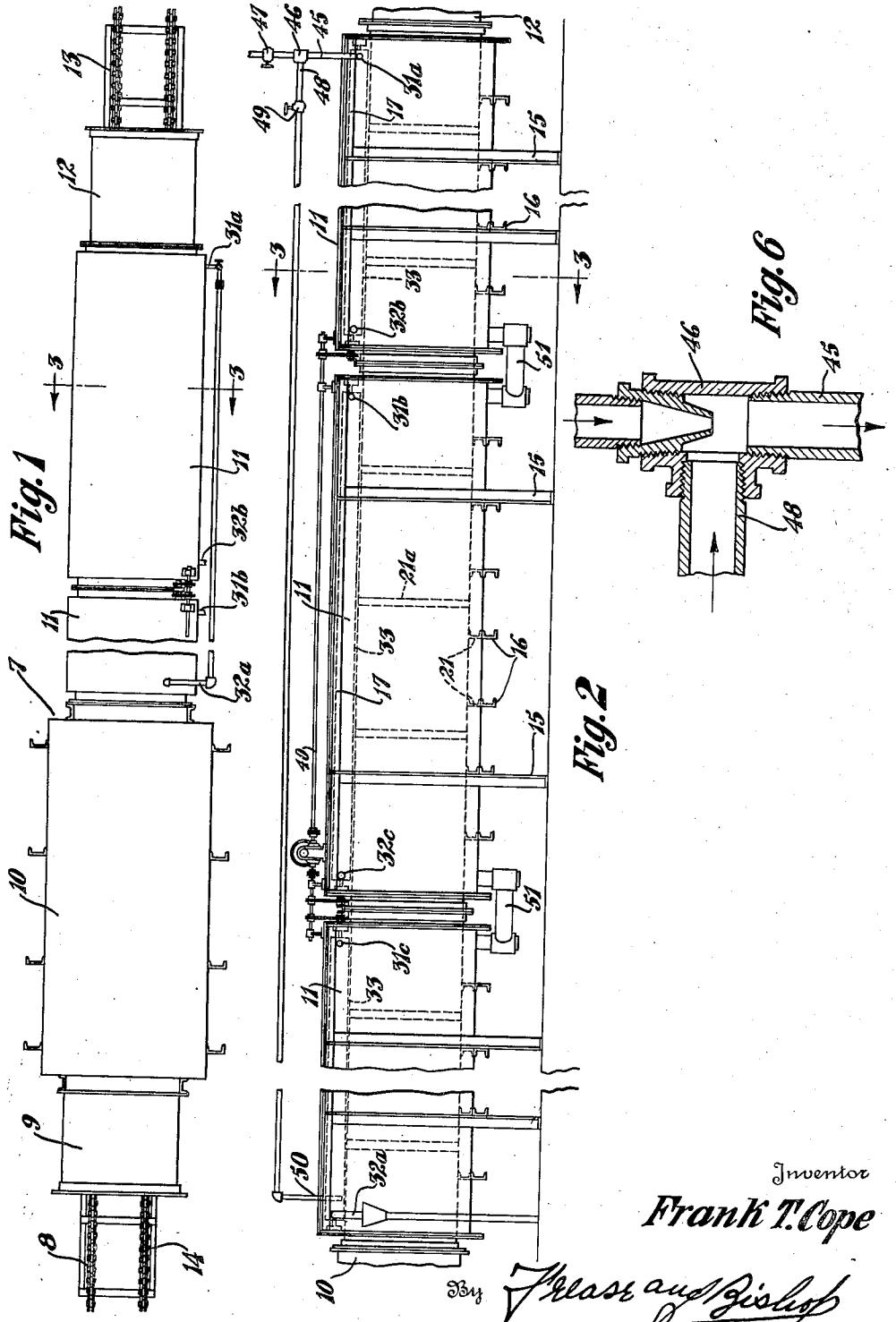
May 28, 1940. F. T. COPE 2,201,988

COOLING CHAMBER CONSTRUCTION FOR FURNACES

Filed May 31, 1938 2 Sheets-Sheet 1



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COOLING CHAMBER CONSTRUCTION FOR FURNACES

Filed May 31, 1938 2 Sheets-Sheet 2

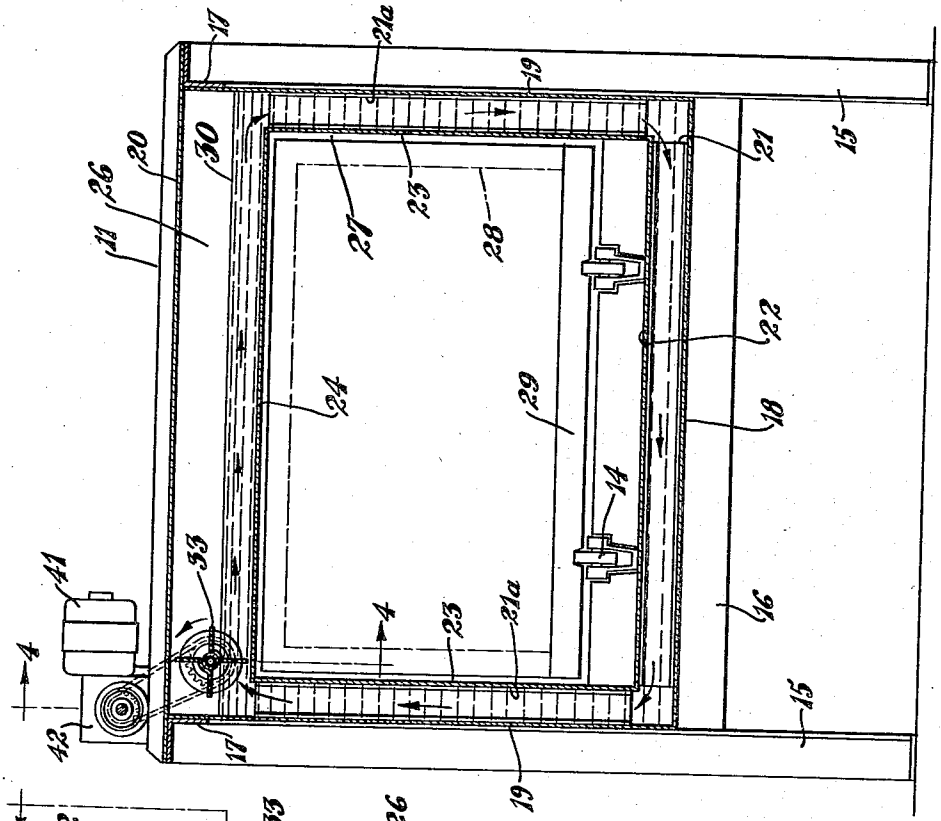

Fig. 3

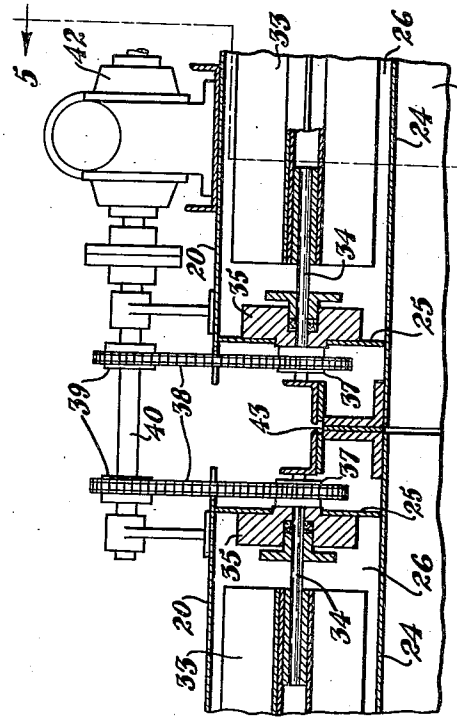

Fig. 4

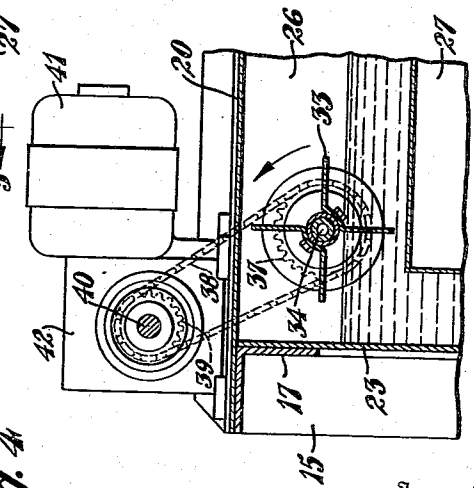

Fig. 5

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COOLING CHAMBER CONSTRUCTION FOR FURNACES

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13 Claims. (Cl. 263—44)

The invention relates generally to furnaces and more particularly to special or controlled atmosphere furnaces and to an improved cooling chamber construction for special or controlled atmosphere furnaces.

