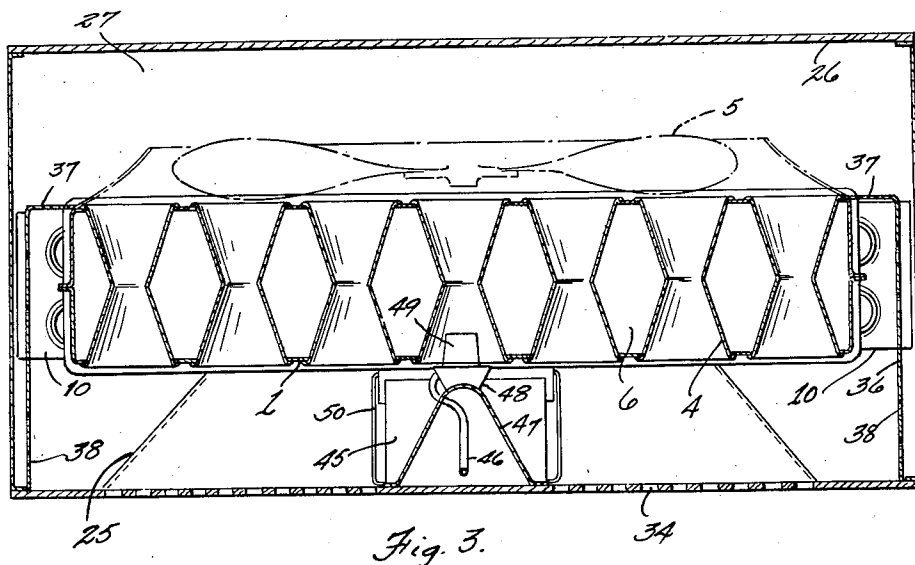
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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,023,136

AIR HEATING AND CONDITIONING  
DEVICE

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Application February 23, 1934, Serial No. 712,603

8 Claims. (Cl. 257-171)

This invention relates to an air heating and conditioning apparatus and particularly to a new and improved gas heater for household use.

One of the principal objects of the present invention is to effect efficient combustion of the fuel and utilization of the resultant heat.

A correlative object is to provide a new and improved heat exchanging head for use in forced heat circulating systems which is efficient and quiet in operation.

Additional objects are to humidify the air in an efficient manner preparatory to discharge of the same into the room, to maintain an efficient circulation of air in the room.

Other objects and advantages will become apparent from the following specification wherein reference is made to the drawings in which

Fig. 1 is a vertical sectional view of a preferred form of apparatus embodying the present invention;

Figs. 2, 3 and 4 are sectional views of the apparatus taken on the planes indicated by the lines 2-2, 3-3 and 4-4 respectively of Fig. 1;

Fig. 5 is an enlarged vertical sectional view of the regulating valve for controlling the degree of humidity of the air.

For purposes of illustration, the important features of the present invention are shown as embodied in a heater which is adapted to be installed readily and directly in the room or compartment to be heated, the application thereof to heaters for other purposes being clearly apparent from this disclosure.

The heater comprises a hollow radiating head 1, preferably disposed in an upright position and having, near the top, an exhaust flue 2 discharging into a suitable stack, or, if desired, into the room to be heated. Mounted beneath the radiating head 1 is a combustion chamber 3 which is open at its upper end and communicates through the upper end with the interior of the hollow radiating head, the combustion chamber and head preferably being in sealed engagement with each other so that all products from the combustion chamber enter the interior of the head and escape therefrom into the outside atmosphere only through the flue 2.

In order to effect the most efficient utilization of the heat from the combustion chamber, the radiating head is provided with a plurality of transverse air heating tubes 4. The tubes 4 extend entirely across the interior of the head from front to rear and are in sealed engagement with the front and rear walls thereof so as to permit the passage of air through the tubes into the

room and, at the same time, maintain said air out of contact with the products of combustion from the combustion chamber 3.

