May 8, 1934. S. M. BEROLZHEIMER ET AL 1,957,932

METHOD OF AND FURNACE FOR HEAT TREATMENT

Filed Sept. 25, 1930 4 Sheets-Sheet 1

Fig 2.

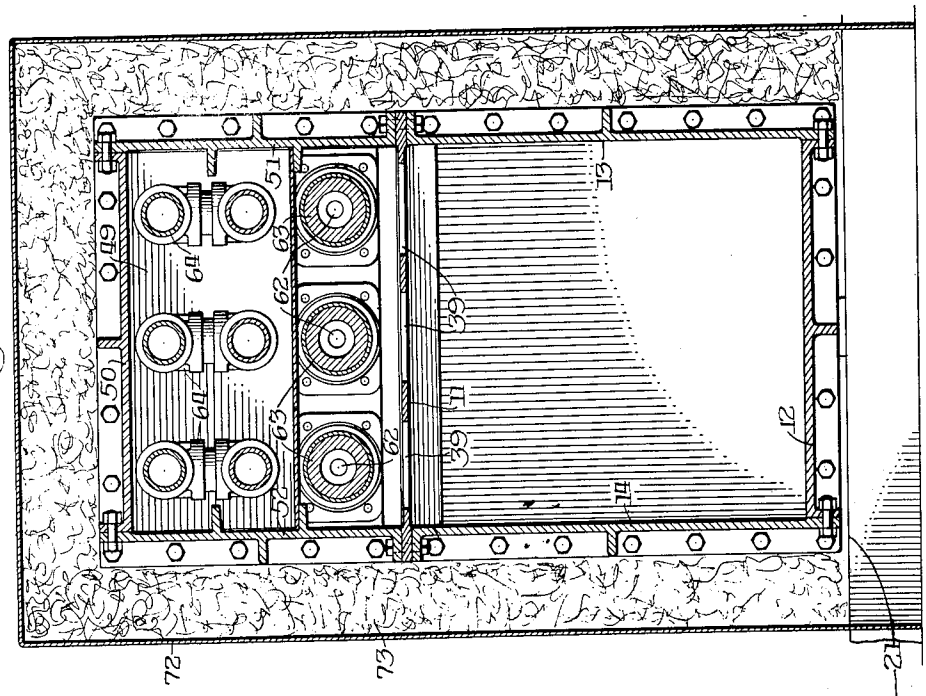
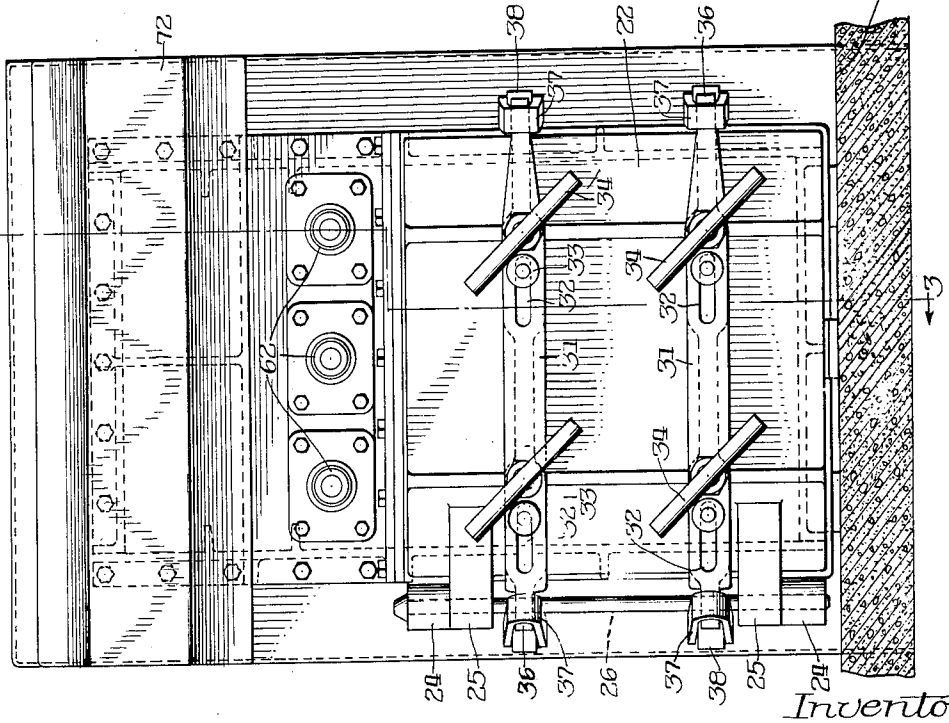


