CLOSURE FOR OPENINGS IN HEAT-TREATMENT FURNACES

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3 Sheets—Sheet 1

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WITNESSES:

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Fig. 4.

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My invention relates generally to heat-treating furnaces through which charges to be heat-treated are moved, the charges preferably being heat-treated while enveloped by a controlled or special gaseous atmosphere; and more particularly relates to a conveyor furnace of the type in which miscellaneous and differently-shaped articles or pieces of work are to be heat-treated at different times.

In furnaces to which my invention is particularly applicable, the work is continually fed onto the conveyor which continually carries the work through the furnace, and after the heat-treatment in the furnace, discharges the work continuously, and by the term continuously, I intend to include either or both a continuous flow of the work or operation of the conveyor, and an intermittent flow of work or operation of the conveyor at relatively short intervals. Because of the continual flow of the work through the furnace, it must be provided with an entrance opening, and perhaps a discharge opening through which the work can pass. This means that ordinarily the openings cannot be closed to conserve heat or prevent an excess loss of the controlled atmosphere. Accordingly, a furnace of this character has definite short-comings, especially so if a controlled atmosphere is used inside the furnace to surround the work during its heat-treatment.

The shortcomings aforesaid of a conveyor furnace for heat-treating a variety of work at different times can be directly attributed to the fact that the openings in the furnace are usually fixed in size and, therefore, cannot be accommodated to the different sizes of the different pieces of work being heat-treated. In prior constructions, the height of the unclosed openings could be adjusted by varying the position of vertically-adjustable doors whose lower edges defined the upper boundaries of the openings. The side boundaries of the openings were, however, fixed by the design of the furnace, and were determined, as a rule by the width of the conveyor passing through it. Accordingly, while the height of the exposed openings could be adjusted, the sides could not, and, as a result, free spaces or voids existed on each side of the work being heat-treated as it passed through either the entrance or the discharge opening.

Such voids are objectionable for a number of reasons, among which are: First, there is an unwarranted loss of heat from the furnace which reduces its efficiency and increases its operating expense. Such loss of heat, of course, is the result of radiation through the aforesaid voids, and convection and conduction of heat by the flow of atmosphere or air through the voids. Such losses may be especially high when the exterior of the opening is in proximity to the heating chamber of the furnace. Second, there is an excessive loss of controlled atmosphere through the voids which must be taken into account in the determination of the size of the equipment producing the controlled atmosphere for the furnace. Third, large voids permit seepage of air into the furnace, the air tending to flow along the bottom of these voids while the controlled atmosphere rolls out at the top. The inflow of air may adversely affect the work being heat-treated, and in brazing furnaces may result in poorly joined parts or at least joints which are not as complete as would be obtained if the atmosphere in the furnace were at all times relatively quiet, pure and clean.

It is among the objects of my invention to provide a furnace which will overcome, to a large degree, the aforesaid defects of prior furnaces.

In accordance with my invention, I provide devices for the furnace by which the size of the entrance opening, or the discharge opening if there be any exposed to the air, is more fully controlled. More specifically, for a furnace with a vertical door, shutters are provided slidable sideways over the conveyor so that the side boundaries of the exposed or unclosed part of the opening can be made to move nearly conform to the size of the particular work being heat-treated at the time.

In accordance with my invention, the upper boundary of the exposed opening is determined, as before, by the vertically-adjustable end door, while the side boundaries are determined by two shutters, one on each side of the opening, and each movable laterally or sideways to and from different positions behind the door. The bottoms of the shutters are slightly above the conveyor so that they will not interfere with it, and are maintained in their adjusted positions by their own weight, suitable guides being provided to confine the path of the shutters during their movement.

Further objectives, results and advantages of my invention, in addition to those heretofore recited, will be apparent from the following description thereof as it is applied to one form of a furnace, the description to be taken in conjunction with the following drawings, in which:

Figure 1 is an elevational view, somewhat schematic, of a furnace embodying my invention;
Fig. 2 is a section through the entrance chamber of the furnace taken substantially on the line II—II of Fig. 1; Fig. 3 is a front elevation view of the entrance chamber of the furnace, with the shutters adjusted to define a high, narrow opening. The outer door has been omitted for clarity of illustration.