In general it is desirable to use a forced draft for circulating the air through the tubes 4 and for this purpose a blower, or a motor driven propeller fan, such as indicated at 5, may be provided. If a propeller fan is used, it is preferably arranged immediately in the rear of the radiating head so as to reduce friction losses and more effectively utilize the velocity head. It is well known that in the case of forced drafts, disagreeable noises are often occasioned by the impingement and abrupt deflection of the air against and from obstacles in its path of travel and eddy currents occasioned thereby. In order to eliminate any such disagreeable noises and at the same time to obtain a higher efficiency not only in air circulation but also in utilization of the heat from the radiating head, the air passages of the tubes 4 are in the form of Venturi tubes, the passages each being contracted from both ends toward an intermediate or midportion. By forming the tube passages in this manner, the air may flow more readily thereinto and offer less resistance to the fan. Since the contraction of each of the tube passages from its inlet ends toward its midportion is gradual, very little resistance to flow is occasioned, eddy currents are reduced, and, at the same time, all of the air is brought more intimately in contact with the inner wall surfaces of the tubes. However, when the air has passed along the tube passages a material distance, for example to about the midportion, it has absorbed a large quantity of heat therefrom and consequently would normally expand and build up a back pressure. However, since each of the tube passages gradually expands from its intermediate portion toward its discharge end, the air is free to expand readily with the results that back pressure is substantially eliminated, and the expansive pressure is transformed into velocity and utilized for discharging the air into the room.

Referring particularly to Fig. 1, the degree of slope of the walls of each of the tube passages relative to its axis from both ends toward its midportion is preferably from 11 to 15 degrees. It has been found that this degree of slope is highly efficient both so far as concerns the elimination of noise and the reduction of back pressure. Other advantages resulting from the formation of the air passages through the tubes in the manner described are that greater heat radiating wall surface is exposed to the air than

would be the case were the tube passages cylindrical or of uniform cross section throughout their length and of the same capacity, and also the air passing through the tubes is brought into more intimate contact with the walls.

Each of the tubes 4 is preferably made in the form of a shell so that the outer wall surfaces are contracted from both ends toward an intermediate portion in the same manner as the air passage therethrough. Several advantages result from this external formation of the tubes. In the first place, a larger surface area is exposed to the hot gases and products of combustion discharged into the interior of the head than in the case of tubes of uniform cross section, so that a larger proportion of the heat of the products may be absorbed. Furthermore, due to the shape of the tubes, a larger number can be placed within a head of given size without choking the passage therebetween through the interior of the head. Referring to Fig. 3, it is apparent that the resultant passages 6 between the tubes is much larger than would be possible were each of the tubes of uniform cross section and the same diameter at its ends throughout its length and at the same time a larger tube surface is exposed to the heated products than would be the case were the tubes cylindrical and of a diameter equal to the average diameter of the tubes illustrated.

In order to insure that substantially the entire circumference of each tube will be contacted or "washed" by the products of combustion passing upwardly through the head 1, the tubes are arranged in rows, each row extending substantially across the full width of the radiating head and the tubes of each row being spaced apart a slight distance from each other. The tubes of each row are staggered with respect to the tubes of adjacent rows so that each tube acts as a deflector for causing the products of combustion to pass around the upper surface of the two adjacent tubes of the row beneath and each pair of adjacent tubes in the same row, in turn, deflect the products around the upper surface of the tube therebetween in the row below, as indicated by the arrows 6a in Fig. 2.

Since the lower tubes are first subjected to the intense heat directly from the combustion chamber, they ordinarily would tend to receive a greater proportion of the heat from the products than would the rows of tubes thereabove and more remote, and thus the heat distribution from the head would be uneven and the efficiency of radiation decreased. To overcome such a disadvantage, the tubes of the lower rows, for example, the three lower rows, are of smaller external and internal diameter than those of the rows thereabove and are positioned with their centers the same distance apart both vertically and transversely as those in the upper rows, thus forming larger passages therebetween so as to permit the products of combustion to flow readily to the upper tubes. The more rapid passage of the products around these bottom tubes is substantially offset by the fact that a greater unit tube surface area per unit of air passage through the tube is exposed to the products and the contact of the air with the tube walls is more intimate, as described, and also by virtue of the fact that the gases that finally reach the upper tubes have already lost an appreciable portion of their heat. It appears that with the arrangement illustrated, the temperature of the air discharged from the head is substantially uniform.