Fig 1

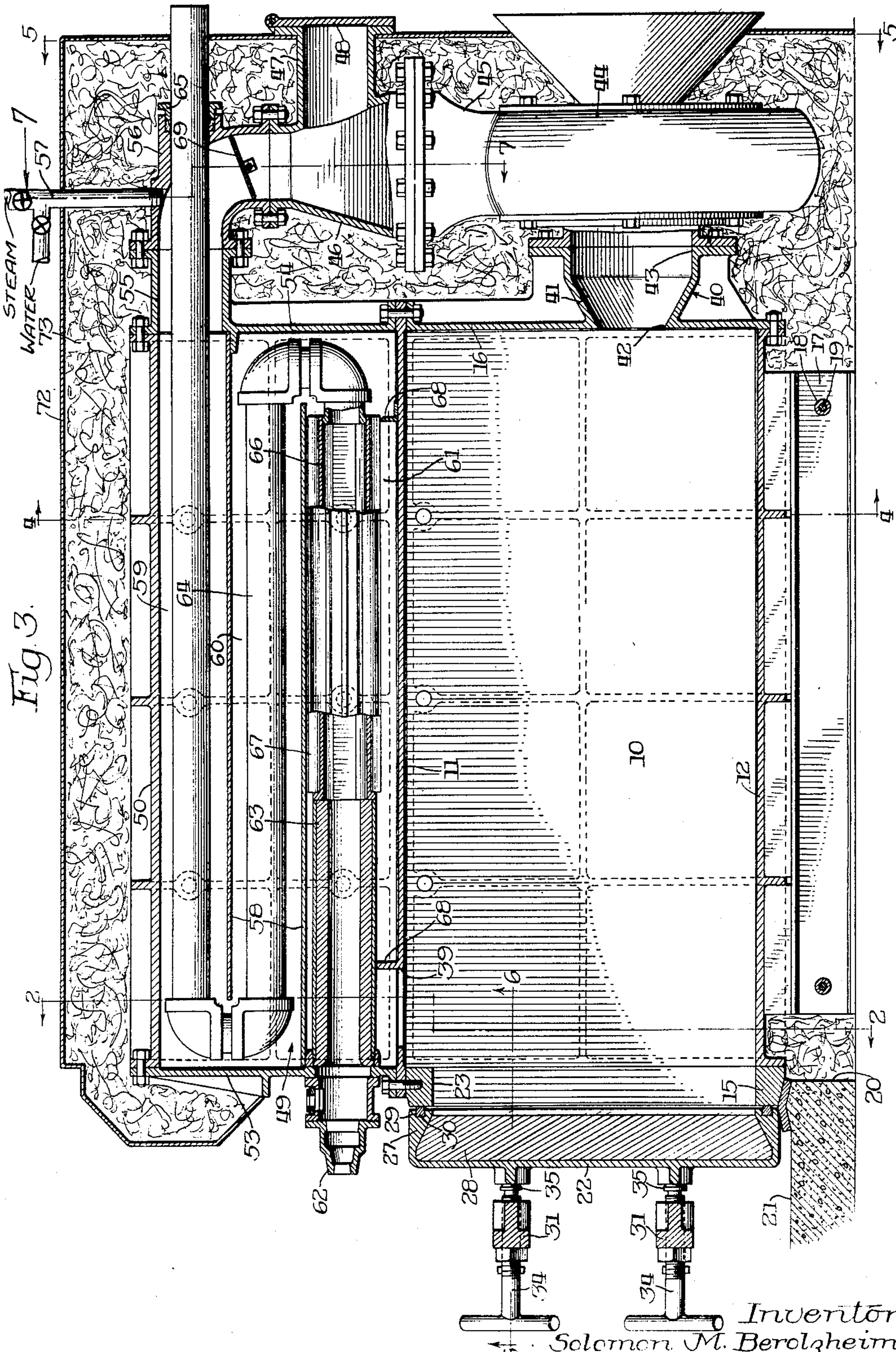


Inventors
Solomon M. Berolzheimer
Slade B. Gamble
By Chindahl, Parker & Carlson
Attys

May 8, 1934. S. M. BEROLZHEIMER ET AL 1,957,932

METHOD OF AND FURNACE FOR HEAT TREATMENT

Filed Sept. 25, 1930 4 Sheets-Sheet 2



Inventors
Solomon M. Berolzheimer
Slade B. Gamble
By Chindahl, Parker & Carlson Attys.

May 8, 1934. S. M. BEROLZHEIMER ET AL 1,957,932

METHOD OF AND FURNACE FOR HEAT TREATMENT

Filed Sept. 25, 1930 4 Sheets-Sheet 3

Fig. 5.

