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2,233,629

APPARATUS FOR AND METHOD OF CONTROLLING TEMPERATURE IN LEHR

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2 Sheets-Sheet 1

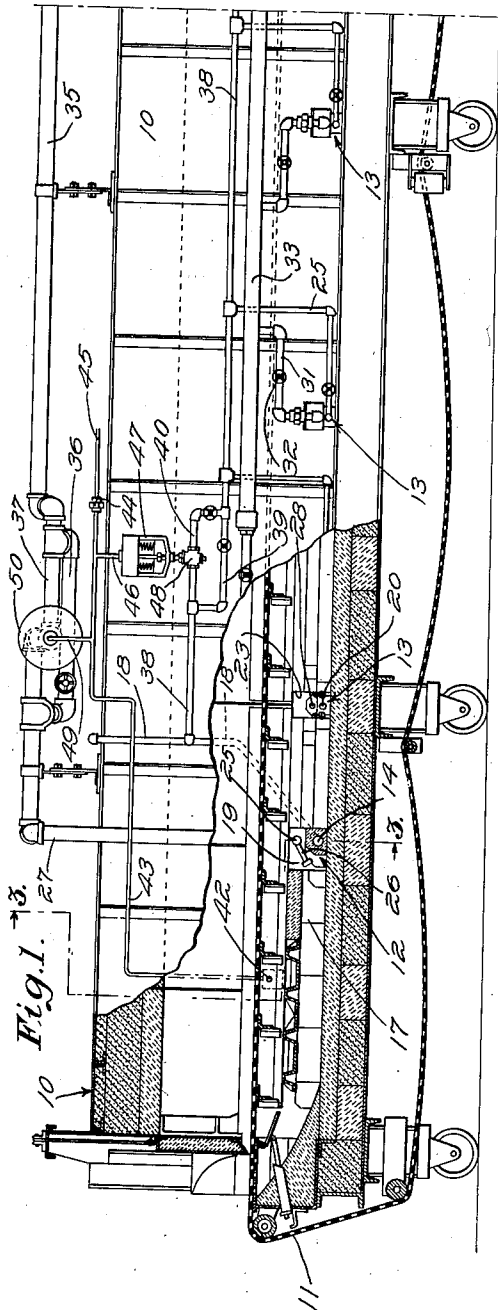


Fig. 1.

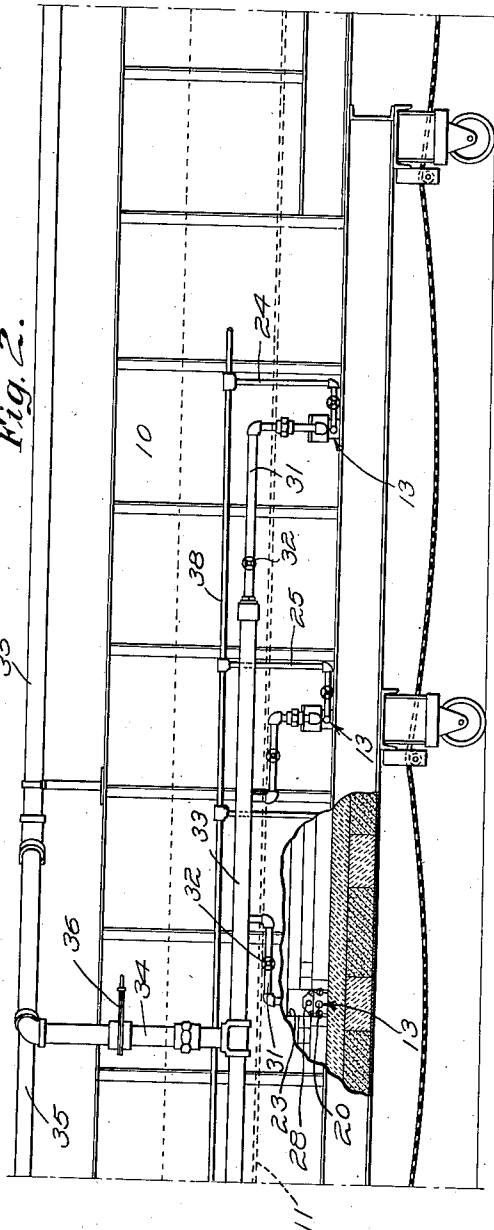


Fig. 2.

