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DIRECT FIRED AIR HEATER

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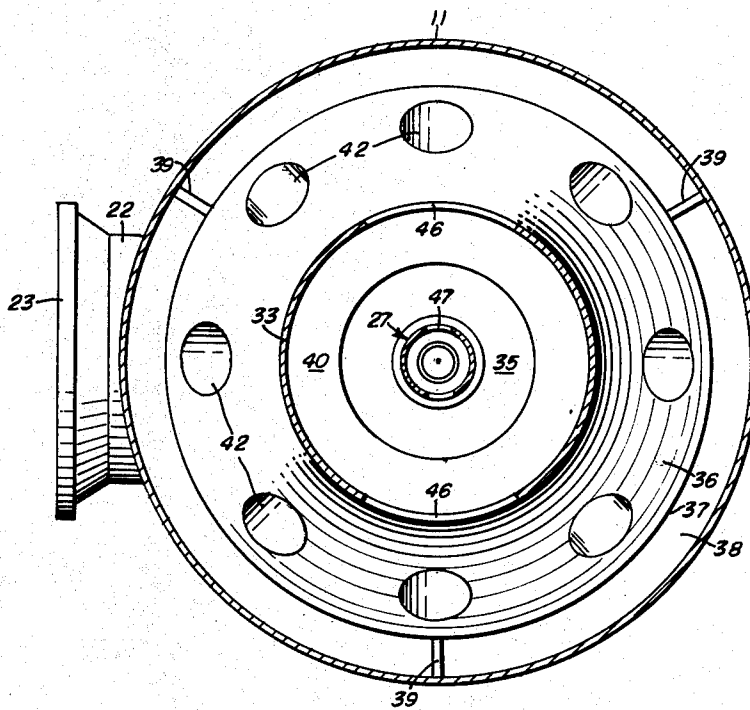


FIG. 3

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DIRECT FIRED AIR HEATER

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3 Claims. (Cl. 263—19)

The present invention relates to apparatus for heating air and more specifically pertains to an assembly including a fuel burner wherein air to be heated is delivered into a closed housing wherein fuel is burned with some of the incoming air to be heated employed to support combustion while other portions of the air are moved into heat transfer relationship with the products of combustion and the heat developed by the burning fuel.

It is an object of the present invention to provide apparatus for heating air which includes structures for guiding a portion of the air to be heated into the presence of the fuel burner to support combustion and in a quantity to provide for complete burning of the fuel without excess air to avoid cooling action and to provide structure guiding the remainder of the incoming air to be heated into the presence of the heat and hot gases developed by the burning fuel at the zone where the combustion of the fuel is complete.

It is another object of the invention to provide partitioning means within air heating apparatus providing chambers and flow paths delivering a portion of the air to be heated to the presence of a fuel burner and to deliver other portions of the air to the presence of the products of combustion after completion of the burning of the fuel with the flow relationship of the total volume of air to be heated so proportional that both the function of the burning of the fuel and maintaining an even temperature throughout the outlet area of the heater is maintained.

A more detailed object of the invention is to provide chambers and a partition structure within the heating apparatus so related to the burner that the incoming air to be heated is divided and a portion delivered to the presence of the burner to support combustion and with another portion by-passing the burner and delivered into the presence of the products of combustion downstream of the burner head in such a manner as to develop a substantially uniform temperature throughout the outlet portion of the heater.

Other objects and features of the invention will be appreciated and become apparent to those skilled in the art to which the invention pertains as the present disclosure proceeds and upon consideration of the accompanying drawings and the following detailed description wherein an exemplary embodiment of the invention is disclosed.

In the drawings:

FIG. 1 is an axial sectional view of heating apparatus exhibiting the invention.

FIG. 2 is a transverse sectional view taken on the line 2—2 of FIG. 1.

FIG. 3 is a transverse sectional view on a larger scale taken on the line 3—3 of FIG. 1.

The invention pertains to heating apparatus and relates to a direct fired air heater wherein the air to be heated mingles with the products of combustion developed during the burning of fuel. A closed housing for the combustion of fuel at pressures greater than atmospheric and wherein air is heated may take any suitable form. In the embodiment illustrated in the drawings the housing 10 is generally of cylindrical shape and has a metal shell 11. The shell 11 is provided with a frusto-conical portion 12 as shown in FIG. 1 near the upper end of the apparatus. A flange 14 may be provided at the upper

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end of the housing for connection of a conduit guiding the heated air and products of combustion from the apparatus. An insulating layer 16 of suitable refractory material covers the inner surface of the upper portion of the housing 10 and the refractory layer defines an outlet opening 17. The lower annular edge of the refractory liner is inclined and provides frusto-conical surface 18 which may be covered with a sheet metal ring 19. The lower end of the shell 11 is provided with a conduit fitting 22 equipped with a flange 23 for connection to a pipe (not shown) leading from a supply of air under pressure substantially above atmospheric for movement through the inlet opening 21. The shell 11 below the refractory layer 16 is unlined.

