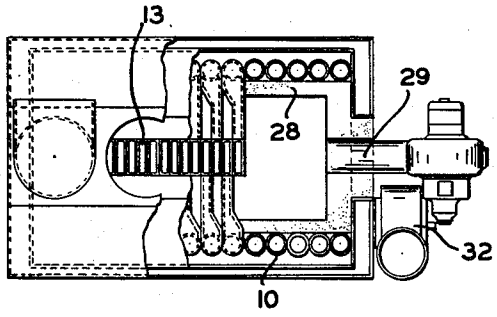
Nov. 18, 1952 A. A. OLSON 2,618,256

DIRECT FIRED AIR HEATING FURNACE WITH MULTIPLE TUBE WALL HEAT EXCHANGE STRUCTURE

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Fig 3



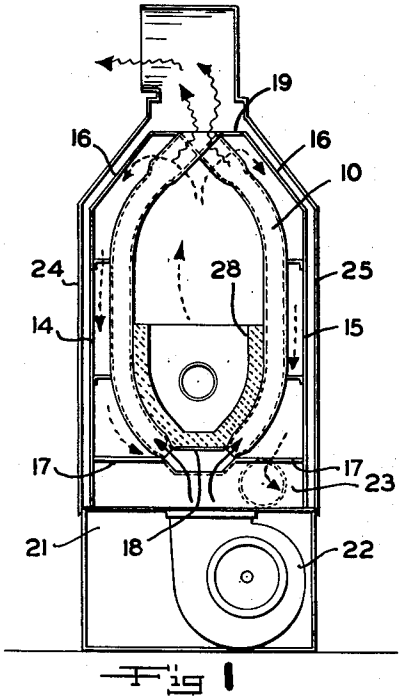


Fig 1

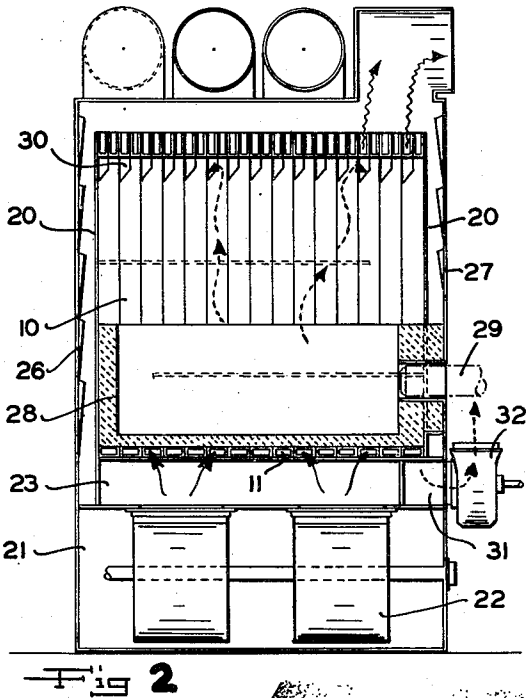


Fig 2

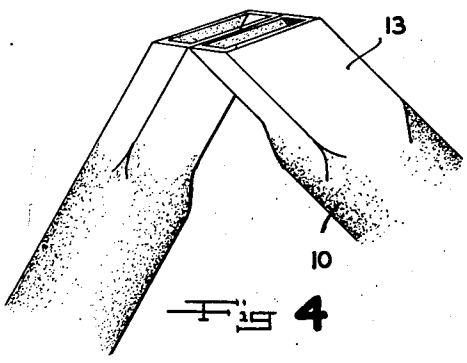


Fig 4

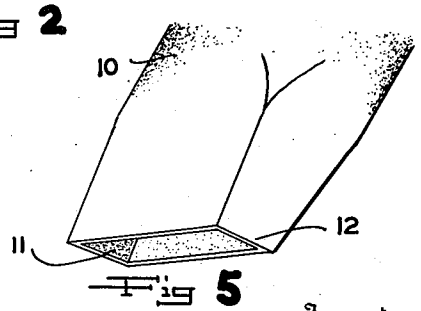


Fig 5

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DIRECT FIRED AIR HEATING FURNACE WITH MULTIPLE TUBE WALL HEAT EXCHANGE STRUCTURE

