

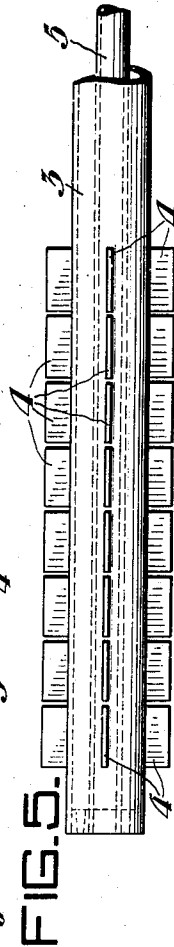
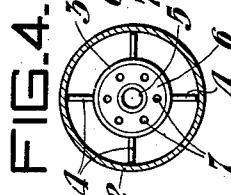
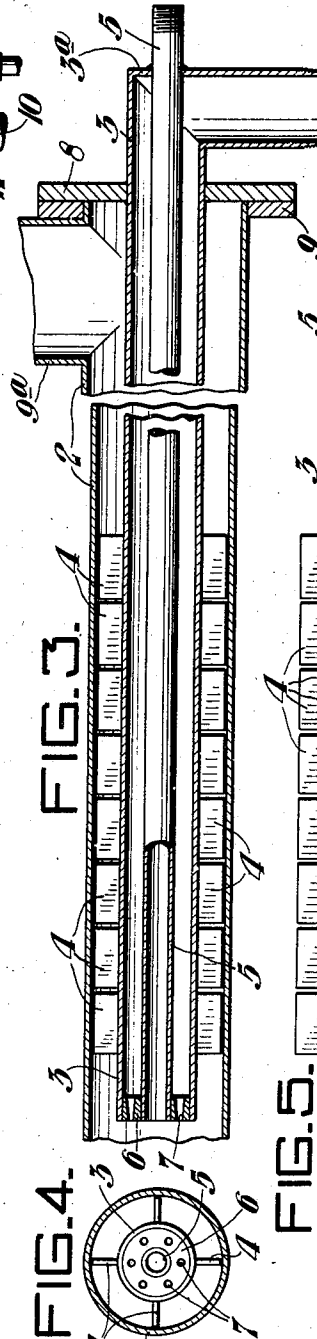
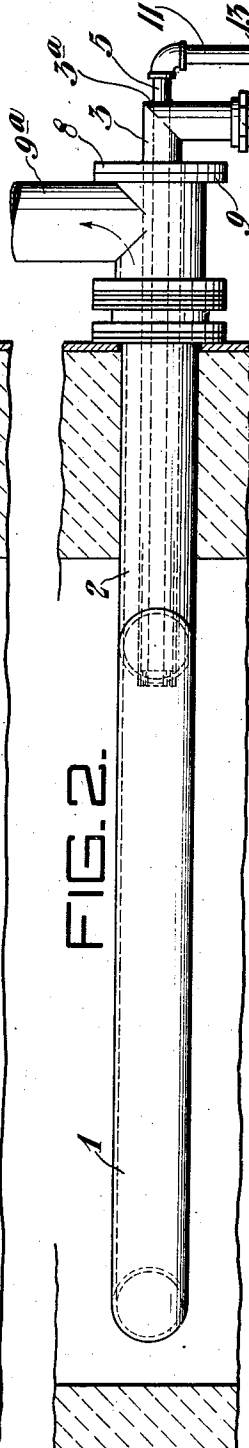
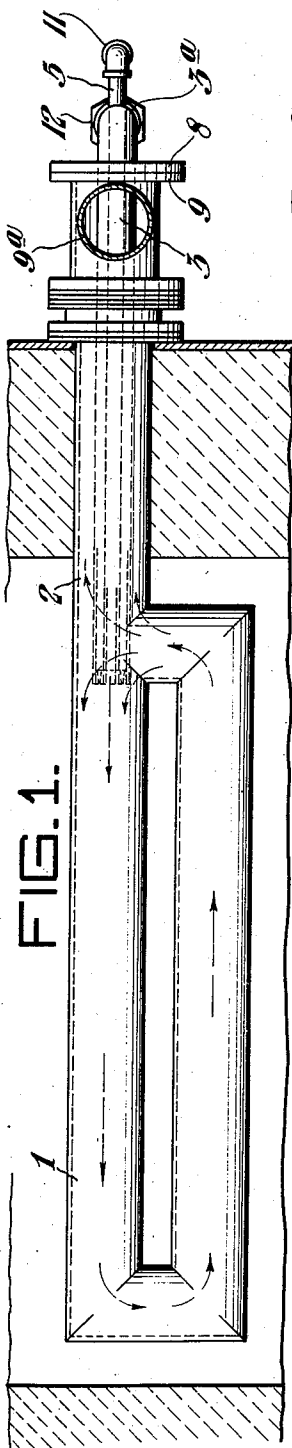
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D. EDGE

2,391,447

RADIANT HEATER

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UNITED STATES PATENT OFFICE

2,391,447

RADIANT HEATER

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Continuation of application Serial No. 348,478,
 July 30, 1940. This application October 15,
 1942, Serial No. 462,183

2 Claims. (Cl. 126—91)

This invention relates to radiant heaters such as are used in metallurgical furnaces, and it is particularly concerned with the type characterized by a radiant tube in which fuel and air are burned, the tube separating the combustion products from the furnace atmosphere. It is common to use a number of these tubes in a furnace for the purpose of annealing or otherwise heat treating metal products.

