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I. B. SMITH

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FURNACE

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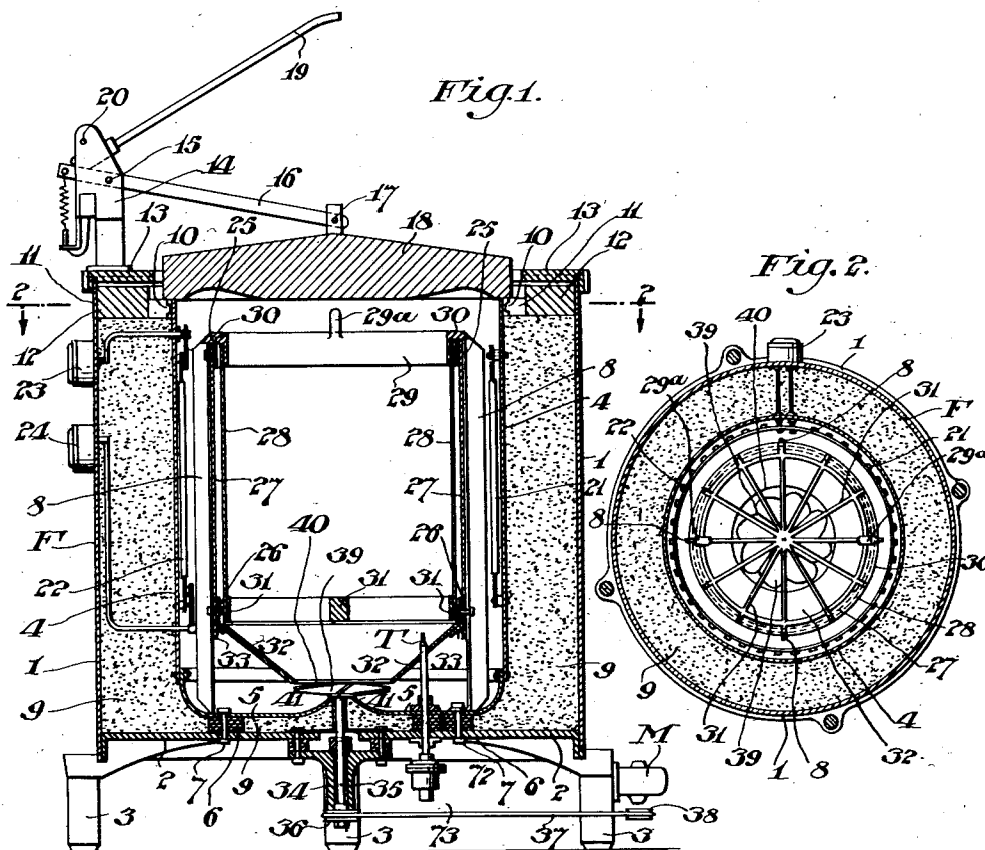


Fig. 2.

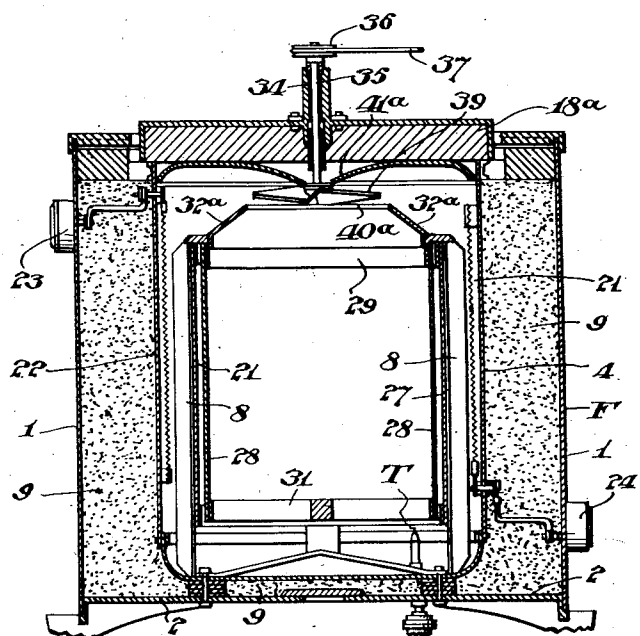
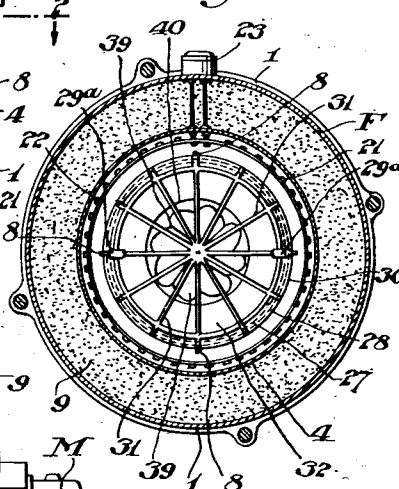


