March 8, 1938. E. O. ENGELS 2,110,209

FURNACE

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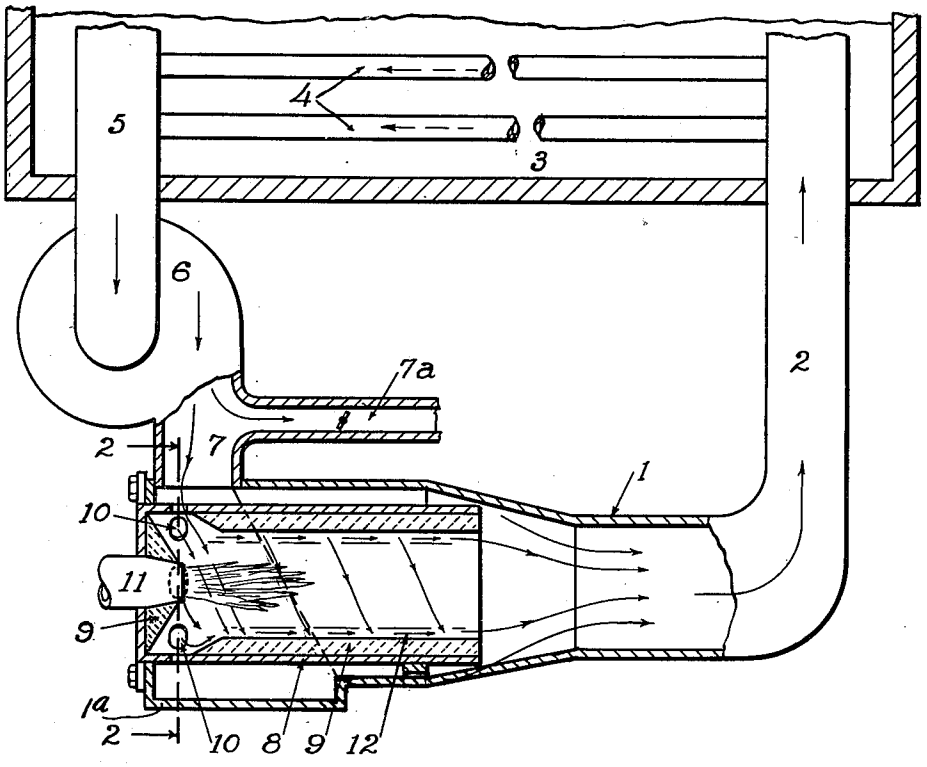


Fig. 1

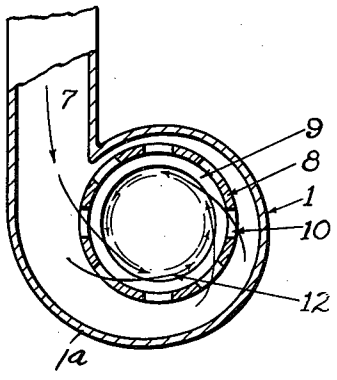


Fig. 2

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FURNACE

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3 Claims. (Cl. 158—1)

This invention relates to furnaces for heating bake ovens, dry kilns, or the like by the circulation of hot products of combustion through the oven, either through radiating flues, or by mixing them directly with the atmosphere of the oven. It has to do more particularly with oil or gas-fired furnaces consisting of a cylindrical tunnel having a burner at one end and opening at the other end into a tubular jacket which encloses it, through which jacket the gases to be heated are drawn or forced at high velocity.

In furnaces of this kind, especially when used in systems which recirculate spent heating gases from the oven over the combustion chamber where they are mixed with fresh products of combustion, it has been very difficult to provide a material for the combustion chamber walls which will withstand the extremely high operating temperatures. The costliest stainless steel cylinders lined with refractory material have lasted only a short time in regular service.

The object of this invention is to provide means for cooling and protecting the combustion chamber walls against intense heat of the gas or oil flame within it, so that longer life will be assured for the structure and its cost of construction and maintenance will be reduced. The invention accomplishes this purpose by providing novel means at the cylinder end of the cylindrical combustion chamber for injecting into the combustion chamber a rapidly moving helically-directed layer of relatively cool inert gases. These gases form a moving blanket over the inner wall of the cylindrical combustion chamber, cooling the wall by convection and preventing erosion by contact with the burner flame.

