Feb. 15, 1944. V. A. FOX 2,341,766

RAPID-QUENCH HEAT-TREATING OVEN

Filed Dec. 12, 1941 3 Sheets-Sheet 1

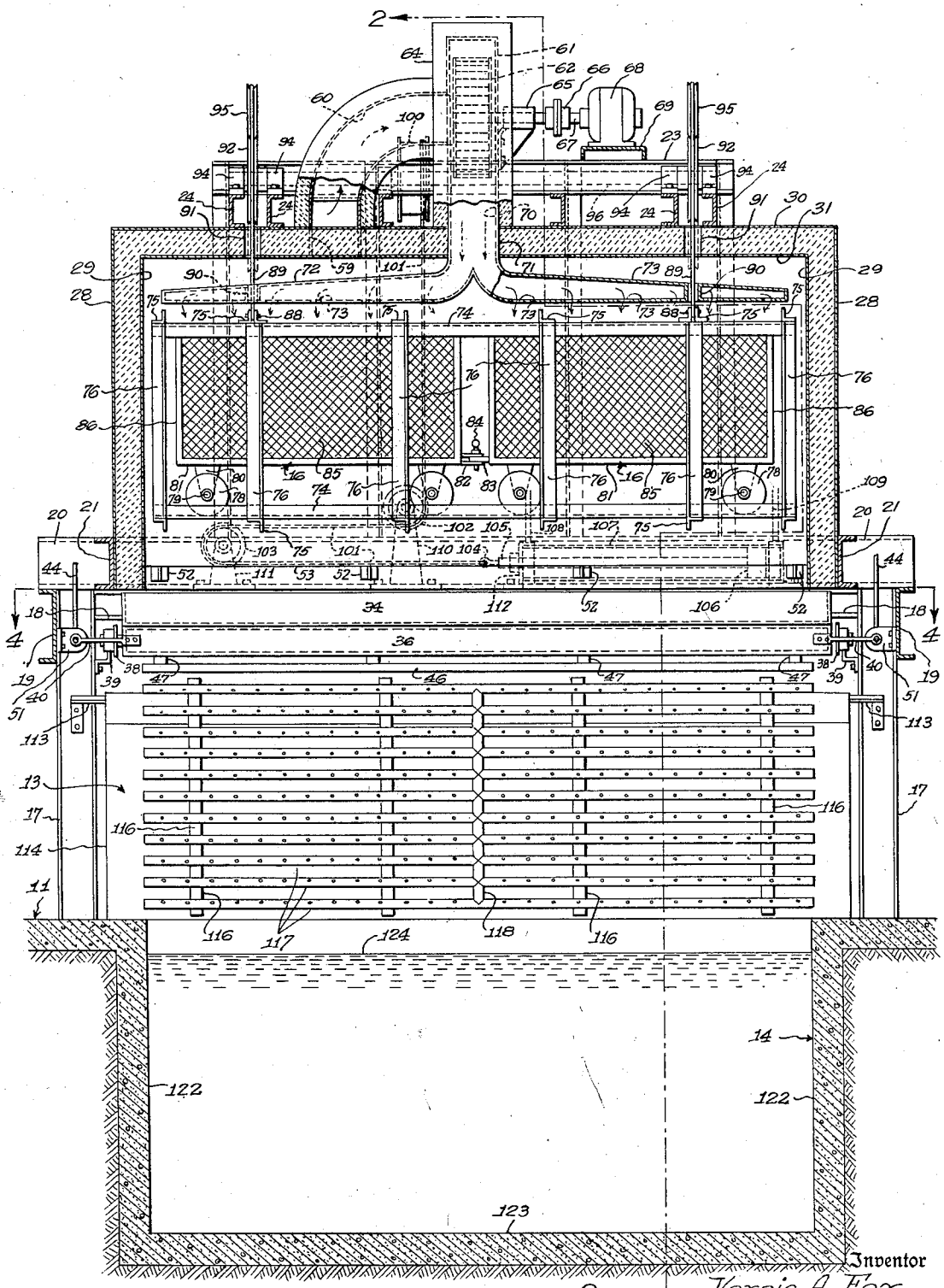


Fig. 1.