Fig. 3.

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FURNACE.

Original application filed October 30, 1925, Serial No. 65,715. Divided and this application filed March 2, 1928. Serial No. 258,489.

My invention relates to heating apparatus, as furnaces, and more particularly to electrically heated furnaces utilizable for various purposes, and particularly for heat treatment of steel and kindred materials, as, for example, for drawing or tempering steel or the like.

In accordance with my invention, to render more uniform the temperature throughout the heating chamber, and more particularly throughout the contents thereof treated therein, circulation, and particularly forced circulation, in either direction, of the air or gas, more particularly within the furnace is effected in a path or circuit including a work-containing chamber, and an air heating chamber, more particularly an outer chamber of said furnace, preferably containing the source of heat, and suitable passages effecting communication between the chambers.

My invention resides in apparatus of the character hereinafter described and claimed.

For an illustration of some of the various forms my invention may take, reference is to be had to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view, partly in elevation, of an electric furnace embodying my invention.

Fig. 2 is a horizontal sectional view, partly in plan, on the line 2—2 of Fig. 1.

Fig. 3 is a vertical sectional view of a modified form of furnace.

Referring to Figs. 1 and 2, there is shown a furnace or heat treating apparatus F, adapted for forced circulation, comprising the metal jacket or housing 1, which may be cylindrical, secured at its lower end to the bottom member 2, carried by a frame having the legs 3. Disposed within and spaced from the jacket 1 is the shell or inner lining 4, whose bottom 5 is spaced from the bottom 2 by the blocks 6, through which extend the bolts 7 which secure the member 5 and also the vertically extending supporting members 8 to the bottom 2. Between the shells 1 and 4, and between the bottoms 2 and 5, is disposed any suitable filling 9, of refractory material of preferably low heat conductivity. The upper end of the lining 4 is secured to the annular member 10, surrounded by the ring 11 of refractory material, which in turn is surrounded by the brick ring 12, upon which latter rests the top annular casting 13,

upon which is carried the support 14, to which there is pivoted at 15 the arm 16, to which is pivoted at 17 the lid or cover member 18, which may be raised by pressing downwardly upon the lever 19, pivoted at 20 and engaging the arm 16 to the left of its pivot 15.

In so far as concerns some of the features of my invention, heat may be developed within the furnace by any suitable method, as by combustion of gas or oil. In the example illustrated, however, and as regards other aspects of my invention, the heat is generated electrically by passage of current through the resistances or resistors 21 and 22 of any suitable type or character, either embedded in refractory material, or, as illustrated, disposed in the open within the furnace chamber adjacent the inner lining 4. As indicated, in Fig. 2, there are two sets of resistances, each comprising a plurality of parallel connected resistors or resistance conductors extending vertically adjacent and insulated from the lining 4. Connections are made to the resistors through conductors having terminals in the terminal boxes 23 and 24. In the example illustrated, the resistance elements 21 and 22 are exposed to direct contact therewith of the air or other gas within the furnace chamber.

