Jan. 3, 1967 K. LOECK ETAL 3,296,039

METHOD OF PREVENTING THE FORMATION OF BLACK STRIPES IN THE HEAT-TREATMENT OF METAL BODIES

Filed Dec. 22, 1965 3 Sheets-Sheet 1

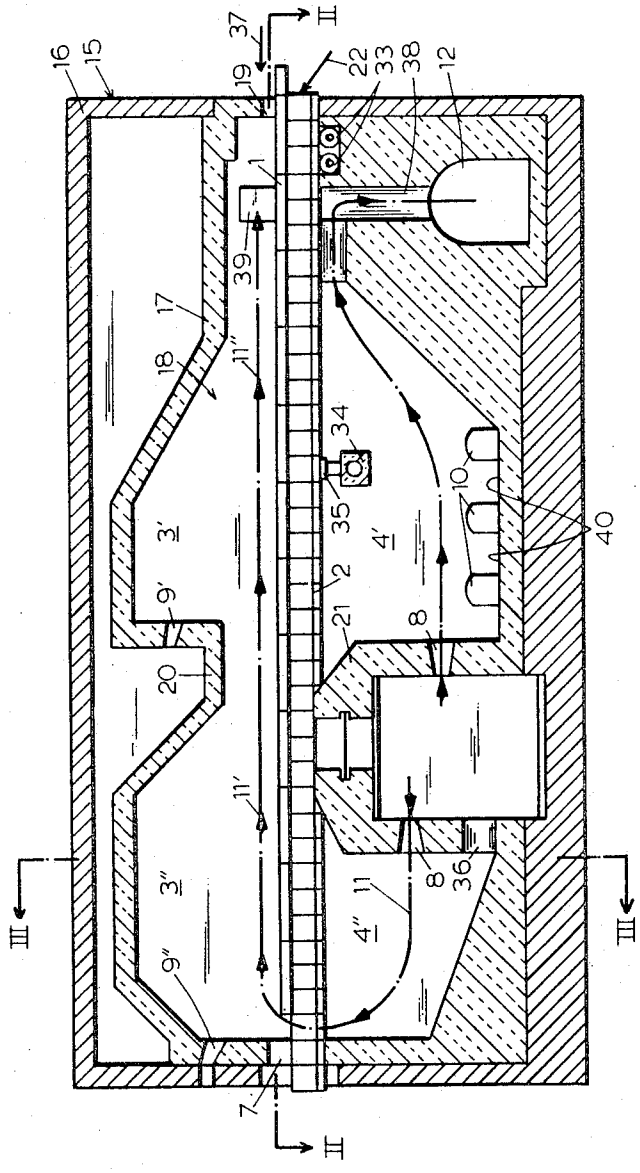


FIG. 1

Karl Loeck
Josef Molz
Hans Weineck
INVENTORS.

BY

Karl F. Ross

Attorney

Jan. 3, 1967 K. LOECK ETAL 3,296,039
METHOD OF PREVENTING THE FORMATION OF BLACK STRIPES IN THE HEAT-TREATMENT OF METAL BODIES
Filed Dec. 22, 1965 3 Sheets-Sheet 2

