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FURNACE ROLLER

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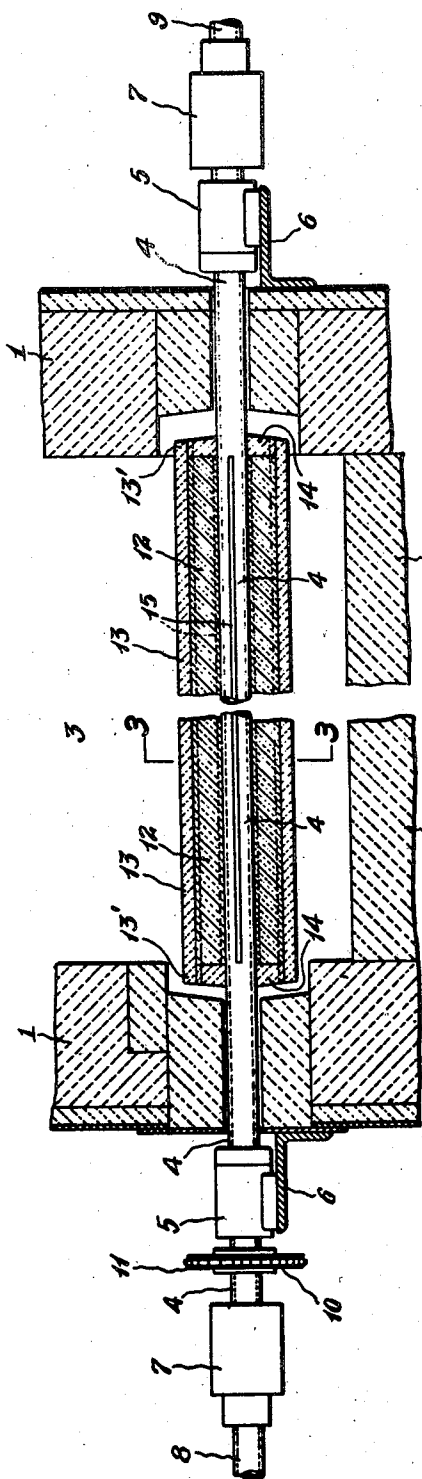


FIG. 1.

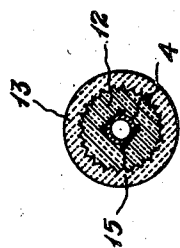


FIG. 3.

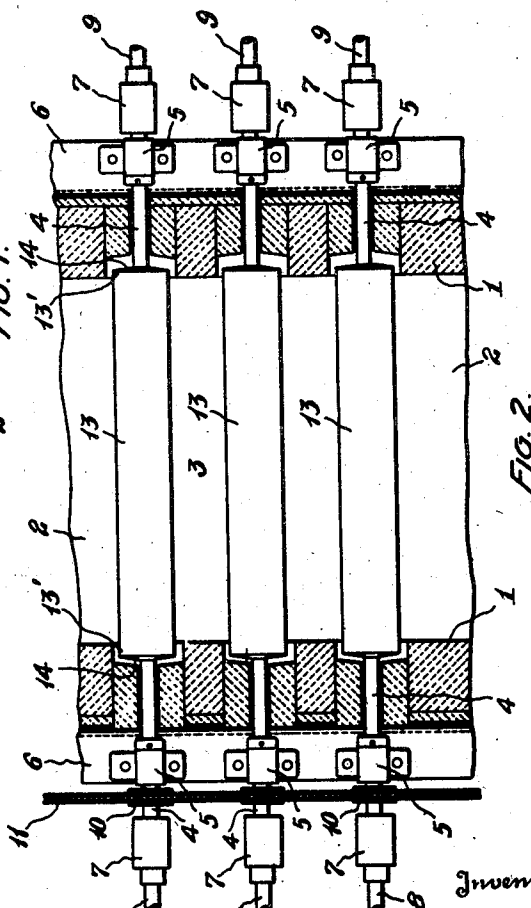


FIG. 2.

