Dec. 8, 1964 W. C. DIMAN ETAL 3,160,403

FURNACE CONSTRUCTION AND METHOD OF OPERATING THE CONSTRUCTION

Filed Sept. 25, 1961 3 Sheets-Sheet 1

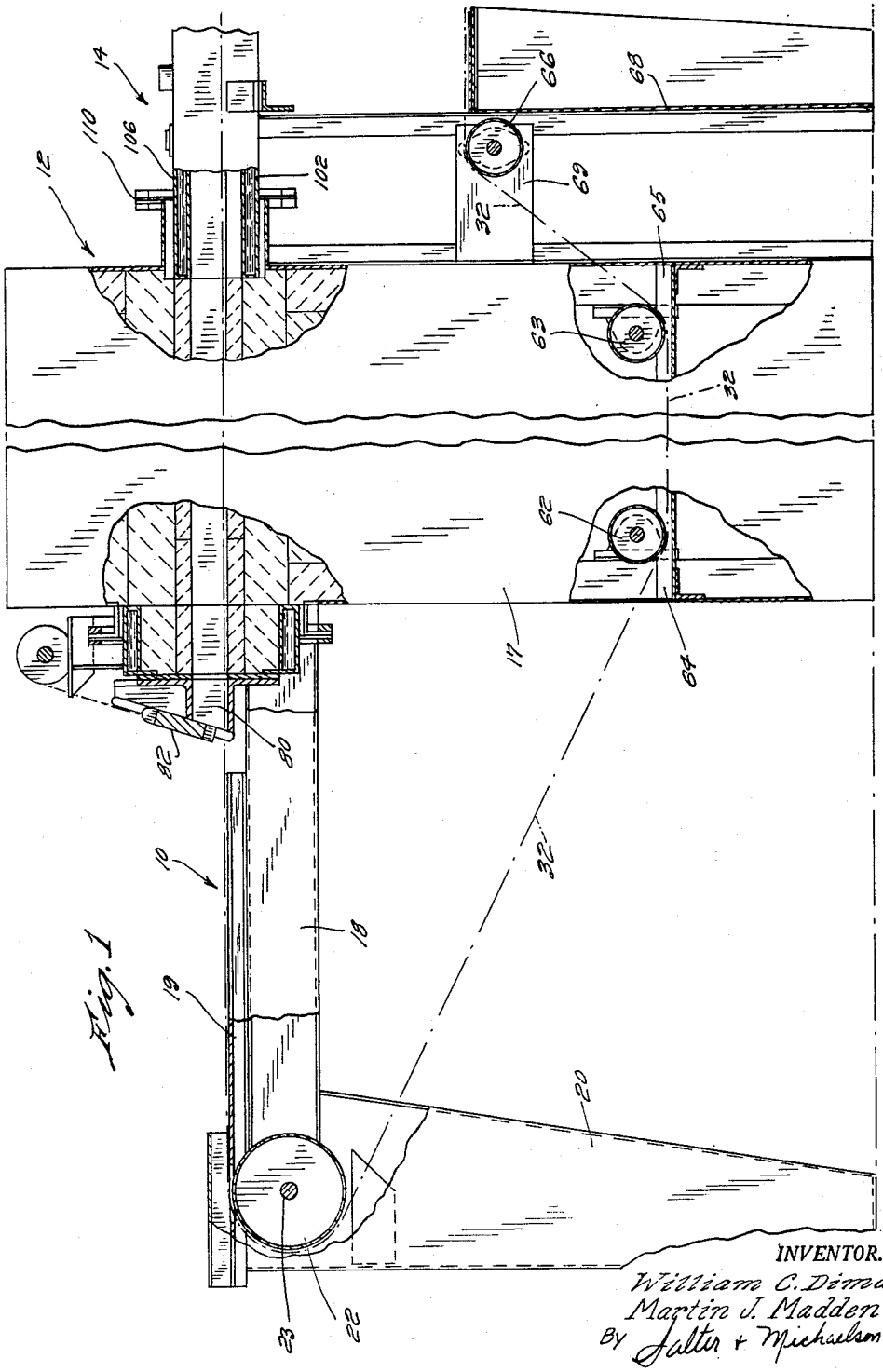


Fig. 1

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Filed Sept. 25, 1961 3 Sheets-Sheet 2

