Oct. 2, 1934. G. L. SIMPSON 1,975,410

ELECTRIC HEATING FURNACE

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Fig. 1.

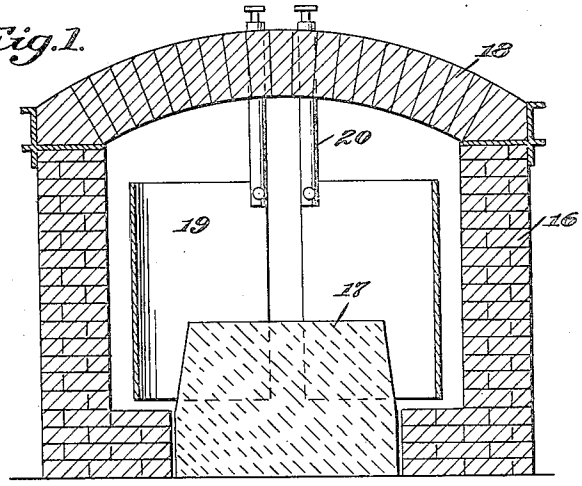


Fig. 2.

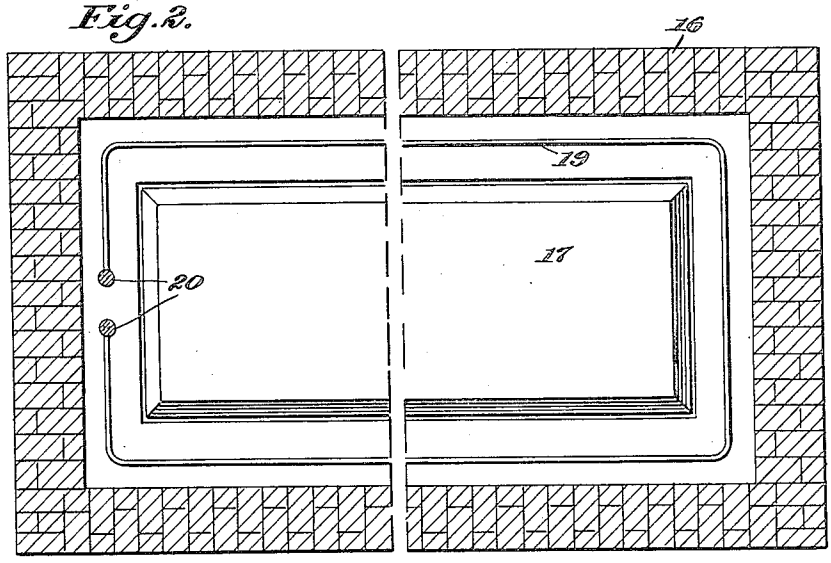


Fig. 3.

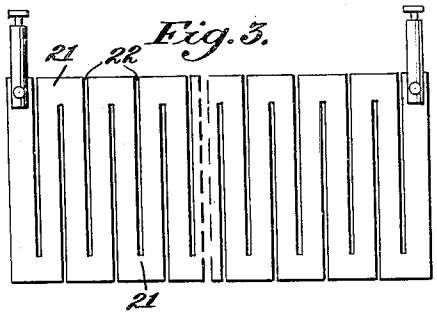
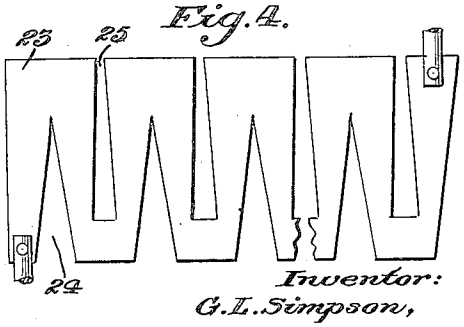


Fig. 4.



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ELECTRIC HEATING FURNACE

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Fig. 6.

Fig. 5.

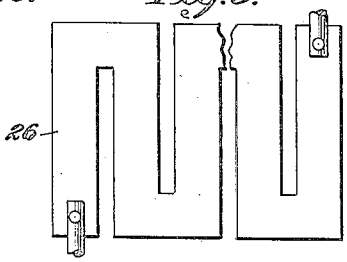


Fig. 9.