364

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UNITED STATES PATENT OFFICE

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FURNACE ROLLER

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6 Claims. (Cl. 263-6)

1

This invention relates to conveyor rollers, and more particularly to conveyor rollers capable of being employed for supporting and moving articles in heating furnaces.

This application is a continuation-in-part of application Serial No. 525,056, filed March 4, 1944, by the applicant.

Furnaces have been proposed in which articles such as metal sheets, strips, tubes, bars or rods are heated while being supported and moved in the furnace by conveyor rolls mounted in or extending into the furnace. It is often desired to employ relatively high temperatures in furnaces of this type, particularly in furnaces for annealing or otherwise heat treating metal articles.

The use of rollers in such high temperature furnaces imposes severe service conditions on the rollers. For example, the rollers usually are subjected to intense heat for long periods of time, this heat being supplied to the rollers by radiation from the furnace or by convection from the gases in the furnace, or by conduction from the articles being heated while carried by the rollers. The temperatures to which the rollers are exposed vary widely, as from room temperature to the maximum temperature to which the furnace is heated, and from such maximum temperature to room temperature, upon the cooling of the furnace. Further, the local temperatures of the rollers may vary considerably while the furnace is being maintained at heat, as when cold articles are introduced into the furnace and contact the heated rollers. The atmospheric conditions to which the rollers are exposed at such elevated temperatures also may vary greatly, as from oxidizing to reducing conditions or vice versa. The rollers are subjected while at such elevated temperatures and for such long periods of time, to loads which may be heavy and varying in magnitude. The article-supporting surfaces of the rollers are often subjected to severe abrasive or wear conditions in supporting and transporting the articles carried by the rollers.

Such severe service conditions require an extremely rugged construction of the rollers, their journals, and bearings. Such requirements have been only partially satisfied by the roller constructions heretofore employed.

In general, two types of roller construction have been used heretofore in heating furnaces.

In one construction, the roller comprised a hollow metal shaft adapted to have a coolant passed therethrough and, spaced from the shaft, a metal sheath upon or from which the articles being carried by the roller were supported; the

2

space between the shaft and sheath often contained heat-insulating material and was bridged by supporting or driving elements of metal. In this construction, usually because of the metal sheath and bridging members, a substantial amount of heat was lost through the roller and hollow shaft to the coolant passing therethrough with a resulting loss in economy of operation. Furthermore, the outer metallic sheath of this type of roller corroded, scaled, blistered, and warped due to the high temperatures to which it was subjected, and wore away quite rapidly because of its poor resistance to abrasion particularly at the high temperatures to which it was subjected. Because of rapid deterioration due to these and other causes, it was necessary to replace such rollers quite often. This greatly increased costs, not only because of the roller cost but also because of the cost of shutting down the furnace while replacing worn-out rollers.

In another roller construction heretofore employed, the rollers were of solid construction throughout and did not include a hollow shaft through which a coolant was passed. As a result, the rollers were at a high temperature throughout during furnace operation. Even if this construction included refractory material, this roller could not support heavy loads because of the weakening of its constituent at the high temperatures. Moreover, such high temperatures caused distortion and rapid deterioration due to spalling, necessitating frequent replacement of the rollers.

Moreover, in carrying out heating operations in high temperature furnaces equipped with rollers of the kinds heretofore employed, it was almost universal practice to continually move the load back and forth on the rollers. This was done to overcome the tendency of the rollers to sag under load, and, of course, increased the cost of operating the furnace.

It is the object of this invention to provide a furnace conveyor roller which, while exposed to elevated temperatures which may vary greatly, is capable of operating for long periods of time without appreciable deterioration. It is another object of this invention to provide a furnace roller which, while subjected to heavy loads which may vary greatly in magnitude, will not tend to sag under a fixed load.