The radiating head and air heating tubes may

be made of any suitable refractory material but are preferably made of sheet steel which has a high conductivity for transferring the heat from the products of combustion into the air passed through the tubes.

It is desirable that the actual flame of the burning fuel used for heating the head is not impinged upon any metallic surface, as this not only decreases the efficiency of combustion and causes the production of carbon monoxide, but also tends to cause carbonaceous deposits on such surface and thereby reduce its heat absorbing and radiating qualities.

Since the interior of the radiating head is not readily accessible for cleaning and since the gases discharged therefrom are often discharged directly into the air of the room, such impingement must be eliminated and only the heated products of combustion, free from unburned suspended matter, passed into the interior of the radiating head. To accomplish this result and at the same time afford efficient combustion of the fuel, a combustion chamber and burner means arranged as illustrated in Figs. 1 and 2 may be provided. The chamber 3 comprises a shell body open at the top, as described, to discharge into the interior of the radiating head and closed at the bottom except insofar as necessary to permit the discharge of fuel therein from the burner means and the admission of secondary air for sustaining combustion. In the form illustrated, a double row of gas burners 7 is used, these burners being arranged to discharge upwardly into the combustion chamber 3 from the lower end thereof. The burners are provided with suitable depending mixing tubes 8, each mixing tube being open at the bottom to receive gas discharged from a suitable supply manifold through a corresponding nozzle 9 spaced below the lower end of the mixing tube with which it is associated, so as to induce primary air therein. Mounted on the bottom of the combustion chamber is a floor plate 10 for controlling the admission of secondary air to the burners and interior of the combustion chamber. The floor plate 10 substantially closes the lower end of the combustion chamber except for a plurality of air inlet ports 11. Each port is positioned to surround one of the burner heads 7 and is of slightly larger diameter than the burner head with which associated so as to define therewith an annular air passage 12. The ports 11 are flared outwardly toward the bottom so that, upon raising or lowering the burners 7 relative to the floor plate 10, the size of the annular passages 12 are decreased and increased respectively. Consequently the amount of secondary air entering the passages 12 may be varied so as to obtain the most efficient combustion with the particular quality of gas being used and a stream of air surrounding each burner so that it may become mixed quickly with the burning mixture from the burners is provided.

In order that the burners may be raised or lowered conveniently, the burners of each row are rigidly secured together and there is provided on the end burners of each row, suitable lugs 13, tapped to receive bolts 14 depending from the floor plate 10, the bolts being threaded to receive a suitable adjusting nut 15 which may be moved for raising and lowering the burners to the desired positions.

The combustion chamber is of such height that when the burners are operating at full flow capacity the burner flames terminate below the lower row of tubes 4 and no impingement of burning

material thereon is occasioned. In order to prevent the flames of the burners from impinging on the side walls of the combustion chamber itself or of the radiating head, and to maintain them nearer the midportion of the chamber, a register 16 is provided within the combustion chamber, the register 16 preferably completely surrounding the burner flames and the side and end walls thereof being in spaced relation to the corresponding walls of the combustion chamber. The side walls of the register are provided with vertical rows of elongated air ports 17, these rows being spaced along the length of the walls and preferably arranged with rows aligned transversely of the combustion chamber alongside of a corresponding one of the burners 7. The lower ports 17 are preferably of larger area than the upper ports, the intermediate ports being proportionately graduated in size from bottom to top. Arranged at these ports are baffles 18, one baffle to each port, the baffles sloping downwardly outwardly of the register so as to direct air rising between the side walls of the combustion chamber 3 and the register 16 inwardly and upwardly through the ports. The baffles 18 may be conveniently formed by bending outwardly at an angle of about 45°, the material punched out for forming the ports 17. It is obvious, however, if air is admitted at the bottom into the space between the register and combustion chamber walls that it will readily flow upwardly and be deflected inwardly and impinge on the flame from the burners, thus forcing both rows of flames toward the midportion of the chamber and maintaining the upper portions of the flames near the center of the register. Since the larger ports are near the bottom, the air supplied to the flames therethrough is more nearly proportionate to the amount of unconsumed fuel passing the particular ports. The tertiary air thus supplied provides an air wash for the side walls of the combustion chamber 3 and maintains the walls at a comparatively low temperature. Thus additional or tertiary air supplied to the burners may be heated preparatory to admission to the flame and recuperates heat from the side walls of the combustion chamber and maintains it at a lower temperature, at the same time maintaining the burner flames in proper position.