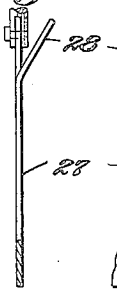


Fig. 8.

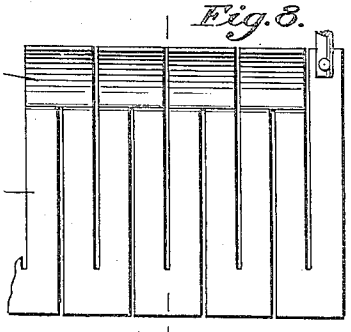


Fig. 7.

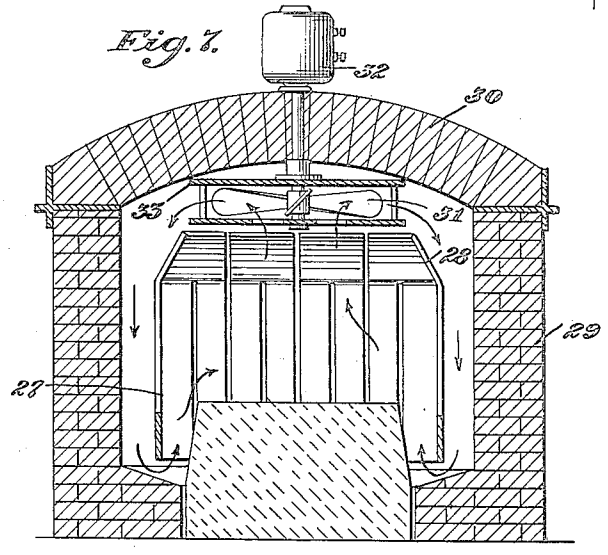


Fig. 10.

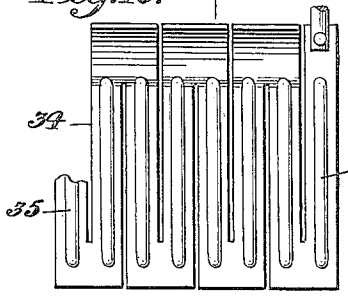
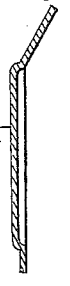


Fig. 11.



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ELECTRIC HEATING FURNACE

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Fig. 12.

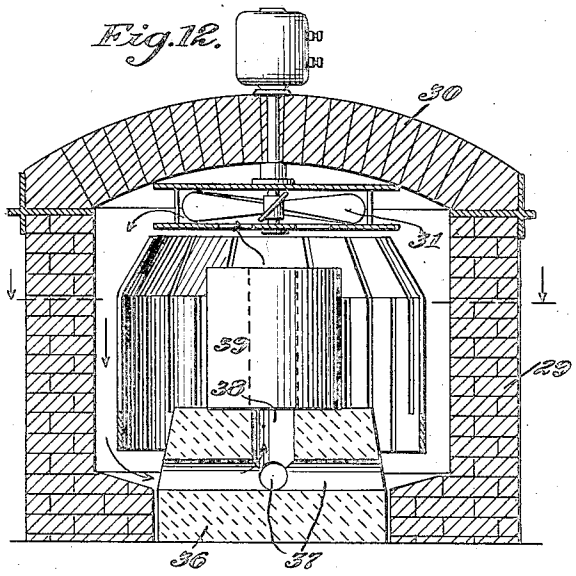


Fig. 14.

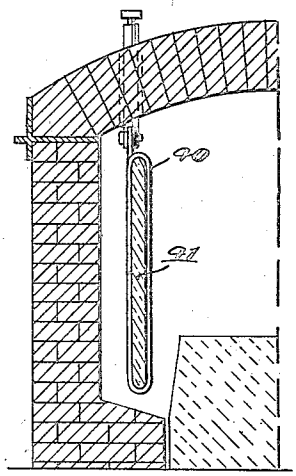


Fig. 13.

