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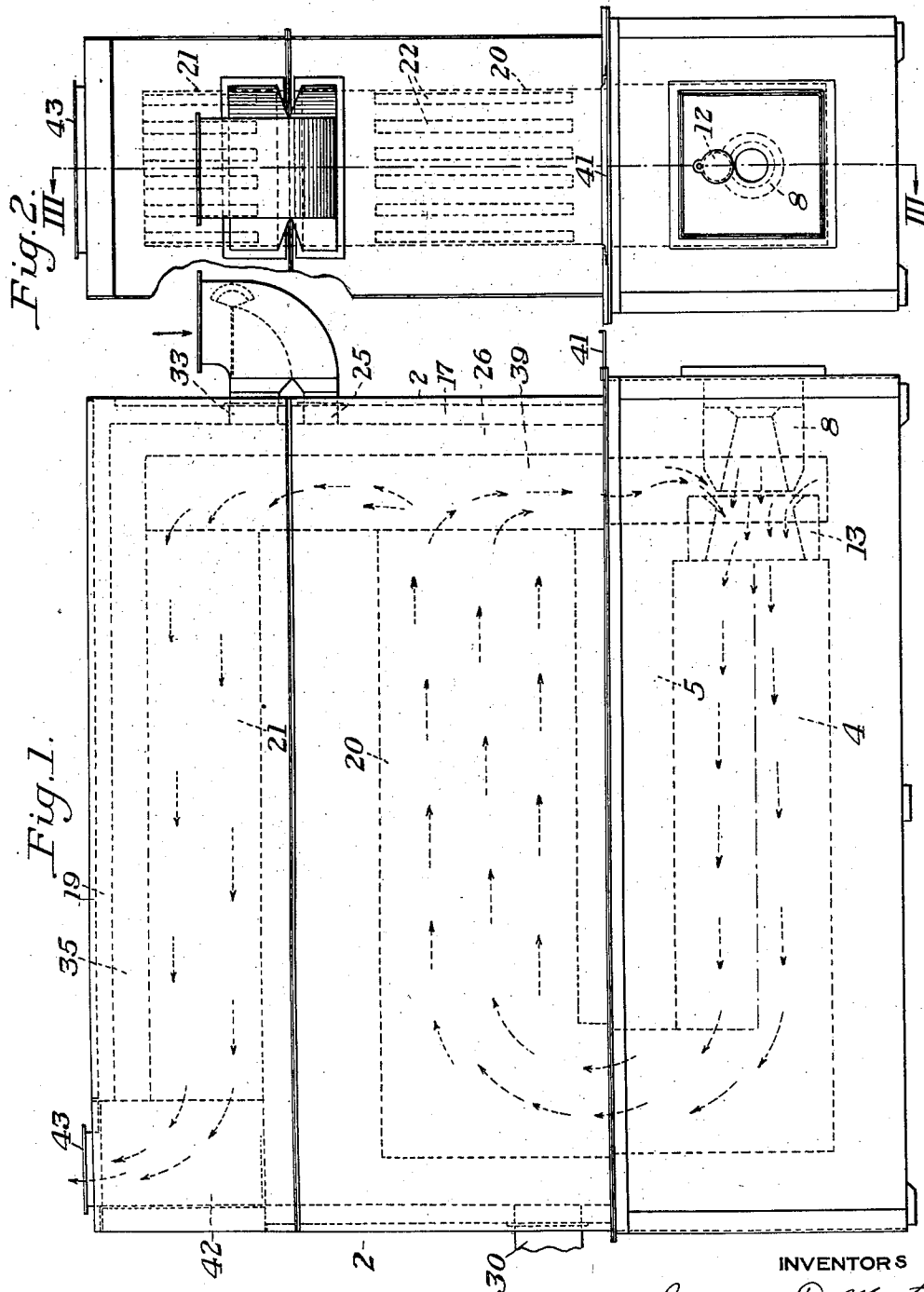
G. D. MANTLE ET AL

