June 15, 1937. F. T. COPE 2,083,638

CONTROLLED ATMOSPHERE FURNACE CONSTRUCTION

Filed June 10, 1936 3 Sheets-Sheet 1

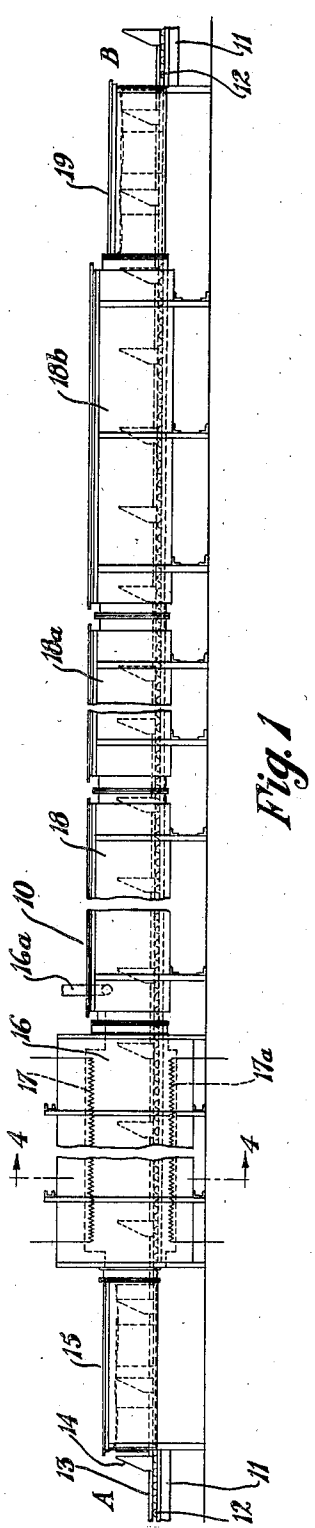


Fig. 1

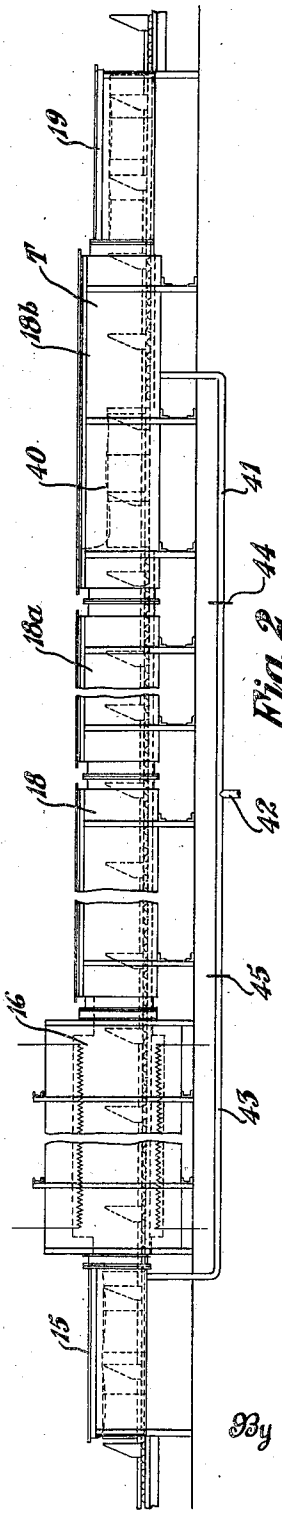


Fig. 2

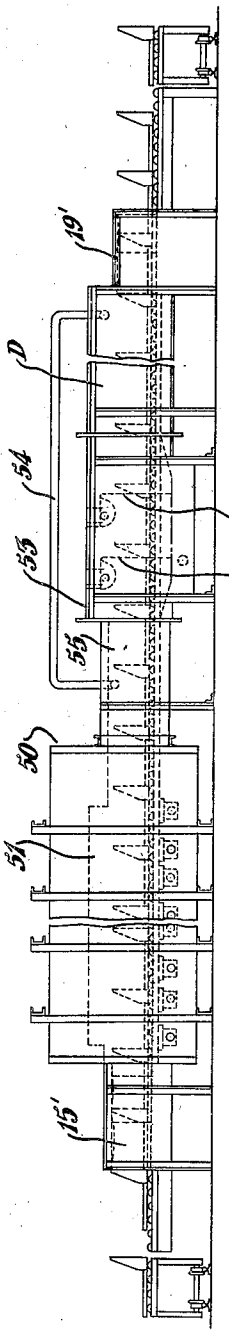


Fig. 3

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CONTROLLED ATMOSPHERE FURNACE CONSTRUCTION

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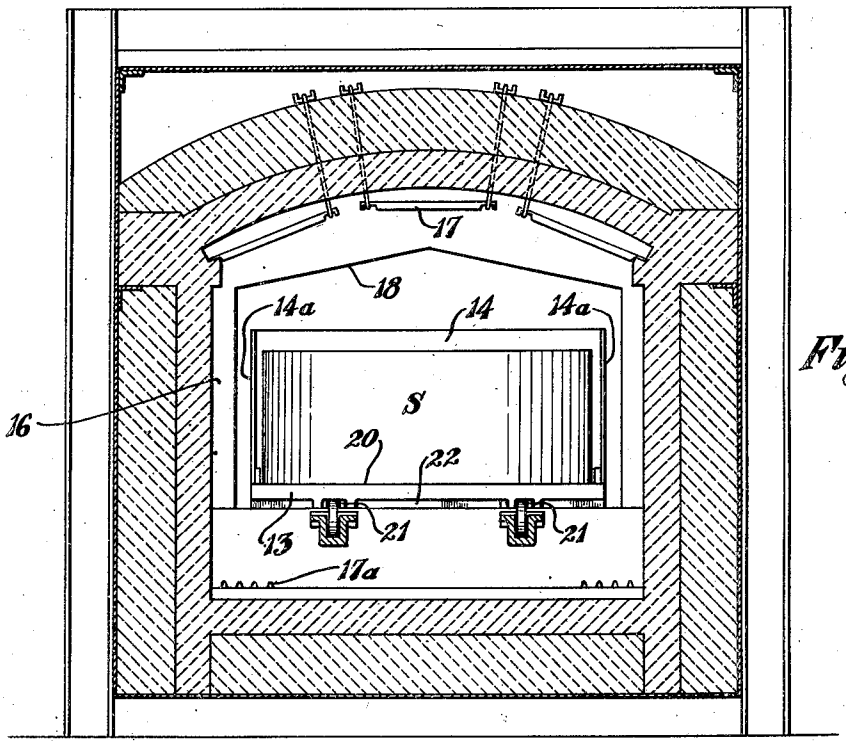