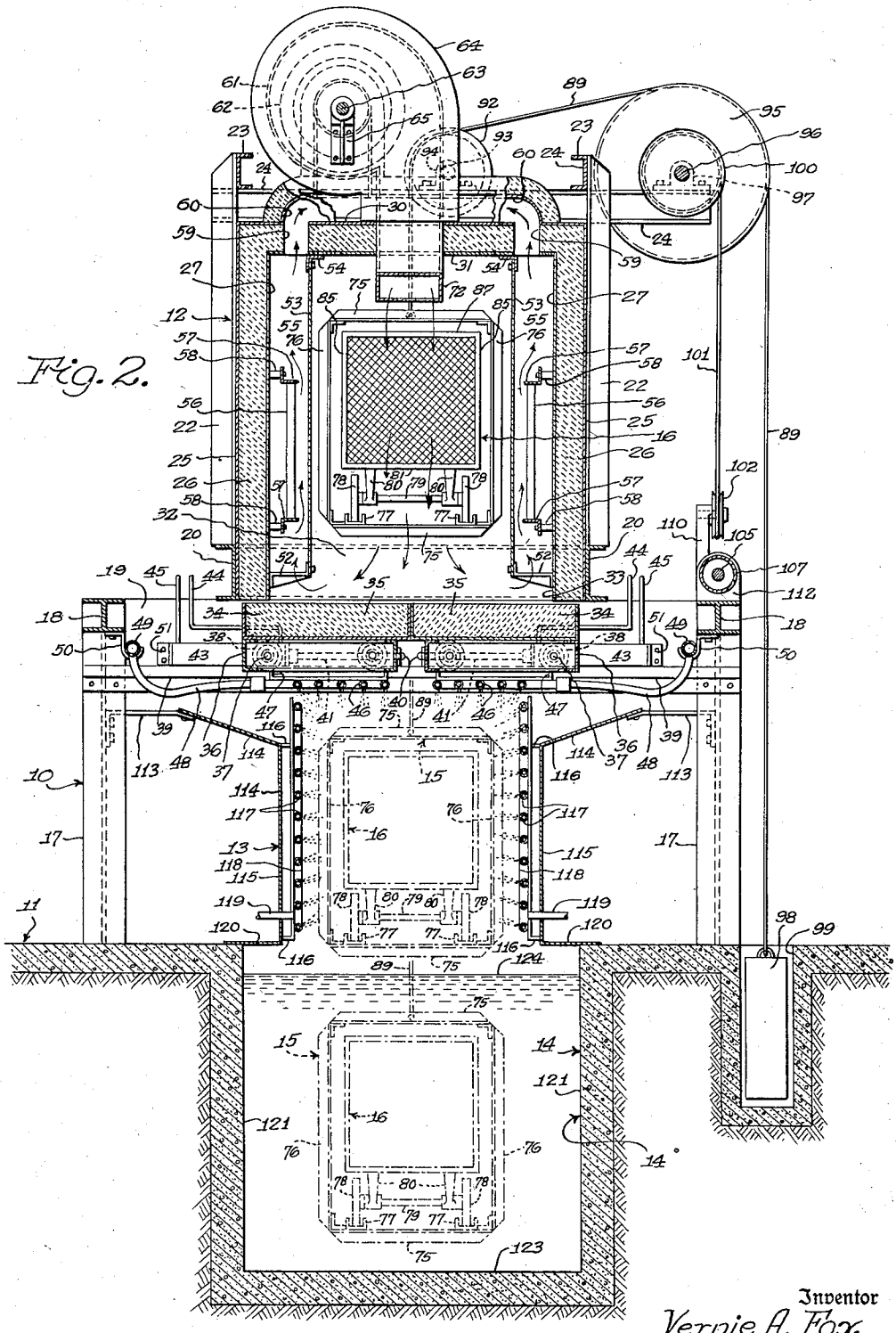
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Filed Dec. 12, 1941 3 Sheets-Sheet 2

Fig. 2.



