

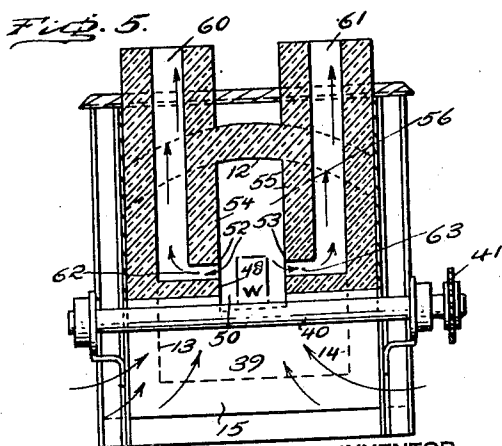
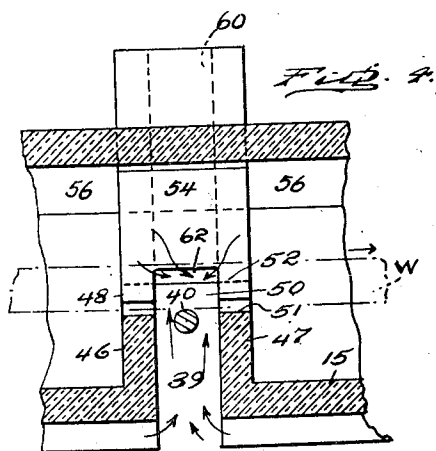
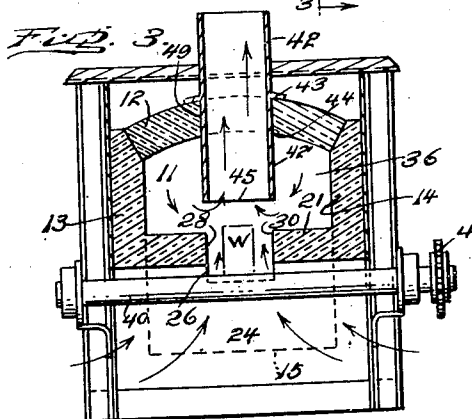
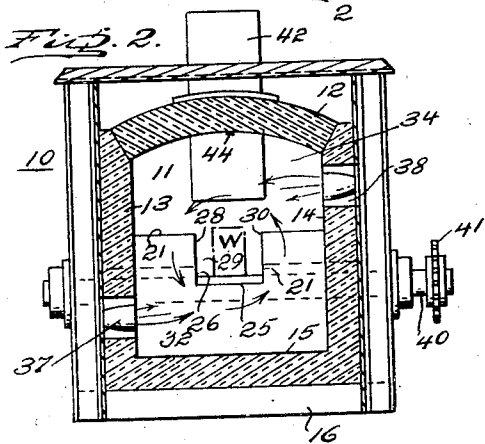
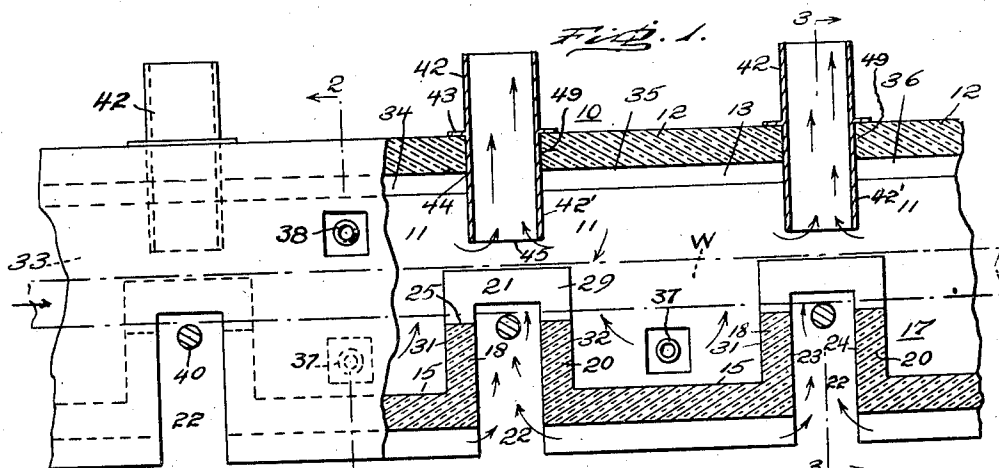
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S. M. STOLER
ROLLER HEARTH FURNACE