Fig. 2

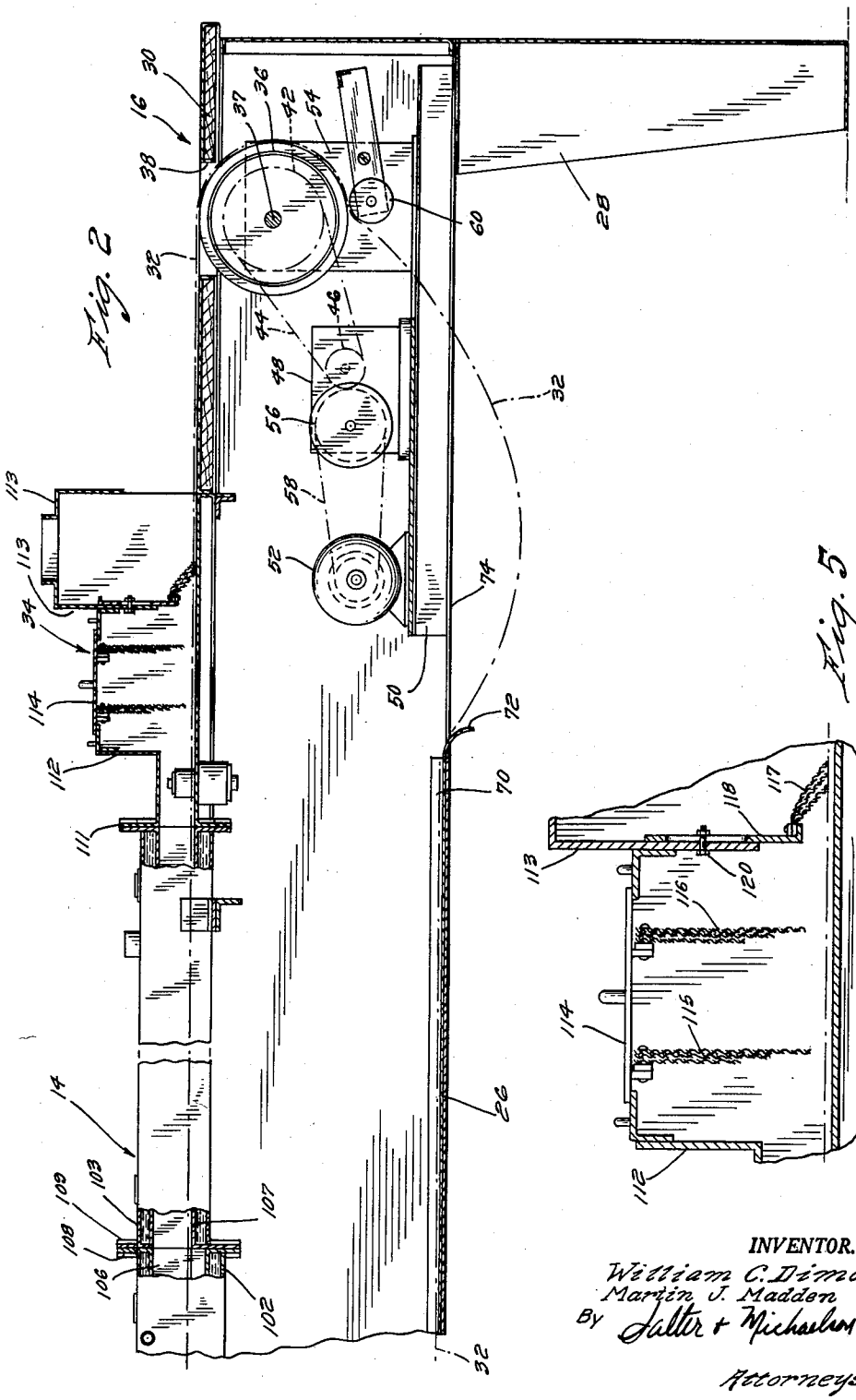


Fig. 5

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Filed Sept. 25, 1961 3 Sheets-Sheet 3