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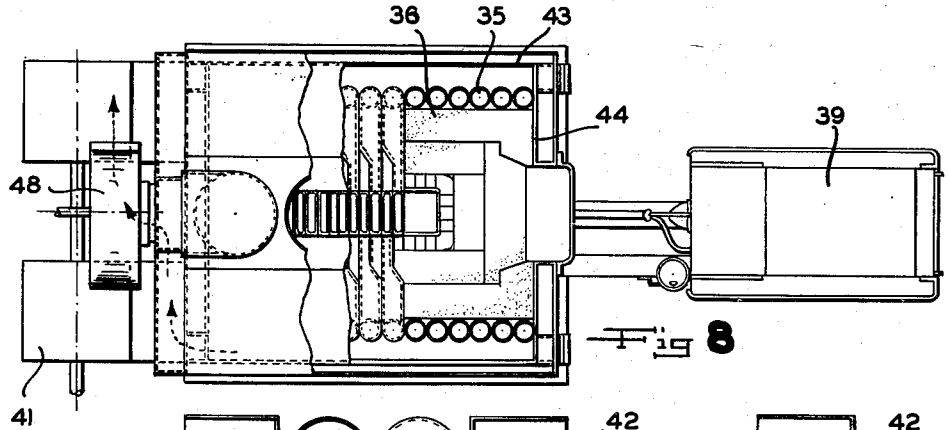