2,492,942

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2 Sheets-Sheet 1



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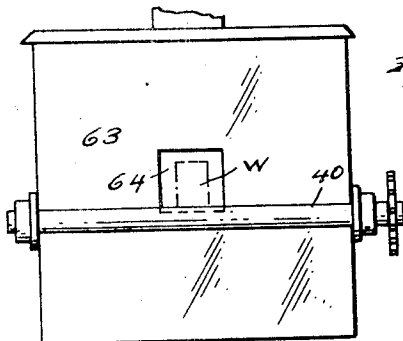
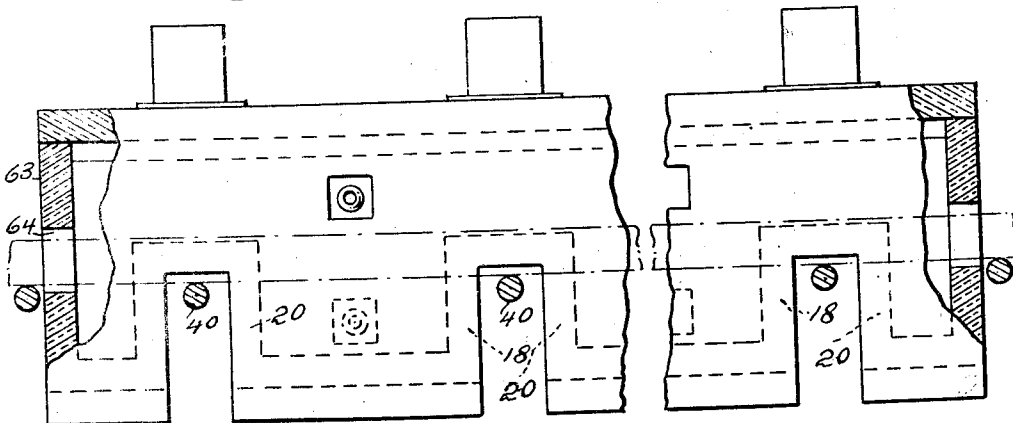
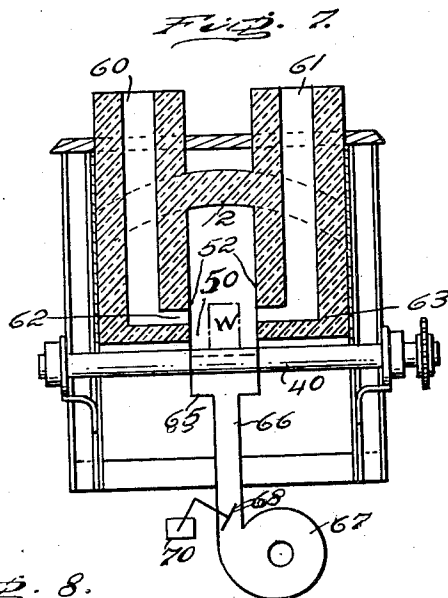
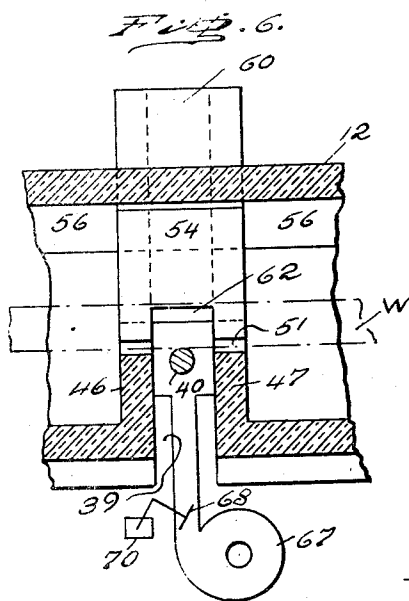
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S. M. STOLER
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UNITED STATES PATENT OFFICE

2,492,942

ROLLER HEARTH FURNACE

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Application January 26, 1949, Serial No. 72,875

15 Claims. (Cl. 263—40)

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This invention relates to roller hearth furnaces.