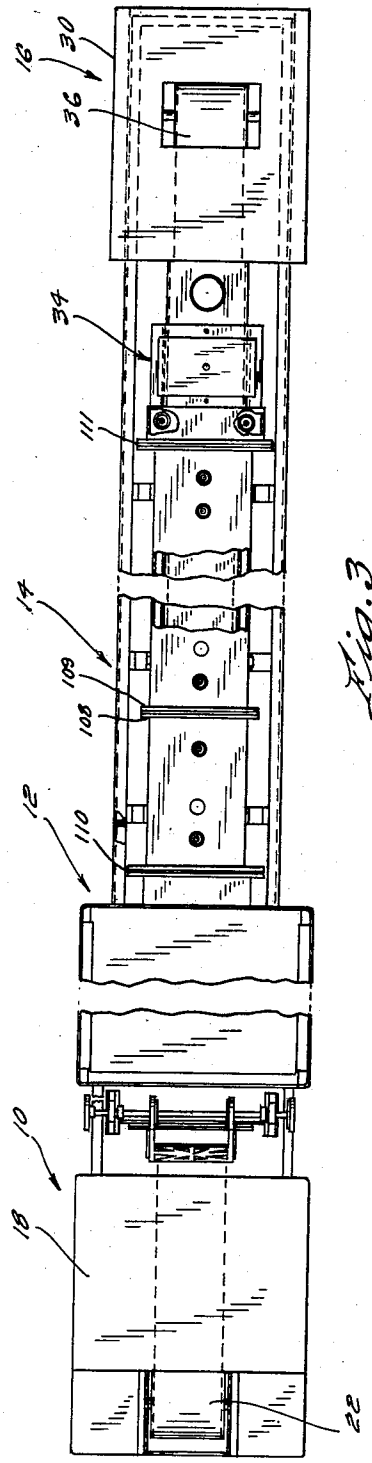


Fig. 3

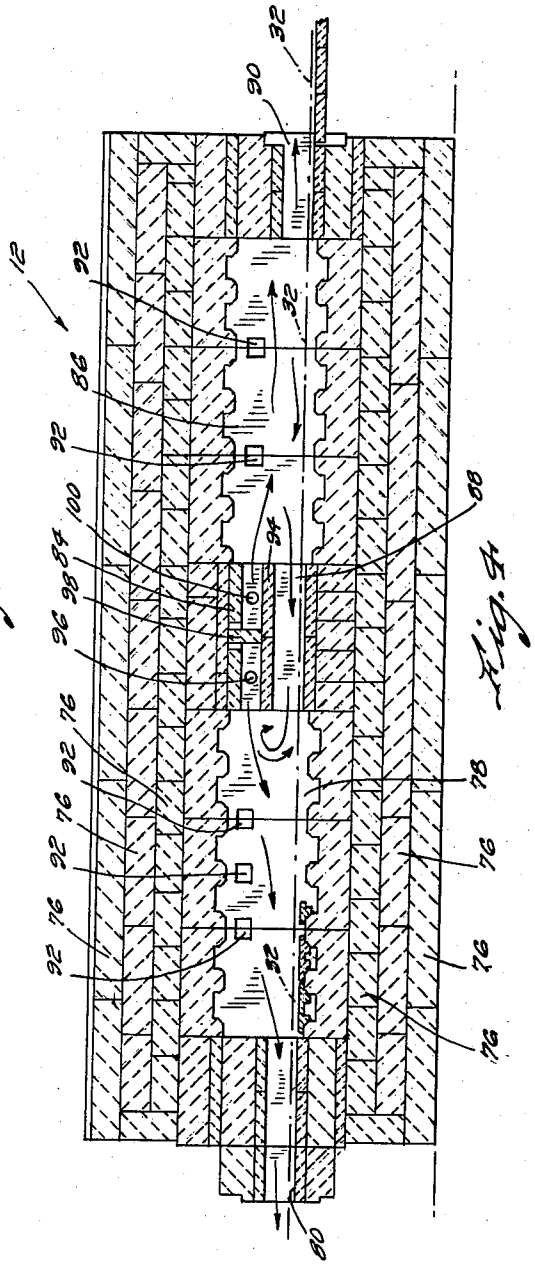


Fig. 4

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FURNACE CONSTRUCTION AND METHOD OF OPERATING THE CONSTRUCTION

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The present invention relates to a furnace construction. More particularly, the present invention relates to a heat treatment furnace that is utilized principally for the heat treatment of metal components wherein the metal components are successively outgased and oxidized.

