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METALLURGICAL FURNACE

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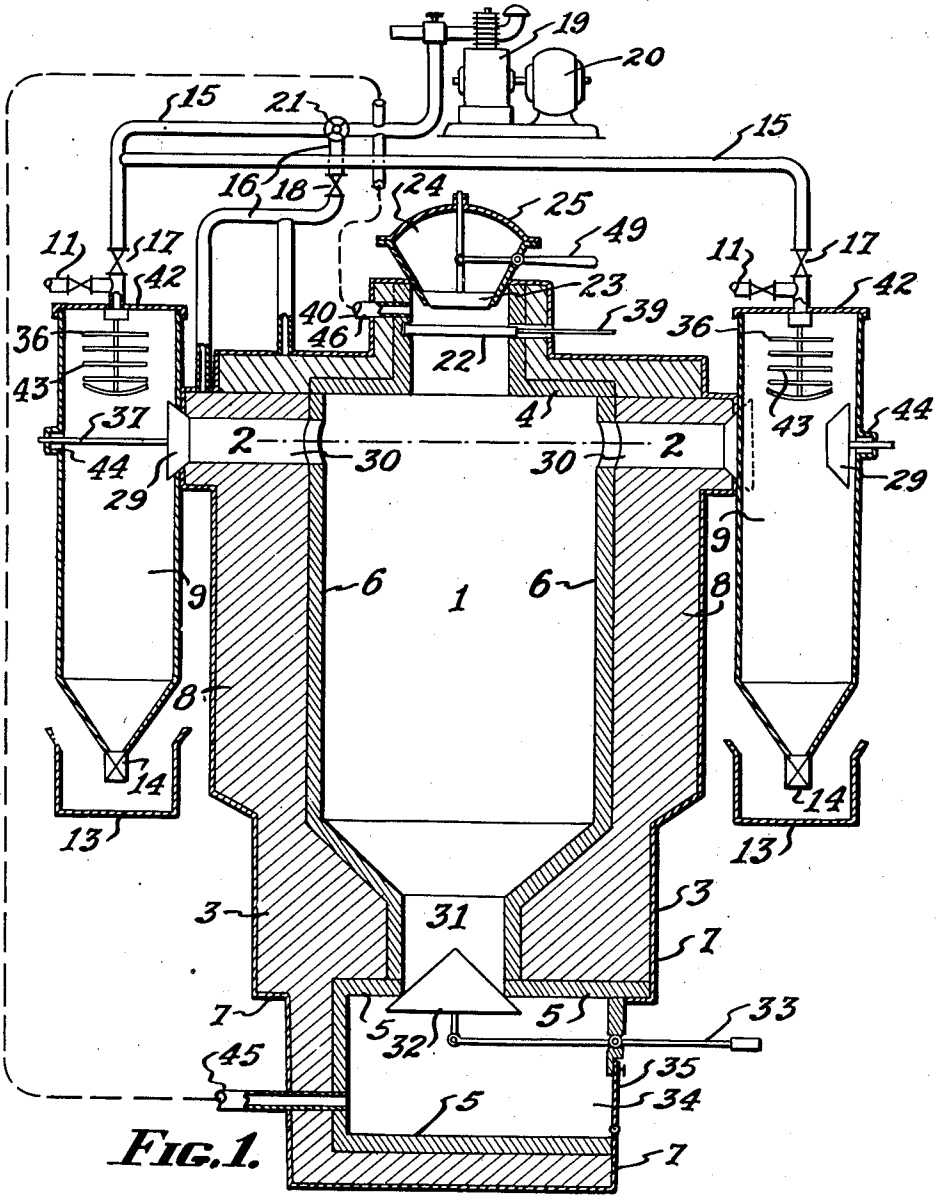


FIG. 1.

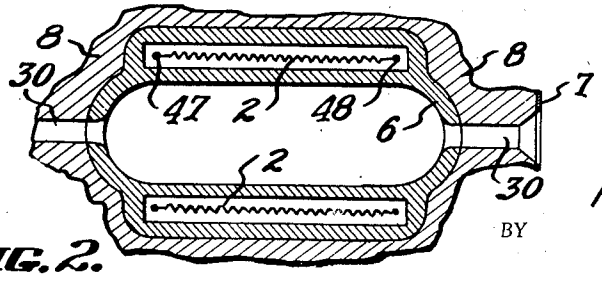


FIG. 2.

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METALLURGICAL FURNACE

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In France January 14, 1938

2 Claims. (Cl. 266—17)

The present application is a continuation-in-part of my application, Serial No. 249,149 filed January 3, 1939.

The present invention relates to a metallurgical furnace for extracting volatile metals, e. g. aluminium and magnesium, out of materials, such as ores, containing the same.

An object of the invention is to provide a furnace of the kind in which a high vacuum is applied to materials when heated at high temperature.

A further object of the invention is to provide a furnace in which the extracting of volatile metals may be conducted, under a vacuum, as a continuous operation.