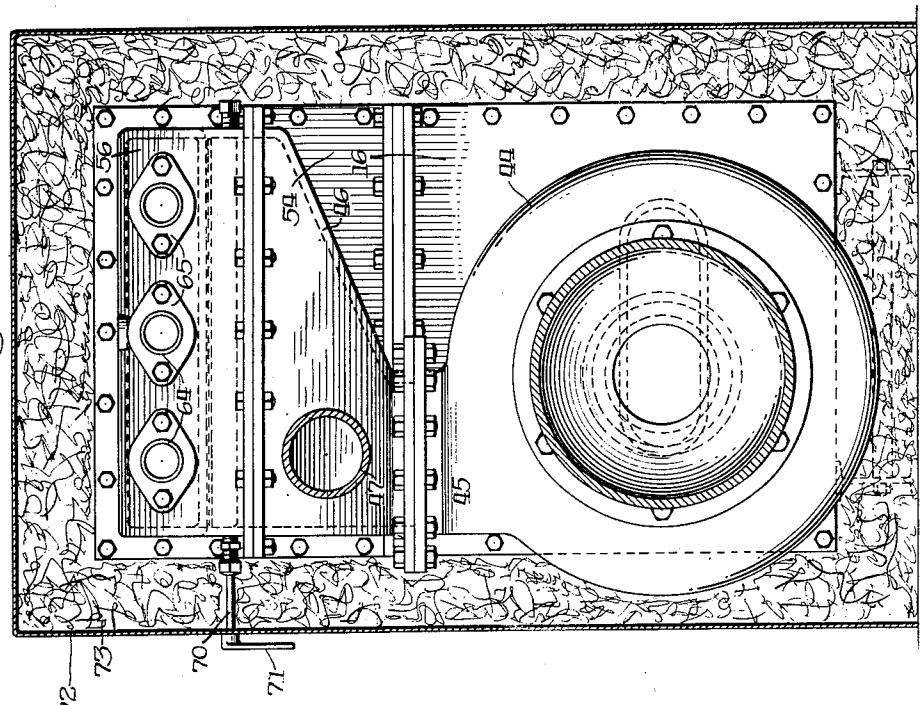
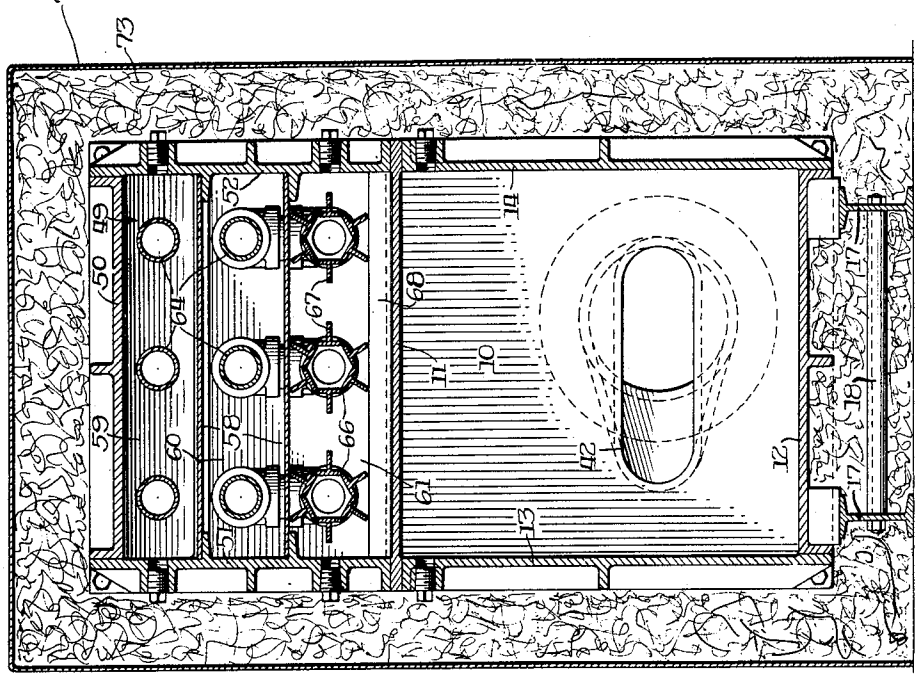


Fig. 4.



Inventors
Solomon M. Berolzheimer
Slade B. Gamble
By Chindahl, Parker & Carlson
Attys.