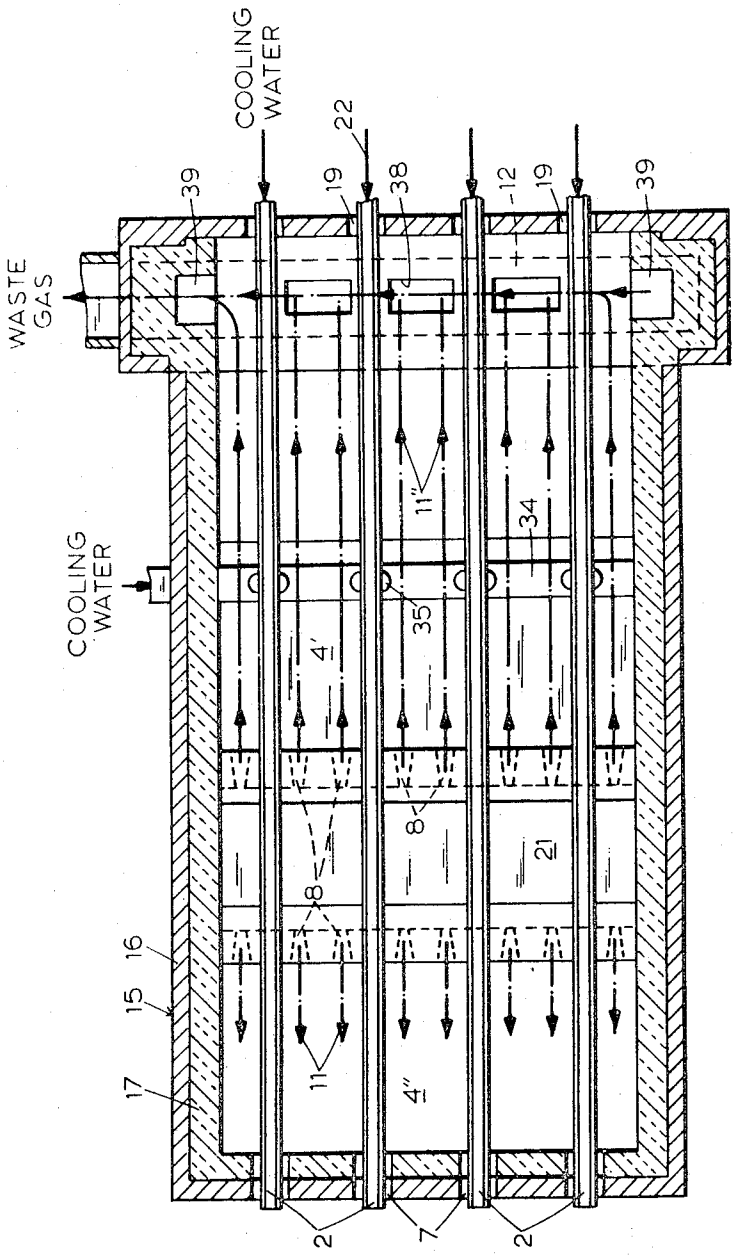


FIG. 2

Karl Loeck
Josef Molz
Hans Weineck
INVENTORS.

BY

Karl F. Ross
Attorney

Jan. 3, 1967 K. LOECK ETAL 3,296,039
METHOD OF PREVENTING THE FORMATION OF BLACK STRIPES IN THE HEAT-TREATMENT OF METAL BODIES
Filed Dec. 22, 1965 3 Sheets-Sheet 3

FIG. 3

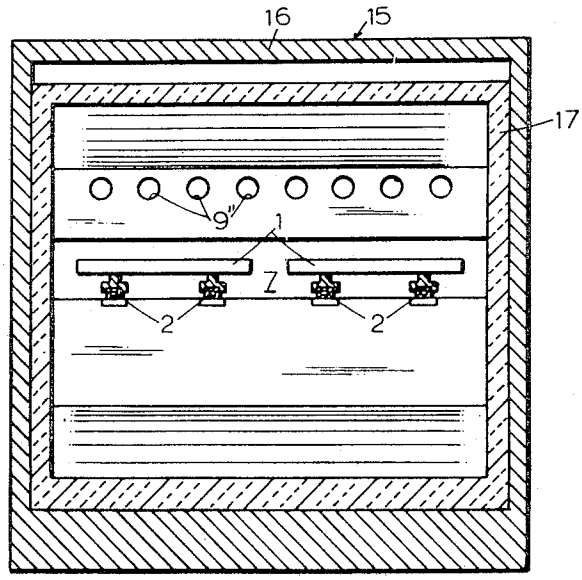


FIG. 4

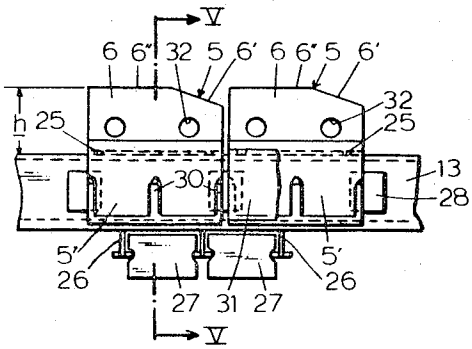
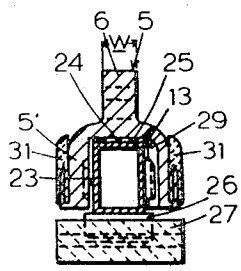


FIG. 5



Karl Loeck
Josef Molz
Hans Weineck
INVENTORS.