The roller of the present invention is comprised of a metal core, an outer tubular body of refractory material surrounding and spaced from the core, and a mass of heat insulating refractory material filling the space between and bonded to

said core and said outer body to unite them into a unitary structure and to form a wholly or substantially continuous barrier to the transmission of heat from the outer surface of said refractory body to the inner metal core. The inner core extends beyond the ends of the outer body and the associated mass of insulating material, to provide journal end portions by means of which the roller may be rotatably supported and by means of at least one of which the roller may be positively rotated if desired.

The refractory material of the tubular outer body advantageously is a hard, tough, abrasion-resistant, non-metallic material of considerable compressive strength, and high heat resistance. The one-piece tubular member preferably consists wholly or predominantly of silicon carbide fused to make the body hard, tough, strong, at least in compression, and resistant to abrasion; such material will hereinafter for convenience be referred to as silicon carbide, although it may contain a minor proportion of other material, such as a fused ceramic binding material. A tubular member of silicon carbide when employed in the roller of the present invention displays unusually high strength at high temperatures; indeed, the strength is greater at elevated temperatures than at room temperature, apparently reaching a maximum at about 2600° F. Moreover, the silicon carbide member in the roller of the invention resists cracking and spalling even when subjected to considerably and rapidly changing temperatures such as may occur in use of the roller in a furnace; apparently the heat conductivity of the silicon carbide is sufficient to prevent spalling even under conditions of considerable thermal shock.

The metal core is preferably a tube of a suitable steel alloy having high strength and fatigue resistance at room and at least moderately elevated temperatures; metals suitable for such use are well known. When the inner core is tubular, a cooling fluid such as water may be passed there-through. This substantially removes the relatively small amount of heat lost through the roller and keeps the inner core, the journals, and driving means for the core at a relatively low temperature, thereby reducing deterioration of these parts and simplifying their design.

The mass of insulating refractory material is advantageously an insulating refractory cement which is initially applied to the space between the outer body of refractory material while in the form of a liquid, and which after it sets and hardens firmly bonds into a unitary structure the outer tubular member of refractory material and the inner core. In rollers intended for high temperature use this insulating cement should be one which has good heat resistance and resists deterioration and crumbling when exposed to elevated temperatures even for long periods. It has been found advantageous to employ a cement composed of calcium aluminate and/or one or more of certain sodium silicates, with or without suitable comminuted heat-resistant material as a filler or aggregate. Such materials may be mixed with water to form a thick liquid cement which, after pouring or casting, sets and hardens to form a strong mass resistant to the transmission of heat at high temperatures. When so manufactured, the insulating cement bonds the outer tubular refractory material and inner core into a unitary structure.

In the roller embodying the present invention the inner core, the outer tubular member, and

the mass of insulating material bonding these two members together cooperate to form a unitary beam structure having an increased depth of section between the end portions of the core. In furnaces embodying the rollers of the present invention and with loads of the sizes normally employed, it is not necessary to move the loads back and forth on the rollers to prevent sagging of the rollers. In general, the rollers of the invention can support substantially heavier loads than those heretofore employed. This is due to the fact that, under the type of transverse loading which a roller carries as a beam, the maximum compressive stresses are located at the top of the roller, where they are carried by the outer shell of refractory material which has relatively high compressive strength though relatively low tensile strength. At the same time, the central steel core, due to the fixed relationship which the insulating cement maintains between the outer shell and inner core, assumes most of the tensile stresses, thereby relieving the bottom of the refractory shell of its tensile stresses which might otherwise fracture it. Although the intermediate insulating cement is responsible for the assumption by the steel core of a substantial part of the tensile stresses generated in the roller, such cement, which may be relatively weak both in tension and compression, is located at the center of the effective beams and, consequently, is only subjected to stresses which may range from zero to a minor proportion of the maximum tensile and compressive stresses. This function of the intermedial insulating cement will continue to be performed even though the bond between the cement and the inner core and/or the outer shell may be broken during service; the close mechanical fit obtained by casting the cement between the inner core and outer shell continues to unite the elements of the roller even though the initial adhesive bond of the cement may be broken.