The furnace construction embodied herein has particular application in the heat treatment of metal components that are utilized as part of a glass-to-metal seal in the manufacture of certain electrical elements for use in communications. Prior to the sealing of the metal component to a glass member, the metal component must first be cleaned by outgasing the surface thereof, and the surface of the metal component must then be subjected to an oxidizing process that is necessary in order for a tight hermetic seal to be produced between the metal component and the glass member. Prior to the instant invention, each of the individual steps of processing the metal components was carried out by a separate furnace. Thus, the surfaces of the metal components were outgased by a furnace in which a highly reducing atmosphere was introduced. After the components were subjected to the proper time-temperature cycle in the reducing atmosphere of the outgasing furnace, they were then moved to a cooling section of the outgasing furnace where they were cooled in an atmosphere. After being removed from the cooling chamber and the outgasing furnace, the metal components were then placed in a second furnace where they were subjected to an oxidizing atmosphere for a predetermined period of time. Here again, the components were cooled, and then after the removal hereof from the cooling chamber of the oxidizing furnace, they were placed in a third furnace where the actual seal between the glass members and the metal components was effected.

The present invention is designed to incorporate the outgasing and oxidizing steps in a single furnace construction and further includes only a single cooling chamber that, in effect, eliminates one of the cooling steps of the heretofore known process in the heat treatment of the metal components. The metal components are adapted to be successively treated by the furnace embodied herein and are placed on a continuous belt drive that carries them through a first chamber in which a reducing atmosphere is introduced for the outgasing thereof, and then through a second chamber located adjacent the first chamber that subjects the components to an oxidizing atmosphere. A portion of the oxidizing atmosphere is infiltrated into the outgasing chamber for mixture with the reducing atmosphere. Normally oxygen and hydrogen will produce ignition or explosion, but the mixing of the oxidizing atmosphere with the reducing atmosphere is accomplished above the ignition point thereof and the resulting mixture produces water vapor that is utilized for decarborizing the metal components.

It is therefore an object of the present invention to provide a heat treatment furnace for use in the processing of metal components wherein an outgasing chamber and an oxidizing chamber are incorporated in the furnace construction.

Another object of the invention is to provide a furnace construction wherein an outgasing chamber and an oxidizing chamber are located therein in adjacent relation so

that components to be processed thereby may be passed therethrough in quick successive relation, a portion of the oxidizing atmosphere being combined with the reducing atmosphere in the outgasing chamber for removing carbon traces from the metal components.

Still another object is to provide a furnace construction that includes an outgasing chamber, an oxidizing chamber located in close relation with respect thereto, and a single cooling section that is adapted to receive the components that have been processed through said chambers for the cooling thereof.

Still another object is to provide a furnace construction wherein a portion of an oxidizing atmosphere is mixed with a reducing atmosphere for producing water vapor that is utilized for decarborizing metal components that are processed by the furnace.

Still another object is to provide a furnace for heat treating metal components wherein a reducing atmosphere is introduced into a first chamber and an oxidizing atmosphere is introduced into a second chamber, the reducing and oxidizing atmospheres being introduced into their respective chambers through inlet pipes that are located intermediate the chambers and are isolated from each other.

Other objects, features and advantages of the invention will become apparent as the description thereof proceeds when considered in conection with the accompanying illustrative drawings.

In the drawings which illustrate the best mode presently contemplated by us for carrying out our invention:

FIG. 1 is a side elevational view with parts shown in section of the inlet end of the furnace construction embodied herein.

FIG. 2 is a view similar to FIG. 1, showing a continuation of the furnace construction and illustrating in particular the cooling section and the endless belt driving assembly.

FIG. 3 is a top plan view with parts shown in section of the complete furnace construction illustrated in FIGS. 1 and 2;

FIG. 4 is a vertical sectional view of the furnace unit illustrating the location of the chambers therein; and

FIG. 5 is an enlarged sectional view of a portion of FIG. 2 showing the construction and arrangement of the cooling section barriers.

Although the furnace construction embodied herein will be described in connection with the heat treatment of metal components that are utilized in glass-to-metal seals, it is understood that the principle and the constructional features of the furnace may be employed in the heat treatment of a variety of articles, both metal and nonmetal.