Fig. 4

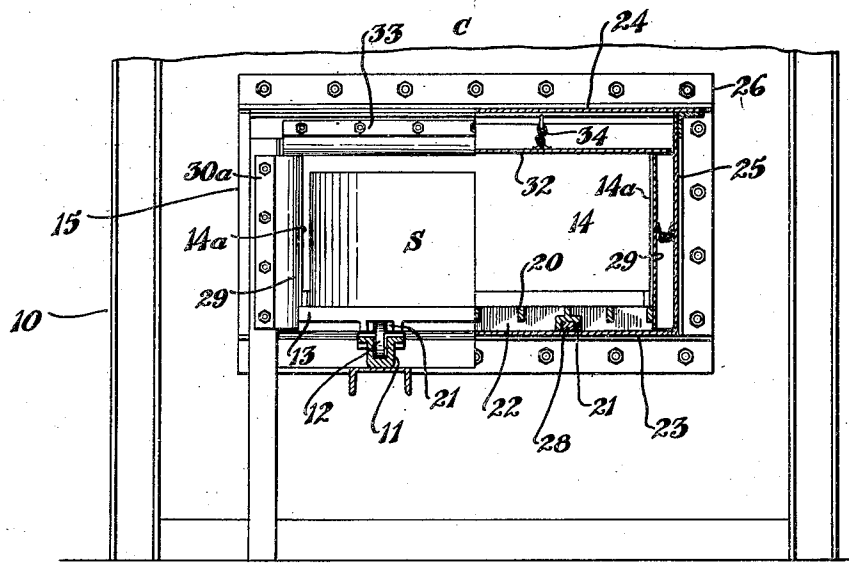


Fig. 7

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CONTROLLED ATMOSPHERE FURNACE CONSTRUCTION

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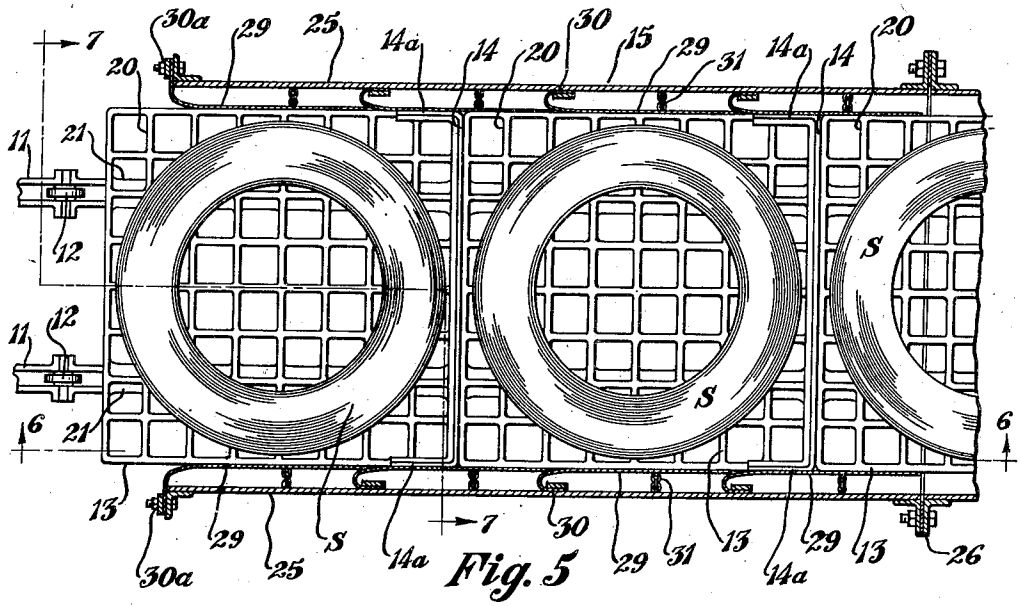


Fig. 5

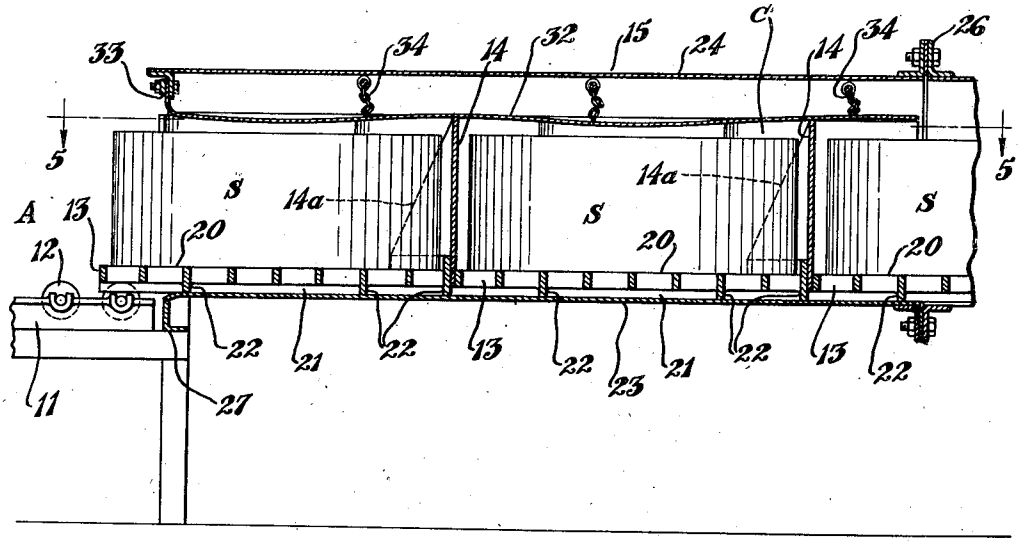


Fig. 6

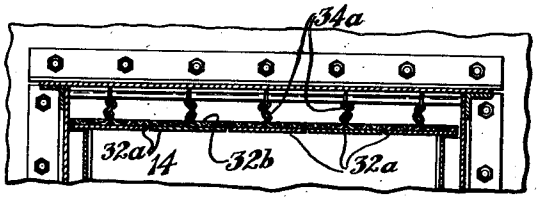


Fig. 8

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UNITED STATES PATENT OFFICE

2,083,638

CONTROLLED ATMOSPHERE FURNACE CONSTRUCTION

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Application June 10, 1936, Serial No. 84,485

17 Claims. (Cl. 266—5)

The invention relates generally to furnaces and is particularly applicable to special or controlled atmosphere furnaces which are used for the heating or heat treatment of ferrous or non-ferrous metals or alloys, or metal products made from such metals or alloys, including among others, coiled wire, sheets, and strips or stripsheets, particularly in coiled form, and the like; and more particularly, the invention relates to an improved manner of sealing either or both of the entrance or exit means for furnaces, and to an improved manner of handling and treating, and in some cases quenching materials in heating or heat treating furnaces.

Special or controlled atmosphere furnaces are extensively used for the heating or heat treatment of ferrous or non-ferrous metals or alloys or products thereof; and such furnaces may be electrically heated, gas fired, radiant tube heated, or heated by any other means, so long as the desired particular or special atmosphere is maintained or controlled within the furnace chambers, zones or compartments. A special atmosphere frequently used as in connection with the bright annealing of copper or copper alloy products, is one which is slightly reducing in character, or at least non-oxidizing in resultant effect upon the surfaces being treated. However, the special or selected atmosphere need not necessarily be reducing or non-oxidizing in character, because in certain cases, a selected atmosphere having other characteristics may be desired.