In order to admit air readily in regulated volumes between the register 16 and combustion chamber walls, a damper 19 is provided, this damper surrounding the plate 10 and terminating outwardly at the lower edges of the walls of the combustion chamber 3. The outer margin of the damper 19 which engages the lower edges of the combustion chamber walls is beveled at an angle of 45°, as indicated at 20, so that upon raising and lowering of the damper 19 relative to the combustion chamber, the passage between the damper and combustion chamber walls is increased and reduced rapidly.

For effecting vertical adjustment of the damper 19, it is provided at each end with a suitable bore 21 adapted to receive a threaded lug 22 depending from the floor plate 10. A nut 23 is provided on the protruding end of the lug 22 for raising and lowering the damper 19.

Since drafts may extinguish the burner flames or decrease the efficiency of combustion, the primary, secondary and tertiary air supplied to the burners and combustion chamber is preferably admitted therein through a duct 25, this duct being in sealed engagement with the combustion chamber 16 and surrounding the burners and

feed manifold. The duct 25 is separate from the inlet of the circulating duct later to be described, and has a separate air inlet. Thus all the air entering the duct 25 passes around the burner structure, through the combustion chamber and radiating head and is not discharged except through the exhaust flue 2.

In order to protect the apparatus and at the same time provide a circulating duct for the air or medium to be heated the entire apparatus 10 is enclosed in a cabinet 26 which is preferably of metal or other fireproof material. The radiating head 1 and combustion chamber are mounted within the casing 26 in spaced relation to all the walls thereof. The radiating head, combustion chamber and walls of the duct 25 form with the cabinet walls an air inlet duct 27. The duct 27 preferably opens to the room through the front wall of the cabinet 26 beneath the duct 25, a suitable grille 28 being provided in the front 20 of the inlet end thereof. Since the inlet end of the duct 27 is near the level of the floor of the room in which the apparatus is exposed, the cold air in the room is drawn readily from near the floor level and the warm air discharged at a considerable distance above the level of the floor. In this manner complete circulation of the air is effected. The duct 25 likewise opens through the front wall of the cabinet 26 and is also covered by a suitable grille 29.

In order to clean the circulating air and thus remove a large amount of foreign matter and to prevent stirring up any appreciable amount of dust and suspended matter and causing the apparatus to become coated therewith, a filter screen 30 is provided in the duct 27 between its inlet end and the radiating head and preferably in advance of the fan. The filter screen, if desired, may be any of the commercial screens readily obtainable. It is disposed with its forward end near the top of the air inlet passage of the duct 27 and is inclined downwardly rearwardly therefrom so that any larger particles of foreign matter entering the duct 27 strike the screen and are deflected downwardly, as indicated by the arrows 31, and entrapped on the floor of the duct. Lighter suspended matter is filtered out of the air as it passes through the screen. If desired, the grille 28 may be made removable and may carry the support 32 for the forward end of the screen 30 so that the grille may be readily removed and the screen drawn out through the inlet opening for cleaning or replacement. It is equally desirable that the air supplied to the burners be clean not only to protect the apparatus 55 from deposits but also to eliminate the hazard of any suspended matter becoming ignited as it passes the burners and discharging through the flue 2 into the room while still burning. For filtering this air a filter screen 33 is provided in the inlet end of the duct 25.