Witness:

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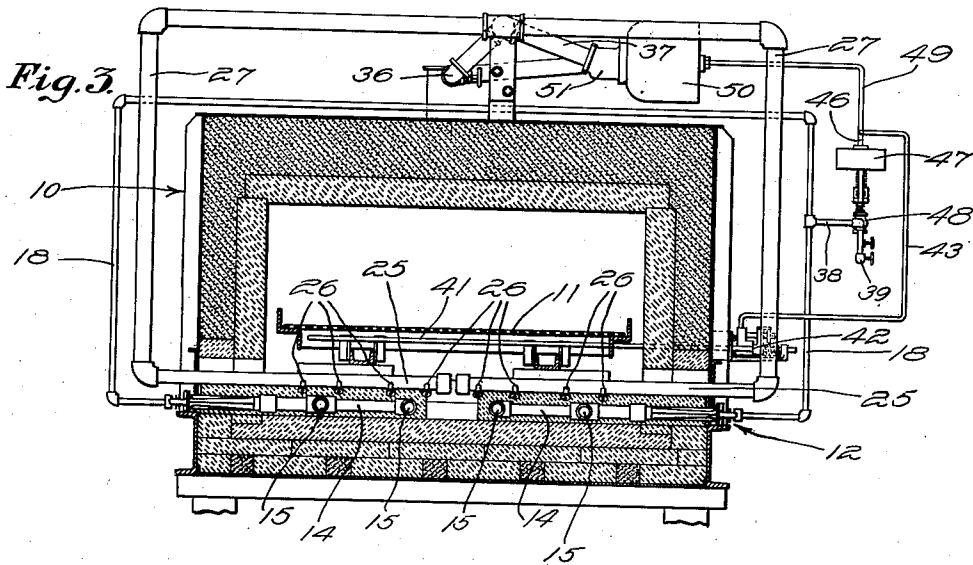
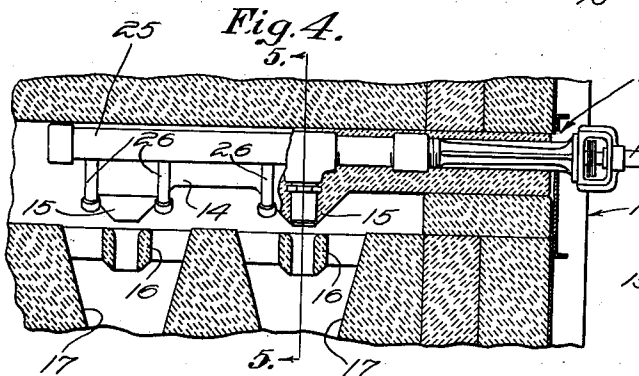
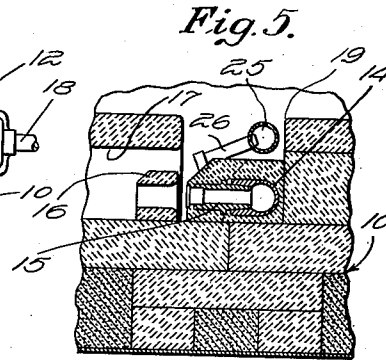
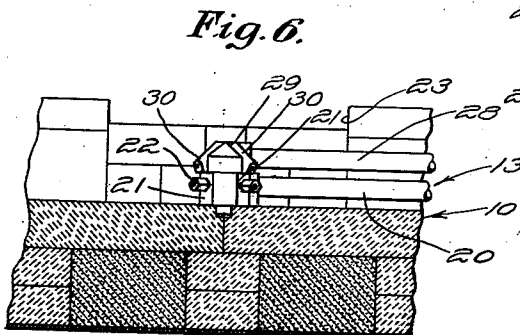
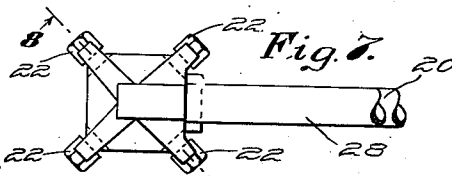
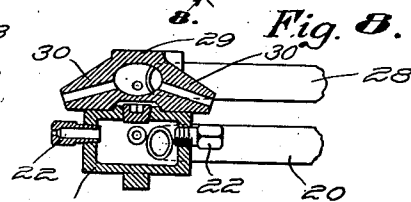
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,233,629

APPARATUS FOR AND METHOD OF CONTROLLING TEMPERATURE IN LEHRs

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Application September 1, 1938, Serial No. 227,891

8 Claims. (Cl. 49—47)

This invention relates to improvements in lehrs for annealing glassware and more particularly in lehrs of the type which is heated at the one or more places along the length thereof by a burner or burners so arranged and operated as to effect a circulatory movement or movements of products of combustion and gaseous media in the lehr. A lehr of this type is illustrated and described in detail in my copending application, Serial No. 66,611, filed March 2, 1936.