Fig 8

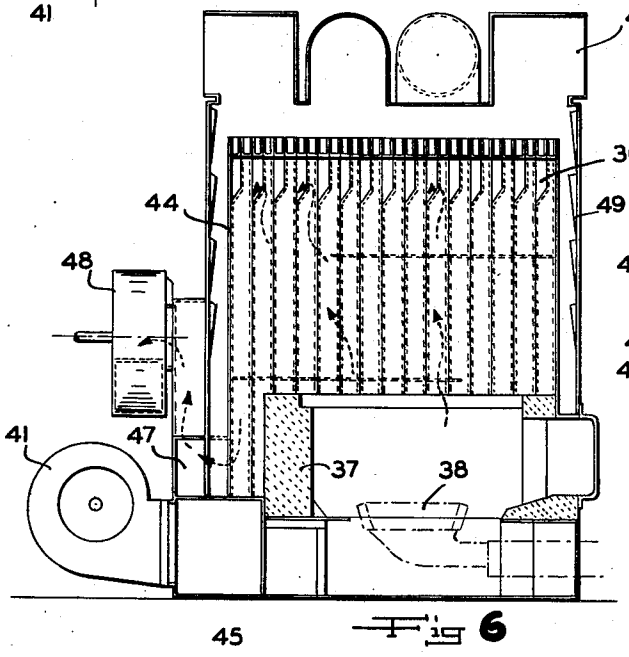


Fig 6

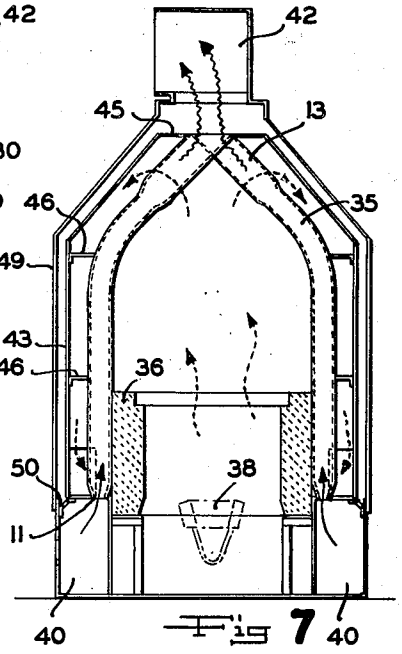


Fig 7

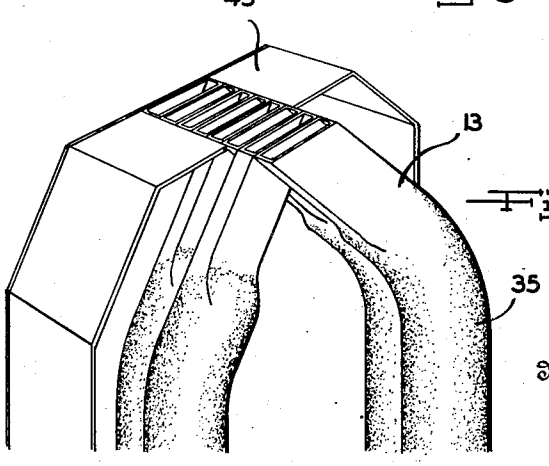


Fig 9

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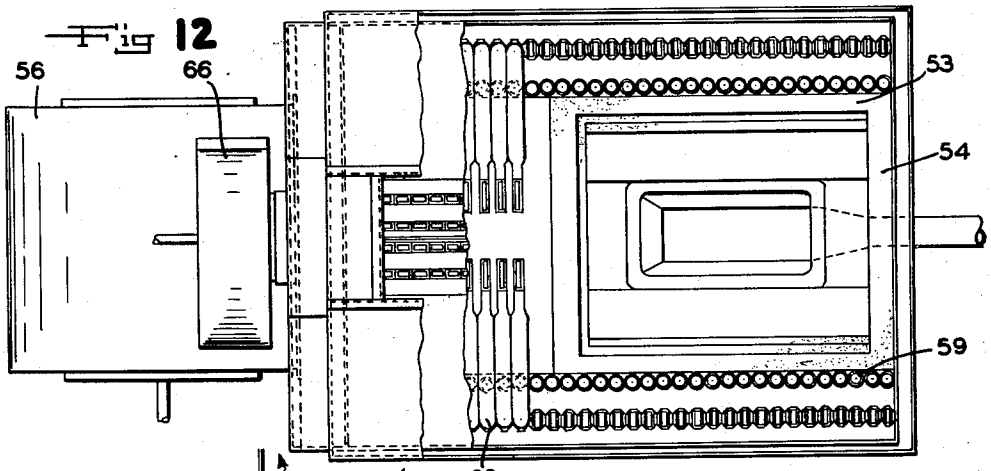
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DIRECT FIRED AIR HEATING FURNACE WITH MULTIPLE TUBE WALL HEAT EXCHANGE STRUCTURE

