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APPARATUS FOR PRODUCING MAGNESIUM

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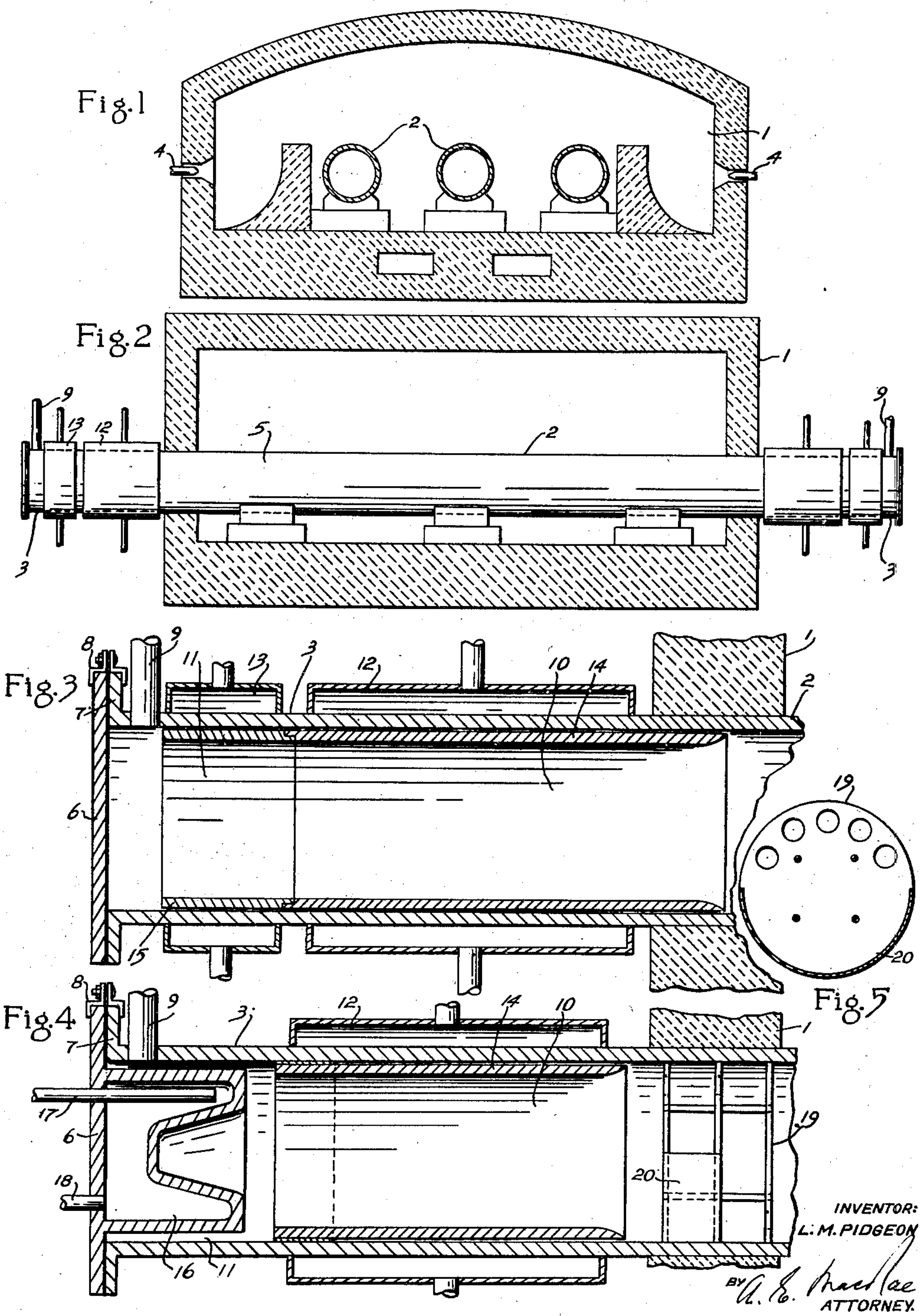

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APPARATUS FOR PRODUCING MAGNESIUM

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This invention relates to the production of solid magnesium metal by thermal reduction with ferrosilicon under low pressure in metal retorts, and more particularly to apparatus therefor.

