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APPARATUS FOR PRODUCING MAGNESIUM BY THERMAL REDUCTION

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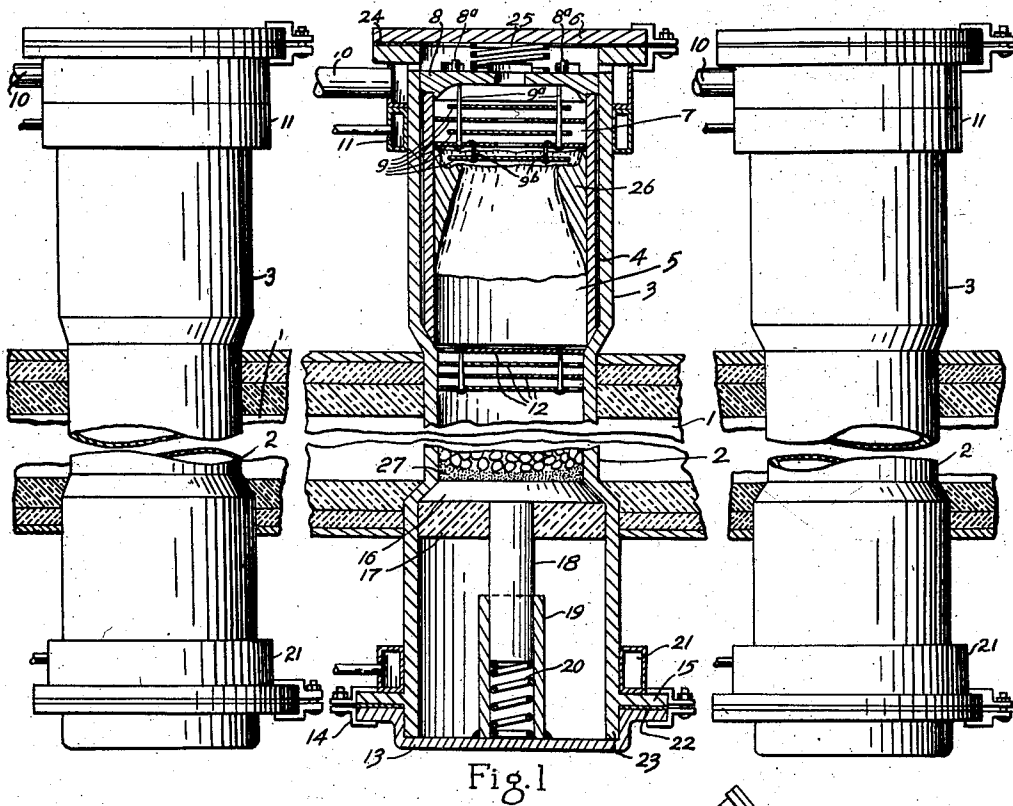


Fig. 1

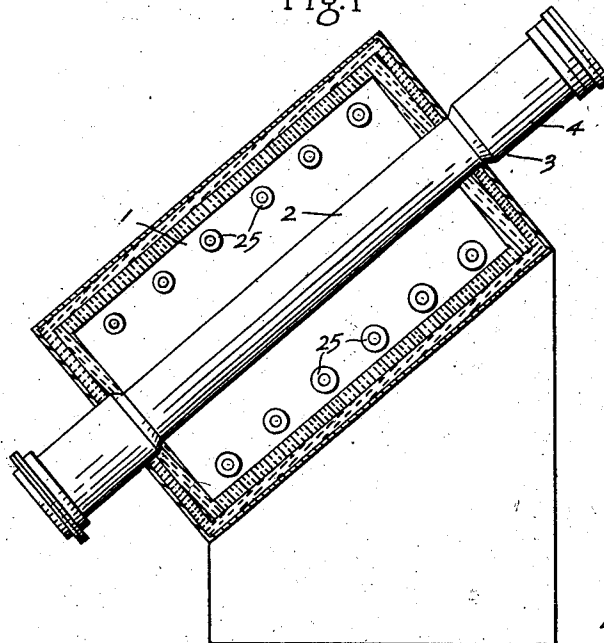


Fig. 2

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APPARATUS FOR PRODUCING MAGNESIUM
BY THERMAL REDUCTION

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5 Claims. (Cl. 266-19)

This invention relates to the thermal production of substantially pure magnesium by ferro-silicon reduction under reduced pressure, and more particularly to apparatus therefor.