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Fig 12



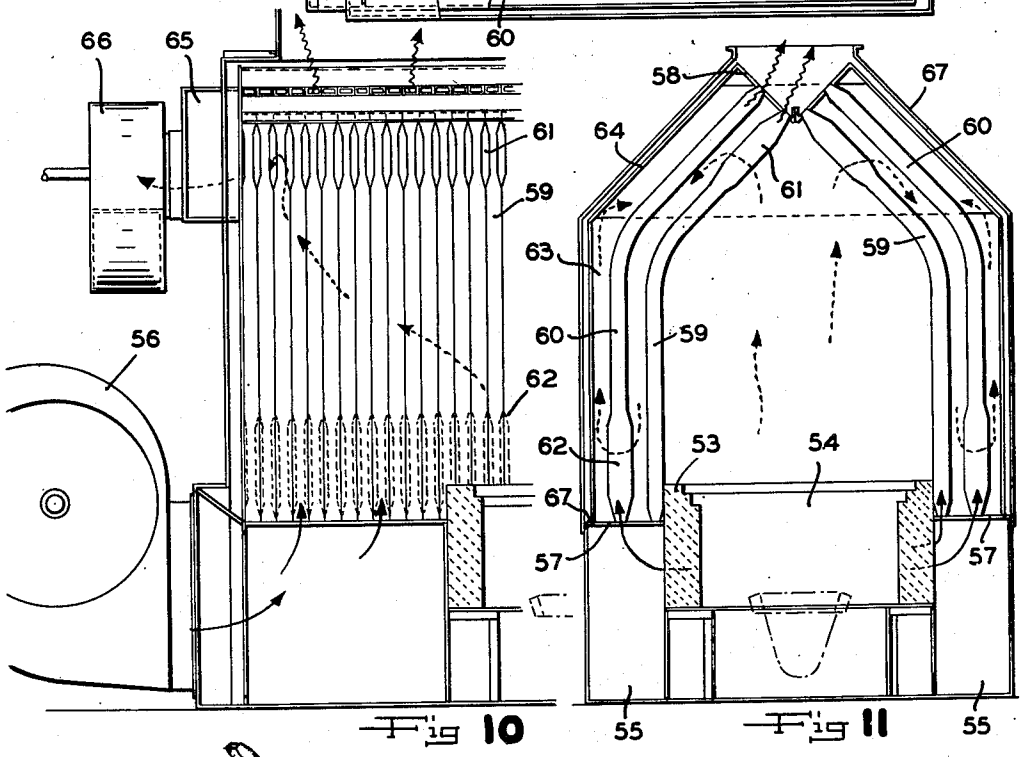


Fig 10 55 Fig 11 55

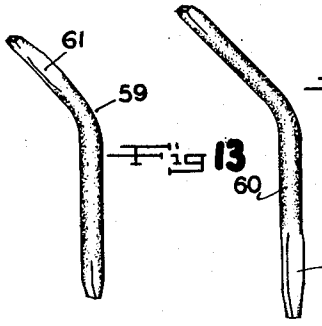


Fig 13 Fig 14

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DIRECT FIRED AIR HEATING FURNACE WITH MULTIPLE TUBE WALL HEAT EXCHANGE STRUCTURE

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Application November 4, 1948, Serial No. 58,311

5 Claims. (Cl. 126—110)

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This invention relates to air heating furnaces and more particularly to improvements in the heat exchanging assemblies for air heating furnaces of the direct fired type wherein the heat of the combustion gases is transferred directly to an air stream to be heated after passing through a separating or dividing wall. As is well understood in apparatus of this nature the structural elements of the heat exchanging assembly are subjected to wide variations of temperature and to large temperature gradients since in some installations the burner is either full on or full off and in all cases there is necessarily a wide temperature differential between the gaseous products of combustion and the air to be heated. Consequently the structural durability of the heat exchanging assembly is a prime consideration in air heating furnaces of the direct fired type and it is the primary object of the present invention to provide improved heat exchanging assemblies for furnaces of this type which, while being economical and practical to construct and assemble, have superior performance characteristics as regards durability and service and freedom from harmful expansion and contraction due to violent changes in applied temperatures or to greatly varying temperature gradients.

Another important consideration in the design and construction of direct fired air heaters is the avoidance of any localized overheating of the metal making up the separating walls of the heat exchanging assembly and, of course, this can only be avoided by dispersing or distributing widely the passage of the hot gases over the heat exchange surfaces and by preventing any excessive velocity in any portion of the gas stream whereby the air flowing on the opposite side of the surfaces is effective to conduct away the heat imparted in a continuous manner. This general object is accomplished in accordance with the present invention by providing, in effect, a hollow walled combustion chamber in which air to be heated is forced up through the walls while the hot gaseous products of combustion are directed up the inside of the walls and down the outside thereof by means of suitable ducts and of a series of distributing ports formed in each side wall of the combustion chamber near the top thereof.

A more specific object of the invention is the provision of improved constructions for combustion chambers formed of hollow walls for the passage of air to be heated. It is a still further object of the invention to provide an improved hollow walled combustion chamber for an air

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heating furnace which is readily fabricated out of stock materials, which is of improved strength and durability, and which is free to expand and contract without danger of opening up any of the seams or joints thereof.

The above and other objects and advantages of the invention will become apparent upon consideration of the following detailed specification and the accompanying drawing wherein there is disclosed certain preferred embodiments of the invention.