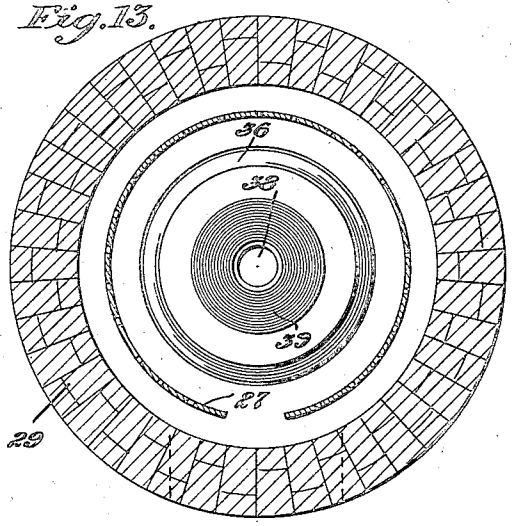
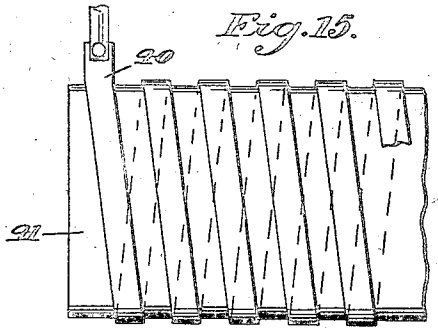


Fig. 15.



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Patented Oct. 2, 1934

1,975,410

UNITED STATES PATENT OFFICE

1,975,410

ELECTRIC HEATING FURNACE

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Application December 12, 1931, Serial No. 580,639

14 Claims. (Cl. 13—20)

My invention relates to improvements in electric heating furnaces and more particularly to improved means for heating such furnaces.

Heat is transferred by radiation, conduction and convection. Heretofore in the operation of this type of furnace it has been the practice to depend almost entirely upon radiation for the transfer of heat energy from the heating elements in the furnace to the charge. Convection and conduction therefore play only a negligible part in the electric heating furnace designs heretofore employed.

In the usual type of electric heating furnace, the heater elements do not completely cover the furnace walls. The average temperature of the combination of walls and heater elements is consequently much lower than the maximum temperature of the heater elements. This is due to the fact that where the heater elements do not completely cover the walls, the walls at a lower temperature are shining through the heater elements on to the work and they lower the average temperature of the radiating surfaces which deliver heat energy to the charge. As a result it is necessary to heat the heating elements to a higher temperature than would be necessary if the heating element covered the entire wall surface of the furnace.

The nickel chrome alloys that are used for most of the commercial heating elements of the present time have a melting point which limits the safe operating temperature of these elements. In the usual steel heat treating practice, temperatures in excess of 1800° C. were not required. The development in recent years, however, of the special alloy steels with corrosion resistant and heat proof properties and high silicon steels, has demanded higher and higher operating temperatures, and furnace builders have experienced considerable difficulties in producing resistor elements that will heat a charge to 1900° or higher within a reasonable time without approaching the softening point of the resistor, and causing the failure of the heating element.

An important object of my invention, therefore is to provide a furnace which can be operated to produce the heat desired for present day heating practice without endangering the resistor element and without producing uneven heating of the furnace charge.

Another object of my invention is to produce even and efficient heating of a charge in an electric heating furnace.

A further object of my invention is to provide a novel resistance element for use in electric heating furnaces.

In the accompanying drawings, which form a part of this specification and wherein like characters of reference denote like or corresponding parts throughout the same,

Figure 1 is a vertical sectional view of a furnace embodying one form of my invention,

Figure 2 is a horizontal sectional view thereof,

Figure 3 is a detail elevation of another form of resistor element,

Figure 4 is a similar view of a further form of resistor element,

Figure 5 is an elevation of still another form of resistor,

Figure 6 is an edge elevation thereof,

Figure 7 is a vertical sectional view of another furnace embodying my invention,

Figure 8 is an elevation of the resistor element used therein,

Figure 9 is an elevation thereof, parts being shown in section,

Figure 10 is a detail of a resistor element similar to that shown in Figures 7, 8 and 9 but having strengthening ribs thereon.