Fig. 4 is a vertical, longitudinal sectional view of part of the entrance chamber with the outer door closed;

Figs. 5 and 6 are front and side elevation views, respectively, of a shutter; and Figs. 7, 8 and 9 are front, and side elevation, and top plan views of a guide for the shutter.

My invention is applicable to any appropriate type of furnace which is used for processing a variety of different parts or pieces of work, and is embodied into a particular furnace, generally indicated by the reference numeral 1, which comprises a charging or entrance chamber 4, a heating section 6, and an elongated cooling section 25 having a discharge end 18.

The furnace is encased in any suitable manner by a metallic casing 12, appropriately constructed with sealing and expansion joints, such as, for example, 14, so that the interior of the furnace may be suitably permeated by a controlled special gaseous atmosphere delivered to the furnace through a pipe system 16 having suitably distributed inlets to the different chambers of the furnace. The pipe system 16 connects to an atmosphere equipment schematically indicated at 18, which may be of conventional design for processing or generating the particular gaseous atmosphere to be employed in the furnace.

The entrance or charging chamber 4 is, in this case, relatively short, and its outer or exterior portions are consequently in proximity to the heating section 6. The chamber has refractory walls 20 defining an outer opening or throat 22 through which work is passed into the furnace.

The heating section of the furnace correspondingly includes suitable refractory walls defining an interior heat-treatment chamber which may be heated electrically, or by any other suitable means, such as, for example, radiant gas-fired tubes disposed along the inside of the walls of this chamber.

The cooling section 8 of the furnace may comprise water-jacketed walls through which water may be passed to cool the work traversing that chamber, and its discharge end 10 may have an opening or throat corresponding to the like passage in the entrance chamber.

For conveying the work through the furnace, an endless belt conveyor 24 is provided having a portion outside the front or charging end of the furnace upon which the work can be placed and extending beyond the back or discharge end of the furnace. Power for the belt 24 is supplied by a motor 25 driving a rubber covered drum 28 through suitable power-transmitting and speed-reducing devices 29, the drum 28 acting as the intermediate drive for the belt 24. A rubber covered pinch roller 30 may be employed to assure a good frictional engagement between the belt and the drum 28.

The discharge end of the belt 24 rides over a steel drum 34 rotatably mounted on a carriage slidably mounted in suitable guides 38. A tensioning device indicated in its entirety by the reference numeral 36 may be employed to maintain the belt in suitable tension, as more fully described and claimed in my patent application Serial No. 319,871, filed February 20, 1940, on Belt-tension control devices, and assigned to the Westinghouse Electric & Manufacturing Company.

The contours of the entrance opening 22 and the discharge end opening are fixed by the design of the furnace but the width of each must be sufficient to permit the belt 24 to pass through them, the belt 24 riding over suitable plates or guides 40 on the floors of the different chambers of the furnace.

To close the openings at the ends of the furnace, suitable vertically-sliding doors 45 may be employed, each abutting the outside surface of a door plate 46 forming part of the outer casing 12 of the furnace, the door plate having an aperture of a size at least as large as the opening 22 and preferably slightly larger, this aperture being indicated by the reference numeral 50.

In constructing the furnace, I prefer to slant the outermost end of the furnace and component work, that is, the door plate 46 so that the door 40 of its own weight, will press against the surface of the plate 46, thereby decreasing gas leakage.

Each door 40 is movable upwardly to an open position and downardly to a closed position. For this purpose, a handle 52 is provided secured to a shaft 54 journaled in side bars 56 secured to the sides of the charging chamber. The shaft 54 has suitable sprocket wheels 58 engaging sprocket chains 60 by means of which the door can be raised and lowered in the customary manner. A sprocket chain 61 is secured to a counterweight 62 and to a sprocket 63 on the shaft 54 may be employed to balance the weight of the door. The door-operating mechanism is so constructed as to have sufficient friction to maintain the door 46 in any vertically adjusted position. However, any suitable latch may be provided for latching the door at any particular position.