One of the problems involved in the operation of this method is to obtain sufficiently rapid introduction of heat uniformly into the charge in the retorts, without excessive deterioration of the useful life of the metal retorts, particularly because of the cost of the retorts themselves. The larger the unit charge per retort, the greater is the production of magnesium per pound of metal constituting the retort itself. Any crack or other rupture of the retort wall which renders the retort incapable of sustaining a reduced internal pressure renders the retort inoperative. This factor constitutes a major operating expense in the method.

The primary object of the present invention is to provide retorts for a heating furnace capable of producing a maximum of magnesium per unit of retort metal utilized in the operation. Other objects of the invention will appear from the following description with reference to the accompanying drawing, in which:

Figure 1 is a transverse sectional elevation of a furnace embodying the invention,

Figure 2 is a longitudinal sectional elevation of the furnace,

Figure 3 is a longitudinal section of a condenser portion of a retort,

Figure 4 is a similar view of another form of a condenser portion of a retort, and

Figure 5 is an end view of the heat radiating shield shown in Figure 4.

In the drawing, 1 represents a furnace in which any desired number of metal retorts 2 are disposed with their ends 3 projecting beyond the furnace walls as shown. The retorts may be supported in the furnace in any desired way, as indicated in Figures 1 and 2. The furnace is illustrated as heated by gas or oil burners 4 but may be heated in any desired way.

The major portion 5 of the retort lying within the furnace constitutes the reducing portion of the retort in which the charge is heated to reduce its magnesia content to magnesium which is evolved as vapour. The ends 3 of each retort, extending without the furnace wall, constitute the condenser portions of the retort in which the magnesium vapour is converted into solid metal. The outer ends of the retort are closed by a leak-proof cover plate 6 secured to a flange 7 by any suitable means 8. At each end of the retort is a pipe 9 connected to one or more vacuum pumps to provide a low pressure throughout the retort.

Each condenser portion 3 comprises two temperature zones 10 and 11. Zone 10 receives the hot vapours from the reducing portion of the retort, and by means of the cooler 12 it is maintained at a relatively high temperature best adapted to condense magnesium vapour into a solid or dense structure. Water or liquids of higher boiling point may be used as the cooling medium. Zone 11 receives the vapours remaining uncondensed upon passing through zone 10, and the secondary cooler 13 surrounding this zone condenses the metals, like sodium, of higher vapour pressure, preferably before the vapours reach the vacuum line 9.

Within the condenser portion and in the magnesium condensing zone 10 is a removable liner 14 on which the magnesium vapours condense for removal from the retort with the liner. This removable liner may be made of magnesium. In this case, particularly, its inner end should not project into the hot reducing zone. Normally the inner end of the liner is located within the bounds of the furnace wall, an area of rapidly falling temperature. As shown in Figure 3, a separately removable liner 15 is provided in zone 11 for the collection of condensed metals of higher vapour pressure, like sodium, so that the metal condensed in this zone may be removed in advance of and independently of the magnesium condensed in zone 10.

In Figure 4 is shown an alternative arrangement for collecting the metals of high vapour pressure in zone 11. A more or less annular chamber 16, through which water circulates by means of pipes 17 and 18, is carried by the retort closure plate 6. Metallic vapours emerging from zone 10 impinge upon the cooled surfaces of this chamber where they condense for removal with the chamber independently and in advance of the magnesium condensed in zone 10.

In Figure 4 is also shown a heat radiating shield 19 located between the hot reducing zone and the relatively cool condensing zones of the retort. Its purpose is to conserve heat, to reduce the time of the heating period and to facilitate cooling of the condensing zones. As shown, it consists of a series of perforated and spaced plates to provide a sinuous travel for the vapours passing from the reducing zone to the condenser zones. The lower portion 20 between the outermost plates may constitute a chamber in which may be placed small waste fragments of magnesium, the independent melting of which entails high losses. The volatilization of this magnesium in the early stage of the heating cycle acts as a "getter" and assists in the removal of oxidizing gases from the system. The metal which does not react in this manner will be distilled and recovered in the massive dense structural form. The heat radiating shield is located in the retort as shown within the bounds of the furnace wall, to reflect the heat from the hot charge back into the reducing zone of the retort. It makes possible occupation by the charge of the maximum capacity of the reducing zone of the retort. Without the shield the ends of the reducing zone may not be so fully occupied by the charge, thus reducing the capacity of the retort.