While the literature discloses much relating to the thermal production of magnesium with reducing agents, commercial use of the method has been surrounded by dangerous hazards as well as economic problems. Indeed the commercial production of the pure metal by direct ferro-silicon reduction has been considered impracticable, if not impossible.

Applicant has produced pure magnesium in coherent dense form by direct thermal ferro-silicon reduction of calcined magnesium containing material. The reducing vessels or retorts are allowed to remain in a heating furnace maintained at substantially constant temperature and the retorts are charged and discharged in air, without the hazard of fire or explosions. Prior applications 417,810, now Patent No. 2,330,142, September 21, 1942, and 427,004, relate to this process and apparatus therefor.

The object of the present invention is to provide further improvements, which facilitate discharge of the spent residue with economy of time, which permit increased production capacity of each retort, which conserve heat, and others which will appear from the following description with reference to the accompanying drawing in which

Figure 1 is a transverse section of a furnace showing a plurality of retorts, one of which is in longitudinal section the furnace being shown as broken away.

Figure 2 is a transverse section of a furnace showing a retort in longitudinal elevation.

In the drawing 1 represents a heating furnace having located therein the reducing portion 2 of any desired number of retorts 3. In Figure 1 the retorts are vertically disposed within the furnace, while in Figure 2 they are disposed at an angle preferably just greater than the angle of repose of the residue of the charge for convenience in discharge of the spent residue. Each end of the retort projects beyond the furnace. In the upper or condensing end 4 of the retort is located a removable condenser 5, having an internal diameter of not less than that of the reducing zone of the retort. This end of the retort is closed by a removable head 6 and has a fractionating condenser 7. As shown the latter comprises a series of spaced metal discs 9 arranged within and adjacent the outer end of the removable condenser, to provide a relatively long

path of travel for vapours through zones of progressively lower temperature. While as illustrated five such discs are shown, any desired number may be used to provide optimum temperature conditions for fractionating the metal vapours and independently condensing them in solid form. The discs are shown as carried by the plate 8 which closes the removable condenser for convenience in their removal. It will be apparent however that they could be held in place and removed independently of the closure plate. The plate 8 may be provided with lugs 8a for convenience in removal and a spring 25 holds it in place. The discs are shown mounted on tapered rods 9a for ease in assembly. The innermost disc 9 is out of thermal contact with the condenser wall and is preferably carried by the adjacent disc by means of thin rods 9b so as to completely avoid undue cooling of this disc, which in operation is maintained relatively hot by impingement of the metal vapours. This hot disc acts as a baffle to direct the hot vapours to the wall of the condenser shell where the magnesium deposit forms. A plurality of these hot baffles extending into the condenser may be used to regulate the location of the deposit.

10 represents means for providing a reduced pressure in the retort, and 11 means for cooling the condenser by the circulation of water or the like. A heat radiation shield consisting of a series of spaced discs 12 is located at the outer end of the reducing portion of the retort. A segment of each disc is perforated to provide a zig-zag path of travel for vapours passing from the reducing portion to the condenser portion of the retort. Four discs as shown have proven effective. The purpose of the shield is to prevent as far as possible the transference of unnecessary heat to the condenser.

The lower end of the retort is provided with a removable closure 13 secured by clamps 14 or the like to a flange 15 on the retort. A plug 16 seals the heated reducing zone of the retort. It may be insulated as by a member 17 secured thereto. It is held in place by a rod 18 mounted in a cylinder 19 carried by the closure 13. A spring 20 in the cylinder urges the plug into close engagement with the wall of the retort. The plug is preferably tapered to rest against a complementary taper or shoulder on the retort wall. The sealing plug is removable upon opening this end of the retort. Water circulation or like cooling means 21 may be provided for this end of the retort.

The gasket 22 for sealing the connection be-

tween the closure and retort is preferably carried by the flange 15 and it is further protected by the outwardly extending lip 23 of the retort. The gasket 24 is preferably carried by the top closure.