Ordinarily, ferrous metals or alloys cannot be satisfactorily treated in a special atmosphere furnace in which an open flame is present, and for this reason, special atmosphere heat treating furnaces for ferrous metals and alloys or products made therefrom are usually preferably electrically heated or are heated by radiant tube heating means.

A number of problems are involved in connection with the heating or heat treatment of materials in special or controlled atmosphere furnaces. In so far as it is possible to do so, atmospheric air must be prevented from entering the chambers or zones wherein it is desired to maintain the special atmosphere; the special atmosphere must be provided and maintained; and changes in the temperature or analysis of the atmosphere sought to be maintained must be guarded against.

These problems are quite difficult of solution in connection with a continuous or semi-continuous type furnace, because provisions must be made for the entry and withdrawal of material to and from such furnaces. This is usually accomplished by providing double doors for forming a so-called lock-chamber; but even with such a construction, the condition of the furnace atmosphere is ordinarily affected or disturbed to a considerable degree, coincident with the entry or withdrawal of material to or from such furnaces.

Moreover, it is usually desired to maintain a substantially static condition of the atmosphere in a controlled atmosphere furnace; but in furnaces equipped with double door, lock-chamber, entrance or exit means, a condition occurs upon opening and closing the doors which is commonly referred to as "sucking" and "blowing", and which is not a static condition of the atmosphere in the furnace.

Likewise, it may sometimes be desired to provide for quenching the articles or materials being treated, near the end of the heat treating cycle, and to sometimes follow such quenching operation with a drying operation, either in a controlled atmosphere or otherwise.

Controlled atmosphere furnaces have been proposed in which continuous material is moved through a furnace, or in which objects of uniform size are moved successively through a furnace, and swinging doors in contact with the material or objects open and close, either above and below or at the sides of the material or objects. However, such furnaces cannot be satisfactorily used for the heating or heat treatment of material in coiled form, or for treating material which may have a finished or a semi-finished surface, or for treating objects or materials in varying sizes and shapes.

I have discovered that these problems may be satisfactorily solved and many other difficulties incident to the operation of heating or heat treating furnaces may be avoided, and that objects or materials having finished surfaces, or having varying sizes or shapes, or in coiled form, may be satisfactorily heat treated in furnaces provided with liquid curtains as seals or closures for either or both of the entrance or exit passages or communications of the furnace, which seals may be utilized for the purpose of quenching the materials or articles being treated, as set forth in my copending application entitled "Controlled atmosphere furnace construction and operation", Serial No. 81,280, filed May 22, 1936.

However, the use of such furnaces necessarily involves a wetting of the material with the liquid medium with which the seals or curtains are formed; and it is sometimes undesirable to wet

certain materials when carrying out a heating or heat treating operation.

I have further discovered that these same problems may, however, be satisfactorily solved without wetting the materials, objects or articles being treated by providing a pusher type furnace with trays or the like upon which the materials to be treated may be supported. Such trays are also provided with a plate or bulkhead at either the front or rear end thereof, which plate or bulkhead cooperates with sealing means or instrumentalities provided at either the entrance or exit ends of the furnace, or in passages intermediate separate compartments of a furnace, for preventing escape of any considerable volume of the special atmosphere from the furnace; for preventing the occurrence of "sucking" or "blowing"; and for preventing a turbulent condition of the atmosphere within the furnace.

Accordingly, it is an object of the present invention to provide an improved closure or seal for a heating or heat treating furnace through which materials to be treated having varying sizes or shapes may be readily and freely passed without causing any appreciable disturbance to the temperature or analysis of the atmosphere within the furnace or compartments leading to or from the same, due to the passage of materials through the closure or seal.

It is a further object of the present invention to provide a special or controlled atmosphere heating or heat treating furnace with improved closure sealing means through which either ferrous or non-ferrous metals or alloys, or materials, articles or products made therefrom, including among others, wire, tubes, pipes, sheets, strips, stripsheets and the like, preferably in coiled form, may be passed for introducing the same into or for withdrawing the same from the furnace without causing the escape from the furnace of any objectionable volume of the special atmosphere, or without causing atmospheric air to enter the furnace incident to the passage of materials through the closure or sealing means.

Moreover, it is an object of the present invention to provide an improved closure means for a heating or heat treating furnace, which, regardless of the character of the furnace heating means, at all times effectively seals and closes the furnace passage, opening or communication with which it is associated, without, however, creating a direct contact between the material being treated and the sealing or closure means.