In the drawing:

Figures 1 and 2 are transverse and longitudinal sectional views, respectively, of an oil fired air heating furnace constructed in accordance with the principles of the invention;

Figure 3 is a plan view, partly in section, of the furnace of Figures 1 and 2;

Figures 4 and 5 are fragmentary perspective views of portions of the air conducting tubes utilized in the furnace of Figures 1 and 2;

Figures 6 and 7 are longitudinal and transverse sectional views, respectively, of a modified form of furnace constructed in accordance with the principles of the invention;

Figure 8 is a plan view, partly in section of the furnace of Figures 6 and 7;

Figure 9 is a fragmentary perspective view showing a detail of construction of the furnace of Figures 6, 7 and 8;

Figures 10 and 11 are fragmentary transverse sectional views of a further modified form of furnace constructed in accordance with the principles of the invention;

Figure 12 is a plan view, partly in section, of the furnace of Figures 10 and 11; and

Figures 13 and 14 are perspective views of inner and outer air tubes, respectively, utilized in the furnace of Figures 10, 11 and 12.

In the furnace of Figures 1 through 5 the principal walls of the combustion chamber, other than the end walls, are made up of a series of identical bent tubes 10 which are arranged in side-by-side contacting relation to form, in effect, impervious side and top walls. Tubes 10 are formed of conventional steel tubing such as used in boiler flues, for example, and as shown more clearly in Figure 1 each of the tube lengths are so bent as to provide inturned upper and lower end portions. The lower end of each of the tubes 10 is formed to provide a rectangular end opening 11 having an outer length exactly equal to the outside diameter of the initially round tube. This means that the straight lower side edges 12 of one of the tubes will lie in contact with similar

straight edges of adjacent tubes when a series of tubes are assembled in side-by-side relation—making it easy to connect the lower ends of the tubes to a header chamber. This relation is shown in Figure 2. The upper ends of the tubes 10 are flattened as shown at 13 and are cut off on a bias so that when the two series of tubes making up the two side walls of the combustion chamber are assembled the upper end surfaces of each of the tubes will lie in a horizontal common plane. Such two series of tubes are assembled in a sheet metal shell having side walls 14 and 15, the upper end portions of which are tapered inwardly as shown at 16 (Figure 1). Secured to and extending inwardly from the lower portions of the walls 14 and 15 are partial bottom walls 17 which are welded along their innermost edges to the lowermost edges of the ends 11 of the tubes 10. Spanning the upper edges of the lower openings 11 of the tubes 10 is a plate 18 which is welded in position along its edges as will be understood. Extending inwardly from the upper edges of the slanting portion 16 of the side walls 14 and 15 are partial top walls 19, the inner edges of which are welded, in abutting relation, to the line of upper ends of the tubes 10.

It should be observed that the end portions 13 of the tubes 10 are each flattened to a dimension which is exactly one-half the initial outside diameter of the tube so that when the bent and pre-formed tubes are assembled as shown in the drawing the upper ends 13 of the tubes will lie in close contacting relation while the series of tubes on either side of the combustion chamber also lie in close contacting relation. The ends of the combustion chamber thus formed of the tubes 10 are closed off by means of plates 20 which also form the end walls for the shell comprised of the walls 14 and 15.

I provide a base 21 in which is mounted a pair of longitudinally spaced blowers 22 which discharge air to be heated upwardly directly in alignment with the inwardly canted lower ends 11 of the tubes 10 as shown in Figure 1. The outlets of the blowers 22 are preferably spaced downwardly from the lower ends of the tubes 10 as by means of the space 23 to allow for equalization of the quantity of air entering the respective tubes, as will be understood. Also supported on the base 21 is an outer jacket or casing comprised of the side walls 24 and 25 and the end walls 26 and 27 and in accordance with usual practice this casing is spaced outwardly of the shell comprised of the walls 14, 15 and 20 to allow for the upward flow of a thin blanket of insulating air.

