Sept. 26, 1944. W. ROTH 2,359,157

GAS-CARBURIZING FURNACE

Filed May 22, 1943

Fig. 1

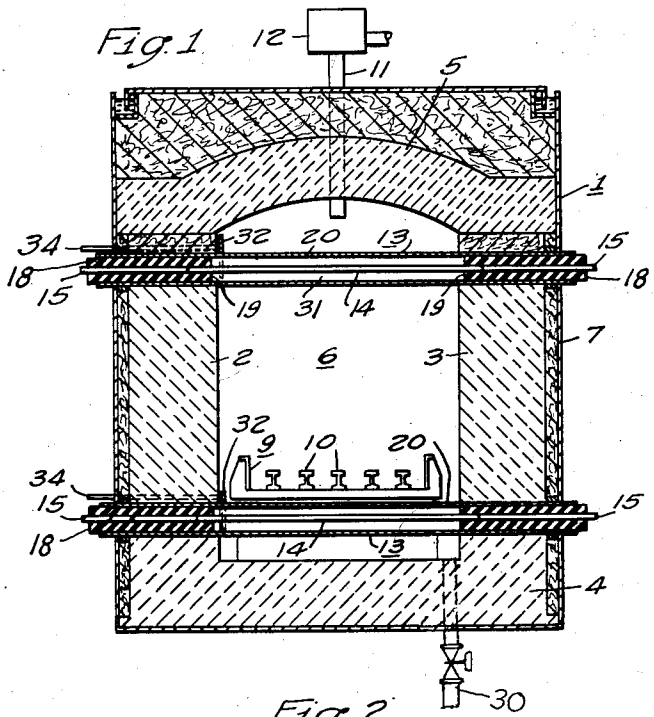
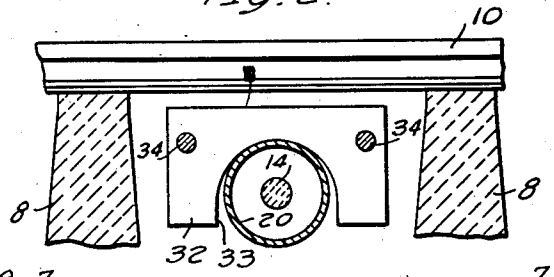


Fig. 2.



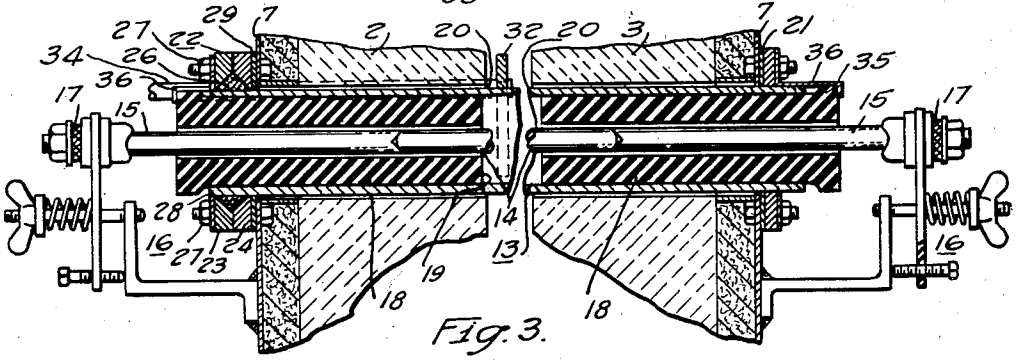


Fig. 3.

WITNESSES:

E. A. McCloskey.

Mrs. C. Gorrue

INVENTOR

Willard Roth.

BY

B. L. Tanguill

ATTORNEY

Patented Sept. 26, 1944 2,359,157

UNITED STATES PATENT OFFICE

2,359,157

GAS-CARBURIZING FURNACE

Willard Roth, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 22, 1943, Serial No. 488,047

10 Claims. (Cl. 13—20)

This invention relates to electrically heated industrial furnaces of a type provided with a heat-treatment chamber in which processes are carried out involving the heat-treatment of charges, usually metallic, while such charges are enveloped by a carbonaceous gas-atmosphere which permeates the heat-treatment chamber.