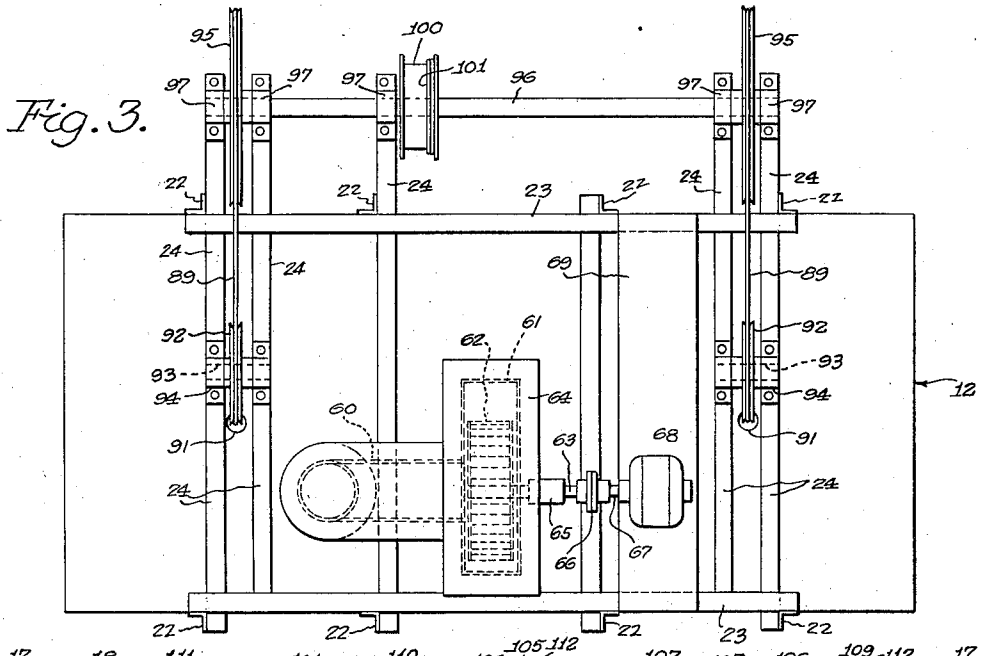
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RAPID-QUENCH HEAT-TREATING OVEN

Filed Dec. 12, 1941 3 Sheets-Sheet 3

Fig. 3.