Between the upper and lower rings 25 and 26 and the standards or members 8 is secured the shell or basket support 27, of sheet metal, preferably circumferentially and vertically continuous or substantially uninterrupted by perforations or openings, to exclude radiant heat from the interior of the shell 27.

The removable basket or container for the material to be heated comprises the closed shell 28 secured at its upper end to the ring 29, having the eyes 29^a for reception of crane hooks, and having the outwardly extending flange 30 resting upon the upper end of the shell 27 and members 8. At its lower end the shell 28 is secured to the spider 31.

Disposed below the basket and its spider 31 and forming a bottom for the shell 27 is the conical or funnel-shaped member 32 secured upon a ring or pieces 33 secured to the members 8.

Bolted to the bottom 2 is the fan shaft bearing member 34, in which is disposed the shaft 35, upon which is secured the pulley

36 driven through belt 37 by the pulley 38 secured upon the shaft of the electric motor M, for driving the fan or blower 39, disposed at the opening 40 at the bottom of the member 32. The bottom 5 of the inner lining 4 preferably deflects upwardly, as at 41, to form a passage leading to the lower side of the fan 39.

In the modification illustrated in Fig. 3, the removable lid or cover 18^a carries the bearing 34 for the fan shaft 35 driven by belt 37 through pulley 36. At its lower end the shaft 35 carries the propeller or fan 39, adjacent and above which is disposed the downwardly extending air-guiding surface 41^a, and beneath the fan is disposed the conical or funnel-shaped member 32^a carried by the upper ring 29 of the basket or work container 28. The opening 40^a of the member 20 32^a is disposed adjacent the fan 39.

In both forms of my apparatus above described, there is effected forced circulation by the fan or propeller 39 through a path or in a circuit comprising the space between the 25 outer and inner chamber walls 4 and 27, the inner chamber, particularly the work holder or container 28, and the upper and lower passages effecting communication between the outer spaces and the inner chamber. This 30 circulation may be in either direction, as may be desired.

The work or material to be heated is placed within the basket 28, resting upon the lower grating or spider 31. The work may be a 35 single piece, or a plurality of pieces either carefully or symmetrically piled within the basket or placed therein irregularly. For example, the contents of the basket may be a plurality of gears of steel or alloy steel to 40 receive heat treatment of any suitable character, for example, for drawing or tempering, although it will be understood that my invention embraces heat treatment of other objects, and of other metals, or their alloys.

45 With the furnace cold, it is brought rapidly to the desired temperature, as, for example, a temperature of a predetermined magnitude at which the chamber is to be maintained, by passing current through the sets 50 of resistors 21 and 22 in parallel. The desired temperature depends upon the treatment to be effected and characteristics of the material or objects to be treated; it is well known that for annealing or hardening the 55 temperatures are from approximately 1300 degrees F. to about 1700 degrees F. while for tempering, the temperature is, in general, lower and may be from about 300 degrees F. to 1200 degrees F., more or less. During this 60 preliminary stage of heating the fan 39 is driven by the motor M at suitable speed, effecting circulation of the hot gases or air downwardly, Fig. 1, between the shells 4 and 27, past the resistors 21 and 22, thence be- 65 tween the members 32 and 41 to the under

side of the fan 39, which forces the air or gases upwardly through the member 32, spider 31, through the basket or shell 28, upwardly through and between the gears or other pieces therein, and thence outwardly 70 over the edge of the basket and thence downwardly again between the shells 4 and 27. This circulation of the heated air or gas serves to maintain the temperature rise more uniform throughout the basket and its contents and serves also to expedite the rise in 75 temperature of the furnace. After the furnace has attained desired temperature, as may be determined by the thermocouple T, connected in suitable circuit by conductors 72 80 and 73, or has approximated such desired temperature, the rate of heat application may be diminished, as by utilizing only a suitable part of either or both of the resistors 21 and 22, or by connecting them in series with each 85 other. The control of the temperature of the furnace may be automatically effected by any suitable apparatus controlled by the thermocouple T, or equivalent temperature-responsive 90 device.