Special or controlled atmosphere furnaces of the continuous type are being used extensively for the heating and heat treatment of various materials. Ordinarily, the material is discharged from the heating chambers of such furnaces at temperatures ranging from 800° F. to 2000° F., but obviously it cannot be discharged at such temperatures directly into the air or the benefits of treatment in a special or controlled atmosphere would be lost.

Usually the material must be cooled to a temperature of about 200° F. to 300° F., or even lower to about 100° F. if a bare hand handling operation is to follow, before discharging the material into the atmosphere; and this cooling is ordinarily accomplished by passing the material from the heating chamber through a cooling chamber or duct provided with water cooled walls.

Large quantities of water must be used for such cooling because the entry water temperature is usually about 70° F. and the discharge water temperature cannot be above the boiling point of water and usually is about 180° F. unless only a smaller temperature rise is permissible. With these conditions a furnace having a useful electrical input of 100 k. w. in excess of losses would use from 400 to 800 gallons of water per hour depending upon the permissible temperature rise.

A problem in prior furnace operation has been to provide for economical use of cooling water; but this problem is further complicated because when the volume of water used is reduced, in the usual double walled cooling chamber construction, hot spots may develop. These so-called hot spots may be pockets of steam which form and suddenly condense causing thumping or "water hammer"; or may be air pockets from air liberated from the water by heating.

When such hot spots develop, the walls, particularly the bottom walls of the cooling chamber, may bend, warp or buckle or even crack from steam pressure, water hammer or because of large temperature differentials between water and steam covered plate wall sections. If a bottom plate warps or is bent, the conditions for forming steam or air pockets therebelow become much worse, thus multiplying the difficulties.

On the other hand, if enough additional cold water is used to eliminate the possibility of the formation of hot spots, then cold spots may develop where the cooling chamber walls are just as cold as the water introduced; and if more than a certain amount of water vapor is present in the furnace and cooling chamber atmosphere, the cooling chamber walls will sweat at the cold spots and drip onto the material being treated and ruin the surface thereof.

Accordingly, it is an object of the present invention to provide a furnace cooling chamber construction in which cooling water may be economically used.

A further object of the present invention is to provide a double walled furnace cooling chamber construction in which rapid and uniform cooling may be effected.

Moreover, it is an object of the present invention to provide a furnace cooling chamber construction in which the formation of hot spots and cold spots, and warping, buckling, cracking and sweating caused thereby, are substantially eliminated.

Additionally, it is an object of the present invention to provide a furnace cooling chamber construction in which the cooling water may be discharged at a relatively high temperature, close to the boiling point, while at the same time the possibility of hot spots developing is avoided.

And finally, it is an object of the present invention to generally improve the construction of furnace cooling chambers and to reduce the cost of maintenance and operation of the same.

These and other objects may be obtained by the elements, parts, combinations, constructions, arrangements and operations constituting the present invention, a preferred embodiment of which is shown in the appended drawings and is hereinafter described in detail and claimed, which may be stated in general terms as including, in cooling chamber construction for furnaces, an inner tubular wall forming a cooling chamber, outer walls spaced from and surrounding said inner wall forming with said inner wall a compartment having a tubular liquid cooling medium body therein surrounding said cooling chamber, means for passing material to be cooled through said chamber, inlet means for supplying liquid cooling medium, preferably water, to said compartment, outlet means for withdrawing liquid cooling medium from said compartment, and means for circulating said cooling medium in said compartment annularly or circumferentially thereabout substantially uniformly throughout the length of the cooling chamber, including a paddle wheel in the compartment extending longitudinally thereof substantially throughout the

length of the compartment, and means for rotating the paddle wheel.

In the drawings,

Figure 1 is a plan view, with parts broken away, of a special atmosphere furnace having the improved cooling chamber construction incorporated therein;

Fig. 2 is a side elevation of portions of the cooling chamber shown in Fig. 1;

Fig. 3 is a cross section of the cooling chamber taken on the line 3—3, Figs. 1 and 2;

Fig. 4 is an enlarged fragmentary section taken on the line 4—4, Fig. 3, illustrating the improved circulating means;

Fig. 5 is a section taken on the line 5—5, Fig. 4; and

Fig. 6 is a fragmentary view illustrating the injector means shown in Fig. 2.

