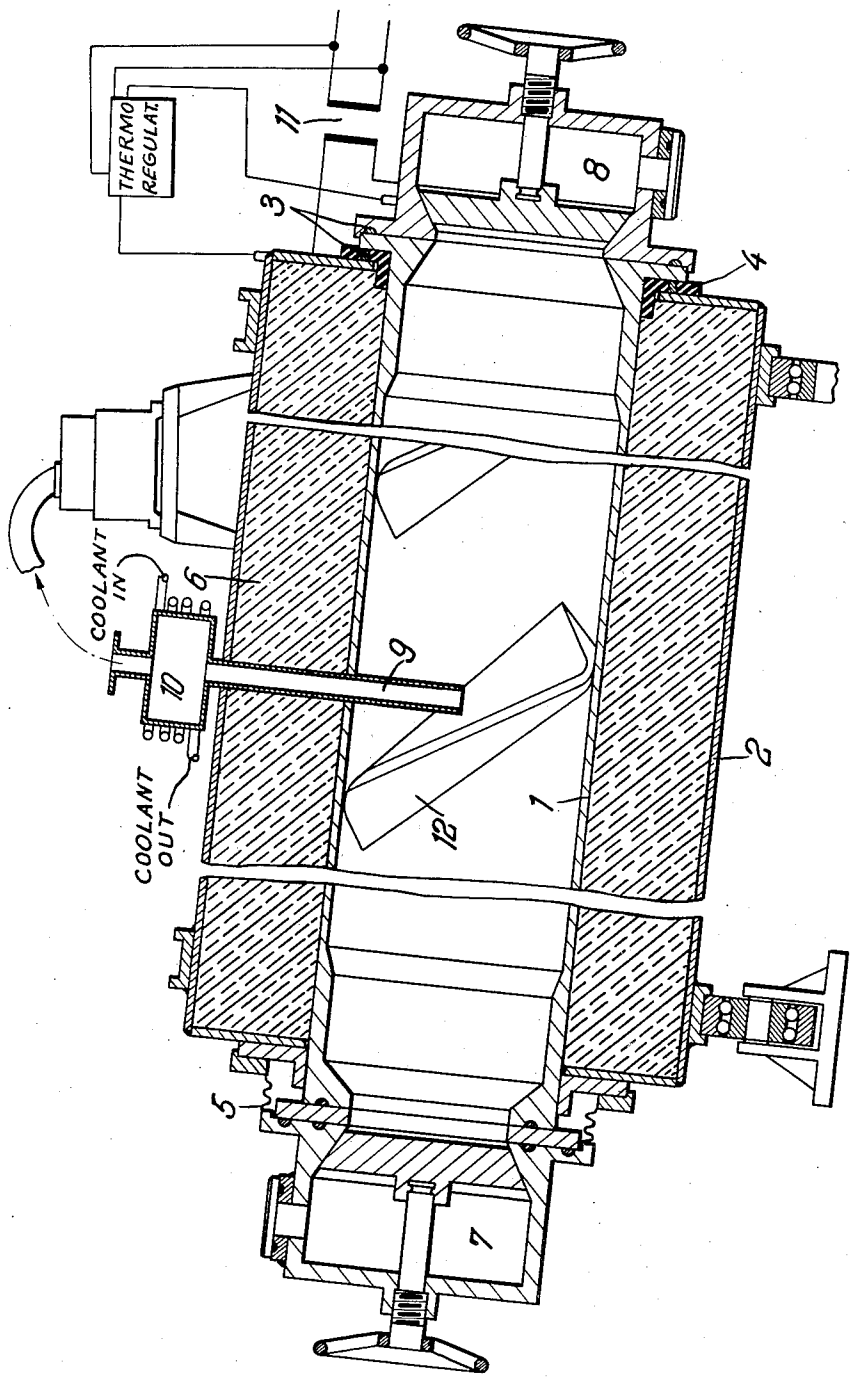
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OVEN FOR PRODUCTION OF MAGNESIUM

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OVEN FOR PRODUCTION OF MAGNESIUM

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The invention relates to an oven, and particularly to one which is intended for the manufacture of magnesium on a silicon thermal base. In this process in particular, high demands are made on a reaction oven. To achieve the highest possible output, the temperature must amount at least to 1200° C. In addition, the handling of the material must be conducted in a vacuum. Individual difficulties arise when difficult processes are applied to continuous charges of large quantities of reaction substances in small areas.

Heretofore, such manipulations have been carried out in vessels made of high heat-resistant and fire-resistant material, which were heated for instance by burners. In this case, however, it has been found necessary to maintain the temperature at the lowest limit of about 1200° C. Then too, the manipulating vessels have had only a very short life span, in that they would become deformed even after a comparatively short time under the influence of exterior air currents. The short life span of the reaction vessels as well as the slight yield and comparatively long reaction time required for the dislocation of the reaction products, namely dolomite and ferrous silicon at 1200° C. are well known reasons why heretofore these processes were unworkable in the recovery of magnesium on the basis of fusion electrolysis.