Another object of the present invention is to provide closure means for furnaces which enables swinging or sliding doors and lock-chambers formed thereby for the entrance and exit openings of a furnace, and the mounting and operating mechanism therefor, to be dispensed with.

Moreover, it is an object of the present invention to provide a heating or heat treating furnace with sealing or closure means for the entrance and exit passages thereof, to also provide for the quenching of material being passed therethrough before it reaches the exit passage, and to provide for drying the quenched material in a special or controlled atmosphere following the quenching operation and prior to its exit from the furnace.

Generally, it is also an object of the present invention to improve the construction and operation of heating and heat treating furnaces, particularly of the controlled or special atmosphere type.

The foregoing and other objects are obtained by the furnace constructions, apparatus, parts, improvements, operations, combinations, and subcombinations, which comprise the present invention, the nature of which is set forth in the following general statements, preferred embodiments of which, together with their modes of use or operation, are set forth in the following description, and which are particularly and distinctly pointed out and set forth in the appended claims forming part hereof.

The nature of the improvements of the present invention may be described in general terms as including in furnace construction having an entrance or exit passage or communication, means for sealing such passage or communication, including a train of trays for being moved intermittently or continuously through the furnace, a substantially rectangular plate or bulkhead supported at the front or rear end of each tray, and instrumentalities in said passage or communication contacting with the bottom of said tray and the sides and top of said bulkhead for cutting off communication between the furnace atmosphere and exterior atmosphere.

By way of example, several embodiments of the present improvements are illustrated in the accompanying drawings, forming part hereof, in which

Figure 1 is a fragmentary, diagrammatic, side elevation of an electric, pusher type, controlled atmosphere furnace having entrance and exit compartments or passages equipped with the improved sealing or closure means;

Fig. 2 is a similar view of an electric, pusher type, furnace involving a construction slightly modified from that shown in Fig. 1;

Fig. 3 is a similar view of a gas fired, pusher type, controlled atmosphere furnace having entrance and exit compartments equipped with the improved closure or sealing means;

Fig. 4 is a cross section taken on the line 4—4, Fig. 1, through the heating zone or compartment of the furnace shown in Fig. 1;

Fig. 5 is a plan sectional view taken on the line 5—5, Fig. 6, showing details of construction of the improved closure or sealing means;

Fig. 6 is an elevation section taken on the line 6—6, Fig. 5 of the construction shown in Fig. 5.

Fig. 7 is an end elevation partially in section, taken on the line 7—7, Fig. 5, showing the improved sealing and closure construction; and

Fig. 8 is a view similar to a portion of Fig. 7 showing a modified form of construction.

Similar numerals refer to similar parts throughout the several figures of the drawings.

Referring to Fig. 1, an electric, pusher type, controlled atmosphere, preferably bright annealing furnace is indicated generally at 10, and may be used for carrying out a bright annealing or heat treating operation on coiled copper wire, coiled copper strips, or the like. Such coils may be of varying sizes and may contain varying amounts of material; and in the case of copper, it is desirable to exclude air from the heating chamber so as to prevent a discoloration of the surfaces of the same in carrying out the annealing operation so that the bright finished surfaces of the material prior to heat treatment will not be affected by the heat treatment operation.

The furnace 10 may be provided with rails 11 carrying rollers 12 (Fig. 7) at the loading zone or station A, at the unloading zone or station B, and within certain portions of the furnace as shown in Fig. 1. Trays generally indicated at 13, having bulkheads generally indicated at 14,

may be moved, preferably pushed in a continuous train through the furnace 10.

The coils or other material to be treated may be placed on the trays 13 at the loading zone or station A and the trays then move into the entrance sealing chamber or compartment generally indicated at 15 and hereinafter described more in detail, then through the furnace heating chamber indicated at 16, which may be heated by electric resistors 17 and 17a, then through a cooling chamber which may comprise water jacketed tunnel portions 18, 18a and 18b, and then through the exit sealing chamber 19 similar to the entrance chamber 15, to the unloading zone or station B. The material may then be unloaded from the trays 13; and the trays 13 may then be returned by means of transfer cars (not shown) or a driven roller tray return, to a position adjacent to the loading zone A.

The entrance chamber, passage or compartment 15 and the exit chamber, passage or compartment 19 are each provided with the improved sealing or closure means, and are substantially identical in construction. The preferred construction of the passages 15 and 19 is best shown in Figs. 5, 6 and 7, which is more particularly illustrative of the entrance compartment 15.

