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ELECTRIC OVEN FOR HIGH TEMPERATURE WORKING UNDER VACUUM OR UNDER NEUTRAL GAS

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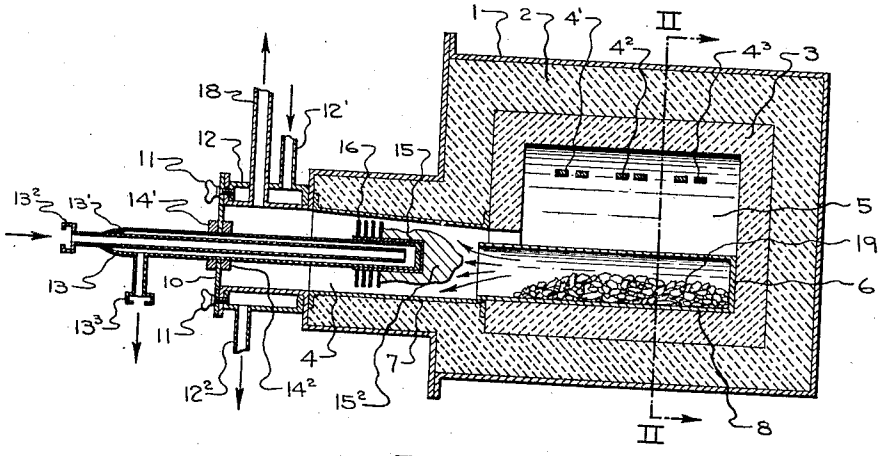


Fig. 1

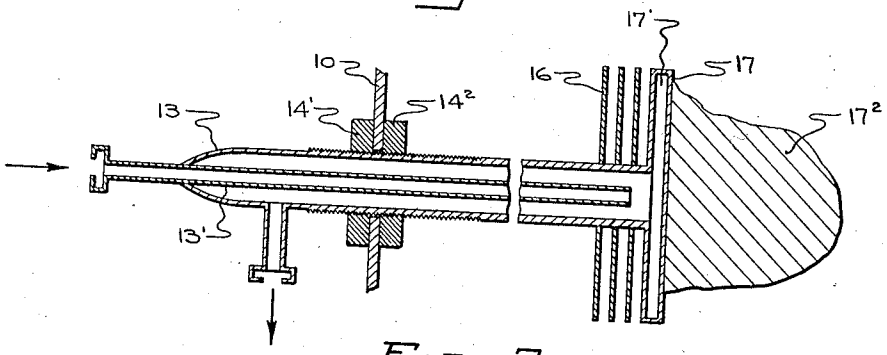


Fig. 3

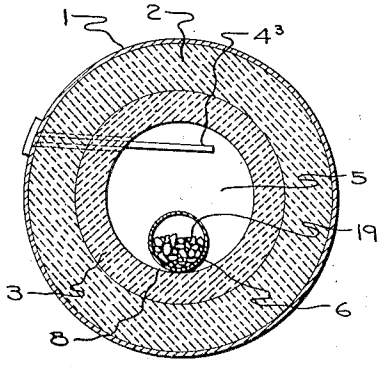


Fig 2

Inventor

FRANCOIS MATHIEU

By Beaman & Langford

Attorneys

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ELECTRIC OVEN FOR HIGH TEMPERATURES WORKING UNDER VACUUM OR UNDER NEUTRAL GAS

Francois Mathieu, Moissac, France; vested in the Alien Property Custodian

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7 Claims. (Cl. 13—8)

The present invention relates to a furnace for the production or recovery of certain metals and more particularly to an electric furnace for carrying out thermal reductions in a vacuum or in a neutral gas for the production or recovery of certain metals.

The recovery of certain metals, and particularly magnesium, by thermal reduction is known and produces certain metals, including magnesium, of a high state of purity. However, difficulties encountered in the use of furnaces for this process, which are capable of long use, the latter being a factor indispensable in the obtaining of a low net cost, have retarded the popularization of the process. Heretofore it has been necessary to use furnaces of thick metal, or furnaces of masonry without strength and air tightness.

