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APPARATUS FOR AND METHOD OF ANNEALING

Filed April 24, 1950

3 Sheets-Sheet 2

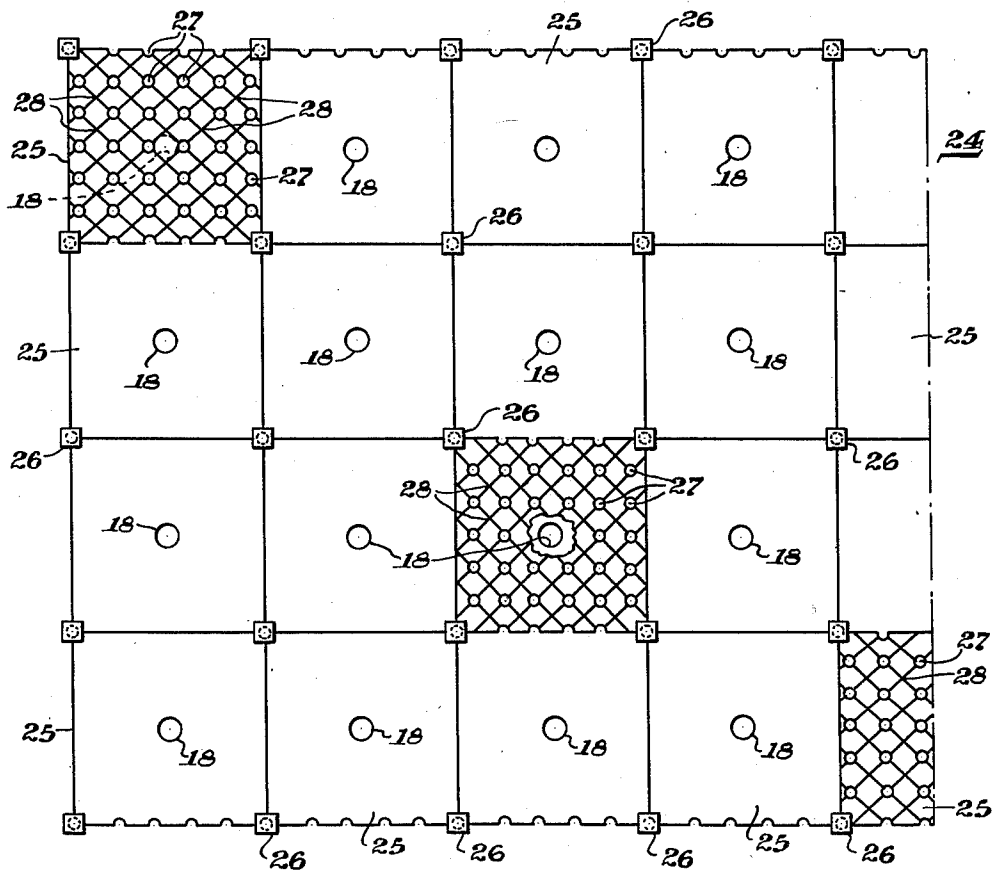


Fig. 3.