Figure 11 is a transverse sectional view thereof,

Figure 12 is a vertical sectional view of still another form of furnace,

Figure 13 is a horizontal sectional view thereof,

Figure 14 is a fragmentary sectional view showing a furnace having a further modified resistor element therein, and,

Figure 15 is a fragmentary elevation of the resistor element used therein.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of my invention, the numeral 16 designates a heating furnace hood arranged about a base 17 and having a removable roof 18. The base 17 preferably extends into the hood as shown, and in place of the usual heater elements arranged on the walls of the furnace hood, I provide a resistance element comprising a flat plate 19 having a height substantially equal to the height of the walls of the furnace hood. The plate 19 extends around the interior of the furnace hood in spaced parallel relation to the walls thereof as seen in Figures 1 and 2, and may be supported in any convenient manner from the bottom, sides or top. I have shown the plate as being supported from the removable roof 18 by means of the terminal posts 20 but it will be understood that any other suitable supporting means may be employed.

It will be seen that the charge arranged on

the base 17 will receive radiation from the inner side of the plate 19 which substantially corresponds in size to the furnace walls. In addition to being heated by radiation, the charge will be subjected to heat by convection, due to the spacing of the resistance plate from the furnace walls which reflect the heat from the outer face of the plate 19 to the charge. This natural convection effectively utilizes all of the heat from the plate 19 and dispenses with the necessity for heating the plate to a much greater temperature than that to which the charge is to be subjected.

In Figure 3, the resistor 21, instead of being an unbroken plate as in Figure 1, is slit at 22 alternately from the top and bottom of the plate to form a series of U-shaped portions connected at their upper ends and with their arms arranged very close together. This form of resistor is better suited to high voltages and low current, in line with present day practice. By slitting the plate as shown, the theoretical radiating surface is slightly reduced but a sufficiently low resistance is maintained in the heating element to permit of higher voltages than required by the unbroken resistor plate.

Due to convection and re-radiation from the roof of the furnace, and other factors, the top portion of a vertically arranged heater element tends to run hotter than the lower portion. This situation is undesirable on account of the unequal temperatures delivered to the charge. This difficulty may be remedied by constructing the resistance element as shown in Figures 4, 5, 6, 8 and 9. In the form of the invention shown in Figure 4, the resistor plate 23 is cut away to produce a resistor which has a larger surface at its upper end than at its lower end. This result is accomplished by providing lower slits 24 which increase in size as they approach the bottom of the plate and upper slits 25 which decrease in size as they approach the top of the plate. As the lower portion of the resistor plate has a smaller surface than the upper portion, it will consequently have a higher resistance, and will liberate more heat energy than the upper portion of the plate, thereby counteracting the tendency of the upper portion of the plate to be heated to a higher temperature than the rest of the plate.

In the form of resistor shown in Figures 5 and 6 the same result is obtained by forming the resistor from a plate 26 which has been rolled or cast thicker at its top than at its bottom and gradually decreasing in thickness towards its lower end. The lower end having a smaller cross-section offers more resistance to the current and produces greater heat than the thicker upper portion of the resistor, thereby counterbalancing the other factors tending to overheat the upper portion of the resistor plate.

In Figures 8 and 9 I have shown a resistor element 27 slit similarly to the plate of Figure 3 but having its upper unslit portion 28 bent inwardly at an angle to form a radiating fin for providing greater cooling at the upper portion of the resistor as well as reducing the electrical resistance in the top portion of the plate with a resulting reduction in the rate of heat liberation at this point.

In Figure 7 I have shown a furnace 29 which is preferably circular, although other shapes may be employed, and having a removable roof 30. A resistance element such as that shown at 27 in Figures 8 and 9, is arranged in the furnace in spaced relation to the walls thereof, and extends from a point adjacent the bottom shelf of the furnace to a point adjacent the top thereof. In place of relying entirely upon natural convection, I provide a fan 31 supported by the roof 30 through which the fan shaft extends, which produces a forced convection by causing a circulation as shown by the arrows. The fan motor 32 may be arranged in any suitable position, such as being mounted on the top of the roof 30 and a fan guard 33 may be provided to protect the fan. It will be seen that the space between the resistor plate 27 and the walls of the furnace will act as a chimney. The furnace atmosphere is forced down into this space, drawn up through the center of the resistor and again forced down through the space between the furnace walls and the resistor plate. With this arrangement for producing forced convection, the heat transfer from the heater element to the furnace atmosphere and to the charge is greatly increased and consequently the resistor need not be heated to as high a temperature as would otherwise be required. I have found in actual practice, for example, that in a furnace where no forced convection was used, a temperature difference of approximately 100° C. existed between the resistor element and the charge. When, however, forced convection was utilized, as seen in Figure 7, the temperature difference between the resistor and the charge was reduced to 10° C.