These and other objects, features, and advantages of the invention will be apparent from the following description, claims and drawings, in which:

Fig. 1 is a vertical sectional elevation through a portion of a furnace comprising a roller embodying the invention, certain portions of the roller and supporting and operating means therefor being shown unsectioned for convenience;

Fig. 2 is a plan sectional elevation, to a smaller scale than that of Fig. 1;

Fig. 3 is a vertical section along line 3—3 of Fig. 1, of the roller of Fig. 1.

The apparatus of the drawing comprises a furnace of more or less conventional construction including side walls 1 and bottom wall 2, which, together with top and end walls not shown, define a chamber 3 to which heat is supplied by suitable means such as that known in the art. These walls are formed of or include refractory heat insulating material such as fire brick.

The furnace is capable of heat treating articles, such as metal sheets, strips, tubes, bars, rods or beams, or ceramic objects, which are conveyed through the furnace from end to end by a plurality of horizontally disposed rotatable rollers on which the articles rest, while they are heated in the furnace. A plurality of such rollers, each embodying the present invention, are shown in Fig. 2.

As shown to advantage in Figs. 1 and 2, each of the rollers illustrated as embodying the invention comprises a central core taking the form of a hollow steel shaft 4 which passes through suitable openings in the side walls 1 of the furnace

and which has its journal end portions journaled in bearings 5 rigidly mounted on brackets 6 fixed to side walls 1 of the furnace. Concentric with the axis of hollow shaft 4 and spaced therefrom is a unitary tube 13 of refractory material, preferably consisting of silicon carbide. The space between the outer surface of shaft 4 and the inner surface of tube 13 is filled with a mass 12 of insulating material taking the form of a hardened and set mass of refractory heat insulating cement which is firmly bonded to both the outer surface of shaft 4 and the inner surface of tube 13 and unites the shaft 4 and tube 13 into an integral structure. This cement is preferably the kind mentioned hereinbefore. In order to provide improved adherence between the cement and the surfaces of the shaft 4 and tube 13, and to aid in interlocking the mass of cement with these surfaces, in the illustrated roller as shown in Figs. 1 and 3, the inner surface of tube 13 is fluted, and the outer surface of hollow shaft 4 is provided with longitudinally extending lugs 15.

In the illustrated roller plugs 14 of refractory material such as silicon carbide are fitted tightly into the ends 13' of the tube 13 between the inner surface of the tube 13 and the outer surface of the shaft 4. In most embodiments of this invention, however, these plugs may be omitted.

In assembling the illustrated roller, the tube 13 of refractory material and shaft 4 are relatively properly positioned with their common axes in a substantially vertical position. Then the insulating cement, which is preferably in the form of a viscous liquid, is poured into the space between the tube 13 and shaft 4 until the space is completely filled. Preferably the roller is maintained in this position until the cement sets and hardens and becomes firmly bonded to the inner surface of the tube 13 and the outer surface of shaft 4.

In the furnace structure of the drawings, each end of the rotatable hollow shaft 4 of the roller terminates in a stuffing box 7. A stationary pipe 8 connected to one stuffing box 7 and a stationary pipe 9 connected to the other stuffing box communicate with the interior of shaft 4, so that a cooling fluid such as water may be passed through the shaft 4 to keep it and the parts of the roller and bearings adjacent the shaft at temperatures below those which will deteriorate or weaken the shaft and such parts.

In the illustrated furnace structure, moreover, each of shafts 4, and the roller of which it is a part, is positively rotated by means of a sprocket 10 located outside of the furnace and engaging a chain 11. This chain engages the sprockets of several rollers and itself is positively driven by a suitable source of power (not shown).

The plurality of rollers in the illustrated apparatus are mounted with their axes substantially horizontal and with their upper surfaces lying in a common plane extending generally horizontally. A sufficient number of rollers is provided to support the articles being heated throughout the length of the furnace.