May 8, 1934. S. M. BEROLZHEIMER ET AL 1,957,932

METHOD OF AND FURNACE FOR HEAT TREATMENT

Filed Sept. 25, 1930 4 Sheets-Sheet 4

Fig 7

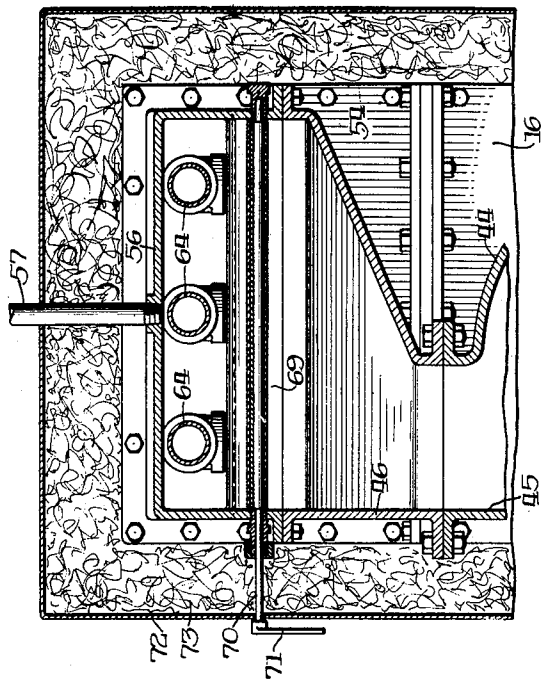
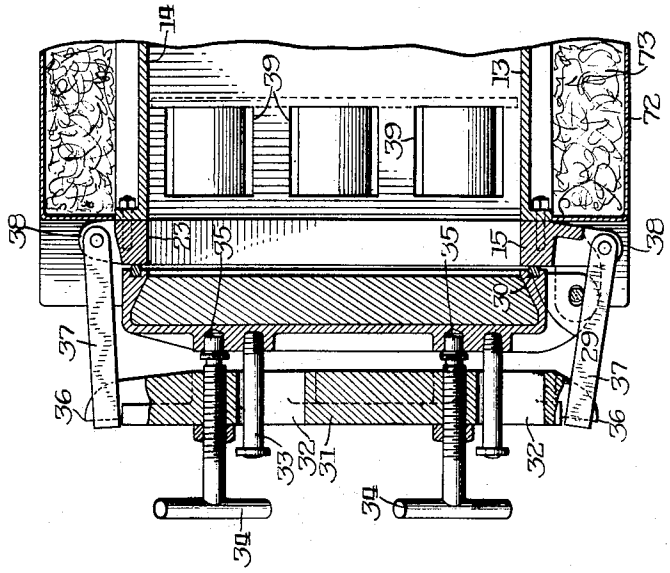


Fig 6



Inventors
Solomom M. Berolzheimer
Slade B. Gamble
By Chendahl, Parker & Carlson
Attys

Patented May 8, 1934 1,957,932

UNITED STATES PATENT OFFICE

1,957,932

METHOD OF AND FURNACE FOR HEAT TREATMENT

Solomon M. Berolzheimer and Slade le Blount Gamble, Chicago, Ill., assignors to Diamond Braiding Mills, Chicago Heights, Ill., a corporation of Illinois

Application September 25, 1930, Serial No. 484,267

17 Claims. (Cl. 263—2)

The present invention relates to improvements in heat treating furnaces and methods, and has particular reference to a new and improved furnace especially adapted for the bright annealing of non-ferrous metals, such as copper and brass. The metal to be annealed may be in any form, for example in the form of wire in coils, flat metal stampings, or tubes.

In one prior type of annealing furnace, the product to be annealed is elevated through a water seal into the annealing chamber, and is heated by radiant heat. This type is objectionable in that the water seal causes a substantial loss in thermal efficiency. Water which is entrained with the product and which is adjacent to the heated chamber of the furnace in evaporating takes up more than one-half of the available heat. The water also results in discoloration of the metal. Difficulty is encountered in heating the product uniformly throughout its mass, and at the desired rate, and strains are set up.

In another prior annealing furnace, the product is heated by air which receives its heat from electrical heating elements within the annealing chamber. The use of air obviously will result in oxidation.

Various objects of the present invention reside in the provision of a novel heat treating furnace which has a high thermal efficiency, and which produces a product that is uniformly soft and ductile, and free from discoloration and oxidation.

Another object is to provide a new and improved furnace which heats by convection, and which is simple, compact and inexpensive in construction, and expeditious and economical in operation.

An important object of the present invention resides in the provision of a novel furnace in which a heated fluid that is advantageously active or in some instances chemically inert with respect to the product undergoing treatment, such as carbon dioxide, illuminating gas, or steam, is circulated through the heating chamber.

A further object is to provide novel means for scavenging the furnace of air, for recirculating the heating medium through the heating chamber, and for superheating the heating medium before it is returned to the chamber.

Another object resides in combining the heating chamber and the superheater in an integral structure so as to substantially eliminate pipe connections and to increase the thermal efficiency of the furnace.