Accordingly, by merely operating the handle 52, the lower edge 64 of the door can be suitably disposed with respect to the conveyor belt 24 to accommodate different heights of work that might be placed on the conveyor. Thus, if the work to be processed in the furnace is high, the door 46 is adjusted with its lower edge 64 above the conveyor 24 a distance somewhat more than the height of the work so that the work will just pass underneath without interference, if the work is low, then the door, of course, is lowered a suitable distance to correspond. However, where the work on the belt does not occupy the full width of the furnace, and this occurs frequently in a furnace employed for processing a large variety of parts, voids invariably exist between the side or lateral boundaries of the passages 20 and 50 and the work itself. These voids permit an unwarranted and unnecessary loss of heat through them, but of more importance to furnaces employing protective atmospheres, a large volume of protective atmosphere can flow outwardly through the voids out of the furnace and, consequently, it has hitherto been the practice to supply enough atmosphere at sufficiently high pressure to maintain the furnace completely filled in spite of this excessive loss, the escaping atmosphere being drawn into an exhaust system 65.

However, when it becomes necessary to treat parts which are high and narrow, the voids at the sides of the work may become so large as to offer very little resistance to the outward flow of atmosphere. An exceptionally great amount...
of atmosphere must, accordingly, be supplied to the interior of the furnace, and this requires that the gas be supplied in such a manner as to be suitably determined with this possibility in mind. Moreover, with very large voids, cold air can enter the furnace at the bottom of the voids in spite of the precautions taken with respect to increased volume and pressure of the atmosphere, which are necessarily provided by practical considerations. For these and other reasons, I apply to the entrance opening or discharge opening, or both, means for closing the aforesaid voids, this being in the nature of laterally-adjustable shutter devices. The shutter devices comprise a pair of shutters 70 and 12 that are slidably mounted to adjustably close the sides of the opening 50 above the conveyor. The shutters are each approximately half the width of the opening 50 in the door plate 48 and slide in back of this door plate. Each shutter has a tube 73, secured to its top, having an oversize bore with respect to a rod 74 passing through an apertured block 76, centrally secured to the back of the door plate 48. The rod 74 extends across the furnace, and protrudes laterally outwardly from the block 76 a length approximately twice the width of a shutter so that either shutter may be slid on the rod to open or closed position, enabling the inner edge 89 of each shutter to be disposed in substantially any position with respect to the vertical center-line of the bell-conveyor.

Each of the shutters 70 and 12 is adapted to close slightly less than one-half of the entrance opening to the furnace and because the shutters are disposed on each side of this opening, they can be suitably operated in conjunction to close as much of the opening as may be desired. For moving each shutter, I weld to each of them a small piece of pipe 62 which can be engaged manually or by a suitable tool.

The entrance chamber shell of some furnaces may not be sufficiently wide to accommodate the full sidewise movement of the shutters to enable them to move entirely within the metallic casing 12. Accordingly, I add shutter guiding means 50 which not only confine the shutters to a predetermined path but also gas-tightly seal this path where it protrudes beyond the ordinary limits of the casing 12. Two such guides are provided, one for each shutter, and each comprises a narrow box-like structure having a closed end 92 and an opposed open end 94, the open end being disposed toward the center of the furnace. The guide means further comprises a back plate 96 and a slightly smaller front plate 98, the front plate 98 being suitably secured to the back of the door plate 48 so that the closed end portion of the guiding means 90 extends beyond the side of the furnace through a suitable aperture in the shell or casing 12.

The guiding means 90 is preferably gas-tightly welded to the metal casing 12 so that the completed outer casing is rendered gas-imperious although the guiding means 90 protrudes beyond it.

Each of the guiding means 90 preferably has its inner edge 100 disposed somewhat outwardly from the sides of the opening 92, to avoid interfering with the work while the shutters may be traveling through the entrance chamber. One end of the rod 74 may further be supported by the end plate 92 of the guide means 90 by passing a threaded end of the rod 74 through an aperture 101 in the end plate 92. A gas-tight joint is secured by threading on this end a nut 102 which clamps a washer and gasket, jointly indicated at 104, against the end plate 92. A small lug 106 on the back of its shutter further maintains it in position in its guiding means 90.

In operation, it is possible to leave any suitably exposed opening through which the articles deposited in the conveyor may pass by laterally adjusting the shutters 70 and 12 to accommodate the width of the work and by vertically adjusting the door 46 to accommodate the height of the work. Consequently, the use of shutter devices such as disclosed herein makes it possible to adjust the entrance to more nearly conform to the shape of the work, and thus the maximum capacity of atmospheric equipment is materially reduced. This fact not only reflects in the initial cost of atmospheric equipment but represents considerable savings in operation of the furnace because the amount of the protective atmosphere required is reduced. Accordingly, the need for less atmosphere resulting from the use of shutters represents a direct saving in the consumption of electrical energy for the operation of the furnace.