Referring now to FIGS. 1, 2 and 3, the furnace construction embodied herein includes an inlet station generally indicated at **10**, a furnace unit generally indicated at **12**, a cooling section generally indicated at **14** and a discharge station generally indicated at **16**. The furnace construction is adapted to process small metal components for the heat treatment thereof and for this purpose includes a continuous belt arrangement to be described that is adapted to carry or transfer the metal components through the furnace unit **12** during the heat treatment process. The furnace unit **12** is constructed as a separate member and includes a housing **17** that extends to the base on which the furnace construction rests and supports the furnace unit components. Joined to the housing **17** at the inlet side thereof is the inlet station **10** that includes a table **18**, the top of which is defined by a stainless steel plate **19**. A standard **20** supports the table **18** and the plate **19** and also houses an idler pulley **22** which is rotatably mounted on a shaft **23** that

is journalled for rotation within the upper end of the standard 20.

Secured to the discharge side of the furnace unit 12 and communicating with the interior thereof is the cooling section 14, the cooling section 14 being mounted on a hollow frame 26 that is also secured to the housing 17 of the furnace unit 12. Supporting the hollow frame 26 and cooling section 14 is a standard 28 while a plate 30 is mounted on the outermost end of the hollow frame 26 at the discharge station 16 for receiving the heat treated components as they are moved thereto by the endless belt to be described.

In order to continuously move the metal components to be heat treated through the furnace unit 12 and the cooling section 14 to the discharge plate 30, an endless belt 32 is provided and, as shown in FIGS. 1 and 2, extends around the idler pulley 22 located in the standard 20, over the inlet plate 19 through the furnace unit 12, the cooling section 24, a barrier construction generally indicated at 34, and to the discharge plate 30. A drive roll or pulley 36 is journalled for rotation within the hollow frame 26 on a shaft 37, the plate 30 having an opening 38 formed therein through which the periphery of the drive roll extends for receiving the belt 32. A pulley 42 is also fixed to the shaft 37 and is driven through a belt 44 by a gear 46 that is mounted in a gear box 48. Mounted on a base 50 that also carried the gear box 48 is a motor 52 that is drivingly connected to a gear 56 of the bear box 46 through a belt drive 58. A mounting 54 for the drive roll 36 is also carried by the base 50 that is enclosed by the hollow frame 26. The endless drive belt 32 extends around the drive roll 36 and is pinched into driving relation therewith by a pinch roll 60 that is mounted for pivotal movement on the mounting 54. As shown in FIG. 1, the endless belt 32 also extends around the idler pulley 22 and is tensioned by guides 62 and 63 that are mounted within the furnace unit housing 17 on suitable brackets 64 and 65 respectively. An adjustable guide 66 is also rotatably mounted within an extension 68 of the housing 17 on a bracket 69 and is located just below the first stage of the cooling section 14. As shown more clearly in FIG. 2, the belt 32 is received within the hollow frame 26 and is slidably located on an elongated plate 70 that has an outturned lip 72 that projects through an enlarged opening 74 formed in the bottom of the frame 26. Since the belt 32 is subjected to temperature changes as it passes through the furnace unit 12 and the cooling section 14, a catenary action, as indicated by the looped end of the belt in FIG. 2 is provided. This catenary action or slack of the belt 32 compensates for the various changes that occur therein during the feeding action of the components through the furnace unit and the cooling section. As described above, the pinch roll 60 acts to press the belt 32 against the drive roll 36 so that a positive driving action of the endless belt 32 is achieved. It is seen that when the motor 50 is energized, the drive roll 36 will be rotated to produce a corresponding movement of the endless belt 32.

Referring now to FIGS. 1 and 4, the furnace unit 12 is more clearly illustrated and as shown is formed of a firebrick construction that includes a plurality of layers of refractory material indicated at 76. The insulating characteristics of the refractory material 76 are well known in the art and form no part of the present invention. Formed interiorly of the furnace unit 12 is a first chamber indicated at 78 that communicates with an inlet passageway 80. As shown in FIG. 1, access to the passageway 80 is controlled by a vertically movable door 82 the operation of which is conventional. Also formed in the furnace unit 12 but spaced therefrom by an intermediate section 84 is a second chamber 86, an intermediate passageway 88 extending through the intermediate section 84 and providing for communication between the chambers. Communicating with the second chamber

86 is a discharge passageway 90 that also has communication with the cooling section 24. Although not shown in the drawings, it is understood that both the chambers 78 and 86 are provided with heating elements that may be located in the roof or floor of the chambers in the conventional manner. The heating elements in both chambers are also adjustable as to temperature, and thermostats indicated at 92 may be provided for not only controlling the temperature of the heating elements, but for indicating temperatures at various stages of the chambers.