A further object is to provide a new and improved horizontal furnace having a door close to the ground so that a skid with a large bulk of material may be easily and quickly driven into and out of the heating chamber, and the necessity of rehandling the material will be eliminated.

Still another object resides in the provision of a novel furnace in which it is possible to cool or quench the treated material without the use of a tank, and to remove the finished product quenched, dry and clean, in which the heat absorbed by the quenching material may be partially recovered, and in which the heating fluid is capable of maintaining high temperatures without entraining a large volume of heat so as to make possible widely varying rates in heating the material and also in cooling the material after treatment.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Figure 1 is a front end elevational view of an annealing furnace embodying the features of our invention.

Fig. 2 is a transverse vertical sectional view taken along line 2—2 of Fig. 3.

Fig. 3 is a vertical sectional view taken along line 3—3 of Fig. 1.

Fig. 4 is a transverse vertical sectional view taken along line 4—4 of Fig. 3.

Fig. 5 is a rear end elevational view taken along line 5—5 of Fig. 3 with the insulation removed.

Fig. 6 is a fragmentary horizontal sectional view taken along line 6—6 of Fig. 3, and showing the door.

Fig. 7 is a fragmentary sectional view taken substantially along line 7—7 of Fig. 3.

While the invention is susceptible of various modifications and alternative constructions, we have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that we do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims. We have herein disclosed the invention as embodied in an annealing furnace, but it is to be understood that this is merely for illustrative purposes, and that in its broad concept, the invention is adaptable to various kinds of heat treatment.

Referring more particularly to the drawings, the annealing furnace constituting the exemplary embodiment of the invention comprises an

annealing chamber 10 which may be of any suitable form and disposed in any desired position. In the present instance, the chamber 10 is rectangular in form, both longitudinally and transversely, and is disposed horizontally. Thus, the chamber 10 comprises upper and lower walls 11 and 12, side walls 13 and 14, and front and rear walls 15 and 16.

A suitable supporting structure is provided, this structure in the present instance comprising a pair of longitudinal I-beams 17 secured in parallel spaced relation by means of elongated tubular spacers 18 at the ends, and bolts 19 extending through the beams and the spacers to hold the parts in assembled relation. The bottom wall 12 is mounted on heat insulating brick on the I-beams 17. The supporting structure is mounted on the bottom of a pit 20 in a base support, such as a floor 21, so as to locate the bottom wall 12 closely to the floor.

The front end of the chamber 10 is provided with a door 22 through which the material to be treated is introduced, and when treated is removed. The door 22 (see Figs. 1 and 6) is pivotally mounted at one side on the front end wall 15 which is in the form of a frame having a rectangular door opening 23. Preferably, the door frame 15 is formed along one side with two vertically spaced forwardly extending hinge lugs 24. Mating hinge lugs 25 are formed along one side of the door 22 between the lugs 24. Extending through the lugs 24 and 25 is a suitable pivot pin 26. Each of the lugs 25 is apertured to receive the pin 26, and the apertures are elongated to permit the door 22 to seat freely and squarely against the door frame 15. Preferably, the door 22 is formed with a rearwardly extending marginal flange 27, the inner surface of which is flared to define a dovetailed recess in which suitable refractory material 28 is secured.

Provision is made for a tight seal between the door frame 15 and the door 22 when the latter is closed during the annealing operation. To this end, a rearwardly opening dovetailed groove 29 is formed in the end face of the door flange 27, and a strip of yieldable refractory material 30 is secured in the groove 29 and projects therefrom for engagement with the marginal surface of the door frame 15 about the opening 23.

Releasable means is provided for clamping the door 22 tightly against the frame 15. Preferably, this means comprises a pair of spaced parallel clamping bars 31 extending horizontally across the door 22. Each bar 31 is formed with two spaced longitudinal slots 32 respectively adjacent its ends. Headed bolts 33 extend respectively through the slots 32 into fixed threaded engagement with the door 22, and serve to retain the bars 31 in position for limited longitudinal adjustment and for movement away from the front. Two spaced clamp screws 34 are operatively threaded through each bar 31. The rear or inner ends of the screws 34 are adapted to engage rotatably in suitable hardened bearing seats 35 rigidly secured in the front of the door 22.

The ends of the clamping bars 31 are formed respectively with suitable hooks 36 which extend beyond the sides of the door 22. Suitable clevises 37, one for each hook 36, are pivotally mounted at their open ends on lugs 38 projecting laterally from opposite sides of the door frame 15. It will be evident that when the clevises 37 are positioned over the hooks 36, and the screws 34 are adjusted to force the clamping bars 31 outwardly against the clevises, the door 22 will be clamped securely and tightly in closed position.