1,790,870

AIR HEATER AND METHOD OF OPERATING THE SAME

Filed July 12, 1927

2 Sheets-Sheet 1



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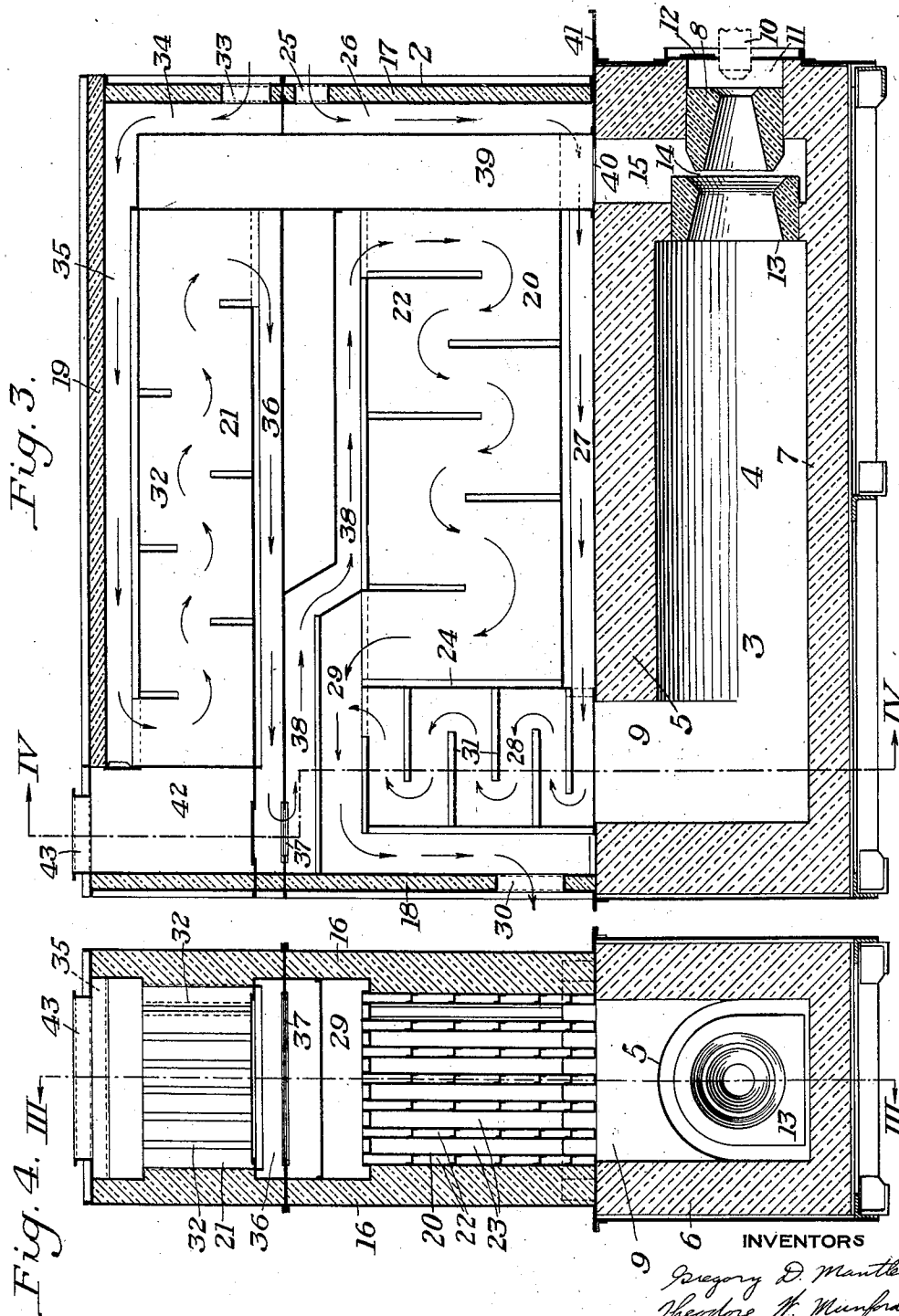
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UNITED STATES PATENT OFFICE

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AIR HEATER AND METHOD OF OPERATING THE SAME

Application filed July 12, 1927. Serial No. 205,105.

This invention relates to air heaters and to a method of operating the same, and relates more particularly to an air heater wherein a novel arrangement is provided for
5 controlling the flame temperature and a method by means of which the flame temperatures can be controlled with a high degree of efficiency.

Various types of air heaters have been developed for use in conjunction with drying
10 or similar operations where the air delivery temperature may vary from 200° F. to possibly 900° F. Such heaters as ordinarily provided are constructed of steel, and the safe
15 working temperature must be kept below approximately 900° F. In the case of direct fired heaters, the fuel must be burned with an excess of air so that the products of combustion will be cooled to the safe operating
20 temperature prior to their entering the heater. This is not economical owing to the fact that the air required to dilute the products of combustion sufficiently to lower the temperature to a safe operating point must be
25 heated from the normal atmospheric temperature to the temperature of operation, which is a difference of several hundred degrees. Consequently, a considerable amount of the fuel is wasted in merely heating the
30 excess volume of cooling air. Most of this heat is lost with the discharge of the products of combustion from the heater.