Each tray 13 preferably comprises a latticed or perforate bottom 20, best shown in Fig. 5, with two or more spaced longitudinally continuous channels 21 formed on the bottom thereof and one or more cross ribs 22 extending laterally between and from the channels throughout the full width of the trays 13. As previously stated, each tray also has an end plate or bulkhead 14 provided preferably at its front end extending vertically upward therefrom and preferably formed integrally with side braces 14a; the bulkheads 14 and braces 14a being secured in any suitable manner to or formed integrally as a part of the trays 13.

The perforate bottom 20 is provided in each tray 13 so that heat from the bottom heating elements 17a in the furnace heating chamber 16 readily heats the under region of the material carried on the trays 13, such as the coiled strip material S shown in Figs. 4, 5, 6 and 7.

The compartment 15 is formed with a bottom wall 23, a top wall 24 and side walls 25 suitably connected at 26 with the furnace heating chamber 17, and at 27 with the means mounting the rails 11. The bottom wall 23 is provided with spaced rails 28 in alignment with the rollers 12 carried on the rails 11, located at the loading and unloading zones A and B and within the furnace heating chamber 17 and cooling passages 18, 18a and 18b, so that the tray channels 21 slide along the rails 28 as a train of the trays is moved, preferably by being pushed, through the furnace 10.

Preferably a plurality of thin spring metal projecting plates 29 are resiliently secured at 30 or 30a to each side wall 25 within the chamber 15, as best shown in Fig. 5; and movement of each plate 29 may be restricted by a chain 31. Each plate 29 preferably rides on the bottom wall 23 of the compartment 15 and extends upward therefrom a distance equivalent to the height of each bulkhead 14.

A similar projecting plate 32 is mounted on the top wall 24, at 33, and secured by a plurality of chains 34 so as to ride on the top edges of the plate 29 and bulkheads 14, as best shown in Fig. 6. The plate 32 is at least slightly longer than one tray 13 in order to insure that the plate 32 is always in contact with at least one bulkhead 14; and as an additional insurance the chamber 15 or 19 is preferably slightly longer than two trays 13 so as to effectively provide a sealed compartment diagrammatically indicated at C between bulkheads 14, the top plate 32 and bottom wall 23.

As shown in Fig. 6, the top plate 32 is preferably longer than two trays 13 so as to be always in contact with two bulkheads 14.

Such compartments C are formed for each tray 13 as a tray passes through the entrance chamber 15 or a similar exit chamber 19 so as to effectively seal off the entrance or exit passage of the furnace as material is being introduced into or withdrawn from the furnace on the trays 13.

Ordinarily, the trays move quite slowly through the furnace, such as for instance, by the passage of say four trays through the entrance chamber 15 per hour, so that the small amount of atmospheric air which is entrapped in each chamber C as the same is sealed off, becomes slowly heated from the tray compartment next ahead as each tray is slowly moved toward and ultimately into the furnace heating chamber.

If the furnace is electrically heated or heated by radiant tubes, the special atmosphere to be maintained within the furnace may be introduced into the same as through a pipe 16a; and a slight pressure is ordinarily maintained within the furnace so that any leakage therefrom will be an outleakage of the special atmosphere rather than an inleakage of atmospheric air.

Accordingly, there may be some slight leakage of the controlled atmosphere from the furnace chamber through the entrance sealing passage 15; but such leakage has a beneficial effect, because it will act to slowly purge the atmospheric air entrapped within a sealed compartment C, and at least partially fill such a compartment C with the special atmosphere so that the small remaining amount of atmospheric air which may be contained in compartment C when it reaches a position communicating with the furnace chamber, will be so slight as to have no appreciable effect upon the atmosphere specially maintained or controlled within the furnace.

After moving through the entrance passage 15, each tray moves slowly through the furnace chamber 16 and the material S thereon is heated to the desired heat treating temperature. Thereafter the trays pass through the cooling tunnels 18, 18a and 18b, which may have water cooled walls if desired, so as to cool the material down to such a temperature that their surfaces will be unaffected when coming in contact with atmospheric air at the station B after passing through the sealed exit passage 19.

The atmosphere in the furnace 16 and cooling tunnels 18, 18a and 18b is controlled, as stated, by the introduction of gases having the desired composition, as through the pipe 16a.

Referring to Fig. 2, the construction shown therein, is similar to that shown in Fig. 1, excepting that sealing or closure means similar to those provided in the entrance passage 15 and exit passage 19 are provided at 40 in the cooling compartment 18b so as to provide a compartment T, which does not communicate with the furnace heating chamber 16 and the remaining cooling passages 18 and 18a.