In Figure 2 the furnace is illustrated as heated electrically as by the resistors 25. The retort is disposed uniformly with respect to the heat radiating walls of the furnace in order to insure maximum uniformity in heating the charge within the retort. It will be observed that the heated portion of the retort in which the reducing action takes place under reduced pressure is maintained in a substantially constant and uniform temperature in the furnace. This avoids temperature shock to the metal of the retorts. This is an important consideration since even a minute crack in a retort renders it useless. The heat resisting alloy steel of which the retorts are composed is costly and maintenance of long life of the retorts is a large factor in the unit cost of the magnesium produced. Any desired number of retorts may be used in a furnace. The furnace provides a static heat reservoir, preferably in an oxidizing atmosphere free from sulphur or other compounds which react with the retort metal. The vertical or angular disposition of the retorts facilitates discharge by gravity of the residue when the bottom closure is removed. This arrangement with its bottom discharge for the residue permits the use of retorts having within the furnace a long reducing portion, which will handle a larger charge than when the residue is discharged through the condenser end. This affords increased production of metal per operating cycle and facilitates discharge of the residue.

In operation with the lower end of the retort closed a portion of finely divided unreactive material 27, such as the residue of a treated charge, is placed over the plug 16 to substantially seal the closure and avoid passage at this point of magnesium vapour from the reducing zone of the retort. This provides a hot vapour tight closure for the lower end of the reducing portion of the retort. In operation this seal remains at a temperature above the condensing point of the magnesium vapour. Being insulated loss of heat to the water cooled atmospheric pressure chamber below the seal is avoided. The use of a gas, such as hydrogen, is unnecessary in directing the flow of vapour to the condenser. A charge of magnesium containing material is placed in the reducing zone of the retort. The preferred charge is crystalline dolomite or crystalline brucitic limestone which has been calcined and mixed with a reducing agent, preferably ferrosilicon. The briquetted material is preheated in air and the degassed charge is fed hot into the retort. The removable condenser shell is inserted, the top closure put in place, and the retort is evacuated to provide therein a pressure preferably less than 0.5 mm. of mercury during the initial stage of heating the charge. The heating cycle is continued under the reduced pressure until the magnesium vapour has been evolved from the charge and condensed into the form of dense coherent metal in the condenser shell as indicated at 28. The vacuum producing means is shut off and the top closure of the retort is removed for discharge at atmospheric pressure. The fractionating condenser 7 in which sodium and like vapours have been condensed is removed with the plate 8 or separately as indicated. The condenser shell with the dense

magnesium metal deposit is then removed from the retort. The bottom closure 13 and the plug 16 are removed for the gravity discharge of the residue. To avoid unnecessary loss of heat from the hot reducing portion of the retort one end of the retort should be closed while the other is being discharged.

Both ends of the retort being without the high temperature of the furnace are not adversely affected by the mechanical manipulation of the closures and condenser upon charging and discharging the retort. Sodium and like vapours being condensed and removed independently of the magnesium the danger of igniting the dense magnesium deposit upon contact with air is eliminated.

I claim:

1. Apparatus for producing magnesium by thermal reduction comprising a heating furnace, a metallic retort having a central reducing portion within the furnace with a condenser portion at one end without the furnace and a residue discharge portion at the other end without the furnace, means within the residue discharge portion sealing it from said central reducing portion of the retort and fractionating condenser means within the condenser portion to cause magnesium vapour to condense at a point removed from the outer end of the condenser portion of the retort.

2. Apparatus as defined in claim 1 having a removable closure for the outer end of the residue discharge portion and wherein said sealing means is supported in place by said closure.

3. Apparatus comprising a retort for the production of magnesium by thermal reduction comprising a metallic retort having a central reducing portion, a magnesium discharge portion at one end and a residue discharge portion at the other end, a heat reservoir surrounding said central reducing portion, removable sealing means between the central reducing portion and the residue discharge portion, fractionating condenser means within the magnesium discharge portion to cause magnesium vapour to condense at a point removed from the outer end of said discharge portion, and a removable condenser within the magnesium discharge portion.

4. Apparatus for producing metallic magnesium by thermal reduction of magnesium ore with ferrosilicon comprising a plurality of metallic retorts having a central reducing portion, a metal discharge portion at the upper end and a residue discharge portion at the lower end, a heating furnace enclosing the central reducing portion of the retorts, a vapour seal closing the lower end of the reducing portion, means within the metal discharge portion to cause magnesium vapour to condense at a point removed from the upper exposed end of the retort, and a series of spaced discs constituting a heat baffle in the upper end of the reducing portion of each retort.

5. Apparatus for producing coherent magnesium by thermal reduction comprising a plurality of metallic retorts, a heating furnace enclosing the central portion of the retorts with the end portions thereof outside the furnace, a vapour seal for the residue discharge end of the central portion removable through one end of each retort, and a plurality of spaced discs constituting a fractionating condenser removable through the other end of each retort.

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