A further object of the invention is to provide a reaction chamber supporting a high temperature and a high degree of vacuum and of which however, the walls do not become wasted nor distorted in an abnormal manner, this chamber being so constructed that it may work in a continuous manner.

One of the essentially few features of the improved metallurgical furnace is the fact that the inner and the outer surfaces of the heated retort or chamber which contains the materials under treatment are both submitted to a high vacuum, the said retort or chamber being to that purpose, enclosed in an outer receptacle submitted to the said vacuum while the inside of the retort or chamber is itself submitted to a high vacuum and preferably to the same degree of vacuum as the one of the retort or chamber. The wall of the outer receptacle can be maintained at a low temperature and the difference of the pressures between the atmospheric pressure and the high vacuum in the retort or chamber is entirely sustained by the wall of the said outer receptacle, the same or about the same low pressure acting on both sides of the walls of the retort or inner chamber.

According also to the invention the furnace is provided with means to allow the feeding of the furnace, the continuous extraction of the volatile metal and the elimination of dross without stopping the working of the furnace.

Again according to the invention the reaction retort or chamber of the furnace is eventually given a very flat shape and the materials to be treated are placed therein in a thin layer in order to hasten the reaction.

Again according to the invention an elongated retort or chamber may be used the two ends of the same being each connected with a condenser, means being provided for interrupting at will the communication between the retort or chamber and either of the condensers or with both. In a general manner, during the working of the furnace, one of the condensers is in communication with the furnace, for condensing the vapours of the volatilized extracted metal, the communication of the other condenser with the furnace being interrupted during this time, which allows the carrying off of the metal condensed herein.

The condenser for condensing the vapours of the volatilized extracted metal is either placed inside the furnace or outside, and it is preferably cooled down to a temperature at which the metal cannot spontaneously take fire when put in contact with the atmosphere. In the latter case it is easy to take the metal out of the condenser without stopping the heating of the furnace.

Other features of the invention will appear from the detailed description given hereunder with reference to the accompanying drawing in which:

Fig. 1 is a diametral section of an embodiment of the invention corresponding to a vertical furnace;

Fig. 2 is a plan view of a section through 2—2 of the furnace illustrated in Fig. 1.

In the following description and claims the word "chamber" will be used for designating either a chamber or a retort.

As shown in Fig. 1 the furnace is a vertical one which comprises a chamber 1 the walls 6 of which are made of refractory material. The upper wall 4 is also constituted of refractory material and joined to the walls 6. The chamber 1 has a very flat shape and two series of electrical resistances 2 are placed along the longest walls of this chamber throughout the height corresponding to the part of the chamber 1 in which there are reactant materials. The electric current for the heating resistances 2 is led to the said resistances by conductors 47, 48. The chamber 1 and heating coil 2 are surrounded by an outer metallic gastight wall 7. Between the walls 6 and 4 of the chamber 1 and the outer metallic wall 7 there is a space 3. This space 3 is filled with a layer of refractory insulating material 8 which prevents the heat of the inside of the furnace weakening the mechanical resistance of the wall 7. The wall 6 may, for instance be constituted of sillimanite or mullite, and the layer 8 of aluminous bricks in the outer half portion of its thickness and with light bricks of kieselguhr in the inner portion, near

the chamber. Two condensers 9 can be respectively connected by means of valves 29 with conduits 30, leading to the chamber 1. Both the condensers 9 and the space 3 are connected by respective conduits 15, 16 provided with valves 17, 18 and through a three-way cock 21 to a vacuum pump 19 actuated by a motor 20.

A special vacuum release valve 11 is provided for each condenser, each condenser is provided with an outlet valve 14 which permits casting the liquid condensed metal into a receptacle 13. Each condenser is also provided with an apparatus 36 which has plates 43 for the purpose of insuring the condensation of the metallic vapours, directly in the solid state. This apparatus 36 is hung to a gas-tight cover 42 provided on the upper part of the condenser. The valves 29 are actuated by means of rods 37 passing through the wall of the condenser, by means of a stuffing-box 44.

A charging hopper 24, closed by a cover 25 and provided with a valve 23, is located at the top of chamber 1 for charging the furnace with the reacting materials and acts as a lock. A tight sluice 22 provides, under the valve 23, a chamber 40 acting as a sieve during the introduction of reacting material. This chamber 40 is provided with a conduit 46 connected with a vacuum pump.

A crucible 31 is formed on the chamber 1 at its bottom and a valve 32 actuated by the rod or shaft 33 permits evacuating the dross from the chamber 1. Under the crucible 31 there is provided a chamber 34 having a gas-tight wall 5, a gas-tight door 35 and a conduit 45 connected with a vacuum pump.

It may be seen easily that by means of the pump 19, the same vacuum can be realized in the condensers 9, the chamber 1 and the space 3. Thus the part of the wall of the chamber 1 which is heated to high temperature is not submitted to a difference of pressure, the atmospheric pressure being totally sustained by the cool wall 7. In order to better insure a correct balance of the pressures on both faces of the wall 6 at its heated part, holes may be provided in said wall in the part referred to. Thus the wall 6 cannot be distorted. A further advantage is that the heat of chamber 1 cannot be conveyed by convection to the outside through the receptacle 3.