One of the features of the invention resides in the provision of novel means for maintaining a heated atmosphere in the annealing chamber 10 which serves to transmit heat by convection uniformly to the product being annealed. Any suitable fluid capable of maintaining the desired temperature may be used. The heating fluid should not be disadvantageously active with respect to the product, but on the contrary should be either advantageously active or as in the use of carbon dioxide (CO_2), illuminating gas, or steam, chemically inert relative thereto. In the present instance, we prefer to circulate superheated steam through the chamber 10. To this end, a plurality of transversely alined openings 39 are formed in the front end of the top plate 11, and are adapted to be connected to a suitable source of steam. The rear end wall 16 of the chamber 10 is formed with a duct 40 defining a discharge passage 41 which converges from an elongated inlet opening 42 extending substantially the width of the chamber 10 to a circular discharge opening 43 at its outer end. A blower or exhauster 44 of suitable construction is mounted on the outer end of the duct 40, and is formed in its periphery with a discharge duct 45 to which a sleeve 46 is connected. The sleeve 46 is formed with a lateral extension 47 opening to the atmosphere. A weighted flap valve 48 is pivotally mounted on the outer end of the extension, and serves to close the latter except when the pressure exceeds a predetermined value. Thus, when the blower 44 is in operation, steam will be supplied to the chamber 10 through the openings 39, and will be exhausted from the chamber through the duct 40. By locating the blower 44 at the steam outlet, it will be exposed to the lowest temperatures prevailing in the path of the heating fluid, and hence will be less likely to operate inefficiently because of excessive temperatures, and will have a larger relative capacity.

Means is provided for superheating the steam before it is supplied to the chamber 10. This means comprises a superheater built integrally with the furnace, and preferably located over the annealing chamber 10. While the superheater may be of any suitable type and form, preferably it comprises a rectangular flow chamber 49 coextensive in length and width with the annealing chamber 10. In the present instance, the superheater chamber comprises a top wall 50, side walls 51 and 52, and front and rear end walls 53 and 54. The top wall 11 of the chamber 10 constitutes the bottom wall of the chamber 49. The rear end wall 54 of the superheater is formed along its upper edge with a rectangular transverse inlet duct 55 substantially coextensive in width therewith. Connected to the outer end of the duct 55 and coextensive in lateral dimensions therewith is an elbow 56. A steam line 57 opens to the elbow 56, and is adapted to be connected to any suitable source of steam (not shown).

A plurality of horizontal baffle plates 58, two in the present instance, extend longitudinally through the chamber 49, and are coextensive therewith in width. In the present instance, the upper baffle plate 58 extends from the rear end wall 54 slightly short of the front end wall 53, and the lower plate 58 extends from the front end wall 53 slightly short of the rear end wall 54. Thus the baffle plates 58 define a tortuous passage through the superheater chamber 49, the passage extending from the duct 55 through a

forward course 59, then a rearward course 60, and finally a forward course 61 communicating with the openings 39.

Suitable means is provided for heating the fluid in the course of its passage through the superheater. In the present instance, this means comprises an immersion gas heater, and more particularly a plurality of gas burners 62, preferably three, mounted in the front end wall 53 between the wall 11 and the lower baffle plate 58. Preferably, the burners 62 are of the proportional air and gas mixer type, and respectively comprise tubular combustion chambers 63 discharging into the inlet ends of three tortuous heating tubes 64. The combustion chambers 63 are of refractory material so as to prevent cooling of the flame and the products of combustion before entering the heating tubes 64. The heating tubes 64 extend in parallel spaced relation along the courses 61, 60 and 59 of the steam chamber 49, and the discharge ends thereof extend through suitable gland fittings 65 in the elbow 56 to the atmosphere.

The lower legs of the tubes 64 are formed respectively with heat radiating sections 66. Preferably, these sections are hexagonal in transverse form, and each wall is formed on its outer surface with a medial longitudinal radiating fin 67. Suitable transverse flanges 68 are provided on the wall 11 across the rear ends of the radiating sections 66 and along the rear edges of the openings 39 to the chamber 10 so as to cause the steam to flow along the interdental spaces between the fins 67.

One of the important features of the present invention resides in the provision of means available to recirculate steam from the blower 44 back to the heating chamber 10 and reheating the steam in the course of its return flow. To this end, the sleeve 46 is connected to the outer end of the elbow 56, the passage through the sleeve converging from the rectangular form of the elbow to the circular form of the discharge duct 45 of the blower 44.

A suitable butterfly valve 69 is mounted on a transverse shaft 70 in the elbow 56 for closing the connection from the blower 44 to the superheater. One end of the shaft 70 extends through one side wall of the elbow 56, and is provided with a hand lever 71.