A further feature of the invention is that the helically flowing layer of gases by its vortex effect produces, or greatly increases, suction at the fuel burner nozzle. This greatly improves the efficiency of combustion and aids in a certain automatic regulation of fuel and air supply, which will be described further in this specification.

The invention by which these objects are attained resides in the provision of a plurality of openings spaced circumferentially of the combustion chamber wall near the end at which the burner is located, together with means for directing inert gases such as recirculated flue gases to be heated at high velocity circumferentially of the combustion chamber. A portion of the inert, relatively cool gases enters the combustion chamber at high enough velocity to form a circumferentially rotating blanket of inert gases which sweeps the wall of the combustion chamber or tunnel throughout its length, and surrounds and encloses the burner flame, thus effectively cooling and protecting the tunnel wall or its refractory lining from direct contact with the burner flame.

A further feature of the invention may consist of means for positively directing the jets of air entering the combustion chamber so that the flow of inert gases is given a definite helical travel toward the discharge end of the chamber. Ordinarily, however, due to the suction usually present in the chamber, produced either by positive suction of the circulating fan, or by the entrainment effect of gases passing its outlet at high speed, the inert insulating gases while whirling circumferentially of the combustion chamber as indicated by the curved arrows in Fig. 2 are drawn toward its mouth, so that they blanket the entire inner wall.

These and other features of the invention are described and illustrated in the accompanying drawing in which,

Fig. 1 is a diagrammatic longitudinal section of a furnace embodying my invention, and

Fig. 2 is a transverse section through the inner end of the furnace, taken along line 2—2 in Fig. 1.

The heating plant, shown in Fig. 1, comprises a tubular jacket or furnace shell 1 which opens into a heated duct 2 which in turn leads to the inside of an oven or kiln 3. The hot gases from duct 2 pass either directly into the oven atmosphere, or through radiating flues 4 shown in dotted lines, and thence into an exhaust duct 5. Duct 5 leads to a centrifugal blower 6 which discharges through a duct 7 back into the jacket 1 at its closed end. This known structure forms a closed circuit for the hot gases of combustion, through which they circulate, giving up their heat in the oven 3 and being continuously reheated in the jacket 1. So much of the gases as is displaced by fresh products of combustion is vented off through a damper regulated flue 7a leading to a suitable stack or other outlet to the atmosphere.

To the above described structure my invention is applied.

A cylindrical combustion chamber 8, open at one end is mounted coaxially within and spaced from the jacket 1. At the burner end the jacket 1 has a spiral portion 1a progressively increasing in radius and tapering in width to the point of connection with duct 7. The tangentially directed duct is thus faired smoothly into the cylindrical body of the jacket, and portion 1a defines a spirally tapered duct surrounding the

combustion chamber at the burner end. The combustion chamber may or may not be lined with refractory material 9, depending upon the temperatures which are to be encountered in particular installations.

Spaced circumferentially of the closed end of the combustion chamber 8 in the outer wall thereof are a plurality of ports or openings 10. The inlet duct 7 is offset, as shown in Fig. 2, so that the gases driven by the blower 6 enter the shell tangentially and are given a rapid travel circumferentially of the chamber past the ports 10. Jets of gas enter the combustion chamber 8 through ports 10 at high velocity and swirl rapidly circumferentially of the interior of the combustion chamber. Due to suction produced by the induction effect of gas passing the open end of the combustion tunnel, the layer of swirling gases travels helically lengthwise along the inner walls of the combustion chamber. As shown in Fig. 1, the gases may be further positively directed in the desired helical path toward the mouth of chamber 8 by beveling the refractory lining 9 where it is cut away adjacent to ports 10.

At the closed inlet end of the tunnel 8 a fuel burner 11 of known type, to burn premixed air and gas or oil, is installed to direct its flame lengthwise of the tunnel toward its open end.

Heretofore in furnaces of this general type a great deal of trouble has been caused by the extremely high temperatures to which the combustion chamber walls were subjected. Expensive alloy steels lasted only a short time under the extreme conditions, and the best refractory lining speedily disintegrated. This invention eliminates that difficulty and permits of the construction of the furnace from relatively inexpensive materials.