In operation of the illustrated apparatus, the chamber 3 of the furnace is heated to the desired temperature by suitable heating means. The articles to be heated are introduced into the furnace at one end thereof and placed on the rollers at that end. By means of chain 11 and sprockets 10, the rollers are rotated in such manner and at such a rate, with periods of rest if desired, that the articles being heated are conveyed through the furnace in a time which will impart

to them the desired heat treatment. While the furnace is being heated, cooling fluid is passed through the hollow shafts 4 of the rollers to remove the relatively small amount of heat which reaches the shaft.

The present invention thus provides conveyor rollers which are capable of being employed for supporting and moving articles through heating furnaces. The unitary beam structure of the roller of the invention, in which the outer tubular member takes the compression stresses and the inner metal core takes the tensile stresses through the agency of the insulating mass bonded to the core and tubular member, makes it possible for the roller to support loads which may be heavier than those which could be supported by prior rollers of the same size. This high hot strength renders it unnecessary to rotate the rollers when under load and exposed to heat at temperatures which may run as high as 2600° F. The outer refractory body does not deteriorate and is not subject to the spalling, corrosion, scaling, blistering and warping of the metallic sheathes of prior rollers. Because of continuous heat barrier provided by the intermediate insulating mass, the inner metal core and its associated parts do not deteriorate or lose strength, and the heat losses in coolant passing through the core are only a small fraction of those heretofore encountered, that is, in the order of 5 to 10% of the heat lost through the rollers generally used heretofore.

The above described roller and furnace embodying it are, of course, illustrative. Without departing from the spirit of the invention, various modifications, such as those discussed above as well as others, may be made in the roller, the furnace, the methods of making them, and the modes of using the roller and/or furnace; and rollers embodying the invention may be employed for other purposes than those indicated above. For example, some or all of the rollers in a furnace may be idler rollers which are not positively rotated; the inner metal cores of the roller may be solid; the roller may be rotatably supported in other manners than that shown above; the work-supporting surface of the roller may have other configurations than the cylindrical configuration shown in the illustrated embodiment.

From the foregoing, it is apparent that this invention is not limited to the illustrated embodiment, either in whole or in part. Those skilled in the art may depart from the illustrated embodiment to meet particular demands without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A roller for supporting work in furnaces comprising a metal load-bearing shaft having journal end portions, a concentric tube of refractory material located between the journal end portions, and a cast heat-insulating cement filling the space between and rigidly adhered to adjacent surfaces of said tube and shaft, whereby said cement unites said tube and shaft into a unitary beam structure having an increased depth of section between the journal end portions of said shaft and forms a continuous barrier to the transmission of heat from said tube to said shaft.

2. A roller as defined in claim 1 in which said concentric tube is a tube of fused silicon carbide.

3. A roller as defined in claim 1 in which at least one of the adjacent surfaces of said tube and shaft is configured to provide a mechanical as

7

well as adherent engagement with said cement.

4. A furnace roller of unitary formation comprising a metal core, a covering for the core consisting of a mass of heat insulating material adjacently surrounding and bonded to the core, and an outer body of refractory material adjacently surrounding and bonded to said mass, whereby the mass unites said core and said outer body into a unitary beam structure and forms a continuous barrier to the transmission of heat from work supported on the outer refractory to the inner metal core, and refractory covers mounted on the core and abutting and secured to the ends of said mass.

5. A roller for supporting work in a heat treating furnace comprising a hollow steel shaft, means for forcing a coolant through said shaft, journal end portions on said shaft, a hard, work-contacting, wear-resistant refractory tube of silicon carbide concentric with said shaft and extending from a point adjacent one journal end portion to a point adjacent the other journal end portion, and a solid body of insulating cement filling the space between said tube and shaft and adhered to adjacent surfaces of said tube and shaft to unite said tube, shaft, and spacing body

8

into a unitary structure, whereby the body of insulating cement transfers a portion of the compression factor of the transverse load on the shaft to the outer tube of silicon carbide and a portion of the tension factor of the transverse load on the tube to the inner steel shaft, while forming a continuous barrier to the transmission of heat from work supported on the tube to the coolant in the shaft.

6. A furnace roller as defined in claim 1 including projections on the adjacent surfaces of said tube and shaft to mechanically interlock with said cast cement.

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