The present invention has for one object the avoidance of the aforesaid difficulties and resides in a readily constructable and inexpensive furnace, which may be used in every case where it is desired to carry out a thermal reduction or like process in a vacuum or in the presence of a neutral gas at elevated temperatures, as for example, from 1300° to 1600° C. The furnace according to the present invention makes possible the recovery, by condensation in the form of crystals, a higher percentage of metal from the heating of substances for reaction, and particularly so when used for the production of magnesium. The furnace makes possible also the purification of this and other metals.

In carrying out one form of the invention, the walls of the heating chamber are made of magnesia brick covered on the outside with a compressible insulating material, which prevents the transmission of heat and the counter pressure to the walls of the frame, which is disposed about the insulating material. Thus the walls of the heating chamber are subjected to the same internal and external pressure and do not require high mechanical strength at the expense of resistance to heat. For this reason it is possible to make the walls in the heating chamber of a material highly resistant to high temperatures, thus assuring them a prolonged usage. The condenser on which the metals recovered are condensed is disposed in a passageway communicating with the heating chamber and the matter to be condensed is directed into contiguity with the condenser, so as to provide for a maximum recovery of metal.

Accordingly, an object of the invention is to provide a furnace of high refractory characteristics.

Another object of the invention is to provide a condensing member for a furnace of the character described disposed in a passage at one side of the heating chamber in combination with means for directing matter to be condensed into contiguity with the condenser.

Still another object of the invention is to dispose the condensing member in a passage at one side of the heating chamber, the condensing member being supported from the outer door to the passage and being protected against direct radiation from the source of heat within the heating chamber.

A further object of the invention is to provide a furnace having a condenser therein shielded against direct radiation from the source of heat within the furnace.

A still further object of the invention is to provide a furnace having a condenser therein and means to direct matter to be condensed into contiguity with the condenser.

These and other objects will be apparent from the following specification when taken with the accompanying drawing, in which

Fig. 1 is a diagrammatic longitudinal section of a furnace according to one way of carrying out the present invention,

Fig. 2 is a section along the line II—II of Fig. 1, and

Fig. 3 is a diagrammatic vertical section of an alternate form of condenser.

Referring particularly to Figs. 1 and 2, the reference character 1 indicates a framework or housing, which preferably, although not necessarily, is of cylindrical form. Disposed within the framework 1 is a heating chamber 5, having a lining 3, preferably constructed of magnesia bricks, although it is to be understood that any suitable refractory may be used. The lining 3 also may be cylindrical although this shape is not essential. Disposed between the framework 1 and the lining 3 of the heating chamber 5 is a mass of compressible insulating material 2. The lining 3 may be supported adjacent the lower side thereof from the framework 1 by suitable supporting members, or it may be supported directly by the insulating material 2 as desired.

Disposed in one side of the heating chamber 5 is a charging passage 4 defined by a tubular member 7, generally in the form of a truncated cone. The member 7 is surrounded by the compressible insulating material 2, which in turn is surrounded by a portion of the framework 1. At the outer end of the member 7 is a hollow annular ring 12, having suitable connections 12^1 and 12^2 for the

circulation of a cooling liquid such as water. The ring 12 forms a continuation of the member 7 and of the passage 4. At the outer end of ring 12 is a removable door or gate 10, which is secured to the ring 12 by suitable screws 11. It will be understood that the door 10 is the door to the heating chamber 5. While, as shown, the ring 12 is not outwardly diverging, continuing the outward divergence of the member 7, it is to be understood that the ring 12 may be outwardly diverging if desired. However, in the claims it is contemplated that the expression outwardly diverging applies to passage 4 whether it is outwardly diverging throughout its entire length or only a part thereof.

Secured to the door 10 is a tubular member 13 supporting a condenser 15 in the form of a hollow cylindrical member. The tubular member 13 is arranged with an internal tube 13^1 and inlet and outlet connections 13^2 and 13^3 respectively for providing for the circulation of cooling liquid through the condenser 15.

The tubular member 13 is connected to the door 10 by nuts 14^1 and 14^2 on opposite sides thereof, whereby the distance of the heating chamber 5 may be reguated so as to place the condenser in the zone of condensation most favorable to the substance treated.