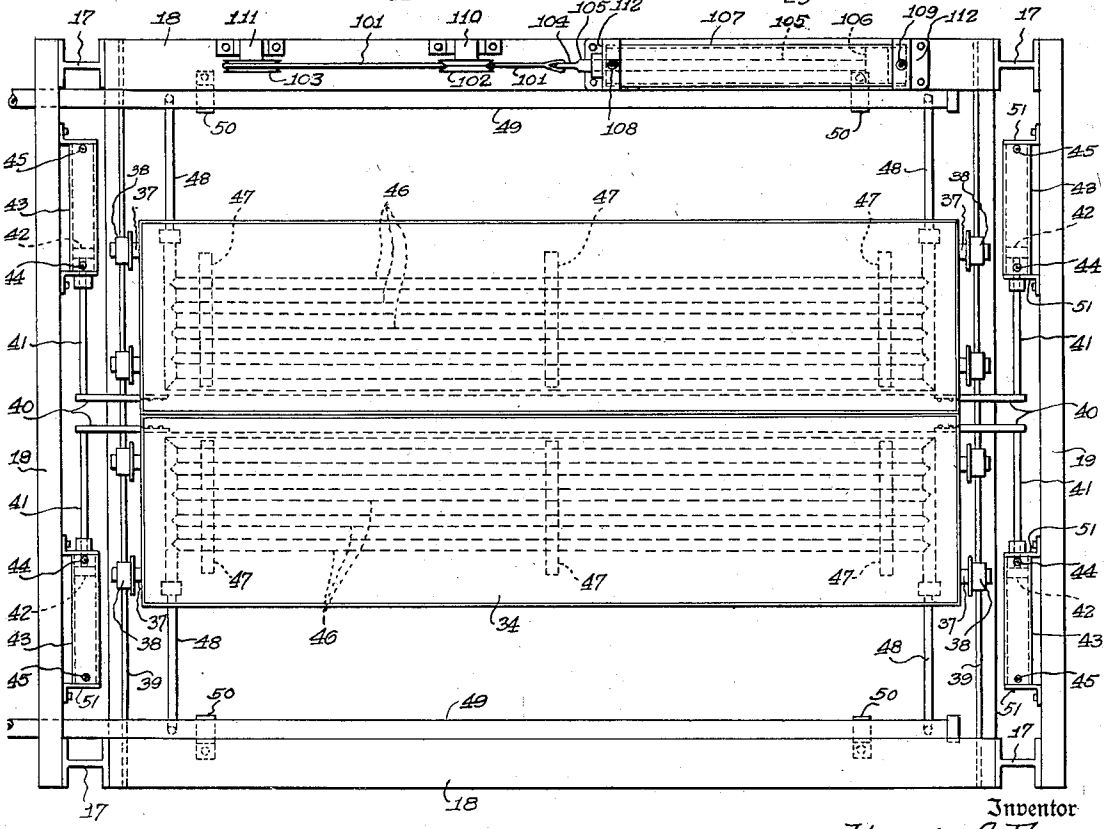


Fig. 4.

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RAPID-QUENCH HEAT-TREATING OVEN

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8 Claims. (Cl. 266—4)

This invention relates to heat-treating ovens and, in particular, to such ovens having quenching means associated therewith.

One object of this invention is to provide an inverted heat-treating oven into which the work to be treated is inserted and withdrawn from below.

Another object of this invention is to provide an inverted heat-treating oven having quenching means arranged beneath it so that the work may be immediately quenched after it is heat-treated without serious loss of heat or change of properties of the material being treated.

Another object is to provide an inverted heat-treating oven arranged above a spray station below which is a quenching station, so that the work may be raised into the oven from below and dropped either to the spray-station or to the quenching station after heat treatment, thereby providing for either spray-cooling or plunge-quenching, or both.

Another object is to provide an inverted heat-treating oven, having movable closures at the bottom thereof and a cage movable up into and down from the oven in synchronism with the doors, thereby conserving heat within the oven.

Another object is to provide an inverted heat-treating oven mounted over a quenching pit or tank and having movable bottom doors, the system being so arranged that an elevator cage carries the work up into the oven in synchronism with the bottom doors, which open and close in timed relationship therewith, and after heat treatment the doors again open and close as the elevator cage moves quickly downward into the quenching pit or tank.

Another object is to provide an inverted heat-treating oven as set forth in the preceding object wherein a spray cooling station is interposed between the heat-treating oven and the quenching pit, so that the work may be quenched either by applying or by plunging, or by a combination of both.

Another object is to provide an inverted heat-treating oven located above a quenching pit and having an elevator operating in synchronism with the oven doors in such a manner that the heat is conserved within the oven by the doors and the work is conveyed so rapidly from the heat-treating oven into the quenching pit that the crystalline structure of the material has very little opportunity to change while the work is travelling from the oven into the quenching pit.

In the drawings:

Fig. 1 is an approximately central longitudinal section through a rapid-quench heat-treating oven according to a preferred embodiment of the present invention.

Fig. 2 is a cross-section along the zig-zag line 2—2 in Fig. 1.

Fig. 3 is a top-plan view of the rapid quench heat-treating oven shown in Figs. 1 and 2.