Furnaces of this type are continuous furnaces, with entrance and exit openings in the ends of the furnace, and with rollers disposed transversely in the furnace to support and advance the work. These furnaces are commonly heated by means of multiple gas or oil burners firing through the furnace walls or by means of electric heating elements internally mounted on the inner surfaces of the furnace heating chamber.

The rollers are of either solid or tubular construction, with the shafts extending through and journaled in or laterally beyond the side walls of the furnace, with externally applied power effective to rotate the rollers. Such power application is either individual to the respective shafts, or in groups from a common power source.

There are usually a plurality of such rollers in general planar alignment longitudinally of the furnace, and they may coact with rollers outside of and longitudinally beyond the furnace to feed work of any desired sort into the furnace entrance, through the furnace, and out through the discharge end or exit at the opposite end of the furnace.

As the furnaces have previously been constructed the rollers within the furnace have been more or less directly exposed, either to direct burner flames in the case of fuel-fired furnaces, or to radiation within the furnace in the case of fuel-fired or electrically heated furnaces, so that it has generally been impossible to elevate the temperatures of the work without also deviating the temperatures of the rollers to practically the same magnitude. In some instances the tubular types of rollers have been used as conduits for a coolant flowing therethrough, and in such cases reliance has necessarily been upon continuous flow of the internal coolant for dissipation of the heat absorbed by the rollers. This form of cooling also effects a limitation upon the heat available for incidence upon the work.

It is well known in the art that the various metals of which rollers have been previously made, lose their strength and tend to disintegrate under elevated temperatures. Rollers made of refractory materials have likewise proven unsatisfactory under elevated temperatures due to their fragility and friability. Combinations of metals and refractories in roller construction have not been very effective in permitting attainment of elevated furnace temperatures without an inherent shortening of roller life. As replacement of a roller involves shutting down the furnace, it will be clear that the economics of the

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situation also place sharp limitations upon the maximum furnace temperatures in order to effect long periods of continuous furnace use.

For these and related reasons, the conventional roller hearth furnace of present commercial acceptance is not capable of furnace temperatures higher than about of the order of 2100° F. This limitation restricts the utility of the furnaces, requires the use of larger furnaces than would otherwise be necessary, and necessitates the use of other types of furnaces when the work must be brought to higher temperatures than such illustrative maximum.

It is among the objects of this invention: to improve the art of roller hearth furnaces; to provide a roller hearth furnace with rollers in such relation to partial partitions in the furnace as to be shielded from direct incidence of the hot gases, and also from radiation from the furnace, while still being effective to support and advance the work under higher furnace temperatures than has previously been attainable; to provide a roller hearth furnace with an air-cooling system for cooling the rollers without any appreciable adverse effects on the work supported thereon; to utilize the velocity of efflux gases as they vent from the furnace to induce a cooling stream of air across and against the rollers in a roller hearth furnace; to provide a roller hearth furnace with a high thermal head by which the work can be quickly heated to a desired working temperature within a short time interval; to provide a furnace and roller assembly in which the hot gases are in continued contact with the work while still affording efficient air cooling for the conveying rollers; to provide a roller hearth furnace in which the temperatures incident on the work are appreciably above the order of 2100° F.; to provide a roller hearth furnace with shielding devices to protect the transverse rollers from direct or indirect heat from the furnace except for an axially short peripherally small area extending above the shield far enough to support the work out of contact with the shield; to provide a roller hearth furnace with rollers of a transverse extent adequate to support and convey or advance work of various sizes to a given maximum with a directed cooling air stream confined to and accelerated against and past the exposed transverse portion of the rollers; to provide a positive flow of air against rollers in a roller hearth furnace for cooling same; and other objects and advantages will become apparent as the description proceeds.