The furnace works as follows: the material to be treated and which is capable of evolving a volatile metal, has been previously charged into the chamber 1 by means of the charging hopper 24, the tight sluice 22 and the valve 23 being opened. The left valve 29 is closed and the right valve 29 is opened, for instance, as shown in Fig. 1. The left valve 17, the valve 23 and the tight sluice 22 are closed but the right valve 17 and the valve 18 are opened. The valve 11 of the right condenser is closed and the pump 19 is set in motion. When a high vacuum is obtained in both the condenser 9 and the chamber 1 and the space 3 current is caused to pass in the heating coil 2. The reaction takes place in the material of chamber 1, owing to the high heat developed; the volatile metal is liberated and vapourised. The metallic vapours so evolved are condensed in liquid form in the right condenser 9. When there is a sufficient quantity of condensed metal in the right condenser the valve 29 of this condenser is closed and the vacuum is released in this condenser by opening the valve 11 and closing 17. At the same time the valves 29 and 17 of the left condenser are opened and the valve 11 closed. Thus the liquid metal in the right condenser can be tapped in the receptacle 13 through the valve 14. The same process may be applied to the other condenser by closing its valves 29 and 17 after having connected the right condenser and so on. Obviously it is possible to leave the valves 29 of the two condensers opened. It is only when metal is carried off from a condenser that it is necessary to disconnect it.

It is possible to obtain directly crystallized solidified metal in the apparatus 36 provided with plates 43 by conducting the operation in such a manner that the metallic vapour be, around these plates, under proper conditions of temperature and pressure, viz those which are different of those of the triple point. For instance in case of aluminium there is directly condensation above the plates 43 in the solid state for a temperature of 1400° C. and a pressure of 2 mm. of mercury. The tight cover 42 provided in the upper part of the condenser is opened and the apparatus 36 charged with solid metal is carried off.

The operation may be conducted in a continuous way. There has already been described means for the continuous extraction of the metal obtained. When it is necessary, during the operation to charge new reactant material it is proceeded as follows. By means of the rod 49, the valve 23 is opened and the material which fills the chamber 24 falls in the chamber 40. The valve 23 is then closed and a vacuum is created in the chamber 40, equal to the vacuum of the chamber 1, by means of the conduit 46. The tight sluice 22 is then opened by means of the rod 39 and the reacting materials are introduced into the chamber 1. The sluice 22 is closed and the reactants have thus been introduced in the furnace, without practically any trouble in the working of the apparatus.

For the evacuating of the dross from the chamber 1 during the working of the apparatus, a vacuum is created in the chamber 34 equal to the vacuum of the chamber 1, by means of the conduit 45. The valve 32 is then opened by means of the shaft 33 and the dross falls down in the chamber 34. The valve 32 is then closed, the tight door 35 is opened and the dross is evacuated without practically any trouble in the working of the apparatus.

In the application of the apparatus, when treating for example aluminium ore by a reducing agent, e. g. iron-sulfide, the pressure in chamber 1 and in space 3 may be lowered down to 10–2 mm. of mercury and the temperature raised to 1200°–1800° C. The liberated aluminium vapours condense in the condensers 9.

When the reactant is in compact mass, which is heated from the outside, the reaction occurs first at the outside and after progressively in the inside of the mass, but very slowly. For instance, when working at the temperature of 1300° C. the reaction has merely progressed for one centimeter from outside to inside of the mass for one hour operation. It is thus necessary to avoid to have a mass of reactants too heavy because the complete reaction be too slow. As it is preferable at industrial point of view to work on important quantities of reactants the apparatus is elongated as shown in Fig. 2, the heating means being placed along the longest sides of the apparatus.

Various modifications may be made in the device embodying the invention without departing from the spirit and scope thereof and all such modifications are intended to be covered by the appended claims.

What I claim is:

1. A metallurgical furnace comprising a closed reaction chamber having non-porous refractory walls, means for heating said reaction chamber to a high temperature, a closed gas-tight receptacle surrounding the said reaction chamber, the space therebetween being filled with porous refractory material, a plurality of separate condensers located outside said receptacle but having gas-tight connection therewith, there being from said reaction chamber to each of said condensers a valved passageway, means providing a gas-tight closure for introducing material into said reaction chamber, means including a gas-tight closure for withdrawing material from said reaction chamber, means including a gas-tight closure for withdrawing material from said condensers, vacuum producing means and connections between said vacuum producing means and said reaction chamber, said receptacle outside said reaction chamber and said condensers severally, the said connections to said condensers being valved, and said condensers each having a valved connection for relieving the vacuum therein.

2. Apparatus as claimed in claim 1 in which the outlet from said reaction chamber is a valved outlet emptying into a chamber having a substantially gas-tight closure and a connection between said chamber and vacuum producing means.

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