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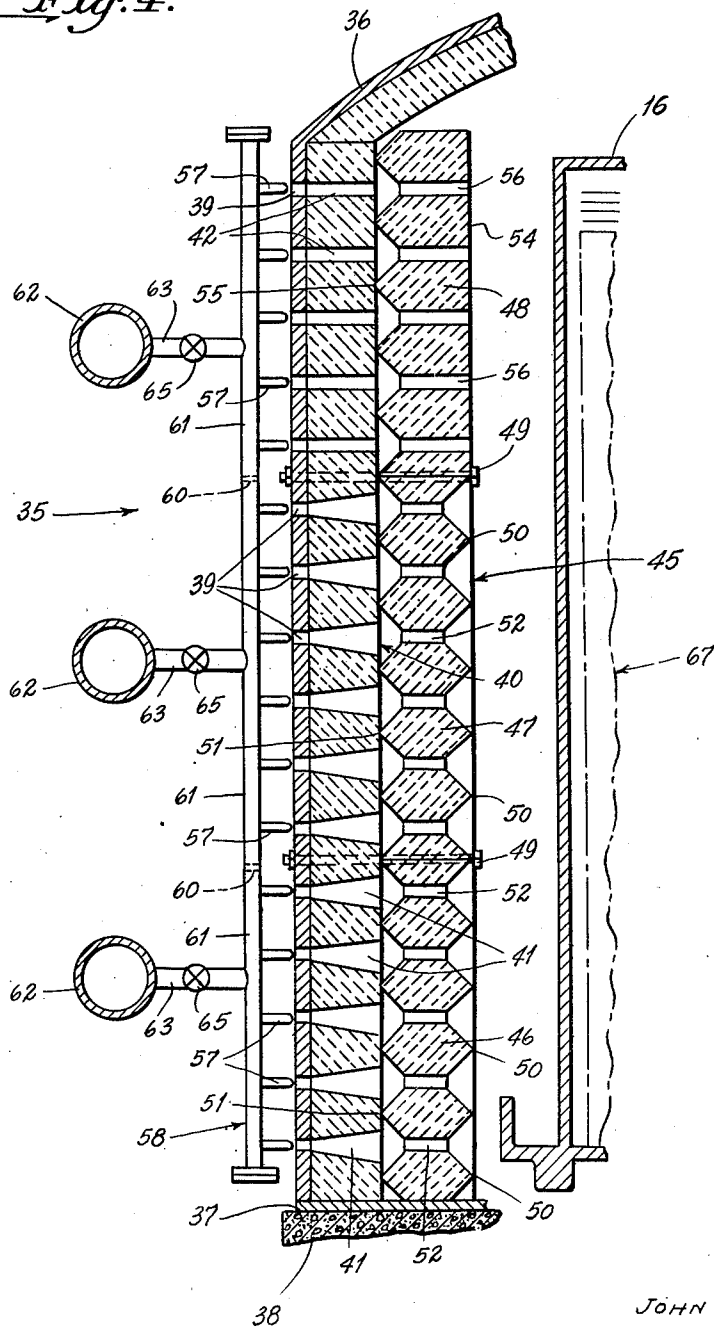
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Fig. 4.



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4 Claims. (Cl. 263—40)

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The present invention relates generally to the heat-treating art, and more particularly to an apparatus for and a method of effecting superior annealing.

The present application is a continuation in part of the applicant's copending application, Serial No. 736,797, filed March 24, 1947, now abandoned.

Annealing furnaces heretofore and presently employed are unsatisfactory in a number of respects, particularly in the manner in which the heat is applied to and in the distribution of the heat against the work load. Repeated efforts to produce an annealing furnace of these long desired heat application and distribution characteristics have been without success.

Therefore, an object of the present invention is to provide an apparatus for and a method of performing long sought superior annealing, and, in brief, the present novel annealing furnace includes a framework supporting outer heat-insulating walls having burner openings there-through, and radiant inner walls parallel to the outer walls which have spaced openings there-through and, preferably, have inner surfaces of radiating points. Flames from burners at the burner openings both heat the radiant inner walls and pass through the openings in the radiant inner walls to a point a very short distance within the furnace so that the work load is heated through both radiation and flame radiation. There is no flame impingement against the work load or its cover. Individual controls are provided for individual burners or groups of burners, as desired, so that heat application may be accurately regulated.

Another object of the invention is to provide an annealing furnace structure and method of heat treatment wherein flames from burners are employed to heat radiants for the heating of annealing boxes or workpieces and also to heat such directly by flame radiation, without impingement of the flames on the work, and wherein there can be an accurate variation and control of the heating effect on the work at various horizontally and vertically spaced zones independently of one another. By "flame radiation" is meant heating by hot jets of flame which are directed at, but do not touch the work, as distinguished from flames sweeping over the workpieces or annealing boxes in the chambers, this sweeping or washing action of flames on the workpieces causing serious oxidizing and scaling with considerable damage to the work or to the annealing boxes that contain the work.

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Another object is to provide a novel annealing furnace wherein heat both through flame radiation and from radiant wall surfaces can be applied to the work in controlled quantities at each of specified zones.

Another object is to provide a novel annealing furnace including radiant walls which can be heated to desired temperatures without hot spots.

Another object is to provide a novel method of applying controlled heat to a work load in an annealing furnace.

Another object is to provide a novel annealing furnace incorporating independently controlled heating zones so that regulation is readily effected to satisfy the heat requirements of varying work loads.

Other objects are to provide a novel annealing furnace in which fuel economy is effected, in which the heating cycle is accelerated, in which work loads of various configurations may be uniformly heated, which is of high efficiency, which reduces to a minimum damage to work loads and to annealing boxes, in which the annealing is uniform so that subsequent work on annealed pieces may be performed with safety to machinery and to operating personnel, and which is otherwise of superior performance.