Fig. 4 is a horizontal section taken along the line 4—4 in Fig. 1 at approximately the bottom of the oven.

General arrangement

In general, the rapid-quench heat-treating oven of this invention consists of an inverted oven mounted on an elevated frame above a spray booth, beneath which is located a quenching pit. The bottom of the inverted oven is closed by a pair of movable doors which are operated in synchronism with an elevator cage. The latter is moved upward into the oven in synchronism with the opening and closing of the doors, so that the work, which is arranged within a car in the elevator cage, is subjected to heat treatment for the desired period of time.

After the heat treatment has been concluded, the doors again open to permit the elevator cage to drop through a spray booth into the quenching pit. Quenching may thus be accomplished either by spraying, by plunging the work into the liquid in the pit, or by a combination of both.

Hitherto it has been very difficult to subject relatively thin or delicate metal structures to heat treatment and then to cool them sufficiently quickly to prevent a change of crystalline structure within the metal. The present inventor has found by tests that the lapse of only three or four seconds between heat treatment and quenching frequently alters the crystalline structure of the metal to a serious extent. This is especially true in the heat treatment of airplane parts, which are constructed of light-weight metal alloys which are peculiarly sensitive to heat changes, especially in the thin structures in which they are so frequently used. For example, it has been found in the cross-bracing structure of airplane wings which are welded together that the metal structure in the vicinity of the welds is quite different from the metal structure elsewhere unless the entire structure is subjected to a careful heat treatment, which may extend as high as 900 degrees F. After such heat treatment, aluminum alloys, especially in sheet form, must be quenched quickly within a few seconds or a serious change in crystalline structure occurs. For some classes of work, spray-quenching is fairly satisfactory but for other types of work, plunge-quenching is preferable. It is also found

that still other types of work are preferably quenched by a combination of both spray-quenching and plunge-quenching.

Referring to the drawings by general designations (Fig. 2) the rapid-quench heat-treating oven of this invention in its preferred form consists of an elevated framework 10 mounted on the building floor 11 and supporting an inverted elevated oven 12 above a spray-booth 13. Beneath the spray booth 13 is located a quenching-pit 14 containing a quenching liquid. An elevator cage 15 containing a work-carrying car 16 is moved, as desired, between the oven 12, the spray booth 13 and the quenching pit 14.

Heat-treating oven construction

Referring to the drawings in detail, Fig. 1 shows the elevated and inverted oven 12 as mounted upon the elevated framework 10. The latter consists of uprights 17 interconnected by longitudinal horizontal channel members 18 and horizontal cross members 19 (Fig. 2).

Supported upon the cross members 19 are upper longitudinal and cross members 20 and 21 respectively. These serve to support the outer oven frame uprights 22 which in turn support the longitudinal and cross top frame members 23 and 24 respectively. (Figs. 1 and 2.) The outer oven side walls 25 are arranged adjacent the outer oven frame uprights 22, and are separated by an insulating layer 26 from the inner oven side walls 27. Associated respectively with these side walls are outer and inner end walls 28 and 29 respectively (Fig. 1) and outer and inner top walls 30 and 31 respectively. These walls define a heat-treating chamber 32 having an open bottom aperture 33 which is closed by horizontally slidable doors 34. The latter are hollow, and contain insulation material 35. The doors 34 are supported upon box-like frames 36 provided at their ends with axles 37 (Fig. 4) carrying flanged whels 38, running to and fro upon transverse track rails 39 (Fig. 1) secured to and extending between the frame uprights 17. The opposite ends of the doors 34 are provided with longitudinally extending brackets 40 (Fig. 4) to which are attached the piston rods 41 of pistons 42 reciprocable in fluid pressure cylinders 43. The latter are preferably operated by pneumatic pressure, and are provided with conduits 44 and 45 at their opposite ends for the admission and discharge of fluid for operating the pistons 42 to open or close the doors 34. The admission and discharge of fluid through the conduits 44 and 45 is controlled by magnetically operated valves (not shown), which in turn are controlled by an electric circuit containing limit switches, which are actuated in response to the upward and downward motion of the elevator cage 15.

