My invention relates to air heating and more particularly to a combustion-type heating unit of the forced-air type for heating a stream of air in controlled amounts for delivery directly or indirectly to the interior of a building.

Space heating is often accomplished by forcing a stream of air between passaged heating elements conducting hot products of combustion from a suitable burner to a flue. The heating elements are conventionally thin-walled units, often formed of sheet metal, heat being transferred from the products of combustion to the air through these walls. It has been found that these walls are subject to corrosion and scaling with continued use and that the scale tends to drop to the burner and clog the openings thereof. The corrosion is so pronounced as to eat through the walls, sometimes after several months operation, requiring all too frequent replacement.

Contrary to early belief that such corrosion was the result of using fuels containing sulfur or other acid-forming substances, it has now been found that it is the result of the inevitable moisture in the products of combustion. So long as the products of combustion are maintained at a temperature above the dew point, the water remains in vapor state and no serious corrosion is encountered. If, however, the water is allowed to condense in the passages of the heating elements or in the bonnet or vent outlet into which the products of combustion discharge, the condensate will corrode the walls and often the burners if permitted to drop thereon. The corrosion is due partly to a rusting action and partly due to the fact that the condensate contains carbon dioxide, extracted from the products of combustion, which produces a highly corrosive, weakly acidic hydrosulfuric gas solution.

It is an object of the present invention to provide a novel heating unit which maintains the products of combustion above the dew point and which avoids the above-mentioned corrosion difficulties.

The present invention provides for passing a portion of the air stream through heating passages between heating elements and for bypassing another portion of the air stream to join the heated port and produce a composite air stream of the desired temperature. It provides for control of this temperature by varying the relative volumes of the two portions of the air stream.

It is an object of the invention to provide a heating unit in which the by-pass is within the same housing as contains the heating elements and in novel relationship therewith.

A further object is to provide an outer passage means for heating and an inner passage means for the by-pass function.

Another object is to employ at least two heating passages spaced from each other to provide a by-pass passage therebetween. In one embodiment of the invention it is an object to provide additional by-pass passages on the outer sides of the heating passages to separate them from other heating passages or from a wall of the heating unit.

It is another object of the invention to provide a simple, easily actuated damper arrangement for varying the relative volumes of air flowing through the heating and by-pass passages. In this connection, a more specific object is to dispose a shaft or operating member transversely of the heating and by-pass passages, this member carrying damper members respectively in the streams moving through the heating and by-pass passages. Another object is to employ one or more of such shafts or operating members and control the position thereof to vary the temperature of the composite stream. In this way the air throughput of the heating unit or the output velocity of the air can be maintained substantially constant even with change in heat demand of a thermostat, a very desirable situation particularly where a desired circulation is to be maintained in a room regardless of changes in heat demand to maintain a desired room temperature.

A further object of the invention is to provide a simplified control system for such a heating unit, in contradistinction to many recently used control systems which exceed in cost the heating unit itself.

Still a further object is to provide a cheap, highly efficient, simple and trouble free heating unit which can be adapted to use as a unit heater, duct heater furnace, etc.

Further objects and advantages of the invention will be apparent to those skilled in the art from the following description of three embodiments which are presented as exemplary.

Referring to the drawings: Fig. 1 is a vertical sectional view of a duct heater embodying the invention; Fig. 2 is a horizontal sectional view taken along the lines 2—2 of Fig. 1, Fig. 1 being taken along the line 1—1 of Fig. 2; Fig. 3 is a transverse sectional view taken along the line 3—3 of Fig. 1; Fig. 4 is a horizontal sectional view, similar to that in Fig. 2 but showing an alternative embodiment of the invention; and Fig. 5 is a side elevational view, with parts
broached away to show internal construction, of a unit heater embodying the invention.

The embodiment of Figs. 1–3 is a duct heater, generally indicated by the numeral 10, and adapted to be disposed between duct sections 11 and 12 through which a stream of air is moved by a remote blower, not illustrated, the direction of air flow being as indicated by the arrow 13. The duct heater 10 provides a conduit-like housing 15 shaped and sized to correspond to the duct sections 11 and 12 and mounted securely at its ends by flanges 16. In the embodiment shown, the duct sections 11 and 12 are rectangular in cross section, the housing 15 providing upper and lower walls 17 and 18 and two side walls 19 and 20.