The portion of the front wall of the casing 26 in alignment with the radiating head is likewise provided with a suitable grille work 34 so as to permit free passage of the air outwardly into the room and yet protect occupants of the room from contact with the radiating head. Heating of the side walls of the cabinet 26 is prevented by baffle walls 36. These baffle walls extend along each side of the radiating head in spaced relation 70 thereto and to the side walls of the cabinet 26, and may be arranged so as to prevent passage of the air from the rear of the heating head forwardly between them and the sides of the head, end walls 37 being provided for this pur- 75

pose. The walls 36 are provided with rows of spaced openings 38 so as to permit circulation of air between the baffle walls and the side walls of the cabinet 26 and into the room, thus air washing these walls to maintain them at a comparatively low temperature. The baffle walls 36 terminate in spaced relation to the floor of the cabinet so that air from the duct 27 may rise readily on both sides thereof. In this manner the air rising between the radiating head and the walls 36 is utilized to absorb the heat radiated from the side walls of the head, the air thus heated flowing upwardly along the sides of the head, as indicated by the arrows 39, and discharging at the top of the casing through a suitable grille 40. Consequently all of the heat radiated from the head is continuously absorbed by the medium to be heated and fully utilized in heating the room. A satisfactory upward flow of air upwardly in this manner is occasioned by the heating thereof.

For humidifying the heated air circulating from the heater, a hot plate 45 is provided. In the form illustrated, the plate 45 is disposed near the lateral center of the radiating head, as better illustrated in Fig. 3, and is disposed so that air from the lower heating tubes is discharged thereagainst. The plate slopes upwardly forwardly from the head so as not to unduly impede the flow of air thereacross and rests with one end adjacent the combustion chamber 3. If desired, a passage may be provided through the side wall of the combustion chamber 3 and the plate may extend thereinto so as to be more effectively heated. Water is supplied to the plate 45 through a tube 46 which may be enclosed in a suitable housing 47 to prevent undue heating of the tube 46 and steaming of the water therein. The discharge end of the tube 46 discharges through a suitable spray nozzle which is formed by deflecting duct 48 and deflector 49 and is operable to direct the air from one of the lower tubes 4 onto the plate at relatively high velocity. The tube 46 discharges into the duct 48 beneath one of the deflectors 49 so that the air rushing across the top of the deflector tends to siphon the water out of the tube 46 and spray it onto the plate 45.

The plate 45 is of fire clay instead of metal as it is found that the evaporation of water from hot fire clay does not produce any objectionable odors as would the metal. The water vapor rising from the plate 45 passes into the path of air discharged from tubes 4 and is carried thereby into the room. A drip pan 50 is provided below the plate 45 so that in case of any excess moisture the same can be entrapped temporarily and gradually evaporated. The water is supplied through a drip nozzle 51 connected with the tube 46. Referring particularly to Fig. 5, this drip nozzle 51 is connected with a needle valve 52, having an operating knob 52a accessible from the front of the casing 26 and is readily operable from the outside of the compartment for controlling the flow of water. The nozzle 51 is arranged to discharge downwardly into the lower part of the conduit 46 which leads to the atomizing nozzle 48, a suitable glass tube 53 being provided in the line and visible through the front of the casing 26 so that the continuance and rate of flow is readily discernible. By this arrangement a controlled supply of water may be evaporated and passed into the room.

As above stated a blower may be used instead of the propeller fan 5 in which instance it could be installed on the floor of the air duct 27. A

change in the direction of the flow of air from the blower would not appreciably reduce the efficiency due to the fact that a blower would depend upon a pressure head built up within the duct 27 instead of a straight velocity head such as caused by the fan 5.

To render the operation of the apparatus substantially automatic, the flow of gas and water and the operation of the fan may be controlled in the following manner. Referring to Fig. 2, for example, gas is supplied to the burners from a manifold 55 to which, in turn, gas is supplied from a conduit 56. Connected between the conduit 56 and the manifold is a manually operated valve 57 for regulating the rate of flow of gas and, if it is desired to circulate cool air only, for stopping the flow. Between this valve and the conduit 56 is a solenoid control valve 58. Gas is also supplied from the solenoid valve to a pilot light 59 through a suitable conduit 60.

It is apparent from the foregoing description that the apparatus provided not only heats, circulates, cleans and humidifies the air, but also effects these results in a highly efficient manner and by means of a simple, compact and durable apparatus.

Having thus described my invention, I claim:

1. In a heating device, a hollow radiating head, means to circulate heating media through the interior thereof, a plurality of rows of closely spaced tubes extending through said head across the path of travel of the heating media, said tubes being uncommunicated with the interior of the head and open at both ends for passage of air to be heated therethrough, and the leading tubes in the direction of flow of the heating media being of smaller cross sectional area exteriorly than the tubes farther along the path of travel of said heating media and spaced to provide a larger passage between adjacent smaller tubes for passage of the heating media therebetween than between adjacent larger tubes, and the axes of all said tubes being uniformly spaced from each other.