Positioned in the bottom of the combustion chamber and supported on the tubes making up the hollow walls thereof is a refractory fire pot 28 adapted to receive the flame from an oil burner tube 29 which projects through an end wall of the fire pot, as shown. As the products of combustion pass upwardly out of the fire pot 28 they pass out of the combustion chamber through the series of openings 30 which are formed due to the flattening of the upper end portions of the tubes 10. Such openings appear in evenly spaced relation along either side of the combustion chamber adjacent the apex thereof and it should be observed that since each of the tubes are of identical construction the openings 30 will be of uniform dimension and will be uniformly spaced longitudinally of the furnace. This makes for an effective longitudinal dispersement of the products of combustion throughout the furnace whereby the structure of the furnace is fully utilized and damaging concentrations of heat are avoided. After passing through the openings 30 the products of combustion move downwardly along either side of the furnace through the spaces between the walls 14 and 15 and the adjacent hollow walls of the combustion chamber and thence pass into a header 31 which extends transversely of the furnace below the inner end of the burner tube 29. An exhaust fan 32 is preferably employed to withdraw the gaseous products of combustion from the furnace at a controlled uniform rate.

The hollow-walled heat exchange assembly described above is exceedingly simple in design and construction and yet, since it is assembled of tubes which in themselves have high structural efficiency, the assembly is structurally very sound and durable. The tubes can expand and contract either in unison or individually without materially effecting the configuration of the heat exchanging element and without danger of loosening any of the welded joints thereof. The structure is highly efficient in its heat transfer characteristic due to the large exposed surface area provided by the multiplicity of the tubes and the furnace operates with a quite advantageously low stack temperature. Finally, the structural nature of the heat exchanging element enables the refractory combination retort to be supported directly in and on the element which makes for economy of construction, and through the simple expedient of flattening the upper ends of the component air tubes an effective method of distributing the heating gases longitudinally throughout the heat exchanging element is provided.

In the embodiment of the invention illustrated in Figures 6 through 9 the heat exchanging assembly is constructed similarly as in the first described embodiment, i. e., having its side walls and arched top formed of a plurality of metal tubes 35 which lie in side-by-side contacting relation. The furnace of this embodiment, however, is arranged for stoker operation and as such the refractory fire pot normally used in conjunction with the stoker has straight side walls 36 and straight end walls 37 and an open bottom in which is positioned the fuel and air feed cone 38 of the stoker 39. As shown in Figure 7, the tubes 35 are bent inwardly only at their upper end portions—the lower end portions of the tubes 35 being straight—but both the upper and lower extremities of the tubes 35 are flattened and made rectangular at 13 and 11, respectively, as for the tubes 10 in the first described embodiment. This enables the lower ends of the tubes 35 to be welded into slits formed longitudinally in the top walls of a pair of spaced sheet metal ducts 40 which are supplied with air by a pair of blowers 41 positioned at the rear end of the furnace.

Tubes 35 are positioned in contact with the outer surfaces of the refractory walls 36 and as shown in Figure 7 air to be heated enters the lower ends of the tubes 35 and is discharged through the open flattened upper ends thereof into an air distributor 42. The gaseous products of combustion are confined within a casing comprised of side walls 43, end walls 44, and a top wall which is formed in part by the outer surfaces of the overlapped flattened upper ends of the tubes 35 supplemented by strips 45 which are welded to the aligned edges of the upper ends of the tubes 35 as shown in Figure 9. Thus, the