The lower end of the housing 10 is closed by means of a bulged shaped disc member 24 which is suitably joined to the shell 11 to provide an impervious connection therewith. An opening 26 is provided within the disc 24 through which a conventional type fuel burner assembly 27 may be introduced and supported within the housing. The fuel burner assembly 27 may be of a known type for burning a gaseous fuel or liquid fuel or for simultaneous combustion of both of such fuels. A conduit fitting carried by the disc 24 defines the opening 26 and the fitting is equipped with a flange 28. A disc 29 closes the opening 26 and may be secured to the flange 28 by cap screws 31. The disc 29 fits closely about the guide tube for the fuel burner assembly 27 so as to prevent entry of air through the opening 26.

A feature of the invention pertains to a partition structure particularly disposed in relation to the inlet opening 21 and the fuel burner assembly 27. Such a partition structure may take the form of a substantially cylindrical shaped barrier 33 which surrounds the guide tube for the fuel burner assembly 27 in substantially concentric relationship. The lower end of the barrier 33 is supported on and may be welded or otherwise secured to the disc member 24. An inverted frusto-conical shaped portion 36 of the partition structure is carried by the upper end of the cylindrical barrier 33. A cylindrical shaped portion 37 of the partition structure is carried by the upper end of the inverted frusto-conical portion 36. An annular passage 38 is provided between the exterior surface of the cylindrical portion 37 and the inner surface of the shell 11. A plurality of centering lugs 39 (FIG. 2) extend radially from the exterior of the cylindrical portion 37 to maintain the upper end of the partition structure in centered relationship with respect to the housing and the shell 11 and provide the passage 38 with substantially uniform width throughout circumferential portions thereof.

The inner surface of the inverted frusto-conical portion 36 and the inner surface of the cylindrical portion 37 and the inner surface of the upper end portion of the barrier 33 are covered by a layer of insulation 41 which may take the form of a lightweight refractory material. A sheet metal annular member 40 covers the lower edge of the insulating layer 41. A plurality of holes 42 extend through the refractory layer 41 and through the portion 36 of the partition structure. In the embodiment shown in the drawings eight holes 42 are provided and at substantially equal circumferentially spaced locations about the partition structure. The axes of the holes 42 converge towards the axis of the housing 10 in proceeding upwardly at angles of approximately forty-five degrees with respect to the axis of the housing. The cylindrical barrier 33 is provided with two diametrically disposed openings 46 as shown in FIGS. 1 and 3. The guide tube for the burner assembly 27 is provided with diametrically disposed air inlet ports 47.

The apparatus as described provides a first annular

chamber A between the shell 11 and the exterior of the partition structure. A second annular chamber B is formed within the partition structure. A third chamber C is provided within the housing downstream of the partition structure. The two openings 46 provide communication from the chamber A into the chamber B. The annular space 38 and the holes 42 provide communication from the chamber A into the chamber C. The area of the annular space 38 plus the area of the openings 46 plus the area of all of the holes 42 constitutes the total area of the passages or flow paths from the inlet opening 21 to the outlet 17. The area of the annular space 38 is about thirty-five per cent of the total flow path area. The area of the openings 46 is approximately fifty per cent of the total flow path area. The area of the holes 42 is about fifteen percent of the total flow path area.

In operation and when fuel is supplied to the burner and ignited combustion of fuel takes place and the burning fuel provides a generally inverted conical shaped flame pattern within the partition structure downstream of the fuel burner head. Air to be heated is supplied through the inlet opening 21 at pressure above atmospheric and at significant velocities. The incoming air impacts the exterior surface of the cylindrical barrier 33 in the sector confronting the inlet opening 21. The air flow spends its momentum at impact and the pressure in the chamber A attains a substantially uniform value throughout all annular portions of the chamber A. Some air from the chamber A moves through the openings 46 into the chamber B. The pressure within the chamber A is greater than the chamber B. Some of the air in the chamber B moves through the ports 47 and within the guide tube to support combustion. Another portion of the air within the chamber B moves through the burner opening 35 and supports combustion of the fuel. The pressure within the chamber B is greater than the pressure within the chamber C. Some air from the chamber A moves through the annular passage 38 into the chamber C. The flow of air from the chamber A through the annular passage 38 and into the chamber C delivers cooling air to the products of combustion in a zone where there is complete combustion of the fuel. Some of the air within the chamber A flows through the holes 42 into the chamber C.

The flow of air through the openings 46 and into the chamber B provides a pressure drop across the two openings 46 and the flow of air from the chamber B into the chamber C provides pressure drop across the burned opening 35. The area of the two openings 46 is fifty per cent of the total flow path area but less than one-half of the air flows through the chamber B because of the two pressure drops which are in series. These pressure drops have the result of approximately forty per cent of the total incoming air being delivered to the presence of the burner as air for combustion and for movement with the hot products into the chamber C. A part of the remainder of the air flows into the chamber C through the annular passage 38 and another part of the remaining air in the chamber A flows through the holes 42 into the chamber C. In view of the fact that the flow through the holes 42 is directly from the chamber A into the chamber C the total flow through the openings 42 is approximately seventeen and seven tenths per cent (17.7%) of the total air volume rather than fifteen percent because there is no intermediate pressure drop. Thus forty-two and three tenths percent (42.3%) of the total air flow is through the annular passage 38.