By so circulating the air or gases within the furnace, greater uniformity of temperature of the work or contents of the basket 28 is obtained, with resultant advantage 95 that the work or material is more uniformly heat-treated, yielding products more uniform in their characteristics as affected by the heat treatment.

The desired uniformity of temperature of the contents of the basket is the more readily 100 obtainable from the fact that the basket 28 or the shell 27, or both, intercept the radiant heat which would otherwise be absorbed by those parts of the contents lying adjacent the wall or shell 28, causing them locally to attain a temperature higher than is due to the 105 heating effects of convection or conduction of or from the hot air or gases. In other words, it is preferred that the heating shall be effected substantially exclusively by convection or conduction and that heating effects due to radiant heat should be minimized.

A furnace of the character herein described is utilizable for various methods of heat treatment, including that described in 115 Letters Patent to Wrighton No. 1,188,128, in which case the thermocouple T may be utilized to control a recorder or equivalent for drawing a curve in the nature of a time-temperature curve for making observable by inflections of the curve the time when the work passes through a decalescence stage; and that 120 of my copending application Serial No. 65,715, filed October 30, 1925, of which this application is a division. 125

The direction of circulation of the air or gas within the furnace may be reversed from time to time or periodically, as by reversing the direction of rotation of the fan or blower 39, as described and claimed in application 130

Serial No. 10,486, filed by John W. Harsch on February 20, 1925.

A further feature relates to the heat capacity of the heater or heating element, particularly the resistors or resistance elements 21 and 22. The source of heater or heating elements 21 and 22 preferably shall have low heat capacity, or small capacity for storing heat, in the sense that they are directly or substantially directly exposed to the air or gas within the furnace, or, if embedded, the mass shall be small enough to store only relatively small amount of heat; or shall have a heat capacity which is low as compared with the heat capacity of the material or work to be heat-treated. This low heat capacity of the resistance elements 21 and 22, or equivalent, is desirable from the standpoint of ability rapidly to change in temperature, thereby contributing, with the circulation of the air, to reduction or elimination of over-shooting of temperature either when bringing the heating chamber up to desired or control temperature, or during control of temperature after the heating chamber has been so brought up to or near the desired temperature.

It has heretofore been proposed, as in drying systems and in systems for annealing metal, to impart heat to and absorb heat from forcibly circulated air in zones comprised in a system characterized by the fact that of the total length of the path of the circulated air the sum of the lengths of the paths in the aforesaid zones is a small fraction, occasioned by the relatively great length of air conduit comprised in the circulatory system and essential to operative intercommunication of the zones. From such systems mine materially differs in that the length of the circulatory path outside of the heating and treating zones is relatively short, communication between the zones is substantially immediate or direct, and of the entire length of the circulatory path the sum of the lengths of the zones is a large or major fraction, thereby procuring the practical advantages of reduction of power consumption for forcibly circulating the air, of economy in fuel or power expended in the generation of heat, of lower cost of installation and maintenance, and of smaller space required to accommodate the system. Because of the relatively great length of the path of the circulating air in the aforesaid proposed systems, external to their air-heating and heat-absorbing zones, greater power is required for forcing the circulation of the air, and more fuel or power must be consumed in the production of the eventually essential heat because of relatively high losses by conduction and radiation.

For brevity in the appended claims, the term "air" is employed generically to include air, gas and vapor within the furnace or heating chamber.

What I claim is:

1. A furnace comprising a heating chamber, a container disposed within said chamber and spaced from the wall thereof for holding the material to be heated, a source of heat disposed in the space between said container and said wall of said heating chamber, and an air propeller within the furnace disposed adjacent neighboring ends of said container and heating chamber for circulating air through said container and the space between said container and said wall of said chamber.