BY

Karl G. Roth
Attorney

United States Patent Office 3,296,039 Patented Jan. 3, 1967

3,296,039

METHOD OF PREVENTING THE FORMATION OF BLACK STRIPES IN THE HEAT-TREATMENT OF METAL BODIES

Karl Loeck, Oberhausen, Josef Molz, Mulheim an der Ruhr-Menden, and Hans Weineck, Oberhausen, Germany, assignors to Huttenwerk Oberhausen A.G., Oberhausen, Rhineland, Germany, a corporation of Germany

Filed Dec. 22, 1965, Ser. No. 515,646
4 Claims. (Cl. 148—157)

ABSTRACT OF THE DISCLOSURE

This disclosure relates to the heat treatment of metal bodies to be rolled or otherwise subjected to working at an elevated temperature in a pusher-type furnace and involves the transport of the bodies upon a pair of heat-conductive rails with thermally insulated flanks which permit the heating of the bodies by nonoxidizing heating gas which is directed against the bodies from above and below during the entire displacement of each of the bodies from the inlet to the outlet, the bodies emerging without any delay in an equalizing chamber and being free from black stripes characterizing nonuniform heating.

This application is a continuation-in-part of our copending application Ser. No. 196,420, filed May 21, 1962, now U.S. Patent No. 3,245,672 granted April 12, 1966.

Our present invention relates to the heat treatment of metal bodies such as steel billets, blooms, ingots and the like adapted to be successively processed in a pusher-type furnace and, more particularly, to an improved method of heat-treating such bodies so that the black stripes hitherto commonly formed thereon and demonstrative of nonuniform heating of the bodies can be avoided.

Heretofore, pusher-type furnaces for the heating of billets and blooms generally have been formed with a preheating zone, main-heating zone and an equalizer or soaking zone successively arranged along a guide path for the bodies to be heated. The equalizing zone was required to permit temperature equalization within the heated body which often had portions in contact with the guide surfaces whose temperature was substantially below that of the remainder of the body so that so-called "black stripes" were formed. In the temperature-equalization chamber, the heat of the hotter part of the body gradually raised the temperature of the cooler parts. The preheating and main-heating zones of such furnaces generally were provided with water-cooled guide rails terminating at a refractory-brick table within the equalizing zone. The disadvantages of this arrangement will become obvious when it is noted that such tables, which may be several meters long, often become encrusted with scale from the heated bodies as the latter are displaced therealong. This encrustation raises the transport surface of the table so that frequent cleaning is often required.

In the aforementioned copending application, we describe a furnace or oven in which the equalization zone is omitted and which nevertheless permits the heat treatment of the bodies without the development of such "black stripes" or other discoloration indicative of nonuniform heating. While the theory under which these so-called "black stripes" are formed has not been fully developed, it is believed that the commonly provided cooled supports maintain the proximal regions of the body at a substantially lower temperature while the balance of each body is heated strongly in the main-heating regions of the furnace. As a consequence, the rail-contacting parts of the body became discolored with respect to the remainder of the body and were also incompletely subjected to the heat treatment. Thus, by maintaining the bodies for prolonged

periods in an equalization zone, it was possible to bring these underheated regions to the temperature of the remainder of the body. Besides the important disadvantages of loss of time, added capital expense in providing the equalization chamber and the difficulties involved in pushing the bodies not only through the equalizing zone, the prior-art systems were forced to convey the bodies along generally flat beds or tables of refractory brick because of the black-striping phenomenon resulting from use of rails. The oven described in this copending application was capable of avoiding these disadvantages.

The object of the present invention is to further develop the principles expounded in this copending application and provide an improved method of heat-treating metal bodies such that the black-striping phenomenon will not occur and that there will be no need for equalization zones as hitherto considered essential.

The above and other objects which will become apparent hereinafter are attained, in accordance with the present invention, by a method which involves the steps of successively feeding the metal (usually steel) bodies through a pusher-type heating-treating oven wherein the bodies slide along laterally insulated heat-conductive refractory members carried by fluid-cooled rails from an inlet of the oven to the outlet thereof with the bodies being then withdrawn from the oven, and directing a stream of heating gas against said bodies from above and below during the entire displacement of each of the bodies from the inlet of the oven to its outlet.