Certain types of heaters have been developed wherein it is possible to operate
35 safely, without interruption, at a temperature as high as 1800° F. Such a heater is shown, for instance, in Patent No. 1,518,258, dated December 9, 1924, granted to F. A. Fahrenwald. In this type of heater the flow
40 of air to be heated is so divided as to secure the greatest possible cooling effect so that the products of combustion can be circulated through the heater at much higher temperatures. However, none of the common fuels
45 may be burned with approximately the theoretical amount of air required for their combustion so as to get a flame temperature as low as 1800° F. With just the theoretical amount of air, the flame temperature of
50 ordinary fuels, such as gas and oil, is consid-

erably higher. Therefore, in the operation of this type of heater also, it has been the practice to introduce atmospheric air into the combustion chamber in excess of the theoretical amount needed to depress the flame
55 temperature so that the products of combustion entering the heater will be at a temperature of approximately 1800° F. This introduction of cooling air to depress the flame temperature, as above pointed out, is not
60 economical because the temperature of the cooling air is raised from atmospheric temperature to approximately 1800° F. and a large amount of this heat is wasted when the products of combustion pass out of the heater.
65 However, with this particular type of heater the efficiency is considerably higher than with the usual type of heater.

According to the present invention, it is proposed to remove some of the products
70 of combustion from the heater at some point in the passage of these products therethrough and recirculate these products of combustion through the combustion chamber whereby
75 only substantially the theoretical amount of air need be supplied the combustion chamber through the burner while the flame temperature will be depressed by the recirculation of
80 some of the products of combustion. Under ideal operating conditions the discharge of products of combustion from the heater will be substantially equivalent to just the theoretical volume of combustion gases. In this way practically all the sensible heat is utilized
85 and the efficiency of the heater increased. According to the present invention it is further proposed to combine the recirculation of products of combustion with a heater capable of operating at temperatures around
90 1800° F. so that the minimum amount of products of combustion need be recirculated to secure the highest maximum efficiency.

The invention may be readily understood by reference to the accompanying drawings, 95 in which—

Figure 1 represents a side elevation of a heater and combustion unit embodying my invention, the arrows indicating the direction
100 of flow of the products of combustion;

Figure 2 is an end view of the heater and combustion unit shown in Figure 1;

Figure 3 is a vertical longitudinal section in the plane of line III—III of Figures 2 and 4, the arrows indicating the course of travel of the air through the heater; and

Figure 4 is a vertical cross section on the line IV—IV of Figure 3.

In the drawings, 2 designates the heater and 3 is a combustion chamber at the bottom of the heater unit. The combustion chamber has a longitudinally extending passage 4 therein with a refractory top wall 5, side walls 6 and a bottom 7. At the front end of the combustion chamber is a burner block, designated generally as 8. At the rear end of the combustion chamber is a vertical passage 9 that communicates with the combustion gas circulating passages in the heater. The burner block 8 has a burner 10 disposed in front of a passage 11. In front of the burner block 8 is a throat 13, and the member 13 is located sufficiently far in front of the member 8 to provide an annular opening 14 between the two members. The annular space 14 communicates with a vertical passage 15 communicating with the interior of the heater, as hereinafter more fully described.

The heater 2 has side walls 16, a front wall 17, a rear wall 18, and a top 19. There are preferably two sections to the heater, a lower one 20 and an upper one 21. The lower section 20 has a plurality of spaced apart air-heating elements 22 with gas circulating passages 23 therebetween. The air-heating elements 22 are formed of heat resistant steel alloy, and the arrangement is such that air is circulated through the elements 22 while hot gases of combustion are circulated around the outside of the elements 22 through the passages 23 and thus effect an exchange of heat between the gases and the air. The elements 22 have a cross wall 24 therein which separates the interior space in the air passages, as best shown in Figure 3, to provide separate passages for the flow of air in different parts of the air heater. The heater is provided with air inlet ports arranged to give a divided flow of air through the heater. One of these ports, designated 25, opens into a vertical passage 26 along the front wall 17 in the heater. From the passage 26 the air flows along a horizontal passage 27 in one side of each of the elements 22. The passages 27 open into the vertical passage 28 at one end of the element 22. From the passage 28 the heated air flows through a manifold 29 to the hot air outlet 30. Baffles 31 are provided in the vertical passage 28. The upper section 21 of the air heater is provided with a plurality of air circulating elements 32. Air enters the upper section of the heater through port 33 in the front wall of the heater. From the port 33 it flows into a vertical passage 34, then along a horizontal passage 35 at one

side of the elements 32, and from the rear end of the passage 35 the air flows into the several air circulating elements 32. The air flows lengthwise along the elements 32 and at the front of these elements it discharges into a manifold 36 extending horizontally along the bottom of the elements 32. The air from the manifold 36 flows through a port 37 into a horizontal passage 38 in the lower section of the heater. From the passage 38 the air flows into the forwardmost ends of the air circulating members 22. The air travels through the members 22 toward the cross walls 24 thereof and discharges into the manifold 29 to mix with the air flowing from the passages 28. The ends of the members 22 extend across the vertical passage 9 in the combustion chamber so that the products of combustion from the combustion chamber will rise between the members 22 and flow horizontally between these members to the vertical manifold 39 at the forwardmost end of the members 22. The bottom of the manifold 39 communicates through a port 40 controlled by a damper 41 with the vertical passage 15 at the forward end of the combustion chamber. The manifold 39 extends upwardly across the forward ends of the air-heating elements 32 in the upper section. The products of combustion travel horizontally from the upper end of the manifold 39 between the elements 32 to the discharge passage 42 and out the discharge opening 43.