Mounted on and movable with the bottom doors 34 are spray pipes 46 which are secured to brackets 47 beneath the doors 34 and connected by flexible conduits 48 (Figs. 2 and 4) to the liquid supply conduits 49 extending longitudinally adjacent the longitudinal frame members 18 and supported upon brackets 50 secured to the undersides thereof. The cylinders 43 are similarly supported upon angle brackets 51 secured to the sides of the cross members 19 (Fig. 4).

Secured to the inner walls 27 of the oven 12 near the bottom thereof are inwardly extending brackets 52 (Fig. 2) which support the lower edges of partitions 53 which extend upward and are secured by the angle members 54 to the inner top wall 31. The partitions 53 are thus spaced apart from the inner walls 27 and form heating chambers 55 containing heating elements 56 secured by the brackets 57 and posts 58 to the inner walls 27. The heating elements 56 are preferably electrical and connected to a source of electric current (not shown).

Opening out of the heating chambers 55 are ports 59 connected to inlet conduits 60 leading to the intake of an exhaust fan or blower 61 containing a blade or vane assembly 62 mounted on a shaft 63 (Fig. 1) within a casing 64. The shaft 63 is supported upon a bearing bracket 65 and connected by a coupling 66 to the shaft 67 of an electric motor 68 mounted upon a base member 69. The latter rests upon the longitudinal frame members 23. The blower 61 discharges into an outlet duct 70 which passes downwardly through a port 71 into the oven chamber 32 where it divides into oppositely extending branches 72 (Fig. 1) having discharge ports 73 disposed in the lower wall thereof.

Elevator construction

The elevator cage 15 consists of a frame work formed of longitudinal members 74 interconnected by cross members 75 and having uprights 76 extending therebetween. Rails 77 are mounted upon the cross members 75 and are of channel cross section for supporting and guiding the wheels 78 mounted upon the axles 79 of the cars 16. Brackets 80 extend downwardly from the bottom 81 of the car 16.

The cars 16, of which there may be one or more (two being shown in Fig. 1), are interconnected by coupling members 82 and 83 joined by a coupling pin 84. The cars 16 are provided with sides 85, ends 86 and tops 87 composed partly of netting.

Connected as at 88 to two of the cross members 75 are cables 89 which pass through apertures 90 and 91 in the conduits 72 and oven walls 25, 27, thence over pulleys 92 (Fig. 3) mounted upon axles 93 supported in bearing brackets 94 mounted upon the cross members 24. Beyond these the cables 89 travel laterally and pass over pulleys 95 mounted upon a common shaft 96 supported in bearing brackets 97 likewise mounted upon the cross members 24. Beyond the pulleys 95 the cables 89 proceed downwardly to counterweights 98 which are received within pits 99 sunk below the floor 11 (Fig. 2).

Also mounted upon the shaft 96 is a drum 100 to which is connected a cable 101. The latter is wound around the drum 100 and extends downwardly around pulleys 102 and 103 (Figs. 1 and 4) and is connected to an eye 104 in the end of a piston rod 105, secured to a piston 106 reciprocable within a cylinder 107 actuated by pressure fluid reaching it through the conduits 108 or 109 (Fig. 4). The pulleys 102 and 103 are supported in bearing brackets 110 and 11 respectively, whereas the cylinder 107 is supported by angle brackets 112. The brackets 111 and 112 are mounted upon one of the longitudinal frame members 18 (Fig. 4). The elevator operating cylinder 107, like the door-operating cylinders 43, is operated by pressure fluid, such as by compressed air or by hydraulic pressure.

