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PROTECTION OF CHILLING NOZZLES

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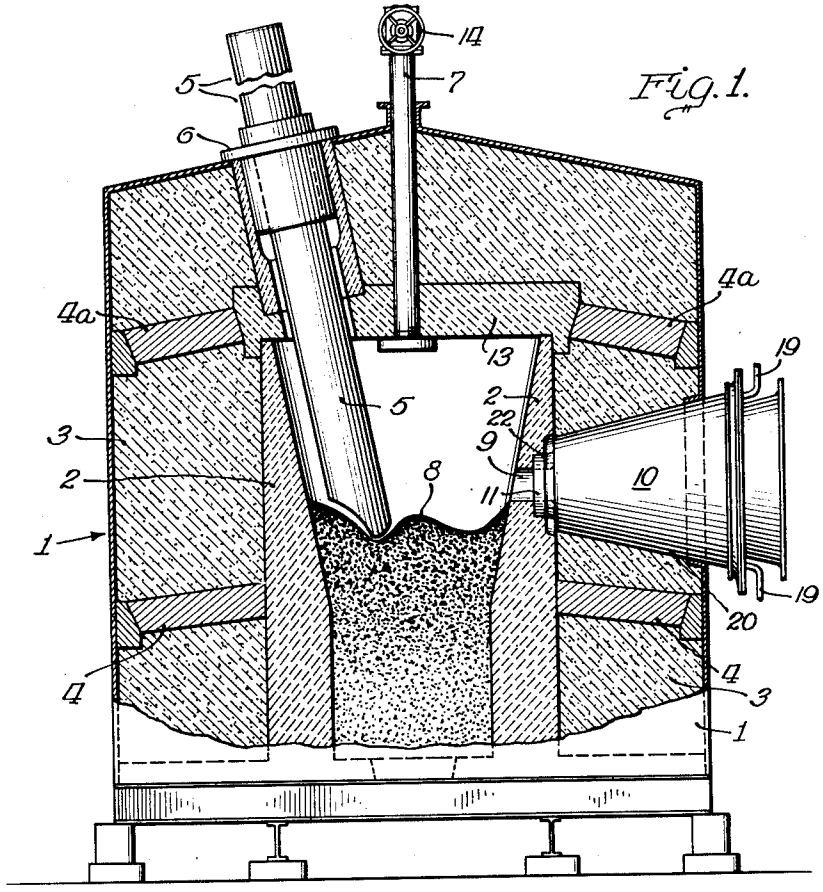

Fig. 1.

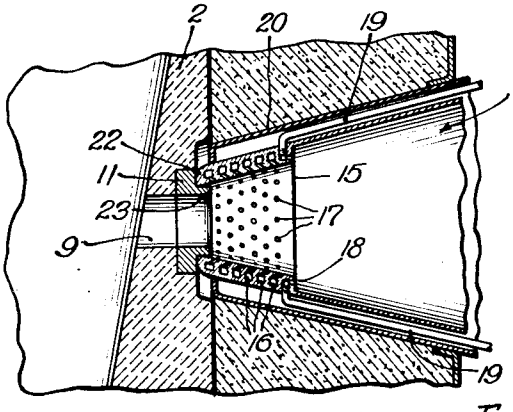

Fig. 2.

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PROTECTION OF CHILLING NOZZLES

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3 Claims. (Cl. 13—8)

The present invention relates to electric furnace construction and more particularly to the protection of a chilling nozzle such as is employed in connection with the carbothermic reduction of magnesium oxide according to the so called Hansgirg process. While herein reference is made to the reduction of magnesium, it is to be understood that the invention is applicable to the handling of other metals or other media.

In the production of magnesium according to the process of Hansgirg Patent No. 1,884,993, magnesium oxide and carbon are reacted in an electric arc furnace to evolve magnesium vapor and carbon monoxide. The products of the reaction, which are magnesium and carbon monoxide, are discharged from the reaction chamber at a temperature high enough—approximately 2,000° C. or higher—to prevent reversal of the reaction. According to this process before any substantial reduction in temperature occurs in the products of reaction, a chilling medium which may be any of the well known fluids employed for this purpose, such as hydrogen, methane, natural gas, liquid hydrocarbon, etc., is injected into the issuing stream of magnesium vapor and carbon monoxide. The products of the furnace, magnesium vapor and carbon monoxide, are by such injection instantaneously and greatly diluted—for example, by 40 to 50 volumes—and suddenly dropped in temperature to a point well below that at which any appreciable reverse reaction between the magnesium vapor and carbon monoxide can occur. This temperature may be from around 400° C. to around 200° C. This procedure is well known to those skilled in the art.