Separated from the intermediate passageway 88 by an insulating wall 94 is an inlet port 96 for a reducing atmosphere that is adapted to be introduced into the chamber 78. Isolated from the conduit 96 by a wall 98 is a second inlet port 100 that is adapted to introduce an oxidizing atmosphere into the chamber 86. As will be described hereinafter, the outgasing or reducing atmosphere that is introduced into the chamber 78 through the port 96 is adapted to outgas the surface of the metal components that are passed through the chamber 78 on the belt 32. Similarly, the oxidizing atmosphere introduced into the chamber 86 through the port 100 is adapted to apply an oxide surface to the metal components so that they may be united with a glass seal in a further step in the process of forming a glass-to-metal seal for an electrical element.

Referring now to FIGS. 2, 3 and 5, the cooling section 24 and the barrier construction 34 are illustrated in more detail, the cooling section 14 including jackets 102 and 103 that are mounted on the hollow frame 26 and that surround cylindrical shells 106 and 107 resepctively. The jackets 102 and 103 are bolted together by flanged end sections 108 and 109 while the jacket 102 is secured to the furnace unit housing 17 by means of a flanged connection 110. A cooling medium, such as water, is introduced into the jackets 102 and 103 and is continuously circulated therein, the metal components discharged from the chamber 86 through the passageway 90 passing through the shells 106 and 107 on the belt 32 for the cooling thereof. It is understood that the continuous flow of the cooling medium may be provided by locating inlet and discharge pipes on opposite ends of the jackets 102 and 103.

Joined to the jacket 103 of the cooling section 14 by a flanged connection 111 is the barrier construction 34 which as shown in FIG. 5 is carried by the hollow frame 26 and, is defined by a first housing 112 and a second enlarged housing 113. Depending from a removable top wall 114 of the first housing 112 are a pair of spaced barriers 115 and 116 that are formed with a plurality of flaps of decreasing vertical dimension. The flaps hang independent of each other so that the size of the metal component being moved through the barrier construction will determine which of the flaps will be moved upon engagement thereby. This construction prevents the unnecessary escape of the oxidizing atmosphere that infiltrates from the chamber 86 to the barrier construction by way of the cooling shells 106 and 107. An adjustable barrier 117 is also provided and is secured to a slidable plate 118 that is adapted to be fixed by a bolt 120 to an end wall of the enlarged housing 113. The lowermost end of the barrier 117 is adjusted in accordance with the size of the metal components that pass thereunder. It is seen that the combination of the barriers 115, 116 and 117 act to effectively prevent the unnecessary loss of oxidizing atmopshere as the components are continuously discharged through the barrier construction 34 and on to the discharge plate 30 at the discharge station 16. It is also understood that the barriers 115 and 116 may be completely removed from the first housing 112, if desired, by lifting the top wall 114 to which they are attached. In addition, the barrier 117 may be moved to the uppermost position thereof to provide additional clearance for any of the components being heat treated as they are discharged onto the dis-

charge plate 30. The adjustment of the barrier 117 is effected manually by loosening the bolt 120 that passes through the plate 118 and the adjacent wall of the housing 113.

In operation, the endless belt 32 continuously carries the components to be heat treated through the chambers 78 and 86 and into the cooling section 14. The components are reduced in temperature by the cooling section 14 and are then discharged through the barrier construction 34 onto the discharge table 30. As the components are passed through the chamber 78, the reducing atmosphere introduced into the chamber 78 through the port 96 outgasses or cleans the surface of the components. In this connection, the reducing atmosphere may comprise any known gas that is utilized for the purpose of outgasing or annealing. Such atmospheres as contemplated for use may comprise 100% hydrogen or 100% dissociated ammonia, or may be endothermic wherein hydrogen comprises 38% of the atmosphere, or exothermic wherein hydrogen comprises 15% of the atmosphere. Whatever are the constituents of the atmosphere utilized in the outgasing or annealing chamber 78, the quality thereof will be determined by the elements being heat treated and the requirement for the outgasing of the surfaces thereof. The outgased components are moved on the belt 32 from the chamber 78 through the intermediate pasageway 88 and into the oxidizing chamber 86. The oxidizing atmosphere introduced into the oxidizing chamber through the port 100 may be nitrogen blended with air or an exothermic atmosphere wherein the oxygen content may be variable. In this connection, the content of oxygen in the oxidizing atmosphere, depends upon the oxide surface to be formed on the components that are being heat treated. It is further understood that the oxide surface as applied is variable in accordance with the length of time of the heat treatment and the temperature of the chambers.