An outer shell 72 is provided to enclose the furnace and superheater structure. The shell 72 projects over the front of the superheater substantially to the burners 62. A suitable heat insulating material 73 is provided within the space between the structure and the outer shell 72 and also below the bottom wall 12.

In operation, the product, for example spools of copper wire, is stacked uniformly in the chamber 10. Because of the location of the door near the floor 21, the product may be loaded onto a skid (not shown), and the skid moved into the chamber 10. Since the furnace is substantially a one-hundred percent convection furnace, the skid may be loaded indiscriminately with wires of various sizes and weights on spools of the same size or different sizes, and the wire may be annealed on the same spool from which it is later drawn for stranding.

When the chamber 10 is loaded, the door 22 is closed. Steam now is supplied through the line 57, and the burners 62 are ignited. At first, the valve 69 is closed so that the steam initially supplied through the superheater to the annealing chamber 10, and exhausted therefrom by the blower 44, will be discharged past the flap valve 48 to the atmosphere, thus scavenging the system of air.

The valve 69 now is opened. As a result, the steam exhausted from the chamber 10 is recirculated through the superheater back to the chamber, joining with any new steam entering the elbow 56, and obviously is reheated in the course of its return flow. A small amount of steam may escape past the valve 48 which acts in the capacity of a weighted pressure relief valve.

The superheated steam is circulated through the system at a high velocity, this being made possible by the specific design of the furnace, the design and capacity of the blower, and the disposition of the blower at the point of the lowest prevailing temperature. The use of superheated steam as the heating medium renders it possible to maintain high temperatures without entraining a large volume of heat, and hence affords a sensitive control over a wide range of the rate at which the product is heated, and the rate at which it is subsequently cooled. The steam permeates all the interstices of the product, thus resulting in uniform heating throughout the mass, and more particularly in obtaining substantially the same temperature in the mass as in the furnace. The pressure and velocity of the steam are such that a sufficient quantity of heat is available, and that the steam will give up a maximum amount of heat in performing useful work. A relatively low pressure of three-fourths pound per square inch above atmospheric has been found to be suitable.

The temperature is caused to rise gradually to the desired point, for example 528° F. for copper. After the product is annealed, the burners 62 are extinguished, and water is injected into the steam line 57 thus cooling the chamber 10 and quenching the product. After quenching, the product is removed from the chamber 10 in a clean dry state. Thus the product is quenched within the furnace without the use of a tank, and the heat absorbed in the quenching operation can be partially recovered.

In general, the product will be clean, dry, uniformly soft and ductile, and free from water discoloration and oxidation, and will have a bright finish. The thermal efficiency of the furnace is high. The heat penetrates uniformly to all parts of the product and is readily controlled. The operation can be carried out with a minimum handling of the product.

We claim as our invention:—

1. A heat treating furnace comprising, in combination, a heating chamber for the product to be treated, means for supplying steam to said chamber, heating means interposed in said first mentioned means, and means for passing steam from said chamber at will either to exhaust or to said first mentioned means for recirculation through said chamber.

2. A heat treating furnace comprising, in combination, a chamber adapted to contain the product to be treated, means for supplying steam to one end of said chamber, a steam superheater interposed in said means, means for exhausting steam from the other end of said chamber, a weighted pressure relief valve opening from said last mentioned means to exhaust, and means including an adjustable valve for connecting the exhaust means to the steam supply means.

3. A heat treating furnace comprising, in combination, a heating chamber for the product to be treated, a superheater structure built integral

with said chamber and discharging thereto, and means including an exhausting fan for recirculating a heating fluid harmless in relation to said product from said chamber through said superheater structure.

4. A heat treating furnace comprising, in combination, a base support, a horizontal heating chamber on said support having a tight door at one end close to said support, a horizontal superheater structure on said heating chamber, means for supplying a heating fluid to said superheater, means for heating said superheater, said superheater discharging to said chamber into direct contact with the product to be treated, an exhauster connected to the one end of said chamber, and means for connecting the outlet of said exhauster either to exhaust or to said superheater.

5. A heat treating furnace comprising, in combination, a heating chamber for the product to be treated, a counterflow superheater mounted on said chamber and communicating with said chamber, an immersion gas heater in said superheater, and means for recirculating a heating fluid from said chamber to said superheater.

6. A heat treating furnace comprising, in combination, a heating chamber for the product to be treated, a superheater mounted on said chamber and communicating with said chamber, baffles in said superheater defining a sinuous fluid passage, a plurality of immersion gas burners in one end of said passage, a plurality of heating tubes connected to said burners and extending along said passage, and means for supplying steam to said passage.

