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3,137,781

FLUID-MOTION POWDER, ELECTRIC BATH FURNACE

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Fig. 1-

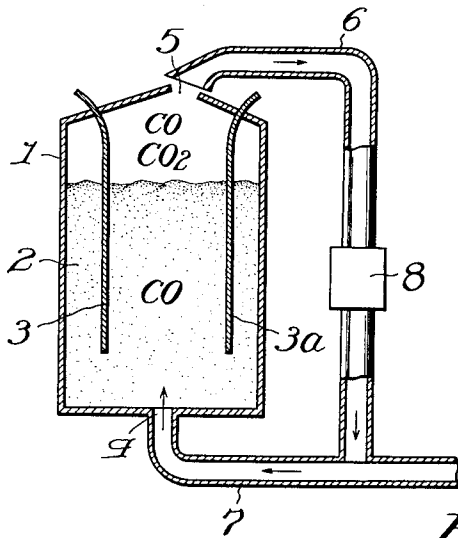
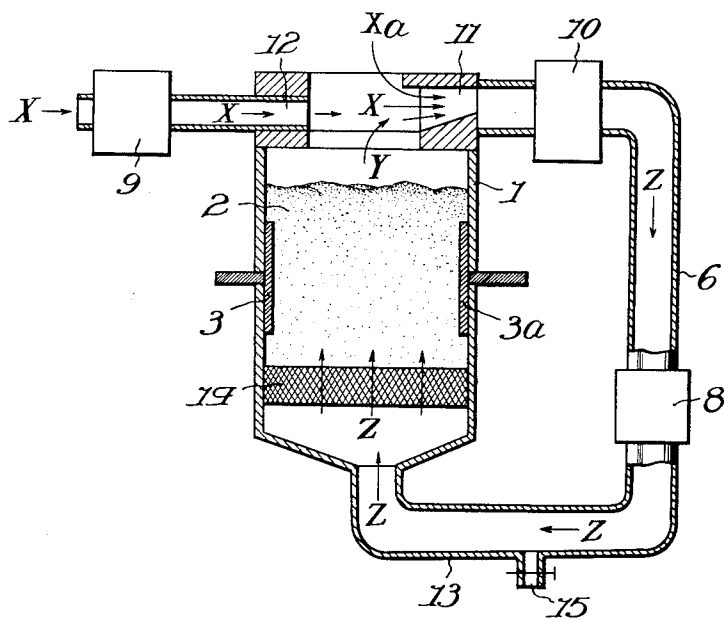


Fig. 2-



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FLUID-MOTION POWDER, ELECTRIC BATH
FURNACE

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2 Claims. (Cl. 219—50)

This is a continuation-in-part of my application, Serial No. 847,372 filed October 19, 1959 and since matured into Patent No. 3,025,385.

This invention relates to a new and improved electric bath furnace of the type wherein substances such as metal articles are heated in a medium of fluid-motion electro-conductive powder which is heated by passing an electric current therethrough.

More specifically, the improved electric bath furnace of this invention is of the type wherein a bed of electro-conductive powder particles is maintained in a state of fluid motion by a current of gas supplied upwardly through the furnace through an inlet opening at the bottom, and the furnace of this invention is further provided with means for recirculating at least a fraction or portion of the exhaust gases back into the inflowing gas in order to realize certain economic and other advantages as will be described in detail hereinafter.

In the case of apparatus of this type known heretofore, air is supplied under pressure into the furnace interior through an air supply opening in order to agitate the carbon powder of the heating medium into a fluid-motion state, and then the air is discharged out through an exhaust opening. During this process, the oxygen in this air chemically combines with the carbon powder to form a large quantity of gases such as carbon monoxide and carbon dioxide, which are continuously discharged out. Consequently, the carbon substances within the furnace are gradually consumed. This consumption is not only uneconomical in itself, but requires frequent replenishment of the carbon. Moreover, a large quantity of heat is discharged.

The furnaces of this type known heretofore have the further disadvantage of minute particles of carbon being swept away by and discharged with the exhaust gases, thereby soiling the surrounding air and objects.

In view of the above-described disadvantages of furnaces of this type known heretofore, it is a general object of the present invention to provide a furnace of this type wherein one or more of these disadvantages are eliminated or rendered negligible.

It is a specific object to provide a furnace of this type wherein the carbon exhausted as oxides thereof and at least some of the added heat are recovered.

It is another object to provide a furnace of this type wherein discharge of minute carbon particles to the outside surroundings of the furnace is prevented.