According to a more specific feature of this invention, the heating gas stream includes at least one gas current formed above the bodies by combustion of a fuel above the transport path, the hot combustion gases and the heat of combustion being directed downwardly against the bodies, with the gas passing in a direction counter to the direction of displacement of the bodies. A further gas current advantageous produced by combustion below the bodies is directed counter to their movement along their undersides while still another gas current can pass in the direction of movement of these bodies over part of their transport path from below before being diverted at a location proximal to the outlet, along the upper parts of these bodies to flow counter-current thereto.

According to another aspect of this invention, the upper and lower compartments of the furnace are generally subdivided into a preheating zone disposed adjacent the inlet opening and a main heating zone disposed adjacent the outlet opening and extending substantially up to the latter. The support rails also extend to the outlet opening and may, in fact, project therethrough. Thus, the use of an equalizing table or hearth is completely avoided.

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a longitudinal cross-sectional view schematically illustrating a furnace according to the invention;

FIG. 2 is a cross-sectional view taken along the line II—II of FIG. 1, with omission of the metallic bodies to be heated;

FIG. 3 is a cross-sectional view taken along the line III—III of FIG. 1;

FIG. 4 is an enlarged elevational view, partly broken away, of the support rails; and

FIG. 5 is a cross-sectional view taken generally along the line V—V of FIG. 4.

The drawing shows a pusher-type furnace **15** comprising a main housing **16** surrounding a refractory structure **17** forming an elongated furnace chamber generally designated **18**. Furnace chamber **18** is provided at one axial end with an inlet opening **19** and, longitu-

dinally remote therefrom, an outlet opening **7**. These openings are spanned by a plurality of transversely spaced guide and supporting rails **2** which also subdivide chamber **18** into upper and lower compartments. Partitions **20, 21** intermediate the openings further subdivide these compartments into preheating zones **3'**, **4'** and main heating zones **3''**, **4''**, respectively. The preheating zones **3', 4'** are adjacent the inlet opening while the main heating zones **3'', 4''** extend to the outlet opening without the intermediary of an equalizing zone of the type previously required.

The guide rails **2** comprise longitudinally extending central supporting members **13** which are tubular and of generally prismatic configuration (see FIGS. 4 and 5). A source of cooling fluid schematically shown as an arrow **22** supplies the tubular members **13** with cooling fluid. The tubular members carry respective rows of blocks **5** of heat-resistant but non-insulating character. These blocks **5** are of inverted-Y transverse cross-section and have arms **5'** embracing with peripheral clearance the respective support member **13**; the arms **5'** form a channel **23** receiving the member. The roof **24** of this channel is formed with protuberances **25** of limited surface area in contact with the upper surface of member **13** for maintaining a gas cushion between the latter and the blocks **5**.

The underside of members **13** carries channel struts **26** which secure refractory bricks **27** to this underside in order to insulate it. The lateral surfaces of members **13** are provided with outwardly extending formations **28** receivable in recesses **29** in the inner surface of arms **5'** to limit relative longitudinal displacement of the blocks and the members. The flanks of arms **5'** are provided with a plurality of longitudinally spaced pins **30** adapted to engage plates **31** of refractory, heat-insulating material.

The heat-conductive upwardly extending flanges **6** of the blocks **5** of each row are substantially coplanar and have beveled corners **6'** facing the inlet opening to cam oncoming bodies **1** (e.g. steel blooms or billets) upwardly onto the flat carrying surface of each flange. The carrying surfaces **6''** operate in a substantially horizontal plane. Advantageously, the flange has a height n ranging between substantially 150 and 400 mm., and a transverse width w ranging between substantially 50 and 150 mm. The flanges **6** are also provided with bores **32** to facilitate their handling when the entire rail **2** is removed upon rolls **33** along the supporting surfaces of the furnace to permit the ready withdrawal of the rails along with these blocks **6**, which may then be lifted from their supporting member **13** and replaced if necessary because of encrustation etc. The rails may also be supported within the furnace by water-cooled thermally insulated tubes **34** via hollow pillars **35** through which water is also circulated.