Supported on the tubular member 13, between the condenser 15 and the door 10, are a plurality of baffles 16 extending into contiguity with the tubular member 7. It will be observed that since the condenser 15 is within the tubular member 7, the tubular member 7 serves to conduct metallic vapors from the heating chamber 5 towards the condenser 15. At the same time the baffles 16 prevent the passage of metallic vapors past the condenser where they would condense on the door 10 and the cooled ring 12.

Within the heating chamber 5 is provided a container 6, which is preferably tubular in form for supporting the substances for reaction 19. One end of the container 6 is open, and the open end is disposed within the passage 4 so that metallic vapors from the substances for reaction will be directed into contiguity with the condenser 15 by the walls of the container 6 as well as by the member 7.

Projecting into the heating chamber 5 are three pairs of electrodes 4^1, 4^2 and 4^3 respectively, having suitable connections with a source of electric power which arcs across the respective pairs of electrodes to generate heat. It is preferred that each pair of electrodes be connected to a transformer having a variable output so that the heat may be varied to maintain a uniform temperature in the chamber 5. Also it is preferred that the electrodes be replaceable independently of the replacing of the lining 3.

For drawing a vacuum in the heating chamber 5 and passage 4 there is provided a tube 18 communicating with the passage 4 between the door 10 and the condenser 15. The tube 18 may be connected to some suitable vacuum pump not shown. The drawing of a vacuum from a position between the door 10 and the condenser 15 not only conveniently exhausts the interior of the heating chamber 5 and the passage 4, but it also tends to direct metal vapor from the container 6 into contiguity with the condenser 15.

In Fig. 3 is disclosed an alternative form of condenser 17 which is supported on a tubular member 13 like that provided for the condenser 15 as disclosed in Fig. 1. The condenser 17 is on the outer end of the tubular member 13 and is plate like in form. It has a liquid chamber 17^1 at the rear thereof, which is connected with a circulating cooling liquid through the tubular member 13 and its internal tube 13^1. Disposed behind the condenser 17 are baffles 16 identical with the baffles 16 associated with the condenser 15 of Fig. 1.

The operation of the furnace is as follows:

The container 6 containing substance for reaction 19 is disposed on the floor 8 of the heating chamber 5, having been inserted through the charging passage 4. The door 10 is then closed and secured by the suitable screws 11. Previously to closing the door 10, however, the relative longitudinal position of the condenser 15 in the charging passage 4 is regulated by manipulation of the nuts 14^1 and 14^2.

When the door 10 has been properly secured in place the circulation of water or other cooling liquid through the ring 12 and the condenser 15 is started, and the vacuum pump not shown is started to exhaust the interior of the heating chamber 5 and the passage 4 through the tube 18. The framework 1 preferably is of metal, all sections thereof being either welded or otherwise secured into a sealed unit so that when the door 10 is secured the atmospheric pressure is resisted by the framework 1 and the door 10. Since there will be some leakage between the lining 3 and the space between the lining 3 and the framework 1, the pressure on both sides of the lining 3 will be equalized so that the drawing of a vacuum within the heating chamber 5 and passage 4 will not place any additional stress on the lining 3. Also the compressibility of the insulation 2 prevents any stress on the lining 3 from expansion thereof that might otherwise result from the resistance of the framework 1. As soon as the vacuum has been created the electric power is connected to the electrodes 4^1, 4^2 and 4^3 to heat the heating chamber 5.

Under the action of the heat the substance for reaction 19 in the container 6 gives off a metallic vapor which is directed by the container 6 and the member 7 into contiguity with the condenser 15 where it condenses and forms a mass of metal 15^2. In Fig. 3 the condensed metal is indicated by the reference character 17^2 and in Fig. 4 the condensed metal is represented by the reference character 20^2. The baffles 16 prevent the passage of metal vapor therepast to prevent it from condensing on the ring 12 and the door 10.

As soon as the operation has been finished and the vacuum pump is stopped, the door 10 is opened and the tubular member 13 together with the condenser 15 are withdrawn to remove the metallic crystals which have settled on the condenser 15. The furnace may be put back into operation again by reloading the container 6 with substance for reaction 19, placing the same on the floor 8 of the heating chamber 5 and either placing a second condenser in the passage 4 or placing the same condenser in the passage 4 after the condensed metal has been removed therefrom.