Said and other objects of this invention have been attained by the furnace provided with an external recirculation system, including a blower, for recirculating the exhaust gases leaving the fluid-motion medium back into the furnace.

The details of the invention as well as the manner in which the foregoing objects may best be achieved will be more clearly apparent by reference to the following description when taken in conjunction with the accompanying illustration in which like parts are designated by like reference numerals or letters, and in which:

FIGURE 1 is a schematic diagram, in elevation and in vertical section, showing one embodiment of the invention; and

FIGURE 2 is a schematic diagram, in elevation and in

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vertical section, showing another embodiment of the invention.

Referring to FIGURE 1, the essential parts of the furnace shown are: an electric bath container 1 containing a fluid-motion medium of carbon powder 2, electrodes 3 and 3a disposed in the powder 2, a gas inlet opening 4, a gas exhaust opening 5, and a gas supply piping system 7, which are similar to the essential parts of known furnaces of this type. The drawing illustrates in FIG. 2 a recirculation means consisting of an external piping system 6 for collecting and conducting a large portion of the exhaust gases exhausted from the opening 5 to the piping system 7 and a suction blower 8 installed at an intermediate location in the piping system 6.

During the operation of a furnace of the above-described construction, the CO and CO₂ gases exhausted at the opening 5 are recirculated by the blower 8, through the piping system 6, to the piping system 7, whereby the carbon contained in the said gases is returned to the furnace interior, and wasteful consumption of carbon by oxygen is prevented. Accordingly, the necessity of frequently replenishing this carbon is obviated, and economical use of carbon is made possible. Moreover, some of the heat contained in the said gases is recovered. In this embodiment, a bottom plate such as shown by numeral 14 in the embodiment of FIG. 2 can be provided in the electric bath container 1. In this case, the gas supplied from the gas inlet opening 4 ascends into the fluid-motion medium of carbon powder 2 after passing through the bottom plate.

The effectiveness and specific details of a furnace of the above-described construction are indicated by the following representative example of an actual application.

Example 1

A furnace having an interior measuring 1,350 mm. by 550 mm. and 1,000 mm. in depth was filled with 150 kg. rated quantity of a fluid-motion medium of amorphous (non-crystalline) carbon of 25- to 100-mesh graded grain size, of apparent specific gravity of 0.34 to 0.35 to a depth of approximately 800 mm. at the time of fluid-motion caused by a current of air supplied at a rate of 350 liters/minute through the inlet 4.

With a fluid-motion medium temperature of 1,100° C., the consumption of the carbon powder was found to be approximately 1 kg./hour when the exhaust gases were not recirculated, but it was found to be 0.2 kg./hour when the exhaust gases were recirculated.

A water-cooled, heat-resistant type blower driven by a 2-horsepower motor was used to recirculate the exhaust gases, the temperature of which was caused to be 600° C. or lower at the time the said gases passed through the blower. When the exhaust gases were recirculated, the temperature of the gas mixture flowing through the inlet 4 was 340° C. Without recirculation of the exhaust gases, the temperature of the air entering through the inlet 4 was substantially equal to the room temperature, or 20° C. Accordingly, it may be said that a quantity of heat corresponding to the difference, i.e., 340° C.—20° C.=320° C. was being recovered.

When the discharge into the surrounding air of minute carbon particles is a serious problem, this problem cannot be solved by merely providing, at the exhaust opening of the furnace a suction intake opening of the recirculation system as described above.

In one form of the present invention, this problem of suspended, minute particles of carbon is solved through the provision of a gas curtain across the access opening of the furnace, as is illustrated in FIGURE 2. The embodiment of the invention shown in FIGURE 2 has a furnace consisting of an electric bath container 1 containing a fluid-motion medium of carbon powder 2, electrodes 3

and 3a disposed in the said powder 2, a flow-porous bottom plate 14 which supports the said powder 2 but permits flow of gas therethrough, and gas supply piping 13, all of which are similar to the essential parts of known furnaces of this type. In addition, the container 1 is provided at its top with an access opening and a gas curtain device consisting of a gas-ejection nozzle opening 12 disposed on one side of the said access opening and a gas-intake funnel opening 11 disposed on the opposite side in a position confronting the said nozzle opening 12. Gas under pressure is blown by a blower 9 through the nozzle opening 12. The gas-intake funnel opening 11 is connected to a recirculation means consisting of an external piping system 6, a particle remover 10 installed in the piping system 6, and a recirculation blower 8 also installed in the piping system 6, which is connected directly to the gas supply piping 13. An exhaust valve 15 is provided at one point in the piping 13, downstream from the blower 8, so as to balance the gas flow rates.