Partition **21** is formed with a chamber **36** admitting the heating fluid (e.g. hot gas or a burning gas mixture) through a plurality of transverse apertures or burners **8** into the lower compartment **4', 4''** of the furnace chamber into contact with the outsides of the bodies **1**. A portion of the hot gas streams counter-current to the direction of displacement **37** of the bodies **1** as indicated by the arrows **11', 11''** while another portion of the gas stream flows in the direction of displacement (arrow **11**). A plurality of burners **9', 9''** in the upper compartment **3', 3''** provide part of the heating fluid for the upper surfaces of bodies **1**, another portion of the fluid arriving from the lower compartments via gaps between the bodies. The cooled gases are removed from the furnace chamber via upright ducts **38** communicating with the lower compartment **4'** and leading to an exhaust-gas conduit **12**. A pair of lateral ducts **39** also leading to this conduit removes the cooled gases from the upper compartment **3', 3''**. Doors **10** are provided in the preheating zone **4'** of the lower compartment for the removal of scale which tends to accumulate on the floor **40** thereof.

Example

A succession of steel rolling-mill billets is passed through a pusher-type furnace at a rate selected with respect to the dimensions of the bodies such that, in the preheating zone **3', 4'**, the bodies are brought to temperatures in the region of approximately 880° C. and thereafter are raised to the desired rolling temperature, generally about 1350° C. The bodies are examined after being withdrawn from the outlet and are found to be totally free of black stripes. When, however, the heat-conductive refractory bodies **6** are disposed with all other conditions remaining the same, the bodies recovered at the outlet are found to have black stripes along their underside indicative of nonuniform heating. In this case, it is necessary to maintain the bodies in a soaking or equalizing zone at a temperature of about 1320° C. to restore homogeneity. When the refractory bodies **6** are used and the rails **13** are not water-cooled, rapid deterioration of the support structure is observed. Furthermore, when the contacts of the bodies with the gas stream is not carried out over the entire furnace length from inlet to outlet and is terminated in advance of the outlet at a distance therefrom corresponding substantially to the length of conventional soaking or equalizing zones, the heat utilization of the furnace is found to be poor and the bodies are found to be of nonuniform temperature.

Thus, this method permits the heating of billets, blooms, ingots and the like without the formation of "black stripes" indicative of cool regions along those portions of the bodies contacted by the support rails, since the flanges **6**, directly in contact with the bodies, are substantially at the furnace temperature and are insulated from the water-cooled support member by the air cushions. The rails **2** thus can extend to or through the outlet opening **7** inasmuch as no equalizing hearth is required. Consequently, a saving in material and labor as well as increased heating efficiency is obtained.

The invention described and illustrated is believed to admit of many modifications within the ability of persons skilled in the art, all such modifications being deemed included within the spirit and scope of the appended claims.

We claim:

1. In the heat treatment of metal bodies which are successively fed through a pusher-type heat-treating oven from an inlet of said oven to an outlet thereof by sliding said bodies along fluid-cooled rails having laterally insulated heat-conducting refractory members interposed between said bodies and said rails, the bodies being thereupon withdrawn from said oven, the improvement which comprises the step of directing a stream of heating gas against said bodies from above and below during the entire displacement of each of the bodies from said inlet to said outlet.

2. The improvement defined in claim **1** which further comprises the step of forming at least part of said gas stream by combustion of a fuel in at least one chamber above said bodies whereby the combustion gases and the heat thereof are directed against said bodies in a direction counter to the movement of said bodies through said oven, said stream including a current of hot gases formed by combustion of a fuel below said bodies contacting said bodies from below while passing in a direction counter to the movement of said bodies through said oven.

3. The improvement defined in claim **2** wherein at least part of the gas stream contacting said bodies from above is formed by a gas current originally flowing in the direction of displacement of said bodies and thereabove, the last-mentioned current passing above said

bodies proximal to said outlet, said improvement further comprising the step of drawing said gas from said oven proximal to said inlet.

4. The improvement defined in claim 3, further comprising the step of subdividing the path of said bodies through said oven only into a preheating zone proximal to said inlet and a main heating zone extending completely from said preheating zone to said outlet forming by combustion of a fuel hot gas streams in each of said zones above and below the bodies.

References Cited by the Examiner

UNITED STATES PATENTS

1,338,003 4/1920 Egler ----------- 263—6

FOREIGN PATENTS

1,094,778 12/1960 Germany.

DAVID L. RECK, *Primary Examiner.*

C. N. LOVELL, *Assistant Examiner.*