In carrying out the invention in an illustrative

embodiment, there is provided a continuous roller hearth furnace of any desired length, with a plurality of shielding, semipartitions in longitudinally spaced transverse disposition. The partial partitions define a combined roller housing and shielding structure, and a vertical channel for cooling air leading externally about the rollers adjacent to the work-supporting portions thereof.

Preferably, as the only vents for the products of combustion other than the end openings of the furnace, vent devices are disposed in the general plane of the partitions so that the accelerated velocity of the hot furnace gases in venting induce a flow of cooling air through the partitions in scouring relation to the rollers. Preferably also, the intakes for the vents are disposed inwardly of the furnace generally contiguous to the work so that the heated gases moving to the vents are forced into scouring relation to the work. As a modification thereof the vents are provided in pairs or other pluralities in order to still further increase or enhance the scouring of the work by the hot furnace gases. The furnace is designed to rapidly heat work to elevated temperatures, appreciably greater, if desired, than the illustrative 2100° F. The work may comprise any elongated articles, whether tubes, bars, billets, blooms, rods, sheets, or smaller articles carried in trays or other supporting means. One illustrative application of the invention, for instance, is for the heating of elongated bars for delivery adjacent to a forging or other working device as shown in my application for patent, Serial Number 29,616, filed May 27, 1948.

In the accompanying drawings forming part of this description:

Fig. 1 represents a fragmentary side elevation, partially in fragmentary longitudinal vertical section, of one form of the invention, remote from either end of the furnace, with the external framing and bracing removed for purposes of clarity.

Fig. 2 represents a transverse vertical section therethrough taken on line 2—2 of Fig. 1.

Fig. 3 represents a transverse vertical section therethrough taken on line 3—3 of Fig. 1.

Fig. 4 represents a fragmentary longitudinal vertical section through a modified form of furnace, having two parallel transversely spaced vents.

Fig. 5 represents a transverse section through the furnace of Fig. 4.

Fig. 6 represents a fragmentary longitudinal section through a further modified form of roller hearth furnace, in which a positive flow of cooling air is provided for impact against the roller.

Fig. 7 represents a transverse section through the furnace of Fig. 6.

Fig. 8 represents a side elevation, partially in section, of a furnace according to this invention, showing the end wall construction thereof.

Fig. 9 represents an end elevation of the complete furnace, showing the end wall and the aperture therein to receive the work fed across the outer or external rollers of the furnace.

Referring to Figs. 1, 2, and 3, the furnace 10 comprises a single furnace chamber 11, defined by the upper wall 12, side walls 13 and 14, and bottom wall 15. It will be understood that end walls 63 having openings 64 corresponding in dimension generally to the slots 29 to be described, will be provided as shown in Figs. 8 and 9. The furnace will be constructed in any desired manner, as to refractories, insulation, and reinforcing

and supporting structures and framing. The bottom wall 15 preferably has a lower clearance or spacing 16, from the ultimate support, in order to provide air flow passages communicating with the cooling slots to be described, although longitudinal air flow is not in any degree essential to the functioning of the furnace. Usually, therefore, this space will receive framing members. The bottom wall 15 and portions of the side walls 13 and 14 of the furnace are interrupted transversely by the respective compound partitions 17, each extending between the bottom wall and vertically along the side walls 13 and 14 to a horizontal upper edge a little above the center of the vertical height of the furnace chamber 11. The partitions 17 are each formed by spaced walls 18 and 20 preferably, but not essentially, vertical, connected at their upper edges by a horizontal wall or web 21. The horizontal wall 21 delineates the horizontal upper edge of the partitions located slightly above the vertical middle of the furnace, and, because of its central opening to be described, forms a partial closure for the vertical air channel 22 formed by the space between the contiguous surfaces 23 of wall 18 and 24 of wall 20. Channel 22 is open on part of the side walls and across the bottom of the furnace in a peripherally continuous entrance. It is incomplete or partial because in the substantial center of the furnace the partition wall 21 is cut away vertically in transverse vertically extending generally parallel spaced surfaces 28 and 30 extending longitudinally of the furnace, and the complementary partition walls 18 and 20 are cut away vertically and horizontally and forms with the opening in the horizontal web 21 a longitudinal horizontal slot 29 in the partition. Slot 29 is defined in walls 18 and 20 and closure 21 by the horizontal bottom edge surfaces 25 and the vertical side edges 26 and 27, and the vertical edges 28 and 30 of the upper wall portion 21 and is generally symmetrical of the longitudinal axis in the center of the furnace. As the upper partition wall 21 is cut all the way through and the partition walls 18 and 20 are cut below the upper wall, it will be observed that the slot 29 is in communication with the space 22, and the latter extends laterally out of both sides of the furnace and in communication with the lower passage 16, if the latter is provided, so that air passing into the furnace from the exterior thereof passes into the channel 22, and thence into the restricted slot 29, in which it is drawn upwardly under high acceleration by means to be described. It will be observed that the partition wall surfaces, respectively 31 on partition wall 18 opposite to channel surface 23 thereof, and 32 on partition wall 20, opposite to channel surface 24 thereof, define respectively adjacent effective ends of a pair of contiguous partial chambers, each of which is completed by the complementary facing surface of the adjacent partition. The furnace is therefore provided with a plurality of partial chambers, as illustratively 33, 34, 35, 36, etc., continued as desired for the length of the furnace, although being only partial, as the upper portion of all of the partial chambers is a continuous straight-through single furnace chamber.