The foregoing and other objects and advantages are apparent from the following description taken with the accompanying drawings, in which:

Fig. 1 is a diagrammatic vertical transverse cross-sectional view through an annealing furnace incorporating the teachings of the present invention;

Fig. 2 is an enlarged fragmentary vertical transverse cross-sectional view of a portion of the annealing furnace shown in Fig. 1;

Fig. 3 is a front elevational view of a portion of one of the radiant walls of Fig. 1; and

Fig. 4 is an enlarged fragmentary vertical transverse cross-sectional view through a composite annealing furnace illustrating two modified constructions.

Referring first to Figs. 1, 2 and 3, there is shown an annealing furnace whose framework and main or heat-insulating walls may be of conventional form, except for the arrangement of burner openings to be hereinafter explained. The furnace comprises a metal shell 10 supported by interconnected structural members, and a hearth or bottom wall 11 having exhaust openings 12 there-through. The top wall of the furnace may also have an exhaust opening 13 with a lid 14, and a motor 15 is provided for moving heating or cool-

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ing air gases through the furnace, as is common with annealing furnaces. Annealing boxes 16 for enclosing certain classes of work to prevent contact thereof with the gases of combustion are supported on the hearth, through the medium of blocks 17 that are spaced apart to permit movement of gases beneath the annealing boxes 16.

Heat insulating side walls 23 of the furnace have burner openings 18 formed therein to receive gas from burners 19 that are supplied with gas from fuel-supply pipes 21. Air inspirating openings 22 are provided through the metal shell 10 to admit air for mixture with the gas. The openings 18 through the side walls 23 of the furnace are flared to provide combustion chamber spaces 32, as is clearly shown in Fig. 2.

An inner radiating wall 24 is provided at each side of the furnace. These walls 24 are formed of refractory slabs 25 of silicon carbide or other highly refractory material and arranged as is shown more clearly in Fig. 3. The slabs 25 are held in place against the side walls 23 of the furnace by tie bolts 26, there being a slab 25 in front of each burner opening 18. Each slab 25 has holes 27 extending therethrough that are widened or flared at the inner and outer faces of the slab to form pyramidal or diamond-shaped points 28 and 29 at such inner and outer faces, respectively. These points 28—29 will become highly heated in the use of the furnace, the points 29 serving not only to assist combustion when they become heated, but their sides also serving as extended areas for absorbing and transmitting heat into the slabs 25. At the inner points 28, their apices become highly heated and their sloping sides provide extended areas for the radiation of heat to the annealing boxes 16.

The burners 19 are arranged in vertical and horizontal rows to conform to the arrangement of slabs 25, and, since each burner 19 has a valve 31, the amount of gas delivered to the rear side of each radiant slab 25 can be controlled, so that certain portions of the annealing boxes 16 or work load, such as those areas near the middle or the top, do not become too highly heated relative to other areas.

While in bringing the furnace up to annealing temperature rapidly, gas may be supplied through the burners 19 in large volume relative to that which will be required during the major portion of the annealing period, the combustion spaces 32 at the outer sides of the radiating walls 24 will cause such diffusion or spreading of the combustible mixture that it will not be projected through the holes 27 with sufficient velocity to cause the flames to impinge against the sides of the annealing boxes 16, although there may be visible flame projecting for a few inches beyond the inner tips 28 of the radiant slabs 25. After the furnace has been brought up to heat, the supply of gas can be reduced and combustion confined to the chambers 32, the heating thereafter being mainly through radiation from the slabs 25, and secondarily from the flames. Manifestly, the holes 27 not only provide means for effective flame radiation against a work load, but also aid in transfer of the heat to the slabs 25 due to the thus provided additional flame contact area.

Referring to Fig. 4, there is shown a composite annealing furnace 35 which includes a metal shell 36 disposed on a base 37 supported on a foundation 38. Spaced openings 39 are formed in the shell 36. A refractory side wall 40 having

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flared openings 41 and cylindrical openings 42 aligned with the openings 39 is disposed adjacent the shell 36. Inwardly of and adjacent to the side wall 40 is a radiant wall 45 shown as formed of slabs 46, 47, and 48. Suitable tie bolt assemblies 49 maintain the walls 40 and 45 in position against the shell 36.

The slabs 46 and 47 are similar to the slabs 25, and includes inner points 50, outer points 51, and spaced openings 52 aligned with the openings 39 and 41, 42. The slab 48 differs from the slabs 46 and 47 only in having a plane inner face 54, there being outer points 55 and spaced openings 56.

A burner tip 57 is disposed adjacent each opening 39 for directing premixed gas therein. A vertically disposed fuel pipe 58 supports the burner tips 57 and is divided by internal partitions 60 into sections 61. A horizontal fuel supply pipe 62 is connected by a pipe 63 to each pipe section 61. A valve 65 is located in each connector pipe 63 for controlling the fuel to each group of burner tips 57. The horizontal pipes 62 are connected into a source of premixed gas (not shown), such fuel being preferred since it produces a hotter more concentrated flame than fuel mixed in the burners, such as is shown in Fig. 2.