2. A furnace comprising a heating chamber, a container disposed within said chamber and spaced from the wall thereof for holding the material to be heated, a source of heat disposed in the space between said container and said wall of said heating chamber, an air propeller within the furnace disposed adjacent neighborhood ends of said container and heating chamber for circulating air through said container and the space between said container and said wall of said chamber, and a member surrounding said container between the container and the wall of said chamber for shielding the work in said container from radiant heat from said source.

3. A furnace comprising a heating chamber, a container for the material to be heated disposed within said chamber and having its side walls spaced from the side walls of said heating chamber, an electric resistor of low heat capacity disposed in said space between the side walls of the container and said heating chamber, and a propeller within the furnace disposed adjacent the neighboring ends of said container and heating chamber for circulating air through said container and through the space between the side walls of said container and said heating chamber.

4. A furnace comprising a heating chamber, a container for the material to be heated disposed within said chamber and having its side walls spaced from the side walls of said heating chamber, an electric resistor of low heat capacity disposed in said space between the side walls of the container and said heating chamber, a propeller within the furnace disposed adjacent the neighboring ends of said container and heating chamber for circulating air through said container and through the space between the side walls of said container and said heating chamber, and a member surrounding said container and disposed between it and said resistor for intercepting radiant heat from said resistor.

5. A furnace comprising a heating chamber having a bottom and a cover, a container for the material to be heated disposed in said chamber with its side walls spaced from the side walls of said heating chamber and having its ends spaced from said bottom and cover to form passages communicating with the interior of said container and with the space between the side walls of said container

- and the side walls of said heating chamber, an electric heater disposed in the space between the side walls of said container and said heating chamber, and a propeller within
 5 the furnace disposed adjacent neighboring ends of said container and said heating chamber for circulating air through said container, said passages and the space between the side walls of said container and said heating chamber.
 10 ber.
6. A furnace comprising a heating chamber having a bottom and a cover, a container for the material to be heated disposed in said chamber with its side wall spaced from the
 15 side wall of said heating chamber and having its ends spaced from said bottom and cover to form passages communicating with the interior of said container and with the space between the side wall of said container and
 20 the side wall of said heating chamber, an electric heater disposed in the space between the side walls of said container and said heating chamber, a propeller within said furnace disposed adjacent neighboring ends of said container and said heating chamber for circulating
 25 air through said container, said passages and the space between the side walls of said container and said heating chamber, and a member surrounding said container and disposed between it and said heater for intercepting radiant heat from said heater.
 30 posed between it and said heater for intercepting radiant heat from said heater.
7. A furnace comprising a heating chamber having a bottom, a removable cover, members disposed within said chamber and spaced
 35 from the side wall thereof, a removable work container resting upon said members and having its side wall spaced from said side wall of said heating chamber, a heater in the space between the side walls of said container and heating chamber, said heating chamber having its ends spaced from said
 40 cover and from said bottom to form circulatory passages between the interior of said container and the space between the side walls of said container and said heating chamber.
 45 walls of said container and said heating chamber, and a propeller within said furnace between adjacent ends of said container and said heating chamber for circulating the air through said container, said passages and the space between the side walls of said container and said heating chamber.
 50 the space between the side walls of said container and said heating chamber.
8. A furnace comprising a heating chamber having a bottom, a removable cover, members disposed within said chamber and spaced
 55 from the side wall thereof, a removable work container resting upon said members and having its side wall spaced from said side wall of said heating chamber, a heater in the space between the side walls of said container and heating chamber, said heating chamber having its ends spaced from said cover and from said bottom to form circulatory passages between the interior of said container and the space between the side walls of said
 60 container and said heating chamber, a propeller within said furnace between adjacent ends of said container and said heating chamber for circulating air through said container, said passages and the space between the side walls of said container and said heating chamber.
 65 container and said heating chamber, a propeller within said furnace between adjacent ends of said container and said heating chamber for circulating air through said container, said passages and the space between the side walls of said container and said heating chamber, and a member surrounding said container and carried by said first named members in position between said heater and said container for intercepting from the latter radiant heat from said heater.
 70 ber.
9. A furnace comprising a heating chamber, a removable container therein for the material to be heated and having its side wall spaced from the side wall of said heating chamber, a heater in the space between
 75 said side walls, end closures for said heating chamber spaced from opposite ends of said container, a propeller disposed between one of said end closures and the adjacent end of said container, and air-guiding members
 80 forming a passage to said propeller between the interior of said container and the space between the side walls of said container and said heating chamber.
 85
10. A furnace comprising a heating chamber, a removable container therein for the material to be heated and having its side wall spaced from the side wall of said heating chamber, a heater in the space between
 90 said side walls, end closures for said heating chamber spaced from opposite ends of said container, a propeller disposed between one of said end closures and the adjacent end of said container, air-guiding members forming
 95 a passage to said propeller between the interior of said container and the space between the side walls of said container and said heating chamber, and a member surrounding said container and disposed between it and said heater for shielding said container from
 100 radiant heat from said heater.
 105
11. A furnace comprising a heating chamber having a bottom and a removable cover, members on said bottom extending upwardly within said chamber, a removable container
 110 for the material to be heated, means on the upper end of said container resting upon said members, an electric heater in the space between the side walls of said container and said heating chamber, and means forcibly circulating air through said space and said heating chamber in succession.
 115
12. A furnace comprising a heating chamber, a source of heat, a shell disposed therein and spaced therefrom, a removable container
 120 in said shell for holding the material to be heated, and means for forcibly circulating air through said container and the space between said shell and said heating chamber.
13. A furnace comprising a heating chamber, a source of heat, a shell disposed therein and spaced therefrom, a removable container
 125 in said shell for holding the material to be heated, and means for circulating air through said container and the space between said container and the space between said
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shell and said heating chamber, said shell preventing access of radiant heat to the material in said container.