In operation, the inert, relatively cool recirculated gases of combustion are supplied at high velocity from duct 7, are given a rapid movement circumferentially of the outside of the cylindrical combustion chamber. Due to their circular travel and relatively high pressure a portion of them flow tangentially into the combustion chamber through ports 10, being so directed by the progressively reduced diameter of the spiral portion 1a of the jacket enveloping the combustion chamber. Here by reason of their high speed, they form a helically rotating layer of gas, wiping and cooling the inner wall of the combustion tunnel and enclosing as in a tube of gas the axially directed burner flame. In addition to cooling the wall by convection the tubular layer of inert or incombustible gases also protects the wall from oxidation or reduction by direct contact with the burner flame.

A further advantage of my invention in a furnace as shown is that it facilitates the use of a small atmospheric type fuel burner, eliminating expensive and complicated pressure regulating devices for the fuel or combustion air.

In a recirculating system as shown it is desirable to use an atmospheric burner for the further reason that suction at the outlet of the combustion chamber and the entraining effect of the circulated gases varies inversely with their temperature. Thus, with a relatively small flame a high degree of automatic heat regulation is obtained. For example, when the heating gases are cooled below the desired temperature, their density increases. The suction in the combustion chamber immediately increases, and additional fuel and air are drawn into the burner to increase the rate of combustion.

My invention enhances this effect by greatly increasing the suction normally prevailing within the combustion chamber around the burner nozzle, and increasing its range of variation with changes of temperature and density of the circulating gases. This increase in suction is brought about by the vortex effect of the layer of gases swirling at high velocity circumferentially of the chamber wall.

While I have shown my improved apparatus applied to a recirculating oven-heating system, it is not limited to such application. For example, it may be used in heating systems for dry kilns, drying tunnels, etc., in which the spent gases are not recirculated, but are discharged directly to a stack. In such an installation sufficient relatively cool inert gases may be bypassed from the stack to the blower 6 to produce the desired cooling and protection of the wall of the combustion tunnel. This, and other modifications in the use of the apparatus embodying my invention may be made without departing from the scope of the appended claims.

From the foregoing, it will be seen that in the operation of my device the burner flame made of a combustible mixture of air and gas or oil is blown axially lengthwise of the combustion chamber or tunnel 8, and that the burner flame is surrounded by an annular layer of burnt, spent, or inert gases, indicated at 12, in the form of a helically swirling film or layer that follows around the inner wall of the combustion chamber from the ports 10 to the end of the chamber. The burner flame is separated from the inner wall of the chamber by this protective gaseous layer. Due to the high rate of travel of the layer the inner wall, or the inner lining, of the combustion chamber is protected from the deteriorating effect of the high temperature burner flame, and consequently the life of the combustion chamber is greatly increased.

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

1. In a furnace, in combination, a cylindrical combustion chamber open at one end, a fuel burner mounted in its other end directed axially of said chamber, and a jacket surrounding said chamber and spaced therefrom, a source of inert gases, a conduit connecting said source of inert gases and said jacket, means for impelling gases from said source at high velocity therethrough, said conduit joined to said jacket adjacent the burner end thereof and directed tangentially of said combustion chamber to direct said inert gases circumferentially of the exterior of said chamber, the wall of said combustion chamber adjacent its burner end being provided with ports therethrough to admit a portion of said circumferentially moving gases to the interior of said combustion chamber to form a helically traveling layer of inert gases over the inner peripheral surface thereof.

2. Apparatus as claimed in claim 1, wherein the jacket adjacent the burner end of the combustion chamber includes a spiral peripheral wall portion connected to the conduit, having its maximum radius at said connection and at its minimum radius merging into the cylindrical wall of said jacket to define a gas passage encircling the cylindrical combustion chamber in which the clearance between the said spiral wall portion and the outer wall of said combustion chamber is progressively reduced circumferentially of said chamber.

3. In a furnace, in combination, a cylindrical combustion chamber open at one end and a fuel burner mounted in the other end directed axially of said chamber, the peripheral wall of said combustion chamber adjacent the burner end being provided with openings therethrough, a source of inert gases, conduit means leading from said source of inert gases to said combustion chamber openings, means for impelling gases therethrough, and means for directing said gases tangentially into said combustion chamber to form a helically traveling layer of said gases over the inner peripheral wall thereof.

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