The up-stream end of the housing 15 provides an entrance chamber 22 receiving the air stream. Vertical partitions 23 and 24, extending between the upper and lower walls 17 and 18, divide the down-stream interior of the housing 15 into an outer passage means, comprising heating passages 25 and 26, and an inner passage means, comprising the by-pass passage 27. The main stream of air, flowing as indicated by the arrow 13, is divided by the partitions 23 and 24 to form three sub-streams flowing respectively through the passages 25, 26 and 27 and mixing or blending therebeyond in an exit chamber 28, formed by the duct section 12 of the housing 10, to form a composite stream flowing as indicated by arrow 29. A deflector 30, aided by directional louvers 31 on each side thereof, divides and deflects the sub-stream moving through the by-pass passage 27 to move outwardly toward the other sub-streams, thus aiding in the mixing or blending thereof.

The heating passages 25 and 26 are, in effect, a part of two heat-exchange units or heating sections 33 and 34 which serve to heat the sub-streams flowing therethrough, the sub-stream flowing through the by-pass passage 27 being substantially unheated. Each heating section provides a plurality of heating elements 35 spaced from each other to pass the air, each heating element providing an internal upright passage. The heating elements 35 are shown as extending between the upper and lower walls 17 and 18, which walls are apertured to permit the internal passages 35 to communicate openly with a vent space or bonnet 38 and a burner space 39. These spaces are formed between front and rear walls 43 and 48 of the heating unit 10 and are enclosed by longitudinal walls 42.

A suitable burner means, shown as a gas burner 44 fed by a supply pipe 45 equipped with a suitable air-mixer 46 and receiving air through ports 47, is disposed in the burner space 39. The hot products of combustion rise through the passages 35, heating the walls thereof and thus the adjacent air streams. The products of combustion enter the bonnet 38 and are discharged through a suitable vent 48.

During continued operation of the heating unit 10 it is desirable that the products of combustion in the passages 35 and preferably also in the bonnet 38 should not be cooled below the dew point, i.e., below that temperature at which water would condense from the products of combustion, thus avoiding the aforesaid corrosion. To accomplish this, the invention provides a damper means for controlling the relative volumes of the heated air and the by-passed air. In general, this damper means includes two primary damper means 50 and 51, respectively controlling the sub-streams moving through the heating passages 25 and 26, and an auxiliary damper means 52 controlling the sub-stream moving through the by-pass passage 27. The primary and auxiliary damper means are preferably interconnected so that one closes while the other opens, all in response to the temperature of the exit products of combustion.

The preferred damper means and control therefor is clearly shown in Figs. 1, 2 and 3. As there shown, a plurality of operating members or shafts 55 have their ends journaled in the side walls 43 and 48 to extend in parallel relationship across the heating passages 25 and 26 and the by-pass passage 27. Each shaft carries two primary damper members 57 and 58, respectively in the heating passages 25 and 26, and one auxiliary damper member 59 disposed in the by-pass passage 27. The damper members 57 and 58 are preferably fixed to the corresponding shaft 55 to lie in the same or parallel planes but the auxiliary damper member 59 is mounted at a different angle. The preferred arrangement is to dispose the damper member 59 at right angles to the damper members 57 and 58, as suggested in Fig. 1.

A suitable connection means is employed to turn all of the shafts 55 through equal angles when any one of them is turned. This means can be a bar 62 pivoted to the ends of the damper members 57 to insure equiangular movement of all of the shafts 55.

Preferably, the damper means should be controlled by the temperature of the products of combustion issuing from the passages 35. This can be accomplished by disposing a fluid-filled, thermostatically-responsive bulb 56 in the bonnet 38 and connected to a suitable fluid-operated motor 63 mounted on the top wall 17. As the bonnet temperature decreases toward the dew point, the contracting fluid moves an arm 64 of the motor 63 in a counter-clockwise direction to move the primary damper means 59 and 50 toward closed position, while simultaneously and correspondingly moving the auxiliary damper means 52 toward open position. This decreases the air flow through the heating passages to decrease the cooling action on the products of combustion while correspondingly increasing the volume of by-passed air. As the fluid expands as a result of excess bonnet temperature, the operative connection between the arm 64 and the damper means may take any one of a number of forms, being shown as a link 65 pivoted to the arm and to the uppermost damper member 50.