A particularly difficult problem in the working of this process is the maintenance of the chilling nozzle against too rapid deterioration. The chilling nozzle must be brought as close as possible to the furnace, so that there is a minimum opportunity for the loss of heat from the issuing stream of furnace products, otherwise there is a tendency to establish a zone of gradually decreasing temperatures in which reversion of the reaction occurs. The issuing stream from the furnace must be kept at a high temperature right up to the point of chilling. Then the chilling must be sudden and complete, i. e. so called shock-chilling. The issuing stream at high temperature tends to lose heat rapidly to the surrounding media and the cooling influence of the chilling zone or condenser is reflected in or on the passageway between the furnace proper and the chilling zone. It is therefore highly desirable that a very steep temperature gradient be maintained between the issuing stream of furnace products and the chilling nozzle. In the operation of such a reduction furnace it not infrequently occurs that deposits of soot in or about the discharge orifice of the furnace occur. This calls for reaming out the orifice or scraping the surfaces, as disclosed in Patent No. 2,109,841.

The problem of maintenance above referred to involves chiefly the difficulty of maintaining the chilling nozzle against too rapid deterioration under the intense heat and eroding effect of the issuing stream of furnace products and the heat of radiation from the inside of the furnace. The nozzle, which for practical purposes, is necessarily made of metal, when installed according to prior knowledge, has failed after a relatively few hours' operation. This in turn has prevented any programmed operation of the furnace. In installations heretofore made, and as illustrated in the above Patent No. 2,109,841, the metallic surface of the chilling nozzle was connected flush with the opening through the lining of the furnace crucible. Thus it was subjected to the inherent difficulties caused by radiation and erosion above mentioned.

According to the present invention, the inner end of the nozzle is shielded from the eroding effect of the issuing stream of furnace gases, and protected from the heat of the said stream and the heat of radiation of the interior of the furnace, by the expedient of telescoping the inner end of the nozzle with a projecting flange or sleeve extension formed on the furnace wall. Preferably this flange is formed as a part of a removable graphite ring. The particular manner in which the interrelation of the parts is produced is within the option of the designer. I have found that a satisfactory arrangement may be produced by setting a graphite ring into the outer wall of the furnace lining, this ring having a neck or extending flange which is inserted into the small end of the chilling nozzle, which is preferably of conical shape, and thereby the forward end of the chilling nozzle is shielded from the intense heat of the furnace, protected from the eroding effect of the issuing stream of hot vapor and gas, and does not become exposed upon a reaming operation, such as may be necessary to clear out the orifice of deposited solids. The joint between the ring and furnace wall and the joint between the sleeve and the chilling nozzle are sealed with graphite paste as will be understood by those skilled in the art.

Now in order to acquaint those skilled in the art with the manner of constructing and operating a device embodying my invention, I shall describe, in connection with the accompanying drawing, a specific embodiment of the same.

In the drawing:

Figure 1 is a vertical section in a more or less diagrammatic form of an electric furnace employing the present invention; and

Figure 2 is a longitudinal axial section on a slightly enlarged scale, of the protecting ring and the chilling nozzle.

The furnace has an outer metal shell 1, which forms a substantially tight casing. Within this casing a crucible 2 advantageously made of carbon in suitable segments, as is known to those skilled in the art, is insulated by suitable insulation 3 between the said crucible and the shell 1. The insulation 3 may be soot, or other heat insulating material as desired. The crucible is preferably made of an upper flared out of conical portion and a lower cylindrical portion, these portions being constructed of blocks suitably shaped to fit with each other in forming a generally circular crucible, braced and held in place in the casing 1 as by means of the supports 4. The upper end of the crucible is closed by a cover member 13 which has a central opening for a feeding tube 7 controlled by suitable valve mechanism, indicated at 14. The cover member 13 is braced by the support 4a. The entire inside of the casing 1 is filled with soot as insulation, or other suitable insulating medium. The cover 13 of the crucible is provided with one or more apertures for one or more electrodes 5, which are sealed to the casing 1 and to the cover 13 by means of the gland or stuffing box 6. Preferably, a carbon sleeve around the electrode forms a seal between the cover 13 and the shell or casing 1.

The furnace may be heated by any suitable means, including three phase current working through three electrodes or by single phase current through a pair of electrodes. A coke bed 8 fills the lower part of the crucible, and provides a hearth upon which the working material introduced through the feed tube 7 may be suitably heated. The three electrodes cooperate with each other and with the coke bed 8 to maintain a central region of intense heat, and the rate of feed is generally such that pellets or tablets of magnesium oxide and carbon are substantially converted into gaseous form as soon as they strike or are about to strike the hearth formed by the coke bed 8.