Heat-treating processes of this kind are known, and generally involve a carbonaceous gas-atmosphere which reacts with a charge in order to change its physical or chemical characteristics. One such process is case-hardening in which the charge to be case-hardened is heated to temperatures more commonly up to about 1700° F.; but in the use of my invention the temperatures also may be substantially higher. In general, the relation between the carbon pressures of the gas-atmosphere and the charge depend on the manner in which the charge is to be heat-treated. However, such atmospheres, and especially gas-atmospheres having relatively high carbon content for gas-carburizing, tend to deposit free carbon on highly heated parts, perhaps by dissociation of the carbon-containing gas-constituents, such as hydrocarbons and oxides of carbon. Such deposits may be relatively heavy, reaching thicknesses of several inches or more after only relatively short operation of the industrial furnace. This characteristic of carbon-deposit has made it impracticable to permit the gas-atmosphere to envelope the electrical heating means of the furnace because the deposited carbon short-circuits or heat insulates the parts of the heating elements with which it is in contact, resulting in difficulty in the control of the heat-treating process and sometimes in the destruction of the heating elements.

Accordingly, it has been a practice of the prior art to provide a gas-impervious charge-holding muffle which constituted the heat-treatment chamber; the muffle being permeated by the carbonaceous gas-atmosphere and the electrical heating elements being disposed outside the muffle.

Such muffle-furnaces have certain disadvantages. For one thing, the charge is indirectly heated by heat transmitted through the muffle, so that the electrical heating means must operate at a slightly higher temperature in order to compensate for heat-travel through the charge-holding muffle. Another disadvantage is the cost of the muffle and the cost of maintaining it in satisfactory operating condition. The muffle is subjected to repeated temperature shocks or temperature gradients along its length because of the heating-up or the cooling-down of the charge, so that the muffle may quickly deteriorate.

My invention has for its primary object the provision of an electrically heated gas-carburizing furnace lacking the aforesaid and other difficulties and disadvantages.

It is an object of my invention to provide an electrically heated refractory-wall muffleless industrial furnace in which suitable charges can be heat-treated to high temperatures in a carbonaceous gas-atmosphere.

Another object of my invention is to provide a muffleless gas-carburizing furnace which may be electrically heated without rapid deterioration of the electrical heating elements exposed to the gas-atmosphere.

Still another object of my invention is the provision of an electrically heated muffleless gas-carburizing furnace which will be capable of being operated continuously for long periods of time, without interruptions for cleaning carbon from the electric heating elements, or for the replacement or repair of such elements.

The above and other objects of my invention will be discernible from the following description thereof, which is to be taken in conjunction with the accompanying drawing. In this drawing, the various figures more or less diagrammatically show the essential parts of my invention on different scales.

Figure 1 is a view diagrammatically showing, in transverse section, a furnace embodying my invention, but with some parts omitted for clarity.

Fig. 2 is a longitudinal sectional view for showing a detail of a part of the furnace; and

Fig. 3 is a sectional broken view showing, in greater detail, a heating element and associated furnace structure involved in a preferred embodiment of my invention.

The furnace 1 comprises, as is customary in furnaces of this kind, side walls 2 and 3, a bottom wall 4, top wall 5, and a pair of end walls one or both of which may be provided with a suitable door-closed opening through which a charge may be inserted into or withdrawn from a heat-treatment chamber 6 which is defined by the walls. The walls may be constructed in any customary manner as, for example, by heat-insulating wool and brick and non-metallic refractory brick bounding and defining the chamber 6. The furnace is provided with a gas-impervious sheet metal shell 7 which encases the outside of the walls and doors, and which is provided with

suitable expansion and contraction provisions.

Within the heat-treatment chamber 6, a plurality of relatively small, spaced brick refractory tiers 8 support a charge-receiving hearth 9 comprising a plurality of spaced rails 10 on which the charge is moved into and from the heat-treatment chamber. A gas inlet pipe 11 passes through the shell 7 and top wall 5 for introducing a suitable carbonaceous gas into the heat-treatment chamber 6 from a gas-generator 12 which supplies such carbonaceous gas.

For heating the heat-treatment chamber 6 and the charge therein, heating means in the form of a plurality of spaced heating-units 13 are provided along the top and bottom of the heat-treatment chamber, the furnace walls and outer shell being provided with suitable holes for accommodating the units. Each such unit comprises a heater-rod 14. So called "Glo-bar" rods comprising essentially silicon-carbide, or a suitable metal or any other appropriate material may be used for such heater-rods. These rods 14 extend across the width of the heat-treatment chamber 6, and partially into spaces in the side walls 2 and 3; and, in order to conduct electricity to them, each of their ends contacts electricity conducting terminal rods 15. Terminals 16 of any suitable form may be provided for pressing the terminal rods against the associated heater-rod 14 so that the last is expansively held in slight compression, the extent of which may be varied. Conductors 17, connected to the terminals 16, convey electrical power to and from the heating-units. In each heating-unit 13, the terminal rods 15 and the heater-rod 14 are preferably solid; and electrically insulating sleeves 18 surround terminal rods 15 and the end portions of the heater-rod 14, the holes in such sleeves being slightly larger than the rods to permit sliding movement of the heater-rod 14 and terminal rods 15. The inner edges 19 of the sleeves 18 terminate somewhat inside the side walls 2 and 3, and the outer ends of the sleeves project outside the furnace.