gaseous products of combustion pass upwardly from the fire bed supported on the cone 38, through the openings 30 provided by the flattened upper portions 13 of the tubes 35 and thence downwardly between the banks of tubes 35 and the walls 43 on either side of the furnace. To lend a more circuitous path to the heating gases staggered baffles 46 may be employed. The products of combustion are collected in a transverse header 47 positioned at the rear of the furnace from which they are withdrawn by an induced draft fan 48. In accordance with usual practice an outer casing 49 is provided having walls spaced uniformly outward from the outer walls 43 and 44 of the combustion chamber to provide for the upward flow of thin blankets of insulating air and suitable openings as at 50 may be provided to discharge air into these uniform spacings from the air supply depths 40. In the embodiment of the invention shown in Figures 10 through 14 the furnace is again arranged for stoker firing but the furnace is of much larger capacity, utilizing two spaced rows of bent air conducting tubes on either side of the furnace. Thus, the furnace of this embodiment may comprise a suitably supported fire pot having straight side walls 53 and end walls 54 and an air supply duct 55 positioned on either side of the fire pot and supplied with air from a blower 56. The heat exchange element comprises an assemblage having a pair of spaced plates 57 which form the upper walls of the ducts 55 and a V-shaped upper header 58 which is interconnected with the header plates 57 by means of an inner bank of air conducting tubes 59 and an outer bank of air conducting tubes 60 on either side of the furnace. As shown in Figure 11, the upper end portions of each of the tubes are bent inwardly toward each other to form, in effect, a general arch-shaped combustion chamber and as clearly indicated in Figures 10 and 12 the tubes of each bank on either side of the furnace lie in line contact with each other to provide, in effect, a pair of spaced parallel hollow-walled partitions on either side of the furnace.

Tubes 59 are flattened for an appreciable extent of their lengths adjacent and spaced from their upper ends as shown at 61. This arrangement provides a series of uniform, equally spaced openings or slits in the top portion of the hollow walls of the heat exchange unit on either side of the furnace for the passage of products of combustion into the space between the two hollow walls on either side of the furnace. The lower end portion of the tubes 61 are each flattened as shown at 62 to provide a series of uniform, evenly spaced elongated openings for the exit of the products of combustion from the space between the two rows of tubes 59 and 60 into the passage 63 on either side of the furnace. An inner casing 64 contains the gases after passing through the openings provided by the flattened portion 62 of the tube 60 and directs the same upwardly and thence longitudinally into a flue header 65 from which the gases are exhausted by an induced draft fan 66. In accordance with usual practice an outer casing 67 is provided which is arranged to receive air from the ducts 55 through openings 67.

It should be particularly observed, in the embodiment shown in Figures 10 through 14, that through the simple expedient of providing a pair of spaced parallel banks and tubes on either side of the furnace and flattening each tube it is possible to readily construct an air heating furnace which is of large capacity due to the increased number of air conducting tubes and which is highly efficient in operation due to the circuitous nature of the resulting gas flow over and about the heat exchanging tubes. The tubular-corrugated nature of the assembled heat exchanging element provides a very large total heat absorbing surface to be presented to the luminosity of the combustion and/or to wiping contact with the hot gaseous products of combustion thereby resulting in an air heating furnace which is remarkably efficient in operation, emitting a quite low stack temperature. These results, moreover, are obtained by a construction which is very economical to produce, employing conventional raw materials and components, capable of withstanding severe conditions of service without appreciably deteriorating.

It should be observed that in each of the embodiments of the invention illustrated, the velocity of the air increases appreciably in flowing about the openings by which the products of combustion are removed from the combustion chamber and since the velocity of the heating gases is also at a maximum in this region the increase in velocity of the air is beneficial in balancing out the increased heat input thereby preventing the formation of overheated spots. In any of the embodiments the adjacent and interposed arrangement of the air and gas blankets is beneficial from a heat transfer efficiency standpoint as is well understood in the art.

It should now be apparent that I have provided improvements in air heating furnaces of a direct fired type which accomplish the objects initially set out. Through the use of easily constructed components the invention enables highly efficient, rugged and durable direct fired air heating furnaces to be economically produced in a wide variety of sizes and capacities. It should be clearly understood, however, that the specific embodiments of the invention herein shown and described are capable of wide variation within the spirit and scope of the invention and reference should accordingly be made to the appended claims in determining the scope of the invention.