During the operation of the furnace of the above-described construction, when a gas X is ejected at high velocity from the nozzle opening 12 and is sucked into the funnel opening 11, a gas curtain is formed between the nozzle opening 12 and the funnel opening 11, whereby the gases Y and suspended, minute particles of carbon powder (not shown) which are exhausted from the fluid-motion medium 2 are prevented from being discharged into the outside air and are drawn into the funnel opening 11.

The drawing power for this drawing in of the gases is provided by the suction of the recirculation pump 8 and the energy due to the velocity of the ejected gas X. During the above operation, outside air Xa is simultaneously drawn in.

The mixture of these gases Xa, X, Y, and the suspended, minute particles of carbon passes through the particle remover 10, where the said particles of carbon are removed, and the gases are recirculated by the blower 8 back through the bottom plate 14 into fluid-motion medium 2. In this manner, the flow of gas necessary for the fluid-motion state of the medium 2 is created by the recirculation blower 8.

In this case, the gas (for example: air) X for the aforesaid air curtain and the air Xa entering from the outside become mixed with recirculated gases. The air flow X enters at a high speed but its flow rate is minute, being of an order not exceeding $\frac{1}{10}$ of that of the exhaust gases Y. The entering outside air Xa can be limited to be less than $\frac{1}{100}$ of the supply air X by adapting the configuration of the funnel opening 11 to open in a downwardly inclining direction as indicated in FIGURE 2. Accordingly, the flow rate of the recirculated gas Z can be made to be almost the same as that of the exhaust gas Y.

In actual practice, however, an exhaust valve 15 is provided, as mentioned hereinbefore, to release surplus gas.

The air X ejected by the nozzle opening 12 and the air Xa entering from the outside, which are drawn into the funnel opening 11, are mixed with the exhaust gases Y, which are at a high temperature and contain suspended, minute particles of carbon. The oxygen in this air X and Xa thereby cause combustion of some of the said particles of carbon. Accordingly, although outside air Xa mixes with the recirculated gas Z, its oxygen content is extremely small. The small quantity of remaining

oxygen is consumed in the combustion of some of the carbon powder in the fluid-motion medium.

The flow rate of air necessary for the air curtain varies greatly according to design, but in the case of a furnace container 1 of 350 mm. by 900 mm. cross section, a flow rate of 100 liters/minute supplied by a blower driven by a $\frac{1}{2}$ -horsepower motor has been found to be sufficient.

Although this invention has been described with respect to a few particular embodiments thereof, it is not to be so limited as changes and modifications may be made therein which are within the full intended scope of the invention, as defined by the appended claims.

What is claimed is:

1. Electric heating apparatus of fluidized electro-conductive powder resistance comprising, means defining a chamber and a support surface for supporting within said chamber a bed of electro-conductive powder particles, means on said apparatus defining a main gas discharge outlet from said chamber, means for fluidizing the bed of powder particles comprising, means to flow a gas through said bed of powder particles and out of said main gas discharge outlet, means to flow an electric-current through said powder particles, a recirculation system to recirculation at least a fraction of said gas through said bed of powder particles comprising a gas inlet into said chamber and another inlet into said recirculation system, means to preclude loss of said particles through said main gas discharge outlet comprising, means to apply a gas curtain under pressure across said main discharge outlet and thereby across the flow path of said gas flowed through said bed and entering said main gas discharge outlet and comprising means to flow said gas curtain in a direction toward said another inlet of said recirculation system, and means in said recirculation system to apply a suction to said another inlet.

2. Electric heating apparatus of fluidized electro-conductive powder resistance comprising, means defining a chamber and a support surface for supporting within said chamber a bed of electro-conductive powder particles, means on said apparatus defining a main gas discharge outlet from said chamber, means for fluidizing the bed of powder particles comprising, means to flow a gas through said bed of powder particles, means to flow an electric-current through said powder particles, a recirculation system to recirculate at least a fraction of said gas through said bed of powder particles comprising a gas inlet into said chamber and another inlet into said recirculation system, means to preclude loss of said particles through said main gas discharge outlet comprising, means to apply a gas curtain under pressure across said main gas discharge outlet and thereby across the flow path of said gas flowed through said bed and entering said main gas discharge outlet and comprising means to flow said gas curtain in a direction toward said another inlet of said recirculation system, means in said recirculation system to apply a suction to said another inlet, and means to recover powder particles from said bed that escape from said chamber into said recirculation system.

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