The present invention has particular adaptability for reduction processes. However, it is not intended that the structure be limited to any particular use as it may be employed wherever desired. The condensing member is conveniently located in the charging passage 4. However, it will be appreciated that equivalent arrangements within the scope of the attached claims may be employed with equally desirable results. Furthermore, while the container 6 for conven-

ience is open ended, it will be readily apparent that the entire end of the container 6 need not be open. When carrying out a process in the furnace according to the present invention in a neutral gaseous atmosphere, the neutral gaseous atmosphere may be obtained in any known manner.

Having thus described my invention what I desire to secure by Letters Patent and claim is:

1. A furnace of the character described comprising a heating chamber, a passage having one end communicating with said chamber, said passage having a removable door on the other end thereof, said passage being substantially uniformly outwardly diverging, a condensing member disposed in said passage and supported by said door, and deflecting means within said chamber to direct matter to be condensed from said chamber into contiguity with said condensing member, said passage being relatively small in transverse cross-section with respect to the size of said condenser.

2. A furnace of the character described comprising a heating chamber, a passage having one end communicating with said chamber, said passage having a removable door on the other end thereof, a condensing member disposed in said passage and supported by said door, said passage being substantially uniformly outwardly diverging, and a substantially closed container within said chamber for supporting matter for reaction, said container having an opening at one end thereof for directing matter to be condensed from said container into contiguity with said condensing member, said end of said container being disposed in said passage, said passage being relatively small in transverse cross-section with respect to the size of said condenser.

3. A furnace of the character described comprising a heating chamber, a passage having one end communicating with said chamber, said passage having a removable door on the other end thereof, said passage being substantially uniformly outwardly diverging, a condensing member disposed in said passage and supported by said door, and a tubular container within said chamber for supporting matter for reaction, said container having an opening at one end thereof, said end of said container being disposed within said passage for directing matter to be condensed from said container into contiguity with said condensing member, said passage being relatively small in transverse cross-section with respect to the size of said condenser.

4. A furnace of the character described comprising a heating chamber, a source of heat in said chamber, a passage having one end communicating with said chamber, said passage having a removable door on the other end thereof, a condensing member disposed in said passage and supported by said door, said passage being substantially uniformly outwardly diverging, and a substantially closed container within said chamber for supporting matter for reaction, said container having an opening at one end thereof for directing matter to be condensed from said container into contiguity with said condensing member, said end of said container being disposed in said passage, said condenser being shielded from direct radiation from said source of heat, said passage being relatively small in transverse cross-section with respect to the size of said condenser.

5. A furnace of the character described comprising a heating chamber, a source of heat within said chamber, a passage having one end communicating with said chamber, said passage having a removable door on the other end thereof, a condensing member disposed in said passage and supported by said door, said passage being outwardly diverging, a substantially closed container within said chamber for supporting matter for reaction, said container having an opening at one end thereof for directing matter to be condensed from said container into contiguity with said condensing member, said end of said container being disposed in said passage, and a plurality of baffling plates associated with said condensing member extending substantially across said passage into contiguity with the walls of said passage between said condensing member and said door for restraining the passage therepast of matter to be condensed, said condenser being shielded from direct radiation from said source of heat.

6. A condensing member of the character described comprising an internally liquid cooled condensing surface, a support for said surface, and a plurality of baffling plates secured to said support behind said surface.

7. A furnace of the character described comprising a heating chamber, a source of heat within said chamber, a passage having one end communicating with said chamber, said passage having a removable door on the other end thereof, a condensing member disposed in said passage and supported by said door, a substantially closed container within said chamber for supporting matter for reaction, said container having an opening at one end thereof for directing matter to be condensed from said container into contiguity with said condensing member, said end of said container being disposed in said passage, and a plurality of baffling plates associated with said condensing member extending substantially across said passage into contiguity with the walls of said passage between said condensing member and said door for restraining the passage therepast of matter to be condensed, said condenser being shielded from direct radiation from said source of heat.

FRANCOIS MATHIEU.