2. A heat exchanging head comprising a hollow body having substantially upright front and rear walls, and being open at the bottom portion for admitting heating media into the interior and having an exhaust passage at the upper portion for permitting escape of said media, a plurality of closely spaced rows of tubes extending from the rear wall to the front wall across the interior of the body portion between the open bottom and the exhaust passage, said tubes of each row being closely spaced from each other and being sealed from communication with the interior of the body and being open at the front and rear, and being contracted gradually in cross section from their ends toward their intermediate portion both interiorly and exteriorly, whereby a large air capacity through the tubes and passage for heating media around the tubes may be provided in a relatively small body.

3. A heat exchanging head comprising a hollow body having substantially upright front and rear walls, and being open at the bottom portion for admitting heating media into the interior and having an exhaust passage at the upper portion for permitting escape of said media, a plurality of closely spaced rows of tubes of circular cross section extending from the rear wall to the front wall across the interior of the body portion between the open bottom and the exhaust passage, said tubes of each row being closely spaced from each other being sealed from communication with

the interior of the body and being open at the front and rear, and being contracted gradually in cross section from their ends toward their intermediate portion both interiorly and exteriorly, whereby a large air capacity through the tubes and passage for heating media around the tubes may be provided in a relatively small body.

4. A heat exchanging head comprising a hollow body having substantially upright front and rear walls and an exhaust passage at the upper portion, the bottom of the body being open to admit heating media, a plurality of rows of closely spaced Venturi tubes extending from front to rear across the interior of the body and sealed from communication therewith, and contracted in cross section both interiorly and exteriorly, said tubes being open at the front and rear and being positioned relative to each other to deflect the heating media passing from the bottom to the exhaust passage around and in intimate contact with the entire periphery of the tubes.

5. In a heating device, a heat exchanging head comprising a hollow body thereabove having an exhaust passage and being open at the bottom to receive heating media rising upwardly thereinto, said body being substantially upright, a plurality of rows of closely spaced Venturi tubes extending from front to rear across the interior of the body and sealed from communication therewith, and contracted in cross section both interiorly and exteriorly, said tubes being open at the front and rear and being positioned relative to each other to deflect the heating media passing from the bottom to the exhaust passage around and in intimate contact with the entire periphery of the tubes, and means for blowing a stream of air from the rear of the head forwardly through said tubes.

6. In a heating device, a heat exchanging head comprising a hollow body having substantially upright front and rear walls and being open at the bottom portion for admitting gaseous heating media into the interior and having an exhaust passage at the upper portion for permitting

escape of said media, a plurality of closely spaced rows of tubes extending from the rear wall to the front wall across the interior of the body portion between the open bottom and the exhaust passage, said tubes of each row being closely spaced from each other and being sealed from communication with the interior of the body and being open at the front and rear, and being contracted gradually in cross section from their ends toward their intermediate portion both interiorly and exteriorly, and means to direct the heating media to the longitudinal mid-portion of said tubes and in spaced relation to the front and rear walls.

7. A heat exchanging head comprising a hollow body having substantially upright front and rear walls, and being open at the bottom portion for admitting heating media into the interior and having an exhaust passage at the upper portion for permitting escape of said media, a plurality of closely spaced rows of tubes extending from the rear wall to the front wall across the interior of the body portion between the open bottom and the exhaust passage said tubes of each row being closely spaced from each other being sealed from communication with the interior of the body and being open at the front and rear, and being contracted gradually in cross section from their ends toward their intermediate portion both interiorly and exteriorly, whereby a large air capacity through the tubes and passage for heating media around the tubes may be provided in a relatively small body, the slope of the walls of each tube relative to the tube axis being from 10 to 16 degrees.

8. The combination with a heat exchanging head having means for blowing a stream of air to be heated into heating relation thereto and beyond the head, of a moisture absorbing fire clay element mounted to be impinged upon by a portion of said air stream after travel of the air stream beyond the head.

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