Thus, it is sometimes desirable to maintain the atmosphere within the heating chamber and cooling passages in as static or quiescent a con-

dition as possible. By providing the closure or seal **40** and by introducing the special atmosphere into compartment T through one branch **41** of a main **42** and similarly through another branch **43** from the main **42** into the entrance passage **15** adjacent to the heating chamber **16**, flow of gases back and forth through the furnace heating chamber **16** and cooling tunnels **18** and **18***a* is substantially prevented.

This static condition of the special or controlled atmosphere may be further controlled by providing orifices **44** and **45** in branches **41** and **43** respectively, of the proper size, so that a controlled amount of special atmosphere is introduced into the various compartments at all times.

Referring to Fig. 3, a gas fired furnace is generally indicated at **50** and the special atmosphere therein is controlled by controlling the combustion within the heating chamber **51** thereof. The furnace **50** may be equipped with entrance and exit passages **15'** and **19'** provided with sealing means similar to the sealing means provided in the entrance and exit passages **15** and **19**.

It may be desired to quench material being passed through the furnace **50** and for that purpose, a plurality of water curtain sealing and quenching means indicated generally at **52**, such as described in detail and claimed in my copending application Serial No. 81,280, may be provided in the cooling passage **53**.

These water curtain sealing and quenching means may be utilized to quench material to the desired temperature and seal off the heating chamber and cooling passage from the drying compartment D formed between the water curtain seals **52** and the sealed exit passage **19'**.

Ordinarily, in such a furnace it may usually be desired to dry in the same special atmosphere that is maintained in the heating chamber **51**, and for that purpose, a pipe **54** may communicate between passage **55** and drying compartment D for introducing the special atmosphere into compartment D.

If it is not desired to use the special atmosphere in drying compartment D, compartment D may be heated by circulating warm gases therethrough in any well known manner.

In the modified form of construction shown in Fig. 8 a series of strips **32***a* may be utilized instead of one plate **32** as shown in Fig. 7; and the strips **32***a* may each be supported by chains or the like **34***a*. For the purpose of sealing the joints between adjacent strips **32***a*, an asbestos fabric sheet **32***b* or the like may entirely cover the strips **32***a* so that the sealing means formed by the strips **32***a* and the fabric sheet **32***b* is yielding or resilient and readily accommodates itself throughout its length and width to the tops of the bulkheads **14** as the trays pass through the sealing chamber.

Having now described the features of the invention, the construction, operation and use of preferred forms of the same, in connection with different types of furnaces, and the advantages and results obtained by the use of the same; the new and useful parts, elements, combinations, constructions and devices, and reasonable mechanical equivalents thereof obvious to those skilled in the art are set forth in the appended claims.

I claim:—

1. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, an entrance passage communicating with the heating chamber, a quenching chamber communicating with the heating chamber, a drying chamber communicating with the quenching chamber, and an exit passage communicating with the drying chamber, trays for supporting material to be treated, means for moving a train of said trays successively through said entrance passage, heating chamber, quenching chamber, drying chamber and exit passage, means communicating between said heating chamber and said drying chamber whereby said special atmosphere is maintained in said drying chamber, and closure means for said entrance and exit passages including an upstanding imperforate plate on each tray, means in said passages cooperating with the bottom of each tray, and movable means in said passages contacting the sides and top of each plate.

2. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material being treated is moved, trays for supporting material to be treated, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, and means in said passage cooperating with the bottom of said tray and yieldingly mounted plates contacting the sides and top of said bulkhead, whereby a substantially sealed compartment is formed between adjacent bulkheads for each tray as each tray is passed through said passage.

3. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material being treated is moved, trays for supporting material to be treated, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, and means in said passage substantially cutting off communication between the furnace atmosphere and the exterior atmosphere including a top plate lying by gravity in contact with the tops of the bulkheads of successive trays.

4. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material being treated is moved, trays for supporting material to be treated, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, and means in said passage substantially cutting off communication between the furnace atmosphere and the exterior atmosphere including movable side plates in pressure contact with the sides of the bulkheads of successive trays.

5. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material being treated is moved, trays for supporting material to be treated, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, and means in said passage substantially cutting off communication between the furnace atmosphere and the exterior atmosphere including a flexible top plate contacting with the tops of the bulkheads of successive trays.

6. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material

being treated is moved, trays for supporting material to be treated, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, and means in said passage substantially cutting off communication between the furnace atmosphere and the exterior atmosphere including movable plates within the passage cooperating with the sides and top of said bulkhead in planes substantially parallel to the direction of movement of said trays.

7. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material being treated is moved, trays for supporting material to be treated, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, each tray having a perforated bottom wall, a cross rib on each tray bottom wall adjacent to said bulkhead, and means in said passage cooperating with the rib and movable means in the passage cooperating with the bulkhead of each successive tray substantially cutting off communication between the furnace atmosphere and the exterior atmosphere.

8. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, an entrance passage communicating with the heating chamber, a quenching chamber communicating with the heating chamber, and a drying chamber communicating with the quenching chamber, trays for supporting material to be treated, means for moving a train of said trays successively through said entrance passage, heating chamber, quenching chamber and drying chamber, and closure means for said entrance passage including an upstanding imperforate plate on each tray, means in said passage cooperating with the bottom of each tray, and movable means in said passage contacting the sides and top of each plate.

9. A furnace having a heating chamber and walls forming a passage communicating with the chamber through which material being treated is moved; tray means for supporting material to be treated, means for moving a train of said tray means through said passage, and closure means for said passage including an upstanding plate on each tray means, means in said passage cooperating with the bottoms of said tray means, and movable means in the passage contacting the sides and tops of said plates.

10. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, a passage communicating with said chamber through which material being treated is moved, trays for supporting material to be treated, each of less length than the length of the passage, means for moving a train of said trays through said passage, a substantially vertical bulkhead on one end of each tray, means in said passage cooperating with the bottoms of said trays, and movable means projecting from the passage walls contacting the sides and tops of said bulkheads so constructed that a substantially sealed compartment is formed between adjacent bulkheads as the trays are passed through said passage.

11. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, an entrance passage communicating with the heating chamber, an exit passage communicating with the heating chamber, trays for supporting material to be treated, means for moving a train of said trays successively through said entrance passage, heating chamber and exit passage, and closure means for each of said passages including an upstanding bulkhead on one end of each tray, means in each of said passages cooperating with the bottoms of said trays, and means in each of said passages spaced from the walls thereof contacting the sides and tops of said bulkheads.

12. In a controlled atmosphere furnace having a heating chamber in which a special gaseous atmosphere is maintained, an entrance passage, an exit passage, and a cooling passage communicating between the furnace chamber and exit passage; trays for supporting material to be treated, means for moving a train of said trays through said chamber and passages, closure means for said entrance and exit passages, and closure means in said cooling passage intermediate said furnace chamber and said exit passage including an upstanding bulkhead on one end of each tray, means in said cooling passage cooperating with the bottoms of said trays, and movable means mounted on the cooling passage walls contacting the sides and tops of said bulkheads to form an intermediate compartment between said cooling passage closure means and said exit passage; and means for introducing controlled amounts of said special atmosphere separately into said intermediate compartment and said heating chamber.

13. The combination with walls forming a passage communicating with the heating chamber of a heat treating furnace through which material is moved on a train of trays, of closure means for the passage including an upstanding plate on each tray, means in said passage cooperating with the bottoms of said trays, and movable means mounted on the passage walls contacting the sides and tops of said plates.

14. The combination with walls forming a passage communicating with the heating chamber of a heat treating furnace through which material to be treated is moved on a train of trays, said passage walls including bottom, side and top walls; of closure instrumentalities for the passage including an upstanding plate on each tray, means substantially cutting off communication through said passage between the tray bottoms and said passage bottom wall, movable means carried by said passage side walls substantially cutting off communication through said passage between said passage side walls and said plates, and movable means carried by said passage top wall substantially cutting off communication through said passage between said passage top wall and said plates.

15. The combination with walls forming a passage communicating with the heating chamber of a heat treating furnace through which material to be treated is moved on a train of trays, said passage walls including bottom, side and top walls; of closure means for said passage including an upstanding plate on one end of each tray and a cross rib on the bottom thereof, said cross rib cooperating with the passage bottom wall as the tray moves through the passage, and spring plates carried by said passage side and top walls contacting with the sides and top of each tray plate.

16. In a controlled atmosphere furnace having a heating chamber, a passage communicating with said chamber through which material being treated is moved, trays for supporting ma-

terials to be treated, means for moving a train of trays through said passage, upstanding bulkheads associated with the trays, means in said passage cooperating with the bottoms of said trays, movable means projecting from the passage walls contacting the sides and tops of said bulkheads, and adjacent bulkheads being spaced closer together than the total length of said movable means contacting with the bulkheads to form substantially sealed compartments between adjacent bulkheads as the trays are passed through said passage.

17. In a controlled atmosphere furnace having a heating chamber, a passage communicating with said chamber through which material being treated is moved, trays for supporting materials to be treated, means for moving a train of trays through said passage, upstanding bulkheads associated with the trays, means in said passage substantially cutting off communication between the furnace atmosphere and the exterior atmosphere including a flexible top plate contacting with the tops of the bulkheads of successive trays, said top plate being longer than two trays so as to be always in contact with two adjacent bulkheads as the trays are passed through said passage.

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