If a thermostatic temperature control is desired, the fuel supply can be controlled by changes in temperature in the room into which the composite stream discharges. I prefer to use a modulated gas valve 70 in this connection, disposed in the supply pipe 45 and controlled by energizing and de-energizing a solenoid 71. The valve 70 may be of the type which moves between limiting positions upon energizing and de-energizing the solenoid 71, e.g., assuming a completely open position when the solenoid is energized and a partially open or minimum position when the solenoid is de-energized. The passage 45 is equipped with a master control switch 72. Also connected across the secondary winding beyond the control switch 72 is a solenoid 76 of a normally-closed shut-off
valve 71 in the supply pipe 45. Closing the control switch opens the shut-off valve 71 and moves the valve 70 to maximum-open position, assuming that the room temperature is low and the thermostat 72 is calling for more heat. When the temperature rises, the thermostat deenergizes the solenoid 71 and the valve 70 moves to partially-open position to retain the burner 44 lighted and supplying heat to maintain about the same room temperature. In this way the heating unit 10 delivers air at two elevated temperatures during continuance of a substantially constant air flow into the room to maintain the desired circulation. To shut off the system or to use it merely to circulate air, the switch 76 is opened to cut off the fuel supply by closing the valve 71.

During thermostatic variations in fuel supply, the temperature of the products of combustion in the passages 36 will vary. However, the damper means and the control thereon will operate to maintain the temperature of the products at combustion. Thus, the damper means can be positioned at any point where they will control the sub-streams. The illustrated positioning is, however, preferable as it prevents air from entering and swirling in the heating passages ahead of the control zone as would be the case if the damper means were disposed toward the exit ends of the heating passages.

While the damper means 50, 51 and 52 have been illustrated as within the entrance portions of their respective passages 25, 26 and 27, this arrangement is not essential as the damper means can be positioned at any point where they will control the sub-streams. The illustrated positioning is, however, preferable as it prevents air from entering and swirling in the heating passages ahead of the control zone. Thus, if the damper means were disposed toward the exit ends of the heating passages.

Air distribution and accuracy of control is bettered by such use of face dampers.

An important feature of the invention lies in the interposing of a by-pass passage between heating sections. This produces a compact unit, gives better control and permits use of the simplified control illustrated.

It should be understood, however, that all of the by-pass air need not move through a single central passage. Thus, Fig. 4 shows an arrangement similar to that of Fig. 2 but with additional partitions 80 and 81 spaced from the side walls 19 and 20 to form additional by-pass passages 82 and 83. The central by-pass passage 27 is narrower than in Fig. 2 but, together with the additional by-pass passages 82 and 83, serves to bypass the desired amount of air. In this embodiment two additional auxiliary damper means 84 and 85 are employed, one of each damper member 86 and 87 mounted on each shaft 55 and positioned in the by-pass passages 82 and 83. This embodiment has the additional advantage that the sub-streams moving through the by-pass passages 82 and 83 are positioned immediately inside the housing thereby maintaining walls 19 and 20 cool. In Fig. 5 the invention is illustrated as embodied in a unit heater 90 of the type adapted to be suspended near the ceiling of a room. The internal construction, including the heating passages and by-pass passage, is identical with the embodiment in Figs. 1-3. Likewise, the damper arrangement is identical, the damper means 51 and its damper members 58 being shown in Fig. 5. However, in the embodiment of Fig. 5 the entrance chamber 22 contains a fan 91 driven by a motor 92 secured to the housing 15 by a suitable bracket, not shown. The link 65 is pivoted to the lowermost damper member 58 and the arm 61 is pivoted at 93, being actuated by a thermally-responsive device 94 positioned in the airstream drawn into the inlet chamber 92 by the fan 91, being thus responsive to room temperature.

In the embodiment of Fig. 5 the three sub-streams moving respectively through the heating passages 25, 26 and the by-pass passage 27 impinge on deflectors 96 which aid in mixing of the component streams before deflecting same downwardly into the room. In this embodiment the burner 44 may be constructed as previously described but the air-mixer 46 is positioned outside the housing 15. The fuel supply pipe 45 contains the previously-mentioned shut-off valve 17 and its solenoid 18, which may be energized simultaneously with the motor 92 to open when the fan is set into operation.

However, this embodiment includes an additional control valve 95 in the fuel supply pipe 45 and controlled by the thermally-responsive device 94. The valve 95 is a flow-modulating valve, typically a globe valve or a gate valve which opens and closes incrementally in response to temperature changes affecting the thermally-responsive device 94. As illustrated, this thermally-responsive device 94 includes a rod 96 carrying a pin 97 extending into a slot 98 of the arm 91. The rod 96 is a part of or is connected to a valve stem 99 of the valve 95.