Spray booth and quenching pit construction

The spray booth 13 consists of angle brackets 113, mounted on the frame uprights 17 and supporting the bent side plates 114, the side por-

tions 115 of which carry members 116 upon which are mounted the spray pipes 117 interconnected by vertical conduits 118 which in turn are connected to the liquid supply pipes 119 (Fig. 2). The lower portions 120 of the side plates 114 are bent at right angles to the side portions 115 and rest upon the floor 11 over the quenching pit 14.

The quenching pit 14 extends downwardly below the floor level 11 and is provided with side walls 121, end walls 122 and a bottom wall 123. The pit 14 thus formed is filled to a suitable level with a liquid 124, such as water.

Operation

In the operation of the rapid-quench heat-treating oven of this invention, the work pieces are loaded into the cars 16, which may be outside the frame structure 10, either to the right or to the left thereof (Fig. 1). The work pieces may stand of themselves, or may be supported upon racks or suspended upon hangers, depending upon their nature.

The cars 16, when thus loaded, are caused to enter the elevator 15, which has been lowered to the middle position shown in the dotted lines in Fig. 2, the wheels 78 running upon the tracks 77. Meanwhile the heating elements 56 have been energized, and the blower 61 operated to circulate the thus-heated air through the oven chamber 32 in the circuit indicated by the arrows (Figs. 1 and 2). During this time the doors 34 are in their closed positions so as to conserve heat.

Pressure fluid is now supplied to the conduit 108 (Fig. 4) forcing the piston 106 to the right and pulling the cable 101 in a direction adapted to rotate the drum 100, shaft 96 and pulley 95 in a clockwise direction (Fig. 2) raising the elevator 15. As the elevator rises, it operates limit switches which energize an electrical circuit to operate magnetic valves which in turn supply pressure fluid to the conduits 44. This moves the pistons 42 and piston rods 41 outward, opening the doors 34 just in time for the passage of the elevator 15. After the elevator 15 passes the level of the doors 34 it operates other limit switches which actuate magnetic valves for admitting pressure fluid to the conduits 45 and discharging it from the conduits 44 causing the pistons 42 and piston rods 41 to move inward, closing the doors 34 immediately after the passage of the elevator 15. The latter then actuates other limit switches which shift the magnetic valve controlling the cylinder 107 so as to halt the elevator 15 in the solid-line position of Fig. 2.

The elevator 15 remains within the chamber 32 of the oven 12 for a predetermined length of time, depending upon the nature of the work pieces and the materials from which they are constructed. After the heat treatment has been completed, the electrical circuit is energized to operate the magnetic valves which control the door-actuating cylinders 43 and the elevator-actuating cylinder 107, causing the doors 34 to open momentarily and likewise causing the elevator 15 to be lowered rapidly through the spray-booth 13 into the quenching pit 14. After the elevator 15 passes the level of the doors 34, the latter are closed automatically by the shifting of the limit switches and the consequent shifting of the magnetic valves controlling the cylinders 43.

As the elevator 15 passes through the spray booth 13 it may be subjected to a spray of cooling liquid from the spray pipes 117 and it may optionally be halted in this position. For delicate work pieces, or those constructed of sensitive metals or alloys, however, it is usually preferable not to halt the elevator 15 within the spray booth 13, but instead to lower it unchecked into the quenching pit 14. When the elevator 15 plunges into the liquid 124 in the quenching pit 14, the work pieces within the car 16 are quenched. This entire passage of the elevator from the heat-treating oven 12 to the quenching pit 14 takes place in an extremely rapid manner, and occupies a period less than the three or four second period within which the crystalline structure of certain metals or metal alloys changes seriously.

If the elevator 15 is halted at its intermediate position in the spray booth 13 (Fig. 2) and if the work pieces within the car 16 are sufficiently insensitive, the car 16 may be run out of the elevator 15 and unloaded at the floor level 11. If the elevator 15 and car 16 have been quenched in the pit 14, however, the elevator 15 is raised to the level of the floor 11 by operating the cylinder 107. The car 16 may then be run out of the elevator 15 and unloaded.