The normal flow of the reducing atmosphere is illustrated by the arrows in FIG. 4, and this atmosphere normally escapes through the inlet passageway 80. Normal flow of the oxidizing atmosphere is also indicated by arrows in FIG. 4, and this atmosphere will tend to accumulate in the cooling section and will be discharged to some extent through the barrier construction 34. However, since the barrier construction 34 limits the discharge of the oxidizing atmosphere, this atmosphere will tend to reverse in the flow thereof, and as shown in FIG. 4, a portion will be directed through the intermediate pasageway 88 into the chamber 78. Normally the combination of oxygen and hydrogen in a single chamber will produce ignition or explosion. However, in the present invention, the mixing of the oxidizing atmosphere with the reducing atmosphere is controlled so that the mixing thereof is above the ignition point and explosion is prevented. The result of the mixture of the atmospheres is a water vapor that is produced just adjacent the intermediate passageway 88. This water vapor tends to coat the components being passed through the furnace unit and will remove traces of carbon from metals, such as steel, for example, and will further decarburize the surface of other types of metal components.

It is to be noted that the reducing or outgasing atmosphere is isolated from the oxidizing atmosphere at the point of introduction thereof by the separating wall 98 and that only a portion of the oxidizing atmosphere is allowed to intermingle with the reducing atmosphere. Since the metal components that are being heat treated are continuously moved through the furnace unit 12, the heat treatment thereof is carried out in a successive step wherein the oxidizing atmosphere applies the oxide to the surface of the components immediately after the outgasing thereof. This continuous and successive application of the atmospheres to the components eliminates the requirement of an additional furnace and further eliminates a cooling step normally associated with heat treatment of components of the type heat treated by the furnace unit of the present invention. Since the entire heat treatment process is continuously carried out by movement of the components on the endless belt 32, the heat treatment of the components with respect to the furnace unit 12 is automatic in effect, and once the components are placed on the belt 32, no further manual action is required. During the heating cycles, the motor 52 will be automatically controlled so that the components being heat treated will remain in each chamber for a specified period of time before being removed therefrom. After the cooling of the components by the cooling section 24, and the deposit thereof on the plate 30 at the discharge station 16, they may be removed from the furnace construction. The sealing of the metal components to a glass member may then be carried out in another furnace which forms no part of the present invention.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the underlying inventive concept and that the same is not limited to the particular forms herein shown and described except insofar as indicated by the scope of the appended claims.

What is claimed is:

1. In a furnace construction, a housing having an inlet passageway and an outlet passageway, a first chamber located in said housing and communicating with said inlet passageway, a second chamber located in said housing downstream of said first chamber and communicating with said outlet passageway, a belt conveyor extending through said inlet passageway, first and second chambers and outlet passageway for conveying articles to be heat treated through said chambers, means for located intermediate said chambers for introducing a reducing atmosphere into said first chamber for outgassing said articles that are conveyed therethrough, and means located intermediate said chambers for introducing an oxidizing atmosphere into said second chamber for forming an oxide on the surface of said articles conveyed therethrough, said means for introducing the oxidizing atmosphere being located adjacent to but isolated from the means for introducing the reducing atmosphere.

2. In a furnace construction for continuously processing metallic articles, therethrough, a housing having a first chamber located therein for initially receiving said articles for the heat treatment thereof, an intermediate section located adjacent said first chamber and downstream thereof, means located in said intermediate section for continuously circulating a reducing atmosphere into said first chamber for outgassing the articles disposed therein, a second chamber located in said housing adjacent and downstream of said intermediate section and communicating with said first chamber through an intermediate passageway formed in said intermediate section, means located in said intermediate section and isolated from said means for circulating the reducing atmosphere for circulating an oxidizing atmosphere into said second chamber for forming an oxide on the surface of the articles disposed therein, means for cooling the heat treated articles at a cooling station, and means for successively conveying said articles to said first chamber, second chamber and cooling station.