I claim:

1. A combined combustion chamber and heat exchanging unit for a direct fired air heating furnace comprising two spaced banks of metal tubes with the tubes in each bank being positioned in contacting side-by-side relation to form in effect hollow air-conducting side walls of the combustion chamber, the upper end portions of each of said tubes being flattened in parallel planes extending transversely of the combustion chamber and having a rectangular cross-sectional shape, the upper end portions of said tubes being curved inwardly whereby the upper extremities of the tubes of one bank are interlaced with the upper extremities of the tubes of the opposite bank, said flattened portions extending downwardly beyond the overlap of the tubes to provide at the upper end of each side wall of the combustion chamber a multiplicity of uniformly spaced interstices for the outflow of the gaseous products of combustion from the combustion chamber, the upper end surfaces of each and all of the tubes lying in a common horizontal plane, the arrangement being such that the assembled upper ends of said tubes presents a rectangular pattern readily receivable in a rectangular opening in a header plate.

2. A combined combustion chamber and heat

exchanging unit for a direct fired air heating furnace comprising two spaced banks of metal tubes with the tubes in each bank being positioned in contacting side-by-side relation to form in effect hollow air-conducting side walls of the combustion chamber, each of said tubes being of substantially uniform peripheral dimension throughout its length and having its upper portion flattened in a plane extending transversely of the combustion chamber and having a rectangular cross-section shape, the upper end portions of said tubes being curved inwardly whereby the upper extremities of the tubes of one bank are interlaced with the upper extremities of the tubes of the opposite bank, said flattened portions extending downwardly beyond the overlap of the tubes to provide at the upper end of each side wall of the combustion chamber a multiplicity of uniformly spaced interstices for the outflow of gaseous products of combustion from the combustion chamber, and means to conduct air to be heated through said tubes.

3. A combined combustion chamber and heat exchanging unit for a direct fired air heating furnace comprising a pair of hollow side walls spaced apart and converging inwardly at their upper ends to form a combustion chamber and each formed of a plurality of metal tubes positioned in contacting side-by-side relation longitudinally of the combustion chamber, the inwardly converging portions of said side walls being formed by inwardly curved upper end portions of said tubes, the said inwardly curved upper end portions of said tubes forming at least a substantial part of the upper wall of said combustion chamber, each of said tubes being substantially uniform in peripheral dimension throughout its length and having its upper end portion flattened in a plane extending transversely of the combustion chamber to thereby provide interstices for the outflow of gaseous products from the upper region of the combustion chamber, and each of said tubes having its lower end portion flattened in a longitudinal plane and formed in rectangular shape to thereby provide an elongated rectangular inlet for air at the lower end of each side wall.

4. In a combined combustion chamber and heat exchanging unit for a direct fired air heating furnace wherein the combustion chamber has longitudinally disposed side, top and bottom walls; a wall structure for said combustion chamber comprising a plurality of vertically extending air-conducting tubes of uniform length and each formed of initially round stock, said tubes being arranged in contacting side-by-side relation and having their upper and lower end portions curved inwardly with respect to the combustion chamber to form portions of the top and bottom walls of the combustion chamber, each of said tubes being of substantially uniform peripheral dimension throughout its length and having its upper end portion flattened in a plane extending transversely of the wall to provide spaced interstices for the outflow of gaseous products of combustion from the combustion chamber, and the lower end portions of said tubes being flattened in a plane extending longitudinally of the combustion chamber and being of rectangular shape to provide an elongated rectangular air inlet for said side wall.

5. An air heating furnace comprising a combustion chamber having longitudinally extending side walls each formed of a plurality of vertically extending air-conducting tubes positioned in contacting side-by-side relation, upper end portions of said tubes being flattened in planes extending transversely of the combustion chamber to provide spaced outlets for gaseous products of combustion from said chamber, and an outer casing for said combustion chamber having outer side walls spaced outwardly from the first mentioned side walls, horizontally disposed but overlapping and vertically spaced baffles positioned between said outer walls and the first mentioned walls comprised of said tubes to direct the gaseous products of combustion from said openings back and forth and downwardly across the outer faces of the first mentioned walls, and duct means positioned below the combustion chamber and at one end thereof and communicating with the spaces between said first mentioned and said outer side walls to exhaust the gaseous products of combustion from said spaces.

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