Although I may use any form of heating that may be desired, it is preferred to use fluid fuel such as gas or oil, and this is introduced through burner openings in the furnace. Illustratively and preferably, I provide a burner opening 37 low in side wall 13, and an additional burner 38 high in the opposite side wall 14. Preferably these

burners, which have a tangential discharge so as to completely encircle the work, supported generally symmetrical or concentric of the longitudinal axis of the furnace, are disposed in the partial chambers spaced from the respective partitions, but any other desired location of the burners, and any desired numbers of burners, and independent or dependent controls thereof may be used as circumstances require.

In order to support and advance the work, a series of conveyor rollers 40 are provided, preferably as cylindrical shafts according in number with the number of partitions, extending across and out of the furnace laterally in order to be driven externally, as by sprockets 41, driven by individual or common power means. Additional rollers 40 are provided externally of the end walls, as shown in Figs. 8 and 9. The shafts are suitably journaled on the frame of the furnace, and are each disposed in the respective channel space 22 of the partitions beneath the upper closures 21 thereof, and extending across and partially into the longitudinal slots 29 of the partitions, with the upper peripheral edge of the roller 40 extending just above the bottom horizontal edge 25 of the slot. Although the preferred form of roller is a cylindrical shaft, it will be understood that the shaft may be of smaller diameter and dropped a little further down and an actual roller may be mounted on the shaft in centered and intersecting relation to the slots in the partition. If desired, the shafts 40 may be tubular and associated with any desired sort of fluid coolant passing internally thereof as is common in the art to augment or amplify the cooling by the external air flow to be described.

An important feature of the invention is the controlled exhaust of the waste gases forming the products of combustion. This is accomplished by providing vent openings in the furnace at carefully selected points or areas, as preferably the only vents in the furnace other than the end apertures through which the bars of metal are fed and delivered, although if desired additional vents can be used at other points, and the whole venting system controlled to secure the results to be explained. A simple structural procedure is the mere formation of vent apertures in the roof of the furnace as indicated at 49, permitting the exhaust directly into the room containing the furnace. It is preferred, however, to provide actual stacks, such as 42, having sealing flanges 43, and extending through the top of the furnace, and, if desired, these stacks may terminate flush with the inner surface of the top of the furnace chamber at the line 44 spaced from flanges 43 by the roof thickness. The stacks illustrated in these figures (1, 2, and 3) are of refractory material such as silicon-carbide or similar heat-resisting material. The preferred form of stack involves an internal stack extension 42' of stack 42, extending internally of the furnace to an intake mouth or entrance opening 45 juxtaposed to the work W, for reasons to be explained. It will be understood that however the vents are formed, whether as mere roof openings, short stacks extending from the roof line upwardly, or complete stacks extending axially in both directions from the roof, the axial center of the vent is disposed generally in a transverse diametric plane passing centrally through the space 22 between the partition walls, and preferably bisecting the respective slots 29. The vents are thus axially juxtaposed in symmetry to the center of the given partitions. In the case of peripherally off-set