In a lehr of the character above referred to, the burner or burners cause circulation of products of combustion and gaseous media in the lehr by the velocity and dynamic effect of the burning fuel mixture and products of combustion produced by the operation of the burner or burners and their inductive effect on the adjacent atmosphere within the lehr tunnel.

The varying conditions of service in the practical operation of a lehr of the type described may require variation of the heat input by the burner or burners according to variations in the load of glassware on the conveyor belt of the lehr, the physical characteristics of such glassware, the sensible heat of manufacture retained by such glassware, wind or air conditions at the exterior of the lehr, etc. Thus, it may be desirable at times to reduce to practically zero the heating effect of a burner or burners of such a lehr or even to apply a greater cooling effect to the interior of the lehr at the place or places at which the temperature is to be substantially reduced.

It is undesirable that the burner or burners be turned completely out and in some instances even doing this may not be adequate to effect the reduction of temperature desired. Moreover, reduction of temperature by turning down the burner or burners may be attended by reduced circulation of gaseous media in the lehr and thus may militate against desirable control of temperature conditions and distribution of heat in the lehr.

An object of the present invention is to improve the control of the temperature conditions and of the circulation and re-circulation of gaseous media in a lehr of the character described so as substantially to improve such a lehr in the features mentioned.

A more specific object of the present invention is to provide such a lehr with means for introducing a suitable cooling gaseous medium under pressure, such as air at room temperature, into the lehr in such manner and by such means as to modify the heating effect of the burner or

burners to an adjustable predetermined extent while maintaining such burner or burners in operation and, at the same time, to maintain desirable circulation and re-circulation of gaseous media in the lehr for any or all adjustment or adjustments of the burner or burners.

A further object of the invention is to provide a control of the temperature conditions and of the circulation and re-circulation of gaseous media in the lehr tunnel that is more extensive and more flexible than can be obtained by control of the lehr burner or burners alone.

A still further object of the invention is to improve a lehr of the character described by the provision of a means for applying cooling gaseous medium, such as air, to the lehr at the place or places required to cooperate with a burner or burners in effecting control of the temperature conditions and the circulation and re-circulation of gaseous media in the lehr tunnel and to provide also means acting automatically in response to temperature changes in the lehr to vary simultaneously but reversely the heating effect of a burner or burners for a high temperature zone of the lehr tunnel and the cooling effect of the cooling gaseous medium applying means for the same zone.

Other objects and advantages of the invention will hereinafter be pointed out or will become apparent from the following description of a practical embodiment thereof as shown in the accompanying drawings, in which

Fig. 1 is a view, mainly in side elevation but partially in vertical section, showing a longitudinal portion of the lehr of my prior application, Serial No. 66,611, equipped with cooling gaseous medium introducing and control means according to the present invention,

Fig. 2 is a view similar to Fig. 1 but showing a further portion of the same lehr equipped with improvements of the present invention,

Fig. 3 is a transverse vertical section through the portion of the lehr shown in Fig. 1, the section being taken along the line indicated at 3—3 in Fig. 1,

Fig. 4 is a fragmentary horizontal sectional view, showing, in relatively enlarged form, the cooperative arrangement of burners and cooling gaseous medium or air introducing nozzles in a portion of the lehr adjacent to the front or ware entering end thereof,

Fig. 5 is a fragmentary vertical section through the structure shown in Fig. 4, the view being substantially along the line 5—5 of Fig. 4,

Fig. 6 is a fragmentary transverse vertical sec-

tion through a more rearward portion of the lehr, showing an arrangement of burner and cooling gaseous medium or air applying nozzles that is specifically different from that shown in Fig. 4.

Fig. 7 is a plan view of the cooperative burner and associate cooling gaseous medium or air introducing nozzles of the arrangement shown in Fig. 6, with the adjacent wall structure of the lehr omitted, and

Fig. 8 is a sectional view substantially along the line 8—8 of Fig. 7.