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

A special atmosphere furnace installation is generally indicated at 7 in Fig. 1 and may include a loading table 8, an entrance vestibule 9, a furnace 10 including a heating chamber, a cooling chamber formed of a plurality of cooling chamber sections 11, an exit vestibule 12 and an unloading table 13. The loading and unloading tables 8 and 13, the vestibules 9 and 12 and the furnace 10 may be of any usual construction, and as shown, the entire installation is of a continuous type with a roller hearth 14 extending therethrough.

The present invention pertains more particularly to the construction of the cooling chamber which preferably is constructed of a plurality of generally similar sections 11, it being understood that one, two, three, four or more of such sections may be used in accordance with the requirements of the furnace 10 in the installation of which the cooling chamber forms a part.

Each cooling chamber section 11 preferably is constructed with upright supporting members 15, cross members 16 and longitudinal members 17 upon which are preferably mounted an outer bottom wall 18, outer side walls 19 and an outer top wall 20 forming together an outer tubular compartment.

Spaced inner cross supporting and wall spacing members 21 and similar spaced side wall spacing members 21*a* are mounted within walls 18, 19 and 20 on which are mounted an inner bottom wall 22, inner side walls 23 and an inner top wall 24, which form with end walls 25, the compartment indicated generally at 26 between the outer walls 18—19—20 and the inner walls 22—23—24.

The compartment 26 surrounds a cooling chamber generally indicated at 27 through which material indicated diagrammatically by dot-dash lines in Fig. 3 at 28, may be continuously passed by any suitable means on trays or the like 29 along the roller hearth 14.

The compartments 26 are each filled with a tubular liquid cooling medium body, preferably water, to a level such as indicated at 30 in Fig. 3 through inlet pipe indicated at 31*a* in Figs. 1 and 2; and the liquid level 30 may be maintained by providing a suitable overflow outlet 32*a*, by which inlet and outlet the cooling medium may be introduced into and discharged from the compartments 26.

Means is provided in each compartment 26 for circulating the tubular liquid cooling medium body annularly around or laterally of the compartments 26 in the direction of the arrows shown in Fig. 3 substantially throughout the length of the compartments. Such means may include a paddle bladed wheel 33 mounted on shaft 34 supported by suitable stuffing boxes and bearings 35 mounted in end walls 25. At least one end of each shaft 34 extends through end wall 25 preferably for a driving connection for the paddle wheel 33 from the exterior of the compartments 26, as by mounting a sprocket 37 on the extended end of shaft 34 and driving the sprocket through chain 38 and sprocket 39 from shaft 40 driven by motor 41 through a suitable reduction 42.

As shown, particularly in Fig. 2, a single motor 41 may drive all paddle wheels 33 in all of the compartments of all cooling sections 11 by extending shaft 40 in each direction from reduction unit 42 through suitable couplings and bearings so that the paddle wheels of adjacent sections may be driven adjacent to each other at the connections 43 between adjacent sections best illustrated in Fig. 4.

Paddle wheels 33 are preferably rotated from 15 to 50 R. P. M., and as previously stated, because the blades or paddles 33 of the paddle wheels extend substantially the full length of each compartment 26, the liquid cooling medium is circulated annularly around the compartment substantially uniformly throughout the length of each compartment. Although an outer top wall 20 has been shown, the same need not necessarily be used as it acts only as a cover or closure for each compartment 26.

Inlet 31*a*, in right hand compartment 26 may be connected through pipe 45 with an injector 46, a cold fluid inlet valve 47 and an injector intake line 48 with a valve 49 therein. The injector intake line 48 may communicate with the cooling medium in a left hand compartment 26 at the hottest region thereof as at 50 whereby cold cooling medium introduced through pipe 45 draws a portion of the hotter used cooling medium through injector intake 48 to temper the temperature of the cold cooling medium if desired. Additional inlets 31*b* and 31*c* and outlets 32*b* and 32*c* may be provided, if desired, so that each compartment 26 may have a separate inlet and outlet.

The continued circulation of the cooling medium within each compartment 26 prevents the formation of hot spots or cold spots therein, particularly beneath inner bottom wall 22 and thus avoids bending or buckling and ultimate cracking particularly of any of the inner walls 22—23—24, and likewise prevents the formation of condensate within the inner walls 22—23—24 in the cooling chamber 27, which might drip upon and spoil the material 28 being cooled therein.