In other oven constructions, in order to overcome the short life span of the reaction vessels, it was also decided to provide the vessels with a fire-resistant coating and heat them from within with powdered coal. Here, however, the durability of the powdered coal presented difficulties. Aside from this, the recurring abrasion, wear and tear and lengthy pumping time resulting from the gas absorption by the fire-resistant materials which had to be taken care of after each use of the coating of the vessel, were annoying.

In addition, the presence of coal proved unfavorable in the production of magnesium at low temperatures. The known significant disadvantage of the familiar processes consists in the inability of these to produce magnesium in a continuous operation.

The invention brings about a change in this case. It points out a way which does away with the heretofore existing defect. With the aid of this invention it is possible to carry out an economical, efficient continuous process for the recovery of magnesium on a silicon thermal basis. In accordance with the invention, this is achieved essentially by means of an oven, by way of example a rotating oven, in which an iron reaction vessel under reduced pressure and leak-proof vacuum condition is connected in an electric circuit as part of it, and the electrical resistance of the vessel itself is employed as a heating means. Regulating means are employed in connection with the circuit to bring about the required temperature. The vessel is at the same time contained in another outer vessel from which air has been extracted, thus providing a vacuum between the two. The outer vessel is provided with a jacket which is maintained at a lower temperature and is likewise maintained under reduced

pressure. It is advantageous to provide an automatically operated arrangement, which may maintain the same pressure in the outer as well as in the inner vessel. By placing the reaction vessel in the vacuum-formed outer vessel, the reaction vessel is safely protected from the stresses imposed by atmospheric pressure. Advantageous, in addition, is the fact that the reaction vessel is separated from the aforesaid heat-insulating outer jacket. To extinguish the fire in the reaction vessel, it is further recommended to advantageously introduce an inert gas, as, for example, hydrogen.

The following advantages in particular are claimed for the new oven in the recovery of magnesium: the electrical resistance of the reaction vessel is used to heat the vessel. The heat originates directly in the places where it is needed. The heat resistance required when coal is used, as well as the provision of separate resistance materials is obviated. Because the same pressure prevails outside the reaction vessel as well as in its manipulation chamber, no special demands worth mentioning are made upon the inner compartment at high temperatures. In addition, during the firing of the manipulation vessel, this assists in maintaining the proper vacuum condition. The low heat-resistance during the customary employment of high temperatures does not matter, because the manipulation vessel is free of immediate contact with the heat-resistant lining.

The inventive idea will become apparent below from the construction illustrated by way of example in the drawing.

The invention will now be more fully described with reference to the single figure of the accompanying drawing showing a sectional view of the oven, but it should be understood that these are given by way of illustration and not of limitation, and that many changes in the details can be made without departing from the spirit of the invention.

In the drawing:

The high-temperature reaction vessel 1, which is almost half-filled with a mixture of dolomite and ferro-silicon, is separated in a vacuum-tight manner from the outer vessel 2. To achieve the smallest possible energy loss in the watercooled packing seal by the current, the wall thickness construction of the vessel 1 at both ends is advantageously double the strength of the middle part. For example, the thickness of the wall in its middle is 20 mm., whereas at the ends it is increased to about 40 mm. In many instances, however, it is advantageous to proportion the cross-sections to correspond with the required temperatures in individual zones, those for preheating the supply of material or those for the reaction energy required for the chemical conversion reaction, in such a manner that the proper temperature is established in the operation. The inner vessel 1 is electrically insulated at least at one end from the outer vessel 2 in addition to the vacuum seal. This is accomplished simply, by providing the two vessels with insulating material which need exhibit only a low temperature stability, the vessels being supported one by the other at the water-cooled location 4. Since the inner manipulating vessel may have a temperature varying from the outer, provision is made for equalizing the difference in heat expansion. To that end there is provided between the inner and outer vessels an elastic vacuum-sealing medium, as for example tombac-tubing. Tombac is any copper or zinc alloy. This insulation may also be effectively made of stiff rubber, or artificial material alone or in combination with a liquid seal.

A heat-resistant lining 6 is provided for heat-insulation of the vessel, the coating being advantageously constructed in such a manner that it separates the inner vessel from the outer vessel. It does not matter whether a massive fire-resistant lining is employed in the inbetween space or whether the space is filled with a loosely spaced fire-

resistant substance. In certain instances a combination of both types of lining may be more advantageous. Finally, the heat insulation between the two vessels may be effected by radiation guard plates alone or in conjunction with a partial heat-resistant lining.

To assure a continuous operation there are in addition provided, at the ends of the reaction vessel, vacuum compartments **7** and **8**, through which the reaction material is fed and discharged. The mixture of dolomite and ferro-silicon required for the recovery of magnesium is continuously admitted in the chamber **1** by the vacuum compartment **7**. The oven proper is advantageously erected obliquely, so that the substance moves along slowly during rotation. It is expedient to introduce scoops **12** or similar arrangements, which make it possible to move the materials further along simultaneously with the rotation of the oven.