7. A heat treating furnace comprising, in combination, a heating chamber for the product to be treated, a closed circulatory passage including said chamber, means interposed in said passage for effecting a forced circulation therethrough, valve means interposed in said passage between said first mentioned means and said chamber, an exhaust vent interposed between said first mentioned means and said valve means, a relief valve for closing said vent, and means for supplying a heating fluid to said passage at a point between said valve means and said chamber.

8. A heat treating furnace comprising, in combination, a chamber adapted for the product to be treated, means for supplying steam to one end of said chamber, a steam superheater interposed in said means, means for exhausting steam from the other end of said chamber, and means for supplying steam from said last mentioned means to said first mentioned means for recirculation through said chamber.

9. A heat treating furnace comprising, in combination, a base support, a horizontal heating chamber for the product to be treated on said support, said chamber having a door at one end adapted to be tightly closed and close to the support, a horizontal steam superheater mounted on said chamber and having a tortuous steam passage opening to one end of said chamber, a plurality of heating elements extending through said passage, means for supplying steam to said passage, an exhauster connected to the other end of said chamber, and a branched duct opening from the discharge of said exhauster, one branch of said duct being connected to the inlet of said passage, a valve interposed in said branch, the other branch of said duct opening to exhaust, and a weighted flap valve for controlling said last mentioned branch.

10. For use in a furnace comprising a chamber adapted to contain the product to be treated, the method of annealing which comprises passing a stream of superheated steam through said chamber in intimate contact with the product, reheating and recirculating the steam through said chamber until the desired temperature is attained and then at said temperature over a predetermined period, and then injecting water into the steam and recirculating the steam without reheating, to quench the product.

11. For use in a furnace comprising a heating chamber for the product to be treated, the method of heat treatment which comprises passing a heating fluid inert with respect to the product through said chamber in intimate contact with the product to purge said chamber of air, then reheating and recirculating the heating fluid through said chamber to heat the product gradually and uniformly to a predetermined temperature, and finally quenching the product in said chamber.

12. For use in a furnace comprising a heating chamber for the product to be treated, the method of heat treatment which comprises passing a stream of steam through said chamber in intimate contact with the product, initially discharging the steam from said chamber to purge the latter and the product of air, then recirculating the steam in a uni-direction through said chamber and reheating said steam before returning same to said chamber to heat the product gradually and uniformly to a predetermined temperature, and then effecting quenching of the product by injecting water into the recirculating steam.

13. For use in a furnace comprising a heating chamber adapted to contain the product to be treated, the method of annealing which comprises passing a stream of superheated steam through the chamber in intimate contact with the product first to the exhaust to purge the chamber of air and then reheating the steam from said chamber and recirculating it through said chamber to heat the product gradually and uniformly to a predetermined temperature, and finally quenching the product in the chamber.

14. A heat treating furnace comprising, in combination, a base support, a heating chamber for the product to be treated on said support, a superheater mounted on said chamber and having a tortuous passage opening to one end of said chamber, a plurality of heating elements extending through said passage, means for supplying a heating fluid to said passage, an exhauster connected to the other end of said chamber, and a branched duct opening from the discharge of said exhauster, one branch of said duct being connected to the inlet of said passage, a valve interposed in said branch, the other branch of said duct opening to the exhaust, and a weighted valve for controlling said last mentioned branch.

15. A heat treating furnace comprising, in combination, a base support, a heating chamber for the product to be treated on said support, a superheater mounted on said chamber and having an elongated tortuous passage opening to one end of said chamber, a plurality of heating elements extending through said passage, heating means discharging into said elements at one end of said passage, means for supplying a heating fluid to the other end of said passage, and an exhauster connected to the other end of said chamber, said exhauster discharging to said last mentioned means.

16. A heat treating furnace comprising, in combination, an elongated rectangular horizontal

heating chamber for the product to be treated, said chamber having a door at one end and an exhauster at the other end, an elongated rectangular superheater mounted on said chamber and communicating therewith adjacent said door, horizontal vertically spaced baffles in said superheater defining a sinuous fluid passage, a plurality of immersion gas burners in the lower end of said passage, a plurality of heating tubes connected to said burners and extending along said passage, and means for supplying a heating fluid to the upper end of said passage.

17. A heat treating furnace comprising, in combination, a heating chamber for the product to be treated, a superheater superimposed on said chamber, said superheater and said chamber being substantially coextensive in width and being in communication, a narrow elongated inlet opening to said superheater, means for supplying steam in proximity to said inlet, a narrow elongated outlet from said chamber, said outlet converging into circular form, an exhauster connected to said outlet, said exhauster having a circular discharge duct, and a connection establishing communication between said inlet and said discharge duct, said connection having a weighted relief valve.

SOLOMON M. BEROLZHEIMER.
SLADE LE BLOUNT GAMBLE.