The compartments 26 of adjacent sections 11 are preferably connected together by jumpers 51 which form inlet and outlet passages for the flow of liquid cooling medium from one compartment to another.

Accordingly, the present improvements eliminate the problems encountered in prior furnace operation with respect to the economical use of cooling water and the development of hot or cold spots because the present improvements prevent the formation of hot or cold spots in the cooling chamber during use, even though the cooling water is discharged at a temperature approaching the boiling point of water. Thus, the present invention provides for most economical use of cooling medium and yet enables the materials being cooled to be rapidly and uniformly cooled. Moreover, warping, buckling, cracking and sweating of the cooling chamber walls are substantially eliminated due to the prevention of

the formation of hot and cold spots; so that the cost of maintenance and operation of the improved furnace cooling chamber construction is appreciably reduced.

Having described the objects of the invention, the new and useful parts, elements and combinations constituting the invention, the operation of the improved cooling apparatus, and the new results obtained thereby; it is understood that the scope of the present invention is not limited to the particular details of construction shown herein, but the elements of any of the claims are intended to include reasonable mechanical equivalents obvious to those skilled in the art.

I claim:

1. In furnace cooling chamber construction, spaced inner and outer walls and end walls forming a compartment between the walls surrounding a tubular cooling chamber inside the inner wall, inlet and outlet means for introducing and discharging liquid cooling medium into and from said compartment, and means for circulating liquid cooling medium in said compartment annularly around said tubular cooling chamber throughout the length thereof.

2. In a double walled compartment for a tubular liquid cooling medium body, means in the compartment between the walls for circulating liquid cooling medium annularly around the compartment throughout the length thereof, and means outside of the compartment for driving said first mentioned means.

3. In furnace cooling chamber construction, spaced inner and outer walls and end walls forming a liquid cooling medium containing compartment between the walls surrounding a tubular cooling chamber inside the inner wall, means for circulating liquid cooling medium annularly in said compartment around said chamber including a paddle wheel in the compartment extending longitudinally thereof substantially throughout the length of the compartment, and means for rotating the paddle wheel.

4. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, and means for driving said circulating means.

5. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, and means for driving all of said circulating means in unison.

6. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, means for driving said circulating means, and inlet and outlet means for each section for introducing and discharging liquid cooling medium into and from the compartment of each section.

7. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, means for driving said circulating means, and means conmmunicating between the compartments of adjacent sections providing passages for the flow of liquid cooling medium from one compartment to another.

8. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, means for driving said circulating means, inlet and outlet means for each section for introducing and discharging liquid cooling medium into and from the compartment of each section, and means communicating between the compartments of adjacent sections providing passages for the flow of liquid cooling medium from one compartment to another.

9. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, means for driving said circulating means, means for introducing cold liquid cooling medium into the compartment of one of said sections including an injector having an intake, and a communication between the injector intake and hot cooling medium contained in the compartment of another section whereby the temperature of the cold liquid cooling medium may be raised.

10. In cooling chamber construction having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, means within the compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length of the compartment, means for driving said circulating means, means for introducing cold liquid cooling medium into said compartment including an injector having an intake, and means communicating between the injector intake and the liquid cooling medium contained in said compartment whereby the temperature of the cold liquid cooling medium introduced into the compartment may be raised.

11. In furnace cooling chamber construction, a plurality of cooling chamber sections each having spaced walls forming a longitudinally extending liquid cooling medium containing compartment,

said sections being aligned and forming a tubular cooling chamber through which material being treated may be continuously passed, means in each compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length thereof, means for driving said circulating means, inlet means at one end of each section for introducing liquid cooling medium into the compartment thereof, and outlet means at the other end of each section for discharging liquid cooling medium from the compartment thereof.

12. In cooling chamber construction having spaced walls forming a longitudinally extending liquid cooling medium containing compartment, means within the compartment for circulating liquid cooling medium laterally of the compartment substantially uniformly throughout the length of the compartment, means for driving said circulating means, means for introducing cold liquid cooling medium into said compartment, and means for mixing some of the cooling medium from the compartment with said cold liquid cooling medium whereby the temperature of the cold liquid cooling medium introduced into the compartment may be adjusted.

13. In furnace cooling chamber construction, spaced walls forming a liquid cooling medium containing compartment, a longitudinally extending tubular liquid cooling medium body in said compartment surrounding a cooling chamber, and means for laterally circulating the liquid cooling medium substantially uniformly throughout the length of the body thereof.

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