Protective means are provided to prevent contact of the gas-atmosphere in the heat-treatment chamber 6 with the heater-rods and terminal rods. To this end, each heating-unit 13 comprises a hollow tube 20 which encompasses the heater and terminal rods and the insulating sleeves 18 of the unit. The internal diameter of the tube 20 is considerably greater than the diameter of the rods 14 and 15. One end of this tube 20, which may be of metal, has an annular flange 21 gas-tightly welded thereto; the flange 21, in turn, being gas-tightly secured to the shell 7 in any suitable manner. The outer end of the tube is slidably, but gas-tightly, held in position with respect to the shell 7 by a packing gland 22 comprising two apertured plates 23 and 24 forming an annular cut-away V-groove which holds a heat-resistant compressible packing 26 against the tube 20 in such manner that tightening of the nuts 27 on bolts secured to and passing through the shell 7, forces the packing firmly against the outside of the far end 28 of the tube 20. A gasket 29 may be provided between the shell 7 and plate 24 for gas-tightly sealing the hole in the shell 7 through which the associated end of the heating-unit 13 passes.

In operation, carbonaceous gas is admitted through one or more gas inlet pipes 11 into the heat-treatment chamber 6, preferably at a pressure slightly above atmospheric pressure so that a plenum system results where the gas-atmosphere tends to leak out of the chamber 6 through any crevices in the shell or separate gas-vent means 30 may be provided to encourage spent-gas leakage. The gas permeates the heat-treatment chamber, being in direct contact with the walls 2, 3, 4, 5, the end walls of the furnace and the cylindrical outside of the tubes 20, and enveloping any charge on the hearth 9. By applying electrical energy to the conductors 17 of each of the heating-units 13, the heater-rods 14 heat up, and heat is transmitted across the empty space 31 between the heater-rods 14 and the outer encasing tubes 20. The tubes 20, in turn, become hot and heat the chamber 6.

Carbonaceous gas around the hot tubes 20 breaks down and carbon accumulates on each of the tubes 20. Since these tubes 20 are electrically insulated from the power-carrying parts of the heating-units, by means of the space 31 and insulating sleeves 18, such deposited carbon will have no detrimental effect on the electrical conducting properties of the electrical heating-units.

However, in time, the carbon deposited may adversely affect the heat-transmission of the heat from the tube 20 to the chamber 6, so that my invention further contemplates a carbon-removing means for keeping the tubes 20 fairly clean. Such a carbon-removing means may comprise a scraper plate 32 having a somewhat semi-circular opening 33 therein which is somewhat larger than the tube 20 so that the plate rests loosely on the associated tube 20, and can be moved without binding along the length of the tube for scraping deposited carbon therefrom. A pair of rods 34, secured to the plate 32, pass through guiding holes the side wall 2 and shell 7, being of sufficient length, outside the furnace, to permit reciprocating the scraper plate the full width of the heat-treatment chamber 6. Packing and packing glands may be used to limit heat and gas losses through the holes in the walls and shell through which the different pairs of rods 34 pass. I have found that, generally, the carbon deposit accumulates on the top of the tube 20 so that it is unnecessary to provide a scraping plate which completely surrounds the tube.

The securing of one end only of the tube 20 fixedly to the shell 7 permits the tube to expand and contract with temperature changes by the sliding of the other end of the tube in the gland 22. Any suitable metallic or non-metallic gas-impervious material having satisfactory heat-resistant qualities may be used for the tube 20, such as a nickel-chromium-iron alloy or other heat-resistant composition.

It is obvious that by utilizing my invention charges may be gas-carburized without the need of a muffle which may be an expensive item, especially for a large furnace such as one actually embodying my invention, which had a heat-treatment chamber with a length of ten feet, a width of about two and one-half feet, and a height of about three and one-half feet, and required about twenty spaced heating-units.