The importance of this efficiency in heating is apparent when the demand for high temperatures forces the operators to dangerously approach the point of softening and failure of the resistor, as in the annealing of sigh silicon steel. With my flat resistor plate and forced convection great heat liberation is effected without approaching the point of failure of the resistor. When heating a charge to a temperature of 1850° C. or 1900° C. in the usual type of furnace, a gradient of 100° C. to 150° C. must exist between the temperature of the charge and of the resistor, if the heating is to be accomplished within a reasonable amount of time. This is due to the fact that radiation largely is utilized to transfer the heat energy in the usual furnace. By the use of forced convection, especially where a flat resistor is used in place of the usual ribbon, the charge can be heated to these high temperatures in a short time without endangering the resistor element.

It will be obvious that in place of the resistor plate shown in Figure 7, any of the resistors shown in the other views may be used in this type of furnace.

In Figures 10 and 11 the resistor plate is constructed similarly to that shown in Figures 7, 8 and 9 with the addition of strengthening ribs 35 arranged vertically of the arms of the resistor and pressed therein. These ribs increase the strength and useful life of the resistor element.

In the furnace shown in Figures 12 and 13, the furnace structure comprises a furnace hood 29 and removable roof 30 with a fan 31, and resistor 27 all identical with or similar to the structure set out in Figure 7. The base 36 however is provided with horizontal bores 37 arranged above the shelf on the lower end of the hood 29 and communicating with a vertical bore 38 arranged centrally of the base. This type of furnace is for use with a charge 39 of coils or other material having a central opening therethrough. The fan 31 forces the furnace atmosphere down through the space between the resistor 27 and the hood 29, into the bores 37, up

through the bore 38 and through the center of the charge to be again forced down behind the resistor plate. This construction results in a very rapid, even, and efficient heating of the charge.

In place of the flat resistors shown in Figures 1 to 13 I may employ a resistor such as shown in Figures 14 and 15. A resistor ribbon 40 is wound in close spirals about a relatively thin barrier such as a ceramic or other refractory plate 41 which extends around the furnace in spaced relation to the walls of the furnace hood. This form of resistor may be used with the type of furnace in which a fan is used, and it may also be used without a fan.

In the types of furnaces in which natural and forced convection is not utilized, practically the only heat utilized is that radiated from those portions of the heater element facing the charge. By forcing the furnace atmosphere to circulate between the walls of the furnace and the heater element, however, I bring the heat from the portion of the heater element facing the walls of the furnace to the charge. This results in the effective utilization of heat usually muffled and to a large extent lost to the charge, and thereby nearly doubles the effective heating capacity of the heater element.

An important feature of my invention is the use of the fan shown at 31 in Figures 7 and 12. It has been proposed to use a paddle type fan with the blades arranged in a plane with the axis of the fan shaft in order to obtain peripheral discharge of air from the fan. This arrangement however is disadvantageous due to the shock loss and eddy current wastage occurring at the inlet of paddle or centrifugal type fans. This wastage is not present in the inclined blade or propeller type fan disclosed in Figures 7 and 12, but as heretofore used this type of fan had the disadvantage of providing axial discharge of the air substantially parallel to the fan shaft.

I propose to combine the advantages of a propeller type fan and a centrifugal fan by the provision of the guard or casing 33 shown in Figures 7 and 12 which gives axial inlet and peripheral discharge as indicated by the arrows in these figures. With the casing 33 therefore I am able to obtain all of the advantages of peripheral discharge of the air or gas from the fan to supplement the convection circulation currents and at the same time avoid the losses and wastage present in centrifugal fans.

In the specification and claims I have referred to a furnace "hood" in describing the body of the furnace. This term is not intended to restrict my invention to the particular type of furnace shown in the drawings but is intended to cover the body of a box type or other types of furnaces as well as that type shown in the drawings, the term "hood" being used in the claims as synonymous with "body".

