This invention relates to a heating apparatus, and, more particularly, to a heating apparatus wherein a combustible mixture is burned in contact with a refractory radiating member of particular shape to which the mixture is delivered from spaced manifolds, and which apparatus is particularly adapted for the rapid heating of tube or bar stock with minimal scale formation.

Various heating apparatuses have heretofore been suggested, but, so far as is known, no device known or suggested before our invention was suited for the rapid heating of one side only of a piece of metal stock, was capable of accomplishing such heating without the use of a controlled atmosphere supplied to the heating apparatus, and independent of combustion products thereof, and was capable of minimizing scale formation on the stock to, for example, less than about 4 to 5 thousandths of an inch. It will be apparent that for many applications where scale minimization is valuable, the provision of a controlled atmosphere furnace in which heating can be effected would be economically unfeasible. Accordingly, the art has heretofore been obliged, in such instances, to tolerate substantial scale formation in the course of such heating operations.

The present invention is based upon the discovery of heating apparatus suitable for the rapid heating of one side only of a piece of metal stock in which separate streams of combustion products are combined and passed over the work, and radiant heating is principally responsible for the transfer of heat to the work, and wherein scale formation in the course of such heating can be held to not more than about one thousandth of an inch. Heating is at least three times as rapid as in previously known furnaces for this purpose.

It is, therefore, an object of the invention to provide a novel heating apparatus for effecting the rapid heating of metal stock with minimal scale formation thereon.

Other objects and advantages will be apparent from the description which follows, and from the attached drawings, in which:

Fig. 1 is a view in elevation showing a section of a heating apparatus according to the invention;

Fig. 2 is a cross sectional view along the line 2—2 of Fig. 1;

Fig. 3 is a view showing details of a baffle and supporting mechanism therefor shown in Figs. 1 and 2;

Fig. 4 is a plan view showing an alternative and adjustable baffle, and details of the mounting thereof, which can advantageously be substituted for the baffle of Fig. 3; and

Fig. 5 is a plan view of a manifold through which a combustible gas mixture is supplied to the heating apparatus of Figs. 1 and 2.

Heating apparatus provided according to the invention comprises a refractory radiating member, spaced manifold means having a plurality of ports for directing a combustible gas mixture in a substantially continuous curtain against and at a small angle to each of two substantially parallel walls of the radiating member, and baffle means for partially closing the space adjacent to and separating the manifold means. The refractory radiating member is of generally semiellipsoid cross-section, and has substantially parallel open ends.

Heating apparatus according to the invention is indicated generally at 11 in Figs. 1 and 2. The apparatus 11 comprises a radiating member 12 composed of a refractory portion 13 having a radiating surface that is generally semi-circular in cross-section, and refractory portions 14 having generally flat radiating surfaces, manifolds 15, and baffles 16. The apparatus 11 is provided with an outer shell 17. Gas conduits 20 are operatively connected to the manifold 15 to supply from a source (not illustrated) a suitable combustible gas mixture, which may be a mixture of air with natural gas, for discharge through ports 21 (Fig. 5) in the manifolds 15.

The baffles 16 rest on supports 25 (Fig. 2) and are supported thereon by bolts 26 (Fig. 3) which are clamped against plugs 27 by nuts 28. The plugs 27 are positioned in open ended tubes 29 which extend through the outer shell 17. The bolts 26 are threaded into retainers 30 rigidly attached interiorly of the baffles 16 in any suitable manner.

An alternative form of baffle 35 is represented in Fig. 4. The baffle 35 is mounted in a carrier 36 which is slidable on tracks 37 and can be moved to any desired position to regulate the opening between the manifolds 15 to accommodate work being heated. It will be apparent that this opening should be adjusted to approximate the minimum size commensurate with satisfactory handling of work of the size being heated at a given time. The baffles 35 mounted as indicated can readily and easily be moved for appropriate sizing of this opening.

Similar sizing of this opening can also be accomplished using baffles 16, but removal of a particular baffle and substitution therefor in an obvious manner of a different baffle of the desired size is necessary in order to accomplish such adjustment.

In the specific embodiment of the invention illustrated in Figs. 1 and 2 provision is made for cooling the portion thereof adjacent the manifolds 15. Water conduits 40 are provided for admitting cooling water into a jacketed space 42, and water outlets 44 are provided for withdrawing water from the space 42.

In the specific embodiment of the invention represented in Figs. 1 and 2 refractory baffles 45 are positioned adjacent the manifolds 15 and extending thereabove. These baffles are advantageous as they prevent the admixture of cold air with the combustible gas mixture from the ports 21.

In operation, a combustible gas mixture is passed through the gas conduits 20 and into the manifolds 15. This combustible gas mixture then passes through the ports 21 of the manifold, and is burned closely adjacent to or impinging on the flat radiating surface of the portions 14 and 13 of the radiating member 12. The gas velocity is greatly increased in the course of the combustion, so that burning gases travel at relatively high velocity against and around the radiating surface of the portion 13 of the radiating member 12 until they reach a point near the vertical center line thereof where they are admixed with similar gases coming from the opposite manifold 15. The gases from the two manifolds then travel generally downwardly through the central portion of the apparatus 11, to contact being heated in the apparatus 11 generally between the manifolds 15 and the baffles 16, and pass out on the heating apparatus 11 around the work. By the time the gases impinge against work being heated combustion thereof is substantially complete so that they constitute a relatively inert atmosphere which minimizes scale formation.
during the heating of metal parts in the apparatus 11. For example, scale on steel tubes being heated in the apparatus has been held consistently to less than .001 inch, as compared with about .004 to .005 inch of scale in previously known furnaces for accomplishing this sort of heating.

It will be appreciated that the refractory member 12 is heated to an extremely high temperature in the operation of the heating apparatus 11. It has been found in practice that the temperature of the radiating surface of this member can be operated at a temperature as high as about 2650°F. or higher if made of a suitable refractory material. As a consequence, heat transfer to work in the apparatus 11 is mainly by radiation, so that the apparatus of the invention is particularly suited for heating, for example, one side only of curved tubing suitable for use in the manufacture of steel tubing fittings.

The apparatus 11 can be provided with suitable end covers (not illustrated) and used as a batch installation or two or more can be mated and provided with suitable end covers and conveying equipment and used as a continuous installation.

It will be apparent that various changes and modifications can be made from the specific details of the apparatus of the invention discussed above and represented in the drawings without departing from the scope of the invention.

I claim:

1. Heating apparatus for heating one side of a workpiece, having a cylindrical refractory radiating member generally semi-circular in cross section and having at opposed sides of the member substantially flat refractory portions substantially tangential to the semi-circular portion, spaced manifold means parallel to the axis of said cylindrical member and having ports positioned to deliver a substantially continuous curtain of combustible mixture adjacent to and substantially parallel to said flat portions and directed towards said circular refractory whereby to burn against said refractory and constitute the same a source of radiant heat for supplying heat to work positioned generally between said manifold means.

2. Heating apparatus according to claim 1 and comprising a pair of refractory lined baffles positioned adjacent said flat portions to define between each said baffle refractory and the adjacent flat refractory a passage for initially receiving the gas mixture from said manifold means and feeding between said baffles a work receiving aperture for positioning work therein to be heated.

3. Heating apparatus according to claim 1 and comprising a pair of refractory lined baffles positioned adjacent and between said manifold means and being adjustable to close the gap between said baffles whereby to constitute refractory lined closures for bridging the space from the manifold means to work positioned therebetween.

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