A lehr equipped with the improvements of the present invention, successive portions of which are shown in Figs. 1 and 2, may comprise a tunnel 10 through which the glassware to be annealed may be transported by the upper reach of an endless flexible conveyor belt 11. Heat may be applied to the interior of the lehr tunnel differentially at different places along such tunnel and circulation and re-circulation of gaseous media in the lehr tunnel may be effected by the operation of a front burner assembly 12 and other spaced burner assemblies 13 in the lower portion of the lehr, as indicated in Figs. 1 and 2, considered together, and as illustrated in the drawings and described in detail in the specification of my aforesaid copending application, Serial No. 66,611.

As shown in Fig. 3, the front or foremost heating means 12 comprises right and left hand transversely aligned fuel mixture pipes or manifolds 14 from which spaced longitudinal horizontal burner nozzles 15 extend toward the front or ware entering end of the lehr tunnel. Each of the burner nozzles 15 may project a fuel mixture in combustion through a spaced auxiliary nozzle or directing ring 16 into the rearwardly flaring mouth or intake end of a forwardly directed combustion passage 17, as shown in Figs. 4 and 5. The fuel delivering pipes or manifolds 17 are supplied with a suitable mixture of air and gaseous or liquid fuel, the latter being supplied by the branch fuel pipes 18. As shown in Figs. 1 and 5, the space around and adjacent to the burner nozzles 15 communicates, as at 19, with the lehr tunnel proper, in which the ware is annealed. The operation of the heating means 12 will cause gaseous media or tunnel atmosphere to be drawn downwardly through the space 19 and then to commingle with the products of combustion and the flames passing forwardly through the passages 17. The arrangement is such that at least part of the products of combustion and circulated gaseous media from the tunnel may be re-circulated through a portion of the tunnel during continued operation of the heating means 12.

The heating means indicated generally at 13 at each of the spaced points shown in Figs. 1 and 2 of the drawings likewise may apply heat to successive zones or portions of the tunnel and to cause circulation and re-circulation of products of combustion and tunnel atmosphere or gaseous media in the tunnel. Each of the heating means 13 may comprise right and left hand burner assemblies or units, the right hand assembly of one such heating means being shown in Figs. 6 to 8 inclusive, and comprising a fuel mixture pipe 20, a burner head 21 and a plurality angularly spaced burner nozzles 22. The space above and around the burner head 21 and its nozzles 22 communicates as at 23, Figs. 1, 2 and 6 with the interior of the lehr tunnel proper. The pipe 20 is supplied with a suitable mixture of

air and gaseous or liquid fuel, the latter being obtained from an individually valved branch fuel supply pipe 24. The burner nozzles project the fuel mixture in combustion into suitable combustion passages in the bottom of the lehr tunnel, into which gaseous media from the tunnel are drawn through the space 23 by the inductive action of such heating means. Thus, each of the heating means 13 applies heat to the tunnel and, by inductive action, causes circulation and re-circulation of the products of combustion and tunnel atmosphere or gaseous media in the lehr tunnel.

The parts that have been described so far may be substantially as shown and described in detail in my aforesaid application, Serial No. 66,611.

According to the present invention, a means for applying a cooling gaseous medium under pressure to the interior of the tunnel may be provided for each of the heating means 12 and 13. As best seen in Fig. 3, a cooling gaseous medium pipe or manifold 25 is provided above each of the fuel mixture pipes or manifolds 14 of the front heating means. Each manifold 25 has nozzles 26 for directing the cooling gaseous medium forwardly and downwardly into the combustion passages 17 at opposite sides of the streams of flames and combustible mixtures from the subjacent burner nozzles 15 and at opposite sides of the auxiliary spaced nozzles 16. The manifolds 25 are connected with branch cooling medium or air supply pipes 27.

In Figs. 6 to 8 inclusive, a cooling medium or air delivery assembly is shown as associated with the burner assembly 20, 21 and 22 of a heating means 13 and as comprising an air pipe 28, an air distributing head 29 and angularly spaced downwardly and outwardly inclined nozzles 30 on such head, respectively located above the burner nozzles 22. The nozzles 30 discharge cooling gaseous medium or air into the combustion passages into which the nozzles 22 discharge flames and combustible mixture. The pipes 28 are connected with gaseous medium or air supply branch pipes 31, each of which may be provided with a separate control valve 32. The pipes 31 may be in turn connected with a gaseous medium or air supply manifold 33 which is joined by the pipe 34, Fig. 2, to the main supply pipe 35. A throttle valve or gate 36 may be provided in the connection 34 between the main supply pipe 35 and the manifold 33. The pipes 27 are also connected with the main supply pipe 35. This connection may be effected through a simple valved pipe such as that which is provided for each of the pipes 31, but I prefer to make such connection by means of a valved by-pass pipe 36, Fig. 1 and an automatically controlled pipe 37.