14. A furnace comprising a heating chamber, a container therein spaced from the wall thereof and adapted to hold material to be heated, said container at one end communicating with the space between it and said heating chamber, and an air-circulating member disposed adjacent an opening at the other end of said container for circulating air there-through and through the space between said container and said chamber.

15. A furnace comprising a heating chamber, an electric heater disposed upon the wall thereof, a shell spaced from said wall, a container in said shell for holding the material to be heated, a member having an opening and flaring from said opening toward said container, and air-circulating means disposed at said opening.

16. A furnace comprising a heating chamber, an electric heater disposed upon the wall thereof, a shell spaced from said wall, a container in said shell for holding the material to be heated, a member having an opening and flaring from said opening toward said container, air-circulating means disposed at said opening, and means on the exterior of said furnace for driving said air-circulating means.

17. A furnace comprising a heating chamber, a work container therein having its walls spaced from the walls of said chamber, an electric heater having heat capacity low as compared with the heat capacity of the work heated within said container, said heater disposed in the space between the side walls of said heating chamber and said container, and

means adjacent neighboring ends of said container and said heating chamber for forcing circulation of air through said container and the space between said container and the wall of said heating chamber.

18. A furnace comprising a heating chamber, heating elements disposed therein, a work-containing structure having side walls of sheet-like material disposed within said chamber, means for effecting circulation of air or equivalent from said heating chamber through said container and work to affect the temperature thereof, and a second structure having sheet-like walls interposed between said heating elements and work container forming an air space between said structures whereby radiant heat from said elements is effectively precluded to a substantial degree from affecting the temperature of the work adjacent the walls of the container.

19. A heat-treating furnace comprising a metal-heating chamber, an air-heating chamber, said chambers being in substantially direct or immediate communication at separated regions, and means forcibly circulating air through said chambers in succession.

20. A heat-treating furnace comprising a metal-heating chamber, an air-heating chamber surrounding said metal-heating chamber and in substantially direct and immediate communication therewith at separated regions, a source of radiant heat in said air-heating chamber, means forcibly circulating air through said chambers in succession, and means shielding the metal in said metal-heating chamber from radiant heat from said source.

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