The air escaping through the exit ends of the holes 42 serve to quench the hot products of combustion and this air is delivered to a zone where the combustion of the fuel is substantially complete. The flow through the passage 38 delivered this portion of the air to a zone where combustion of the fuel is complete. The flow through

the openings 46 is forty percent and the total flow through the holes 42 is seventeen and seven tenths percent (17.7%) so that these two flow paths account for fifty-seven and seven tenths percent (57.7%) of the total air flow. The air flow through the annular passage 38 amounts to forty-two and three tenths percent (42.2%) of the total volume of air.

These flow relationships may vary in the commercial production of the apparatus as a consequence of manufacturing tolerances and the flow coefficients of the openings and passages. The flow relationship as hereinabove defined is proportioned and disposed to provide the desired result of providing a uniform temperature throughout the outlet opening 17. This is in part obtained by the structure providing for mixture of the cooling air with the combustion gases. The air escaping through the exit ends of the holes 42 provide finger like streams for cooling air which converge inwardly in proceeding downstream of the assembly at approximately forty-five degrees with respect to the axis of the apparatus. These streams of cooling air are at substantial velocity because the pressure drops across the holes 42. The cooling air streams escaping through the holes 42 converge towards the axis and entrains the hot combustion gases to converge towards the axis of the apparatus. There is a pre-cooling of the mixture of combustion gases and air. The final cooling is produced as the remainder of the combustion gases meets the air flowing through the annular passage 38.

The invention has been described with reference to specific structural characteristics of a housing and a partition structure together with a known type of burner. Changes and modifications may be made in all of such elements along with alterations in the overall assembly. Various other modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What I claim and desire to secure by Letters Patent is:

1. In a direct fired air heater, a generally cylindrical shaped housing, a burner assembly supported within said housing, a partition structure within said housing including a cylindrical shaped barrier surrounding said burner assembly in spaced relationship providing a first annular chamber between the exterior of the barrier and the interior of the housing, said partition structure having an inverted frusto-conical shaped portion including an insulation layer flaring outwardly in proceeding downstream of the burner assembly, said partition structure having a cylindrical portion downstream of said frusto-conical shaped portion defining an annular passage between the exterior thereof and the interior of said housing providing communication from said first annular chamber into the housing downstream of said partition structure, said barrier providing a second annular chamber therewithin around said burner assembly, insulation carried by the partition structure disposed about the burner assembly providing an opening affording communication from the second annular chamber into said frusto-conical portion of the partition structure, said housing having an inlet opening with its axis disposed generally radially of said barrier for admitting air under pressure which impacts against the exterior of said barrier whereby its momentum is substantially dissipated to provide a supply of air substantially free of turbulence within the first chamber, said barrier having openings therethrough circumferentially displaced from said inlet opening for movement of some of the air from the first chamber into said second chamber around the burner assembly to support combustion, said frusto-conical portion having circumferentially spaced holes therethrough downstream of the burner assembly providing paths for movement of air from the first chamber into the partition structure where combustion of the fuel is substantially complete, and said annular passage providing another path of movement for

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some of the air from the first annular chamber into the housing downstream of the partition structure.

2. In a direct fired air heater, a generally cylindrical shaped housing, a burner assembly supported within a lower portion of said housing, a partition structure within said housing including a cylindrical shaped barrier surrounding said burner assembly in spaced relationship, said partition structure having an inverted frusto-conical shaped portion flaring outwardly in proceeding upwardly from the burner assembly, said barrier and said frusto-conical shaped portion providing a first annular chamber between the exterior thereof and the interior of said housing, said partition structure defining an annular passage between the exterior thereof and the interior of said housing providing communication from said first annular chamber into the housing above said partition structure, said barrier providing a second annular chamber there-within around said burner assembly, means carried by the partition structure disposed about the downstream end of the burner assembly providing an opening providing communication from the second annular chamber into said frusto-conical portion of the partition structure, said housing having a radially disposed inlet opening for admitting air under pressure for impacting against the exterior of said barrier whereby its momentum is substantially dissipated to provide a supply of air within the first chamber, said barrier having openings therethrough circumferentially displaced from said inlet opening for

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movement of some of the air from the first chamber into the second chamber around the burner assembly to support combustion, said frusto-conical portion having circumferentially spaced holes therethrough at locations above said burner assembly with their axes converging towards the axis of said housing providing paths of movement of streams of air from the first annular chamber into the partition structure where combustion of the fuel is substantially complete, said annular passage providing another path for movement of some of the air from the first annular chamber into the housing above the partition structure, and a frusto-conical surface within said housing above said partition structure diverting air escaping from said annular passage towards the axis of the housing.

3. In a direct fired air heater according to claim 2 wherein the frusto-conical surface is formed on an insulating layer covering the interior of the housing above said partition structure.

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