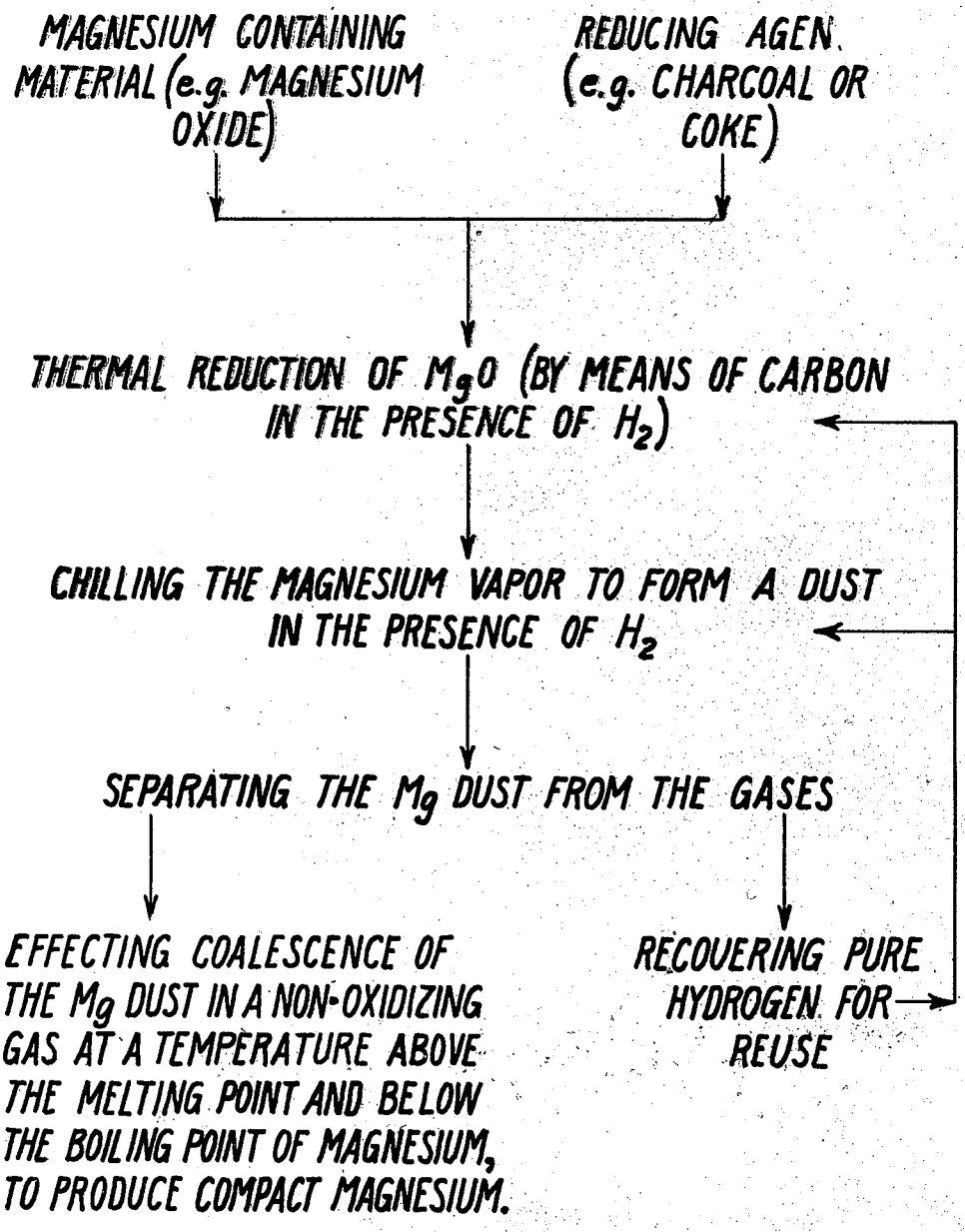
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PRODUCTION OF METALLIC MAGNESIUM

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WITNESSES

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PRODUCTION OF METALLIC MAGNESIUM

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11 Claims. (Cl. 75—17)

My invention relates to the production of metallic magnesium. This application is a division of my application Serial No. 518,915 filed February 27, 1931, for Production of metallic magnesium.

It is an object of the present invention to provide a novel process to produce compact metallic magnesium.

Another object is to provide an improved and efficient method of preparing magnesium, in which the formation of magnesium oxide is substantially minimized.

Yet a further object is to provide a process for producing metallic magnesium in a purified form.

With these and other equally important objects in view the invention comprehends the concept of evolving magnesium vapor from magnesium containing material and then suddenly cooling or shock chilling the vapor so as to produce magnesium in solid and discrete form; the discrete form of metal thus produced is then heated in contact with a non-oxidizing gas to a temperature above the melting point but below the boiling temperature of metallic magnesium. With this type of process it is found that the particles of magnesium vapor readily coalesce or agglomerate to form the compact massive metal.

The accompanying drawing is a flow sheet illustrative of the steps of one embodiment of the process provided by this invention.