In operation, the front heating means 12 may be turned down so as to apply but little heat to the front portion of the tunnel and at the same time sufficient air may be supplied through the nozzles 26 to establish and maintain the desired circulation and re-circulation of gaseous media in the tunnel. The air from the nozzles may be employed or of such character as further to reduce the temperature in the tunnel. Thus, without completely turning out the front burners, it is possible to produce a cooling effect or reduction of temperature in the front portion of the lehr tunnel greater than that obtainable if such burners were turned completely out and, at the same time, the circulation and re-circulation of gaseous media in the tunnel may be kept substantial and even increased. The cooling air

also dilutes the tunnel atmosphere and reduces any tendency of such atmosphere to cause sulphur bloom on the ware.

Similarly, in the case of each of the heating means 13, the burners may be adjusted to apply any desired amount of heat at any given time to a portion of the lehr tunnel and the associate air nozzles 30 may be employed to produce a desirable cooling effect or reduction of temperature in that portion of the lehr tunnel and also to assure desirable circulation and re-circulation of gaseous media in the tunnel.

It may be desirable automatically to control the burner assemblies and the cooling air supply means for the front or high temperature portion of the lehr. To this end, the fuel supply lines 18 of the front heating means may be connected with a main fuel line 38 through a valved by-pass branch line 39 and an automatically controlled branch line 40, instead of being connected with the main fuel line 38 through a simple valved connecting line similar to the connecting fuel lines 25 for the heating means 13. The control of the connecting branch fuel line 40 and of the connecting branch air line 37 may reside in an elongate heat responsive member or thermostat 41, located in the forward end portion of the lehr tunnel, as shown in Fig. 3. This thermostat may control a valve 42, Figs. 1 and 3, at one end of a pressure air control line 43. The air line 43 is connected through a reducing fitting 44 with a source of air under pressure, represented by the pressure air line 45. The air line 43 has a pipe connection 46 with a pneumatic operating mechanism 47 for operating a valve 48 in the branch fuel line 40. Another pipe connection 49 is from the air line 43 to a pneumatic valve operating mechanism 50 for operating a valve 51 in the branch air line 36.

The automatic control mechanism just described has been shown more or less diagrammatically in the drawings since the details of construction and operation of the parts thereof are well known to those skilled in the art. In the operation of this automatic control mechanism, a change of pressure in the line 43 in one direction from a predetermined pressure will cause an opening adjustment of the valve 51 controlling the air line 37 and a closing adjustment of the valve 48 controlling the branch fuel line 40 while a change of pressure in the line 43 in the opposite direction will effect reverse adjustments of the respective valves 48 and 51. As applied in the structure shown, an increase of temperature in the portion of the lehr tunnel adjacent to the thermostat 41 beyond a predetermined temperature will cause a lowering of pressure in the air control line 43 which in turn will cause a closing adjustment of the fuel control valve 48 and an opening adjustment of the air controlled valve 51. A decrease of temperature will cause an increase of pressure in the control line 43 and reverse adjustments of the valves 48 and 51. The valve 42 for controlling the pressure in the line 43 in response to the thermostat 41 does not per se form part of the present invention but may be substantially as disclosed in Patent No. 1,866,366, granted to Mulholland et al., July 5, 1932 for Heat regulator for lehrs. The valves 48 and 51 and their fluid pressure actuated operating mechanisms 47 and 50, respectively, likewise do not per se form part of the present invention as these valves and their operating mechanisms may be purchased as assembled commercial units and are well known to those skilled in the art. In fact,

it is not essential to the present invention that any particular type of thermostatically controlled mechanism be employed to vary the flow of fuel in one line and the flow of cooling gaseous medium or air in another line, as above described, as any suitable mechanism for automatically accomplishing these results may be employed.

It is also obvious that similar automatic control mechanisms may be applied to the cooling air and fuel supply lines of the air applying heating and assemblies, respectively, in a more rearward portion or portions of the lehr.

Various changes may be made in the structure shown in the drawings without departing from the spirit and scope of the invention. The appended claims are to be construed as broadly as the prior art will permit.