In the preceding discussion the term "rotation" is understood to also include a rocking motion of the oven, for example up to 360° C. Such an arrangement of the oven has certain advantages, in that the water cooling and other connections may be brought in through movable conductors which can resist torsion. In this manner such connections may be made more easily.

To exhaust the magnesium fumes, customary during the reaction, heat-resistant pipes **9** are emplaced in the reaction vessel, and these lead to a cooled chamber **10**, in which the magnesium vapor is precipitated. Since other gaseous products are also formed in addition to magnesium, which must usually be eliminated, it is advantageous to simultaneously employ the pipe **9** for the evacuation of the vessel. In this manner all of the magnesium recovered is conveyed by the gas current to the cooled chamber **10** and thereby the condensation at the compartments **7** and **8** is in effect prevented. This action may further be increased by so designing the inner vessel even with the temperature up to nearly 800° C. on both sides of the oven, that it is completely filled with material. Furthermore, it is possible to introduce additional inert gas from both sides of the vessel **1**, so that this gas resists the diffusion of the magnesium to the cooler parts of the oven, and is then likewise exhausted through the pipe **9** and the receptacle **10**. In many instances it is helpful to install the exhaust pipe **9** inside the vessel **1** and lead it out through the axis of rotation.

Particular care must be taken in connection with the electric circuit. For example, with an oven length of 10 meters, a reaction vessel with a diameter of 100 cm., and a wall strength of 20 mm. and with the employment of unalloyed steel, the resultant resistance is 10.4 ohms. For such an oven a power output of approximately 1000 kilowatts is required, in which case at a voltage of 10 volts the current flow is about 100,000 amperes. This current intensity may, without a doubt, be carried over ordinary flexible wire. However, it is advantageous to have the transformer participate in the rotation of the oven, whereby only the low currents of the primary will have to be carried over said flexible wires.

The following arrangement has proven beneficial in this respect: the transformer **11** is attached to the rotating oven and revolves with it. On the side, carrying the transformer, the inner vessel **1** is electrically insulated from the exterior vessel **2**. The vessels are directly connected with one another on the opposite side. The outer vessel jacket **2**, which has a greater wall strength in order to assure the safety of the device, also serves as the return conductor. In this arrangement the transformer may be securely attached to the vessels **1** and **2** by means of the bus bars.

The above described oven for magnesium recovery may also be employed with advantage in other fields of high-temperature operation. Its construction makes it possible to employ it at a pressure above the atmospheric. To this end, it is merely necessary to maintain essentially the same pressure in the outer as well as in the inner reaction vessels, thereby relieving the operating vessel from pressure differences.

What we claim is:

1. In a rotary oven for the recovery of magnesium, of the type comprising an inner reaction vessel; an outer vessel enclosing the inner vessel; electrical insulating means and heat insulating means in the space between said vessels, securing said vessels in spaced relationship to one another; an electrical resistance means for heating the oven, with electrical connections for a lead-in to the wall of said inner vessel and a lead-off from said outer vessel: said inner vessel consisting of a cylindrical vacuum-tight tube being an electrical conductor, a first vacuum compartment at the inlet end of said tube for admitting magnesium thereto, a second vacuum compartment at the outlet end of said tube for discharging magnesium, which has been thermically treated, from said tube, and means for evacuating the insulation-filled space between said inner vessel and said outer vessel.

2. The oven according to claim 1, wherein means are provided for mounting said tube forming the inner vessel so as to be freely expansible in axial direction with respect to said outer vessel, and wherein resilient vacuum-tight packing means are provided for compensating the difference in heat expansion between said inner and said outer vessels.

3. The oven according to claim 2, which comprises, in addition, a transformer, means for securing the secondary of said transformer to the inner vessel and the outer vessel of said oven, said transformer being secured to said oven opposite the end at which the two vessels are connected.

4. The oven according to claim 3, comprising an exhaust pipe for the escape of reaction vapors and for the evacuation of the inner vessel, a receptacle outside of said oven, and cooling means for said receptacle whereby a condensation of said reaction vapors is effected in said receptacle.

5. The oven according to claim 4, comprising scoops obliquely secured in spaced relationship to the interior surfaces of the said inner vessel.

6. The oven as claimed in claim 5, wherein the wall thickness of the said inner vessel is variously proportioned at different portions thereof to obtain the temperatures required for the manipulation of magnesium.

7. The oven as claimed in claim 6, wherein the wall end portions of the said inner vessel are of a thickness greater than that of the central portion.

8. The structure in claim 7, wherein outlet and inlet means are provided in the said inner vessel for the admission and escape of inert gas.

9. The oven as claimed in claim 8, and regulating means associated therewith for regulating the temperatures of the said vessels.

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