It is to be understood that a plurality of vertical pipes 58 and supported burner tips 57 are disposed along each side of the furnace 35, so that accurately controlled heating of the radiant walls 45 and a work load 67 within the box 16 is provided.

In the composite modified construction of Fig. 4, heating is by radiation from the radiant wall 45 and by flame radiation through the openings 52 and 56, as is true of the construction of Figs. 1-3. The radiant wall 45 is quickly brought up to desired temperatures throughout its full area by means of the multiple burner tips 57, and the sectional control through the valves 65. The fuel pressure is maintained at a figure so that flames no more than barely pass the radiant wall 45.

Whether the construction of Fig. 1-3 or those of Fig. 4 be employed, accurately controlled heating of a work load obtains. Any work load can be evenly heated, since more or less heat can be supplied as desired at any point of the radiant walls 24 and 45. For example, if the work load is a stack of sheeting within a box 16, a temperature of 1600° F. may be required at the bottom of the stack where the sheets are tightly compressed and 1300° F. at the top, with the temperatures between graduated from 1600° F. to 1300° F. to bring the whole stack of sheets to an annealing temperature of about 1200° F. at substantially the same time. In present day annealing furnaces, the upper sheets of a stack are often damaged through being maintained at and above annealing temperature for too long a period which is necessary in order to properly anneal the other sheets of the stack.

The same principle illustrated in the preceding paragraph applies to articles of varying cross section, it being manifest that, for example, a large article of frusto-conical cross section would require less heat at the top than at the bottom to bring the whole article to annealing temperature substantially simultaneously. Obviously, the principle may be pursued indefinitely.

With the present construction of multi-flame application, hot spots in the radiant walls are avoided. The present slabs heat quickly and evenly. The multi-diamond shaped inner faces of the radiant walls 24 and 45 radiate more heat

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than a flat surface, such as that of the slabs 48 of Fig. 4, due to the larger radiating area, but the flat surface under controlled heating and multi-flame application as shown is entirely satisfactory.

It is manifest that there has been provided novel apparatus for and a method of applying heat in an annealing furnace which fulfills the objects and advantages sought therefor.

It is to be understood that the foregoing description and the accompanying drawings have been given by way of illustration and example. It is also to be understood that changes in form of the several parts, substitution of equivalent elements or steps, and rearrangement of parts or steps, which will be readily apparent to one skilled in the art, are contemplated as within the scope of the present invention which is limited only by the claims which follow.

What is claimed is:

1. Heat-treating apparatus comprising a furnace chamber having side walls, heat-radiating wall elements disposed in spaced proximity to the side walls and in planes parallel thereto, the said elements having straight parallel restrictive openings extending therethrough, said openings having a length substantially in excess of the width thereof, and burners directed perpendicularly to the planes of the walls for supplying heating flames and gases through the spaced side walls and through the said openings, to the work-receiving space in the chamber, there being heat-radiating projections on the inner surface of the said wall elements at points between the perforations.

2. An annealing furnace comprising outer side walls of insulating material, a wall construction of high heat radiation characteristics disposed in spaced proximity to each outer side wall, vertically and horizontally spaced openings through said wall constructions, said openings having a length substantially in excess of the width thereof, heat radiating projections disposed over the inner surface of said wall construction, vertically and horizontally spaced openings through said outer side walls directed axially toward said openings in said wall constructions, a burner disposed adjacent each opening in said outer side walls for

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discharge thereinto, and means for controlling fuel to individual burners independently of other burners.

3. A method of bringing a work load to an annealing temperature comprising disposing the work load in a furnace having a wall with elongated perforations therein and of high heat radiation characteristics, heating different areas of the wall construction to different temperatures by applying different flame intensities originating from separate sources against the outer surface of said perforated wall and into the elongated perforations of the different areas, and radiating the resultant different concentrations of heat energy directly from the inner surface of the different areas to different portions of the work load.

4. A method of bringing a work load to an annealing temperature comprising disposing the work load in a furnace having a wall with elongated perforations therein and of high heat radiation characteristics, directing an individual flame into each of the elongated perforations, controlling the intensity of the individual flames at least in groups so as to heat different areas of the perforated wall to different temperatures, and radiating the resultant different concentrations of heat energy directly from the inner surface of the areas of different temperature to corresponding portions of the work load.

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