3. In a method of heat treating a plurality of articles in a heat treatment furnace that includes a first chamber, a second chamber located downstream of said first chamber and a cooling chamber located downstream of said second chamber, comprising the steps of moving said articles through said chambers in successive order while simultaneously circulating a reducing atmosphere in said first chamber and an oxidizing atmosphere in said second chamber, and cooling the heat treated articles in said

cooling chamber while circulating said oxidizing atmosphere therein.

4. In a method of heat treating metallic components in a heat treatment furnace that includes an outgassing chamber, an oxidizing chamber located downstream of said outgassing chamber and a cooling chamber located downstream of said oxidizing chamber, comprising the steps of successively moving said articles through said outgassing, oxidizing and cooling chambers while simultaneously circulating a reducing atmosphere in said outgassing chamber and an ozidizing atmosphere in said oxidizing chamber, causing a portion of the oxidizing atmosphere to combine with the reducing atmosphere in said first chamber for removing carbon traces from said metallic components, and cooling the heat treated components in said cooling chamber while circulating said oxidizing atmosphere therein.

5. In a heat treatment furnace, for heat treating metallic components, a main furnace housing having an inlet passageway and an outlet passageway formed therein, a first chamber located in said housing and communicating with said inlet passageway, a second chamber located in said housing in spaced relation to said first chamber and communicating with said second chamber, an intermediate passageway providing for limited communication between said first and second chambers, means intermediate said chambers for introducing a reducing atmosphere under pressure into said first chamber for annealing and outgassing said metallic components, said reducing gas being discharged from said first chamber through said inlet passageway, means intermediate said chambers but isolated from said reducing gas introducing means for introducing an oxidizing atmosphere into said second chamber for forming an oxide in said metallic components located therein, a cooling chamber communicating with said second chamber and receiving the heat treated metallic components therefrom for cooling them for further handling, said oxidizing atmosphere being circulated through said cooling chamber for the further treatment of said components during the cooling thereof, and a barrier construction located adjacent said cooling chamber at the discharge side thereof, said barrier construction inhibiting the discharge of said oxidizing atmosphere from said cooling chamber and causing the oxidizing atmosphere to increase on back pressure so that a portion thereof is forced through said intermediate passageway into contact with said reducing atmosphere, the water vapor resulting from the combined atmospheres acting to remove carbon traces from said metallic components.

6. In a furnace construction for continuously processing metallic articles therethrough, a housing having a first chamber located therein for initially receiving said articles for the heat treatment thereof, an intermediate section located adjacent said first chamber and downstream thereof, a first inlet port located in said intermediate section and communicating with said first chamber for continuously circulating a reducing atmosphere into said first chamber for outgassing the articles passing therethrough, a second chamber located in said housing adjacent and downstream of said intermediate section, a restricted intermediate passageway extending through said intermediate section and providing for access of said metallic articles therethrough, said second chamber communicating with said first chamber through said restricted passageway, a second inlet port located in said intermediate section and isolated from said first inlet port for introducing an oxidizing atmosphere into said second chamber, whereby an oxide is formed on the surfaces of the articles passing therethrough, means for cooling the heat treated articles at a cooling station, and means for successively conveying said articles through said first chamber, said second chamber and said cooling station.

7. In a furnace construction as set forth in claim 6, an insulating wall formed in said intermediate section and defining a wall of said restricted passageway, said restricted passageway having communication with said inlet ports only through the adjacent first and second chambers and being isolated from said inlet ports in said intermediate section by said insulating wall.

8. In a furnace construction for continuously processing metallic articles therethrough, a housing having a first chamber located therein for initially receiving said articles for the heat treatment thereof, an intermediate section located adjacent said first chamber and downstream thereof, a second chamber located in said housing adjacent and downstream of said intermediate section, means in said intermediate section for introducing a reducing atmosphere into said first chamber, means in said intermediate section and isolated from the first-named means for introducing an oxidizing atmosphere into said second chamber, a passageway formed in said intermediate section and isolated from said atmosphere introducing means, said passageway communicating with said first and second chambers and defining a limited access route for passage of limited quantities of said oxidizing atmosphere into said first chamber for mixture therein with said reducing atmosphere, and means for conveying said articles through said housing.

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