The control arrangement is such that the rod 96 moves respectively upwardly and downwardly in response to increase and decrease in room temperature. Thus, if the room temperature increases above the desired point, the rod 96 will be lifted. This will have two actions. In the first place, it will move the valve 95 toward closed position thus throttling the fuel supply to the burner 44. In the second place, it will pull downwardly on the link 53, thus tending to close the primary damper members 57 and 58 to restrict the air flow through the heating passages 25 and 26 while simultaneously opening the auxiliary damper members 59 to increase the air flow through the by-pass passage 27. As a consequence, the amount of air flowing through the heating passages 25 and 26 is deducted simultaneously with the temperature of the products of combustion rising in the internal passages 36 of the heating elements 35. By proper correlation of the damper means and the valve 95, the products of combustion will never be cooled below the dew point.

With this arrangement, it will be evident that there will be a differential change in the volumes of the air streams moving through the heating passages 25, 26 and the by-pass passage 27. As a consequence, the temperature of the combined streams will vary from time to time as the heat demand changes. At the same time, it will be apparent that the total volume of air issuing from the heating unit will be substantially constant and independent of heat demand. This is very desirable as the exit air stream will maintain the desired circulation of air in the room. This is in contrast to those heating systems in which the unit is controlled to supply hot air to the room intermittently in response to a thermostatic control which turns the fuel supply completely on or completely off.

While exemplary embodiments of the invention
have been illustrated; various changes and modifications can be made without departing from the spirit of the invention as defined in the appended claims.

I claim as my invention:

1. In a heating unit, the combination of: a pair of heating sections spaced from each other to define a by-pass passage therebetween, each heating section providing a heating passage, all of said passages providing inlet ends, communicating with each other and exit ends communicating with each other; means for flowing three streams of air respectively through said heating passages and said by-pass passage; these streams joining after they have exit ends to form a composite stream; means for heating the air streams flowing through said heating passages, said heating means including a plurality of internally-passed heating elements traversing said heating passages and means for conducting hot products of combustion to the passages of said heating elements to heat said air streams flowing through said heating passages by heat conduction through said heating elements; and damper means for controlling the relative volumes of said two air streams moving through said heating passages and the air stream moving through said by-pass passage and for limiting the volume of said two air streams to prevent cooling of said hot products of combustion to such extent as to allow water to condense from said products in said heating passages; said damper means including a movable shaft extending across said heating passages and said by-pass passage, two primary damper members secured to said shaft in substantially the same angular relationship to be substantially parallel to each other and respectively disposed in the air streams which flow through said heating passages, and an auxiliary damper member disposed in the air stream which flows through said by-pass passage and secured to said shaft to lie at an angle to said primary damper members whereby turning of said shaft in one direction will simultaneously move said two primary damper members toward the closed position and said auxiliary damper member toward the open position and in an opposite direction will simultaneously move said two primary damper members toward the open position and said auxiliary damper member toward the closed position to dependently adjust the volume of air flowing through said by-pass passage relative to the volume of air flowing through said heating passages.

2. In a heating unit for heating air, by indirect heat transfer with hot products of combustion while preventing corrosion and scaling of the heat-transfer surfaces by preventing cooling of the hot products of combustion below the dew point, the combination of: walls defining a heating passage and a by-pass passage disposed side-by-side and having entrance ends opening on an entrance chamber; at least one internally-passed heating element traversing said heating passage; means for delivering hot products of combustion to the passage of said heating element; means for delivering a stream of air to said entrance chamber to divide between said heating and by-pass passages and form separate air streams flowing therealong; and means for differentially changing the volumes of said air streams, this means comprising a shaft providing a longitudinal axis extending across said passages and two damper members secured to said shaft to lie at an angle relative to each other and respectively disposed in said air streams, whereby turning said shaft in one direction will move one of said damper members toward closed position and the other damper member toward open position, a heating element traversing said heating passage and providing an upright passage; a burner for supplying products of combustion to the lower end of said upright passage, said products of combustion heating the stream of air moving through said heating passage and being cooled by this air; and means for preventing cooling of said products of combustion below the dew point, said last named means including means responsive to the temperature of the products of combustion leaving said upright passage and means for connecting said damper means to vary the relative volumes of air moving through said heating passage and said by-pass passage.

ORAN W. OTT

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