A gas and vapor discharge passageway 9 is formed in the side walls of the crucible 2 and the gaseous products of the furnace, that is, magnesium vapor and carbon monoxide resulting from the reaction between the magnesium oxide and carbon are discharged through the opening 9 into and through the chilling nozzle 10 into a condenser chamber, not shown. The chilling nozzle is a conical or tapered hollow body which functions as the means for diluting and rapidly reducing the temperature of the products of reaction to suppress the reverse reaction, thereby producing metallic magnesium in solid form, though finely divided. The cooling nozzle or chilling cone 10 is substantially of the construction disclosed in the aforesaid Hansgirg Patent No. 2,109,841, or it may be of any other preferred or desired form. Suffice it to say that at the inner or smaller end the shock chilling nozzle comprises a conical metal body 15 having a series of annular manifold ducts such as 16 for supplying a series of nozzles or outlet openings 17, 18, with a suitable shock chilling fluid medium. This medium may be hydrogen, methane, natural gas, or liquid hydrocarbon in either liquid or vapor form. The nozzles may be modified to adapt them to the particular medium employed. The nozzle 15 is shown as of a form suitable for introducing gaseous products. Each manifold duct is supplied with the desired gaseous medium through connections such as 18, 19, connected to a source of fluid, preferably through a common supply manifold. Connections, such as 19, 19 are connected to the respective annular manifold passageways 16. Preferably, the tubular connections are disposed in a cooling jacket 20, so that the gaseous chilling medium may be cooled by the fluid in the jacket and be delivered to the outlet openings 17, 18, at a temperature as low as room temperature or less. It will be observed that the openings 17, 18 are directed radially inwardly and rearwardly or to the right as viewed in Figure 2, so as to produce an ejector action, propelling the gaseous products of the furnace towards the right and into the condenser (not shown), where the metallic magnesium particles are separated from the gaseous components of the issuing stream.

The inner or smaller end of the cooling nozzle 10 is disposed in register with a ring 11 which ring is set into the side wall 2 of the crucible, surrounding the opening 9. The ring 11 has an axially extending flange 23, which is disposed in telescopic relation to the inner end 22 of the annular nozzle 15.

Whereas heretofore the inner end 22 of the nozzle ring 15 has suffered from the intense heat and erosion of the issuing gases, and from the radiant heat from the inside of the furnace crucible, and has been subjected to exposure even to a greater extent by any scraping of the passageway 9, this has now been overcome by the simple expedient of projecting the collar or short sleeve formed by the flange 23 telescopically on the inside of the nozzle ring 15.

The particular method of constructing the protecting sleeve or flange 23 is not of the essence of the invention, since this may be varied within the scope of the appended claims. However, the specific form herein illustrated is advantageous, in that the collar or inwardly extending flange 23 forms a part of the main body of the ring 11, and may be renewed by substituting another ring 11 where that is found desirable.

This shield may be made a part of the crucible wall, or it may be built up of sections, but with less advantage. However, it is to be understood that satisfactory results are obtainable so long as the shield is slipped over the cooling nozzle in a protective manner.

With the installation of the shield of my invention, it has been found possible to prolong very greatly the life of the chilling nozzle. At the same time, the sharpness or suddenness of temperature change from the high temperature around 2,000° C. to the lowered or reduced temperature around 200° C. is not altered, but in fact is enhanced.

I do not intend to be limited to the precise details shown and described, except as the same are made essential by the appended claims.

I claim:

1. In a furnace of the class described, the combination of furnace walls defining a sealed furnace chamber, electrodes extending into said chamber, means for feeding a reactive charge into the chamber for evolving magnesium vapor, there

being an outlet in the sidewalls of said chamber, an outwardly extending metallic chilling nozzle registering with said opening, and a removable carbon sleeve connecting said opening, and said nozzle, said sleeve projecting telescopically inside the entrance opening of the nozzle, said sleeve overhanging the adjacent annular wall of the nozzle and protecting the same from the intense heat of the furnace, and of the discharged furnace products.

2. In a device of the class described, a furnace wall having an outlet opening therethrough, a ring of refractory material inset in the wall about said opening, said ring having an axially extending neck, a chilling nozzle comprising an outwardly flaring nozzle wall having openings directed toward the axis thereof, means for supplying said openings with a chilling medium and a cooling jacket for said nozzle wall, the inner end of said nozzle wall embracing and being shielded by the said axially extending neck.

3. The combination of claim 2 wherein the ring is a graphite ring, and the furnace wall outside the said ring has an annular recess to receive the inner end of the chilling nozzle.

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