In operation, the preferably hot charge of calcined magnesium oxide containing material and ferrosilicon in the form of dense briquettes is placed in the reducing zone of the retorts. The briquettes should preferably have a density of at least 2.2 to insure efficient heat conductivity. Preferably the heat radiating shields are inserted. The parts are assembled in the condenser zones and the ends of the retort are closed. Vacuum is applied to produce a pressure within the retort of preferably less than 0.25 mm. of mercury and the temperature of the surface of the retorts is maintained at 1160 to 1200° C.

As metallic vapours pass from the reducing zone, the magnesium condensing zone 10 is maintained at a temperature which, at the operating pressure, will insure condensation of the magnesium vapours in a dense structure. With fixed operating conditions experience enables the operator to control the temperature of this zone, by regulation of the flow of cooling fluid, to insure efficient condensation of the magnesium in dense form and practically without condensing sodium or the like in this zone. Similarly by regulating the rate of cooling the zone 11, sodium and like metals of higher vapour pressure are condensed on the surface of the liner 15 or that of the chamber 16.

The heating cycle being completed, the vacuum is broken, air admitted and the retort opened at both ends. The sodium and like metal condensed in zone 11 is removed from the retort with the liner 15 or chamber 16. This independent removal of the sodium avoids dangerous fire hazards and precludes ignition of the magnesium deposited on the liner 14, which is next removed. The residue of the charge is then removed and the hot retort is ready for recharging.

It is known that magnesium containing rock usually contains sodium and like metals of vapour pressure higher than magnesium. Crystalline dolomite, for example, may contain 0.06% of sodium. Some magnesium containing rocks contain several times as much. If the rock employed contains a negligible portion of sodium the condenser may be operated as a single unit.

The retorts should preferably not be more than 12 inches in diameter, as this affords a maximum thickness of charge for efficient heat penetration and absorption. The relatively short condenser at each end provides the necessary condensing capacity for a long reducing zone in the retort, which remains in the normal temperature of the furnace, free from substantial fluctuations in temperature. The length of the retort is thus primarily dependent upon the facilities utilized for charging and discharging the retort.

I claim:

1. In apparatus of the character described, a furnace operating normally under substantially atmosphere pressure, a metallic retort having a reducing portion permanently within the furnace and at least one condensing portion without the furnace, the latter comprising two temperature zones, means in each zone for the collection and independent removal of condensed metal deposited therein, means for cooling one of said zones to a temperature adapted to cause deposit therein of a dense structure of one metal, means to cool the other of said zones to a temperature adapted to cause deposit therein of another metal of higher vapour pressure and means to provide reduced pressure within the retort.

2. Apparatus as defined in claim 1 including a removable liner in one condensing zone and an independent liner in the other of said condensing zones.

3. Apparatus as defined in claim 1 including a removable liner in one condensing zone and an internally cooled chamber in the other zone.

4. Apparatus as defined in claim 1 including a heat radiating shield between the reducing portion and the condenser portion of the retort, said shield having a chamber therein to carry scrap magnesium and passages through which metal vapours pass to said condensing portion.

5. Apparatus for the production of magnesium by thermal reduction of magnesia containing material comprising a heating furnace operating normally under substantially atmospheric pressure, a plurality of retorts each having a reducing portion permanently within the furnace subjected to said normal pressure therein and a condensing portion at each end thereof without the furnace, means providing two temperature zones within each condenser portion adapted to separately condense within the retort vapours of magnesium and vapours of metal having a higher vapour pressure, means in each condenser portion for the reception and removal separately of metal condensed in each of said temperature zones and means for providing a reduced pressure within each retort.

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