stacks or vents, in respective asymmetry with the vertical center line of the furnace, even if need be in the side walls of the furnace, it is preferred that the center line or axis thereof lie in said transverse diametric plane containing the center line of the air channel 22 transversely of the furnace. With the stacks or vents disposed as single openings, or as plural related openings transversely symmetrical or asymmetrical of the furnace, it will be observed that efflux gases comprising the products of combustion, generated in the partial chambers, must move across the adjacent partitions to exhaust through the stacks. This forces the heated gases to scour the work lying in the lots 28 on the rollers on their path toward the vents. Simultaneously with the forced exhaust of the gases passing through the vents, there is an acceleration in the velocity of the flow which effectively lowers the pressure adjacent to the slot 29, to induce and force an accelerated upward flow of external cooling air, confined, however, to the slots 29, which scours and partially but adequately cools the roller portions in the slots 29, with minimal effect on the portion of the work passing therethrough, owing to the simultaneous scouring of the work by the heated gases on the sides and upper surface of the work. The induced cooling draft mixes with the heated gases passing up the stack. Under certain controlled conditions the combustion in the furnace may be partially incomplete so far as concerns gases passing across the work and up the stack, and the cooling air may be used to complete the combustion about the work.

In forming the vents or stacks, it is preferred, as noted, to extend the stacks into the furnace, so as to dispose the entrance mouth thereof close to the upper end of the slot 29 so as to force the venting gases to pass even closer to the work on their path across the partition and into the open mouth of the stack. Thus, as noted, stacks 42 are continued inwardly of the furnace in a preferably integral extension 42' having the inner open mouth 45 in spaced relation to the wall of the furnace through which it extends. While it will be recognized that the optimum length of the extension 42' and thus the actual disposition of the entrance mouth 45, may vary within a certain range of predetermined adjustment, the structure is designed to abstract the products of combustion from a point or area within the furnace in relative adjacency to the work. The function is that the point or area of abstraction of the products of combustion be disposed in relative adjacency to the work.

It will be seen that there is thus provided a roller hearth furnace of high efficiency in which pieces of work can be fed continuously through the furnace supported and conveyed by rollers in the furnace, but which rollers are maintained at safe heated conditions by forced external cooling without appreciable adverse effects on the work and with steady increase of heat investiture along the length of the work as it progresses.

It will be appreciated that many changes may be made in the furnace without departing from the principles of the invention, and such are, of course, to be construed as within the scope of the invention unless otherwise limited in the hereinafter appended claims. One proposed modification is disclosed in Figs. 4 and 5 herein. In the form of the invention of these figures the main body of the furnace and rollers are substantially identical with those already

described so that the same reference characters apply and are used therewith. The partial partitions between chambers and the vents, however, are different, and in place of a single entrance for the exhaust gases adjacent to the work, two generally diametrically spaced entrances adjacent to the sides and upper surface of the work are provided. In this form of the device the partitions and stacks are shown as formed from refractories, and comprise the transversely extending longitudinally spaced walls respectively 46 and 47, which, with external faces presenting longitudinally of the furnaces, are continuous from the bottom wall to and through the upper wall 12 of the furnace adjacent to the respective side walls 13 and 14 thereof. The respective walls 46 and 47 are spaced in the lower portion to define an air conduit 39 closed, except toward the center, by a horizontal cross connection 48, analogous in part to the cross connection 21 of the earlier figures. The cross connection is cut away in the substantial center to form the longitudinal slot 50, formed by the lower horizontal surface 51 in the walls 46 and 47, and the side edge vertical surfaces 52 and 53 of the cross connection 48, continued vertically and longitudinally of the furnace in the internal spaced mutually facing walls 54 and 55, merging into the roof of the furnace and forming and defining a narrowed portion of the through axial passage 56 of the furnace in longitudinal communication with the adjacent incomplete or partial furnace compartments or chambers defined by the respective incomplete partitions. The side walls 13 and 14, the cross connection 48, and the walls 54 and 55 define respectively substantially vertical stacks or vents 60 and 61 leading into communication with the slot 50 and with the air conduit or channel 39 by the respective exhaust intake openings 62 and 63 respectively. The entrances to the stacks are disposed on opposite sides of the slot in the vicinity of any work W disposed therein and supported on the roller 40.