While a specific embodiment of the invention has been described and illustrated, it will be understood that various modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

What I claim is:

1. In a rapid-quench heat-treating apparatus, an oven having an aperture at the bottom thereof, heating means located in vertical passageways on each side of said oven, a quenching device disposed below said aperture, an elevator movable vertically through said aperture between the interior of said oven and said quenching device, means for moving said elevator, and means for circulating air upwardly past said heater and downwardly through the interior of said oven whereby the heated air will not pass in juxtaposition to the aperture during the initial portion of its flow.

2. In a rapid-quench heat-treating apparatus, an oven having an aperture at the bottom thereof, heating means located in vertical air passageways on each side of said oven, a quenching device disposed below said aperture, an elevator movable vertically through said aperture between the interior of said oven and said quenching device, means for moving said elevator, and means for circulating air upward past said heater and downward through the interior of said oven whereby the heated air will not pass directly to the area of said aperture before traversing said oven chamber.

3. In a rapid-quench heat-treating apparatus, an oven having an aperture in the lower wall, a heater in said oven, a liquid spraying device disposed beneath said aperture, an elevator movable vertically between said spraying device and the interior of said oven, means for moving said elevator, and a shiftable closure movable into and out of closing relationship relatively to said aperture certain portions of said spraying device being mounted on the underside of said closure and movable therewith to direct a spray in the direction of the bath.

4. In a rapid-quench heat-treating apparatus, an oven having an aperture in its lower wall, a heater in said oven, a liquid spraying device disposed beneath said aperture, an elevator movable vertically between said spraying device and the interior of said oven, means for moving said elevator, a shiftable closure movable into and

out of closing relationship relatively to said aperture, certain portions of said spraying device being supported and movable with said closure and means operable in timed relationship with said elevator for opening said closure during the passage of said elevator through said aperture and for closing the same when said elevator is inside or outside of said oven whereby vapors from the spraying device will be excluded from said oven.

5. In a rapid-quench heat-treating apparatus, an oven having an aperture in the lower portion thereof, a closure for said aperture, a heater in said oven, a plunge-quenching bath disposed beneath said aperture, an elevator movable vertically between said bath and the interior of said oven, means for moving said elevator, and means for moving said closure in timed relation with said elevator, a spraying device disposed between said oven and said plunge-quenching bath certain portions of said spraying device being supported and carried by the closure to direct a downward spray in the direction of the quenching bath.

6. In a rapid-quench heat-treating apparatus, an oven having an aperture in the lower portion thereof, a closure for said aperture, a heater in said oven, a plunge-quenching bath disposed beneath said aperture, an elevator movable vertically between said bath and the interior of said oven, means for moving said elevator in timed relation with said closure, a spraying device disposed between said oven and said plunge-quenching bath, certain portions of said spraying device being carried by the closure for directing a spray toward the bath and loading and unloading stations adjacent said spraying device and between the oven and quenching bath.

7. In a rapid-quench heat-treating apparatus, an oven having an aperture in the lower portion thereof, a heater in said oven, a plunge-quenching bath disposed beneath said aperture, an elevator movable vertically between said bath and the interior of said oven, means for moving said elevator in timed relation to the shifting movement of said closure, a spraying device disposed between said oven and said plunge-quenching bath, a shiftable closure movable into and out of closing relationship relatively to said aperture and portions of said spray device being supported on said closure and movable therewith to direct a spray of fluid downwardly toward the quenching bath.

8. In a rapid-quench heat-treating apparatus, an oven having an aperture in the lower portion thereof, a closure for said aperture, a heater in said oven, a plunge-quenching bath disposed beneath said aperture, an elevator movable vertically between said bath and the interior of said oven, means for moving said elevator, a spraying device disposed between said oven and said plunge-quenching bath, and means operable in timed relationship with said elevator for opening said closure during the passage of said elevator through said aperture and for closing the same when said elevator is inside or outside of said oven certain portions of said spraying device being supported by said closure and movable therewith.

VERNIE A. FOX.