A specific example of a radiant heater embodying the principles of the present invention is illustrated by the accompanying drawing, in which:

Figure 1 is a top view;

Figure 2 is a side view;

Figure 3 is a vertical section;

Figure 4 is a cross section; and

Figure 5 is a side view of the burner unit of the heater.

More specifically, this drawing shows the heater as having the radiant tube characterized by being in a form providing a long oblong loop portion 1 with a straight arm portion 2 extending from one of the long sides of this loop portion in alignment therewith. The tube is made of suitable alloy, the arm portion 2 and the long side of the loop portion with which it aligns being formed from a continuous length of tube and the loop portion being formed by a shorter length placed in communication with the first tube by two tube stubs, the various necessary junctions being formed by welding. The arm portion 2 is of sufficient length to pass through the furnace wall, it functioning to position the loop portion 1 inside the furnace and for various other purposes which will presently be understood.

A first pipe 3 having radial fins 4 extending longitudinally thereof is positioned concentrically inside the arm portion 2 of the radiant tube, the fins 4 being proportioned to bear against the inside of this arm portion and so support the pipe 3, and a second pipe 5 is fixed concentrically inside the first pipe 3 in spaced relation to its inside. The first pipe 3 has an elbow 3a at its outer end, and the second pipe 5 extends through the wall of this elbow so as to be fixed in its proper position, the front end of the second pipe 5 being supported by a ring 6 having a circumferential series of stream-lined orifices 7, and the front ends of both pipes being substantially flush as shown in the drawing.

The first pipe 3, the fins 4, the second pipe 5 and its supports consisting of the elbow 3a and the ring 6, are all formed into an integral burner unit that can be slid longitudinally into the arm portion 2 of the radiant tube. A flange 8 is welded to the outer end portion of the first pipe 3 and cooperates with a flange 9 fixed to the outer end of the arm portion 2 of the radiant tube to close the space between the inside of the arm por-

tion 2 and the outside of the pipe 3. Any suitable means may be used for releasably interfastening these flanges. However, the space between the inside of the arm portion 2 and the outside of the pipe 3 is open to the atmosphere by way of a stack 9a that connects with this space at the outer end of the arm portion 2 and extends vertically.

The method of using the heater consists in supplying the first pipe 3 with air under pressure and the second pipe 5 with a suitable fluid fuel, such as gas. The air ejects by way of the streamlined orifices 7, this producing fast-moving air jets which support combustion of the fuel introduced by way of the pipe 5. Since these pipes point straight along one side of the oblong loop portion, the flame which results upon ignition travels around the loop portion, the products of combustion exhausting out the arm portion 2 in the space between the inside of this portion and the outside of the pipe 3 to the stack 9a for ultimate exhaustion into the atmosphere.

As the products of combustion pass through the arm portion 2, their heat is given up to the incoming air traveling in the first pipe 3, the fins 4 serving to facilitate the heat exchange. In this way the products of combustion return a great deal of heat to the loop portion 1 which would otherwise be lost up the stack. Since the pipe 3 contains a fast-moving flow of air, the fuel flowing through the second pipe 5 inside the pipe 3 is protected from being heated to too high a temperature. Thus, if the fuel in the pipe 5 is hydrocarbon gas, the temperature of this gas may be kept below a point where it cracks and deposits clogging carbon deposits, even though the gas is flowing as a counterstream inside the arm portion 2 through which the combustion products are exhausting.

A further feature of the heater is that by making the open ends of the pipes 3 and 5 extend inside the loop portion 1 as is shown by the drawing, the inspirating action of the air ejected from the orifices 7 of the ring 6 drags some of the combustion products into the flame. The result is a recirculation of a portion of the combustion products, this smoothing out the action of the flame and preventing hot spots from appearing in the loop portion 1 of the radiant tube. It is to be understood that a considerable proportion of the combustion products continuously exhausts through the arm portion 2 to the stack 9a while the mentioned portion is being recirculated through the loop portion 1 of the radiant tube. The proportion of combustion products recirculated in the loop portion 1 may be varied by varying the amount the ejecting ends of the pipe 5 extend into the loop portion, although these open ends should always be at least adja-

cent the junction between the loop and arm portions of the radiant tube.

It is to be understood that the gas and air may be supplied the pipes 3 and 5 in any suitable fashion, the drawing showing supply pipes 10 and 11 connecting with the pipes 3 and 5, respectively, by releasable couplings 12 and 13. The mounting of the arm portion 2 in the furnace wall may follow conventional practice, although it should be noted that the difficulties connected with sealing a large number of radiant tubes in a furnace wall is reduced 50 per cent since there is only one arm portion for each heater in the case of the present invention.