As, depending upon the vertical dimensions of the elongated work passing through the furnace, the entrances to the stack are preferably symmetrically and oppositely disposed below the level of the upper surface of the travelling work, it will be observed that the efflux gases in the partial chambers must pass scouringly around and about the work in moving longitudinally of the furnace and into the vents. The same accelerations of the exhaust gases and the same injector action in drawing in the cooling stream of air will maintain, as in the earlier figures. The rollers will be forcibly cooled by the air intake, while the spent flames will be forced about practically the entire bar or rod being heated, as it moves between contiguous partial furnace chambers.

It will be understood that the stacks or vents may discharge into the furnace room, or, if desired, be connected to chimneys or other draft creating evacuation devices, to expedite the controlled flow of the spent gases. It will be understood that suitable conventional dampers or the like may be associated with any of the vents in order to regulate and control the rate of efflux gas flow in accordance with the predetermined rate and volume of fuel input, and as modified by variations in masses of the work being heated.

It will be seen that in the forms described hitherto reliance has been made upon the induction of a draft by the efflux velocity of the spent gases

passing up the respective stacks. While in general this is completely adequate, it will be seen that this cooling flow can be augmented to advantage under certain demands by the modification shown in Figs. 6 and 7. In this form of the invention the parts are all substantially similar to the disclosures of either Figs. 1, 2, and 3, or of Figs. 4 and 5, and illustratively they are like the latter, so far as the furnace structure is concerned. However, the partitions of the latter, in place of being in free communication with the outer air, are closed transversely and vertically by the transverse ducting elements 65 effectively closing the lower edge of the slot 29 except for the conduit 66 which leads to the blower 67, power driven to force a stream of air from outside of the furnace into and through the slot 29. Preferably, the flow through the conduit 66 is controlled by a damper 68 positioned by a control device 70, to regulate the flow within close limits to accord with the instant demand at the particular roller 40. It will be understood that the ducting mentioned may be actual metal or like inserts, or may simply be the boundary surfaces of refractory material so placed as to define the conduit, or part thereof, and the communication with the lower end of an otherwise closed slot 29. Obviously, the passage of the roller 40 through the ducting will require a small clearance to permit rotation thereof without frictional contact with such ducting. The advantages of the forced draft for cooling will be apparent.

I claim as my invention:

1. A roller hearth continuous integral furnace comprising a furnace chamber, partition means in the chamber defining a cooling air conduit, a roller mounted in the furnace chamber juxtaposed to said partition substantially in the path of cooling air passing through said conduit means for directing a cooling air stream from the conduit externally about said roller and means juxtaposed to said conduit for venting gases from the chamber.
2. A roller hearth continuous integral furnace comprising a furnace chamber, partition means extending transversely of the chamber and defining a cooling air conduit, a roller mounted in said partition means in said conduit, said partition means providing a clearance adjacent to said roller to permit elongated work to rest upon said roller, a vent for the furnace chamber disposed in general vertical alignment with the partition means so that spent gases passing into said vent must pass across said partition means in incidence with the work passing across said partition means supported on said roller so as to induce a cooling airflow from said channel against said roller.
3. A roller hearth continuous integral furnace comprising a furnace chamber, a plurality of partition means extending transversely of the chamber in longitudinally spaced relative dispositions, each partition means having an internal space, a roller disposed in said space, a vent in the chamber in substantial vertical alignment with a partition means and juxtaposed to the path of the work so that gases passing into said vent must scour the work passing across the instant partition means, said vents being respectively substantially vertically aligned with said partition means.
4. A roller hearth continuous integral furnace comprising a furnace chamber, partition means in said chamber to define a plurality of partial

combustion chambers, rollers associated with the partition means between combustion chambers, vents in the furnace chamber between combustion chambers, and means associated with the partitions defining air conduits for externally cooling said rollers, said vents respectively substantially vertically aligned with said partition means.