I claim:

1. In a tunnel lehr, the combination with means, including a burner, constructed and arranged to apply heat directly to the interior of the ware-annealing tunnel of the lehr and to cause therein a circulation and recirculation of gaseous media tending to vary with the velocity of the flames and products of combustion from the burner, and means for projecting into such flames and products of combustion a stream of a gaseous medium of such character and direction of movement as to decrease the heating effect and to augment the gaseous media circulating effect in the ware-annealing tunnel of the flames and products of combustion produced by the burner

2. In a tunnel lehr, an adjustable heating means, including a burner, constructed and arranged to cause in the ware-annealing tunnel of the lehr a circulation and recirculation of products of combustion and gaseous media tending to vary in heating effect and velocity as such heating means is adjusted to vary the heat generated by the burner, means for projecting a stream of a gaseous medium into the flames and products of combustion produced by the burner to decrease the heating effect and to aid the gaseous media circulating action thereof in said ware-annealing tunnel, and means for adjusting said last named means to prevent substantial decrease of said circulation of gaseous media on adjustment of said heating means to reduce the heat generated by the burner.

3. In a tunnel lehr, adjustable heating means including a burner arranged to cause a circulation of products of combustion from the burner and residual gases in the ware-annealing tunnel of the lehr, adjustable cooling means including a nozzle for projecting cooling air under pressure into and in the direction of movement of the products of combustion from the burner, and automatic means for controlling said adjustable heating means and said adjustable cooling means to decrease the cooling action of the latter on increase of the heating action of the former, and vice versa.

4. In a lehr having a tunnel comprising a heated section extending from the front or ware receiving end of the tunnel for part of the length thereof, said heated section having a series of separately controllable heating means including burners spaced longitudinally of said section and respectively arranged to cause circulatory movements of products of combustion and gases in the ware-annealing tunnel, a series of separately controllable cooling means including air discharging nozzles spaced longitudinally of the tunnel in accordance with the spacing of the burners and each arranged to discharge a stream of cooling

air into and in the direction of movement of the products of combustion from the corresponding burner, and means for automatically controlling the foremost heating means and the corresponding cooling means to increase the effective action of the latter on decrease of the effective action of the former, and vice versa.

5 The method of controlling temperature in the tunnel of a lehr having adjustable heating means including a burner for causing a circulation of products of combustion from the burner and gaseous media in the ware-annealing tunnel, comprising adjusting said heating means to decrease both the heating effect of the burner 10 and the media-circulating effect thereof when the temperature in the portion of the tunnel controlled by said circulation is to be lowered, and projecting a stream of gaseous media into said circulation in a direction to increase said circulation to compensate for the decrease thereof 15 by the adjustment of the heating means.

20 6. The method of controlling temperature in the tunnel of a lehr having adjustable heating means including a burner for causing a circulation of products of combustion and gaseous media 25 in the ware-annealing tunnel, comprising adjusting the heating means to reduce to a minimum the products of combustion from the burner while the burner remains in operation, and projecting 30 a stream of cooling gaseous medium into and in the direction of movement of said products of combustion to cause in the ware-annealing tunnel a reduction of temperature greater than could be obtained by rendering the burner completely 35 inactive and at the same time causing a substantial circulation of the products of combustion

and gaseous media in said ware-annealing tunnel.

7. The method of controlling temperature in the ware-annealing tunnel of a lehr which comprises causing discharge directly into such tunnel 5 of heated products of combustion moving in a direction to cause circulation of gaseous media in the tunnel, projecting cooling air under pressure into and in the direction of movement of said products of combustion to decrease the temperature thereof and to increase said circulation 10 of gaseous media in the tunnel, and varying said products of combustion and said cooling air with relation to each other to produce wide variations in the temperature controlling effect of said circulation without causing like variations in the 15 circulation itself.

8. The method of controlling temperature in the ware-annealing tunnel of a lehr having separately adjustable heating means respectively including burners located at spaced places along 20 the length of the heated portion of the lehr tunnel and each adapted to cause circulation of products of combustion from the burner and gaseous media in the ware-annealing tunnel, comprising 25 adjusting the several heating means to produce in zones longitudinally of the ware-annealing tunnel circulations there-within having predetermined heating effects within such zones and decreasing the heating effects and increasing the 30 circulations in said zones by projecting predetermined amounts of cooling air into and in the directions of movement of the products of combustion from the respective burners.

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