A summary of the foregoing shows that the loop portion 1 constitutes a recirculating radiant combustion chamber, while the pipes 3 and 5 form conduit means for introducing a combustible gas mixture into this chamber, this conduit means being provided with at least one velocity-increasing orifice associated therewith and pointing in the recirculating combustion chamber in its recirculating direction. The orifice mentioned is provided by the annular series of orifices 7 in the ring 6, the orifices being not only streamlined but also shaped to provide outwardly tapering passages.

The prior art has carefully avoided velocity-increasing orifices used as mentioned above, because of the necessity of restricting the velocity of the combustible gas mixture to one not exceeding its maximum or critical flame propagation rate, the thought having been that if this was exceeded the flame would blow out. Contrary to this, the present inventor has found that if the initially ignited combustible mixture is first introduced at low pressure so that its velocity is sufficiently low to maintain the flame without blowing it out, and is then gradually increased in pressure so as to produce a gradual increase in its velocity, it being remembered that recirculation is going on in the combustion chamber and that this recirculation gradually increases simultaneously in velocity, that it ultimately becomes possible to introduce the combustible mixture at a velocity exceeding its maximum or critical flame propagation rate. This follows from the fact that the burning combustible mixture is introduced to a recirculating flow of the burning mixture and its combustion products all moving at substantially the same speed, it following that the combustible mixture is spread throughout the entire recirculating flow while it burns under the equivalent of static conditions. The use of a proper volume of the combustible mixture at this high velocity produces a glowing ring of completely uniform flame which is entirely free from any apparent local combustion. This accounts for the reason no hot spots are formed in the case of the burner described.

Due to this inventor's discovery of the possibility of using such high velocities for the reasons above noted, it becomes possible to go to much higher temperatures than when the teachings of the prior art are used. This not only follows from the fact that the tube loop portion may be heated throughout to a much higher temperature than is normally considered safe, because of the absence of local hot spots introducing the danger of unpredictably higher temperatures, but also because large volumes of the combustible gas mixture under heavy pressure may be continually introduced through the pipes 3 and 5 so as to maintain the fuel gas component at a properly low temperature to prevent the

cracking characteristic of so many such gases. This is particularly true since extremely large volumes of air may be forced through the pipe 3 so as to protect the fuel gas pipe 5, this, incidentally, picking up unusually large amounts of heat from the combustion products existing outside of this pipe 3 inside of the arm pipe 2. By using the velocity increasing orifices 7, in conjunction with the use of high air pressures and an adequate supply of fuel gas through the pipe 5, velocities greatly in excess of the flame propagation rate of the gas and air mixture are obtained, but since the introduction is to a recirculating flow driven by the high velocity air streams at substantially the same speed, combustion becomes possible without fear of the flame being blown out. In fact, the flame cannot be blown out because it exists as a softly glowing atmosphere rapidly recirculating inside the tube loop 1, the extreme velocity forcing the combustible mixture to mingle with the combustion products evenly and uniformly throughout the entire recirculating flow, whereby substantially the same amount of fuel gas and air are combining at all portions uniformly throughout the recirculating flow at the same time.

It becomes apparent that the orifices 7 in conjunction with the outlet of the fuel pipe 5 do not in any sense constitute a burner, but, instead, form a means for injecting the combustible mixture into the recirculating flow at a speed in excess of the normal flame propagation rate, this following from the flush arrangement of the outlets of the pipes 3 and 5 because the air jets ejected through the orifices 7 of the outlet of the pipe 3 can only function to move the gases around the loop 1 at very high speed and they cannot function to produce a combustible mixture adjacent the outlets from directly ejected gas and air. The combustion of the recirculating flow is continuously sustained by the continuous introduction of a flow of the combustible mixture into the recirculating flow, the tube arm 2 serving to continuously exhaust the combustion product's excess from the recirculating flow.

This is a continuation of a copending application of the same title, filed July 30, 1940, bearing Serial No. 348,478.

I claim:

1. A radiant heater including an endless tube loop with a tube arm projecting therefrom in substantial alignment with one tube side, superimposed radially spaced gas and air pipes inserted in the tube arm with their outlets substantially flush relative one another and adjacent the tube loop and arm junction, and an annular series of velocity increasing orifices for the outlet of the air pipe, the gas pipe being inside the air pipe and the latter being radially spaced inside the tube arm.

2. A radiant heater including an endless tube loop with a tube arm projecting therefrom in substantial alignment with one tube side, superimposed radially spaced gas and air pipes inserted in the tube arm with their outlets substantially flush relative one another and adjacent the tube loop and arm junction, and an annular series of velocity-increasing orifices for the outlet of the air pipe, the gas pipe being inside the air pipe and the latter being radially spaced inside the tube arm, the outer end of the tube arm having an upstanding exhaust stack for the space between the tube arm and the air pipe.

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