While I have shown and described the preferred embodiment of my invention, it is to be understood that various changes in the size, shape and arrangement of parts may be resorted to without departing from the spirit of my invention or the scope of the subjoined claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. An electric furnace comprising a base, a furnace hood therefor, a removable roof for said hood, and a heating element supported by said roof and comprising a resistor plate extending around the walls of the furnace hood in spaced relation therewith, and extending to points adjacent to but spaced from the bottom of the hood and the furnace roof.

2. An electric heating furnace comprising a furnace hood, a resistor element arranged in spaced relation to the walls of the hood and comprising a plate having openings therein extending from its top and bottom, the openings extending from the bottom of the plate being larger than the openings extending from the top of the plate whereby the plate has a greater surface adjacent its upper end than at its lower end.

3. An electric furnace comprising a base, a heating hood therefor, and a resistance element extending around the interior of the hood in spaced relation to the walls thereof, and comprising a plate having slits extending thereinto from the top and bottom thereof, said slits being widest at their lower ends and becoming narrower as they approach the top of the plate, whereby the resistance plate has a greater surface at its upper end than at its lower end.

4. A resistance element for electric heating furnaces comprising a plate cutaway to form a series of connected U-shaped portions, said plate being progressively thicker from its lower to its upper end.

5. An electric heating furnace comprising a furnace hood, a resistance element arranged therein and spaced from the walls thereof, said resistance element comprising a plate cutaway to form a series of connected U-shaped portions, said plate being progressively thicker from its lower end to its upper end.

6. An electric heating furnace comprising a furnace hood, a resistance element arranged therein and spaced from the walls thereof, said resistance element comprising a plate having slits therein forming a series of connected U-shaped portions, the top portions of said U-shaped portions being bent over at an angle to form cooling fins at the top of the plate.

7. An electric heating furnace having a resistance element arranged therein and spaced from the walls thereof, said element comprising a plate slit to form a series of connected U-shaped portions, said U-shaped portions being bent inwardly at their upper ends, and a fan arranged above the resistance plate and adapted to circulate the furnace atmosphere around the resistance plate.

8. An electric furnace comprising a base, a furnace hood arranged thereover, and being substantially circular in cross section, a resistance element arranged concentrically within said hood and spaced from the walls thereof, said resistance element comprising a plate extending from a point adjacent the bottom of the hood to a point adjacent its top, means to pass an electric current through the resistance plate, and a fan arranged to circulate the furnace atmosphere from the exterior of said plate to its interior.

9. An electric furnace comprising a furnace hood, a base extending up into said hood and adapted to support a charge, said base having openings extending therethrough, a resistance plate extending around said furnace hood interiorly thereof and spaced from the walls of the hood, and means to circulate the furnace atmosphere around said resistance plate and through the openings in the base.

10. An electric furnace comprising a furnace hood, a base extending into said hood and adapted to support a charge having a central opening therethrough, a resistor plate extending around said furnace hood interiorly thereof and spaced from the walls of the hood, and means to circu-

late the atmosphere from the space between the furnace walls and resistor plate through the central opening in the charge.

11. An electric furnace having a resistance plate arranged therein and spaced from the walls thereof, and means to circulate the furnace atmosphere in oppositely moving streams separated by the resistance plate.

12. An electric furnace adapted to receive a charge having a substantially centrally arranged opening therethrough, a resistance plate extending around said furnace walls interiorly of the furnace and in spaced relation to the furnace walls, and a fan arranged to circulate the atmosphere from the space between the furnace walls and resistor plate through the central opening in the charge.

13. An electric furnace having a resistance element arranged therein and spaced from the walls thereof, and means to circulate the furnace atmosphere in streams separated by the resistance element, said means comprising a propeller type fan having a casing arranged to provide peripheral discharge of the atmosphere from said fan.

14. An electric furnace having a resistance plate arranged therein and spaced from the walls thereof, and means to circulate the furnace atmosphere in oppositely moving streams separated by the resistance plate, said means comprising a propeller fan arranged in the furnace, and a fan casing arranged about said fan, said casing being provided with an inlet opening adjacent the axis of the fan and an outlet opening adjacent the periphery of said fan.

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