Any suitable means may be provided for maintaining the insulating sleeves loosely in position; for example, they may be provided with enlarged heads 35 and retaining brackets 36 to prevent excessive movement of the sleeves outwardly. The sleeves 18 need not fit the tube snugly, but preferably are sufficiently loose to allow for necessary adjustments in position between these parts during heating and cooling steps of a heat-treating process.

While I have shown my invention in a preferred form thereof, it is obvious that many expedients may be utilized within the novel fundamentals of my invention.

I claim as my invention:

1. A muffleless industrial heat-treating furnace comprising: non-metallic refractory walls defining a heat-treatment chamber; charge-supporting means in said chamber for supporting a charge in said chamber in exposed relation to said walls; means comprising gas-inlet means for admitting a carbonaceous gas-atmosphere to said chamber and causing the chamber to be permeated by said gas-atmosphere; electrical heating means comprising electrical heating-portions for heating said chamber; protective means for said heating means, comprising casing means exposed in said chamber for encasing said electrical heating-portions for protecting said electrical heating-portions from direct contact with carbonaceous gas-atmosphere permeating said chamber, said casing means being electrically insulated from said electrical heating-portions.

2. A muffleless industrial heat-treating furnace comprising: non-metallic refractory walls defining a heat-treatment chamber; an outer substantially gas-impervious shell for said walls, charge-supporting means in said chamber for supporting a charge in said chamber in exposed relation to said walls, a plurality of rod-like heating elements for heating said chamber; a plurality of hollow tube means, each associated with and around a said heating element, said tube means being exposed in said chamber; means comprising gas-inlet means for admitting a carbonaceous gas-atmosphere to said chamber for enveloping, at least to some extent, the exposed charge and said tube means; and means for said tube means for removing deposited carbon therefrom.

3. In a device of a class described, in combination, means defining a heat-treatment chamber, tube means comprising a heat-transmitting hollow gas-impervious tube-portion passing through said chamber, means for permeating said chamber with a carbonaceous gas-atmosphere, electrical heating means comprising a heating conductor inside said tube portion in electrically insulating heat-transmitting relation thereto, and conducting means for conducting electrical energy to and from said electrical heating means.

4. The invention of claim 3 including scraper means resting on said tube-portion and movable therealong for scraping carbon deposited on said tube-portion by said carbonaceous gas-atmosphere.

5. A muffleless industrial heat-treating furnace comprising: non-metallic refractory walls defining a heat-treatment chamber; an outer substantially gas-impervious shell for said walls; charge-supporting means in said chamber for supporting a charge in said chamber in exposed relation to said walls; a gas-impervious hollow tube passing through said chamber; means for movably holding said tube in gas-tight relation to said shell; means comprising gas-inlet means for admitting a carbonaceous gas-atmosphere to said chamber for enveloping the charge therein; said hollow tube being exposed to said gas-atmosphere; and electrical heating means comprising a heating conductor inside said tube in electrically insulated heat-transmitting relation thereto.

6. A muffleless industrial heat-treating furnace comprising: non-metallic refractory walls defining a heat-treatment chamber; an outer substantially gas-impervious shell for said walls; charge-supporting means in said chamber for supporting a charge in said chamber in exposed relation to said walls; heating means for electrically heating said chamber comprising a gas-impervious hollow tube passing through said chamber, means for holding said tube in gas-tight relation to said shell, said holding means being such as to permit relative displacement of an end of said tube whereby to permit expansion and contraction of said tube with changes in temperature.

7. The furnace of claim 5 further comprising cleaning means operable for cleaning carbon deposited on said tube by said gas-atmosphere, said cleaning means comprising a carbon-removing device inside said furnace, which is relatively movable with respect to the outside of said tube, said cleaning means comprising operating means therefor outside said shell.

8. The furnace of claim 6 further comprising cleaning means operable for cleaning carbon deposited on said tube by said gas-atmosphere, said cleaning means comprising a carbon-removing device inside said furnace, which is relatively movable with respect to the outside of said tube, said cleaning means comprising operating means therefor outside said shell.

9. The furnace of claim 5 further comprising a scraper loosely about the top of said tube, said scraper being movable along said tube, and means comprising a rod passing through a guiding hole in one of said walls and said shell for moving said scraper back and forth along said tube.

10. The furnace of claim 6 further comprising a scraper loosely about the top of said tube, said scraper being movable along said tube, and means comprising a rod passing through a guiding hole in one of said walls and said shell for moving said scraper back and forth along said tube.

WILLARD ROTH.