Another important saving effected by my invention resides in the reduction of the total heating energy required by the furnace. By holding the voids to a minimum, direct heat losses by radiation are reduced, and convection heat losses by escaping atmosphere are minimized.

My invention is especially useful in continually operating brazing furnaces. Many such furnaces will produce excellently brazed products when the door opening is nearly filled by the assembly being brazed. In such case the assembly practically fills the width of the opening and the door can be adjusted to clear the assembly, so that the resulting condition may be well within the requirements for proper brazing conditions within the heating chamber. However, if a high narrow assembly must be brazed, the door must nevertheless be raised to the top, leaving great voids or holes on the sides of the work. Without the use of shutters, the atmospheric furnace in the work would rush out at the tops of these voids 45 and air would seep into the heating chamber at the bottoms. Air, of course, in the heating chamber causes oxidation of the parts being treated, and this fact makes it difficult, and frequently impossible, for brazing metal to wet and flow. Moreover, brazing furnaces are very sensitive to drafts, and under ordinary conditions, the slightest breath of air near the charge may overcome the slight positive pressure of the furnace atmosphere. A restricted opening, such as obtained with shutters, produces higher gaseous pressures, and higher velocities of atmosphere flowing outwardly through the exposed opening, which thereby prevent influx of air.

It may be observed that by the use of my invention both the width and height of the opening 50 can be closed to variable extents, that is the position of the bottom edge of the door 46 may be adjusted to any point along the height of the opening, and one or both of the shutters may be adjusted to a position at any point along the width of the opening. Consequently, the closure means specifically provided closes the opening along two directions at right angles to each other. While the edges of the doors and shutters have been shown as straight lines extending in horizontal and vertical directions, respectively, it is obvious they need not necessarily be so directed for closing, to variable extents, the height and
width of the opening. Even so, the closure means will nevertheless close the opening to variable extents in two component directions at right angles to each other in a plane transverse to the movement of the conveyor 24 through the aperture 50.

I claim as my invention:

1. A furnace of the type described for heat-treating different types and sizes of work at different times, said furnace having an opening through which the work passes, continually-operating conveyor means for moving the work through said opening into said furnace for heat-treatment, and adjustable closure means for partially closing said opening along at least two component directions at right angles to each other in a plane transverse to the direction of movement of said conveyor means through said opening.

2. A furnace of the type disclosed for heat-treating different types and sizes of work at different times, said furnace having a wall with an opening through which the work passes, continually-operating conveyor means for moving the work through said opening into said furnace for heat-treatment, including a conveyor device passing through the said opening at the bottom thereof and of slightly less width than said opening, and adjustable closure means for partially closing said opening above said conveyor along the height and width of said opening which is above said conveyor, whereby the unsealed area of said opening can be adjusted to the size of particular work passing through it.

3. A furnace of the type described for heat-treating work while enveloped by a controlled protective atmosphere, said furnace having an outer wall with an opening, a gas-tight metallic casing substantially encasing said furnace, said casing having an aperture substantially corresponding to the first said opening, continually-operable conveyor means passing through the said opening and aperture, an adjustable closure means for said openings for defining the height of the unsealed area of said opening and aperture, and a second adjustable closure means for said opening and aperture for defining the width of the unsealed area.

4. A furnace of the type described having an end wall including an outer metallic sheet, said wall including an opening through which work to be heat-treated passes, continually-operable conveyor means passing through said opening along the bottom thereof, a substantially vertically-movable door for said opening, said door being slidable along said sheet, means for adjustably positioning said door, and means comprising a shutter behind said sheet at each side of said opening, adjustable for closing to variable extents the corresponding vertical side portions of said opening.

5. A furnace of the type described for heat-treating different types and sizes of work at different times while enveloped by a protective atmosphere, said furnace having an opening through which the work passes into it, continually-operating conveyor means for moving the work through said furnace, said conveyor means comprising a belt-conveyor passing along the bottom of said opening, a pipe system for conveying controlled atmosphere into said furnace to permeate its interior at a pressure slightly above atmospheric, and adjustable closure means for said opening for partially decreasing the width and height of said opening above said conveyor to define an adjustable unsealed area above said conveyor whereby the said unsealed area can be adjusted to the size of the particular work passing through it.

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