5. A roller hearth furnace comprising means defining a furnace chamber, a plurality of rollers mounted in the chamber and extending transversely thereof, a vent for products of combustion in general axial intersection with the axis of each of the respective rollers, shielding means comprising generally parallel spaced walls extending transversely of the chamber on both sides of each roller to shield same and to define a plurality of partial combustion chambers in the furnace chamber, means for heating the combustion chambers, and means associated with the respective shielding means for establishing communication between external air and the rollers to cool the latter.

6. A roller hearth furnace comprising means defining an elongated furnace chamber, a partial partition extending transversely of the chamber and comprising internally a vertical air channel and externally partition surfaces between contiguous partition-spaced partial combustion chambers in the furnace chamber, means for heating the combustion chambers, a vent in the furnace chamber substantially over said partition, and a roller disposed in said channel.

7. A roller hearth furnace as described in claim 6 characterized by the fact that the vent has an intake mouth disposed inwardly of the means defining the chamber.

8. A roller hearth furnace comprising walls defining an elongated furnace chamber, a partition extending transversely and vertically of the chamber from the lower wall thereof to define an air conduit passing through the side walls thereof, a slot in said partition axial of the chamber, a roller mounted for rotation in the conduit having a surface in said slot to receive and support work out of contact with said partition, means for heating the chamber, and a vent for spent gases having an entrance substantially juxtaposed to said slot.

9. A roller hearth furnace comprising upper lateral and lower walls defining an elongated furnace chamber, a partition device extending transversely of the chamber between lateral walls and the lower wall to define partial combustion chambers spaced apart axially of the furnace chamber by the device, said device comprising spaced walls merging into the walls defining the sides and bottom of the furnace chamber to define a conduit for cooling air which passes through the lateral walls of the furnace chamber, said spaced walls of the device having registering horizontal openings to define a slot, means closing the space between the walls of the device on each side of said slot to define an outlet for the cooling air conduit within the furnace, roller means mounted for driven rotation in the space between the walls of the device having a work supporting and conveying peripheral edge thereof exposed within said slot and said outlet, and vent means in the

furnace chamber in general alignment with the partition device so that efflux gases entering said vent means from the partial combustion chambers must traverse the partition means.

10. A roller hearth furnace as described in claim 9 characterized by the fact that the vent means comprises a stack having an entrance mouth within the furnace chamber.

11. A roller hearth furnace as described in claim 9 characterized by the fact that the vent means comprises a plurality of vents each aligned generally with the partition device.

12. A roller hearth furnace as described in claim 9 characterized by the fact that the vent means comprises a plurality of transversely spaced vent devices each having entrance mouths within the furnace chamber in respective juxtaposition to said outlet.

13. A roller hearth continuous integral furnace comprising a furnace chamber, partition means in the chamber defining a cooling air conduit, a roller mounted in the furnace chamber juxtaposed to said partition, said partition having a constricted outlet forming mean for directing a cooling air stream from the conduit externally about said roller, vent means in the upper portion of the chamber and power means for forcing cooling air to the constricted outlet.

14. A roller hearth continuous integral furnace comprising a furnace chamber, a plurality of partition means extending transversely of the chamber in longitudinally spaced relative dispositions, each partition means having an internal space, a roller disposed in said space, a vent in the chamber in substantial alignment with a partition means and juxtaposed to the path of the work so that gases passing into said vent must scour the work passing across the instant partition means, and power driven means for forcing cooling air through the means establishing communication.

15. A roller hearth furnace comprising means defining a furnace chamber, a plurality of rollers mounted in the chamber and extending transversely thereof, a vent for products of combustion in general axial intersection with the axis of each of the respective rollers, shielding means comprising generally parallel spaced walls extending transversely of the chamber on both sides of each roller to shield same and to define a plurality of partial combustion chambers in the furnace chamber, means for heating the combustion chambers, means associated with the respective shielding means for establishing communication between external air and the rollers to cool the latter, and means for forcing cooling air through the means establishing communication.

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