In Figure 3 the arrows indicate the direction of air circulation, and in Figure 1 the arrows indicate the direction in which the products of combustion circulate.

In the operation of the heater the fuel is burned in the combustion chamber 4 and the hot gases rise through the passage 9 between the rear ends of the air heaters 22. The gases then flow horizontally forward between the members 22 to the vertical manifold or passage 39. It will be apparent that the rear ends of the members 22 over the passage 29 are subject to the most intense heat. They are therefore cooled by leading air directly from the port 25 through the passages 26 and 27 to the vertical passage 28. With this arrangement relatively cold air flows through that portion of the heater which is subjected to the highest temperatures. By this arrangement also, the temperature of the products of combustion is lowered considerably almost as soon as the products of combustion enter the heater, and the portions of the elements 22 forwardly of the cross barrier 24 are subject to less intense temperatures. Therefore, the air circulated through the forward portions of the members 22 is first heated in the upper section of the heater and then introduced into the forward ends of the elements 22. The general arrangement for a divided flow of air through the air heater as described is not new, and is shown

in the said Patent No. 1,518,258, dated December 9, 1924, granted to F. A. Fahrenwald, hereinbefore referred to.

There is a drop in the temperature of the gases between the point where they leave the combustion chamber at 9 and the manifold 39. The aspirating action of the burner tends to draw the gases of combustion from the passage 39 down through the port 40 into the passage 15 and from the passage 15 through the mixer passage 14, where the products of combustion are mingled with the combustible mixture to depress the flame temperature in the combustion chamber. The products of combustion drawn from the manifold 39 through the port 40 and into the burner, while being relatively hot, are still considerably below the temperature of the flame when burned with the theoretical amount of air. Thus, the products of combustion introduced in this manner into the combustion chamber serve to lower the flame temperature so that excessively hot gases will not flow from the combustion chamber into the air heater. At the same time, only approximately the theoretical amount of air need be introduced into the combustion chamber through the burner, and the discharge of products of combustion from the outlet passage 43 should, under ideal operating conditions, be only the theoretical volume of gases.

By thus drawing partially cooled products of combustion from the heater back into the combustion chamber, and properly regulating the volume of flow by means of damper 41, accurate control of the flame temperature is secured and practically all of the available heat is utilized. In using the recirculation of products of combustion in a heater having a divided air flow, the most efficient conditions of operation can be secured with the greatest economy of fuel.

The adaptation of our invention to a two section heater has particular importance. If the theoretical volume of gases of combustion were discharged after they had passed through the first section, the temperature thereof would be so high as to occasion a considerable loss of heat. If the gases were recirculated from the discharge end of the second section; they would be cooled to too great an extent for the most efficient operation.

According to our invention, the gases are recirculated from an intermediate point in the heater, that is, the point between the two sections, at which time they are relatively hot, while the theoretical volume of gases circulates through the upper section to further deliver up heat to the air. By the use of sufficient transfer surface in the upper heater section, the gases may be cooled to a relatively low temperature, say about 250° F., under normal operating conditions before they are discharged. This means that we actually

utilize all heat in the gases above 250° F. in addition to eliminating the loss occasioned by the use of cold air for depressing the flame temperature.

While the invention has been specifically described in connection with a preferred construction thereof, it will be understood that the invention is not confined to the particular form of heater shown, or to the particular design of combustion chamber, and that various changes and modifications may be made therein within the contemplation of our invention and under the scope of the appended claim.

We claim:

Apparatus for heating air including a combustion chamber having a gas discharge passage and having a combusted gas intake passage, a burner in the combustion chamber adapted to draw gases from the combusted gas intake passage and discharge them into the combustion chamber, an air heater having air circulating elements therein with gas circulating passages therebetween, one end of the air heater being disposed over the gas discharge passage of the combustion chamber, the gas circulating passages between the air circulating elements communicating with the said gas discharge passage of the combustion chamber, means for circulating cold air through that portion of the elements most nearly adjacent the gas discharge passage of the combustion chamber, means whereby the air will flow through the remaining portion of the air heating elements in a direction counter to the circulation of gases between the air heating elements, and a passage connecting the combusted gas intake of the combustion chamber with the gas circulating passages in the heater at a point remote from the point where the gases of combustion enter the heater.

In testimony whereof we have hereunto set our hands.

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