With the major concepts in mind it will be appreciated that a number of modified forms of processes may be employed within the scope of the invention. According to one preferred method the magnesium containing material, such as magnesium oxide, is crushed or ground and is mixed with a finely divided reducing agent such as charcoal or coke. If desired, the magnesium containing material may be mixed with powdered or finely divided carbon and the mass bonded with suitable binding substances, such as tar oil, tar, pitch, molasses, asphalt and asphalt emulsions, etc. This mass may be briquetted and heated to temperatures sufficiently high to insure the carbonization or coking of the binder. The carbonization products thus obtained may be finely ground.

The mixture of magnesium containing material and carbon, whether prepared by the method described or by any other suitable method, is preferably blown into the zone of action of a high tension electric arc. Preferably within the zone of thermal decomposition reducing conditions are maintained. This may be done by either blowing in preheated hydrogen with the raw material or by maintaining an atmosphere of highly heated hydrogen in the decomposition zone. The hydrogen employed in the process is preferably preheated; as for example by passing it in a heat exchange relationship with the effluent combustion gases.

While it is preferable to rapidly raise the magnesium containing material to the volatilization temperature, by passing the raw material immediately into a high temperature zone, it is to be understood, that the invention is not restricted to this particular step. Advantageous results may be obtained by charging a mass of the raw material and coke to a furnace and heating the whole mass by means of an electric arc or by resistance heating.

Under the concomitant action of high temperature of the reducing zone and the reducing gas, the magnesium in vapor form is evolved and passes out of the furnace into the condensing section, where the temperature of the magnesium is very rapidly reduced so that it passes from the vapor phase very rapidly to the solid phase.

This sudden chilling or shock cooling may be obtained in a number of specific manners. One method comprises subjecting the magnesium vapors to the action of chilling agents, such as cooled indifferent gases. A preferred material for this purposes is cooled hydrogen which may be blown into the condensation chamber so as to intimately contact with the dispersed magnesium vapor. In lieu of using chilled hydrogen the magnesium vapor may be caused to impinge upon extensive cooled surface areas. By reason of this sudden drop in temperature the formation of magnesium dust or finely divided solid magnesium is promoted and at the same time the reoxidation, causing the formation of an oxide coating on the surface of the metal grains, is reduced because of the great chilling rapidity.

The gaseous stream may be withdrawn from the condensing chamber and the entrained finely divided magnesium powder may be separated from the gases in any desired manner, as for example by passing the gas through suitable filters, centrifugal separators, etc.

After the finely divided magnesium has been obtained in the manner described, it is then treated to reduce it to a compact or massive form. This is, according to this invention, accomplished by treating the metallic powder at such a temperature in a reducing or inert atmosphere, as in an atmosphere of hydrogen, that between the small particles local evaporation processes are formed, and the finely divided magnesium pow-

der flows or coalesces together as a liquid metal. It is to be understood that this temperature must be in any case above the melting point of metallic magnesium, that is, 650° C., but below its boiling temperature. The boiling temperature can be lowered by reducing the pressure, and it is contemplated that this coalescing step can be performed at a reduced pressure, taking care that the temperature at such reduced or subnormal pressure is not high enough to cause distillation of the coalescent magnesium mass.

The nature of the process permits of a wide flexibility in operation. The two steps may be carried out separately and with any desired time interval, or the process may in fact be made continuous by passing the magnesium dust from the separating element directly to a retort.

In carrying out the operations the hydrogen employed in the first and second stages may be recycled so as to insure maximum economy by reuse.

I claim:—

1. A process of producing magnesium which comprises extracting magnesium in the form of vapor from its compounds, then condensing the magnesium vapors to produce solid magnesium in finely divided form, and then heating the thus formed magnesium in contact with a non-oxidizing gas nearly to boiling temperature of metallic magnesium to cause the finely divided magnesium to flow together.

2. A process of producing magnesium which comprises extracting magnesium in the form of vapor from its compounds by means of a carbonaceous reducing agent, then condensing the magnesium vapors to produce solid magnesium in finely divided form, and then heating the thus formed magnesium in contact with a non-oxidizing gas nearly to boiling temperature of metallic magnesium, to cause the finely divided magnesium to flow together.

3. A process of producing magnesium which comprises evolving magnesium vapor from magnesium containing material by thermal reduction, then shock cooling the vapors to produce magnesium in finely divided form, and then heating the thus formed magnesium in contact with a non-oxidizing gas nearly to boiling temperature of metallic magnesium, to cause the finely divided magnesium to flow toegther.

4. A process of producing magnesium which comprises evolving magnesium vapor from magnesium containing material by thermal reduction in the presence of an indifferent gas, then shock cooling the vapors by contacting them with a cooled indifferent gas, to produce solid magnesium in finely divided form, and then heating the thus formed magnesium in contact with a non-oxidizing gas nearly to boiling temperature of metallic magnesium, to cause the finely divided magnesium to flow together.

5. A process of producing magnesium in compact form which comprises evolving magnesium vapor from magnesium containing material, then shock cooling the magnesium vapors in the presence of a non-oxidizing gas, to transform the vapors to discrete solid particles, and then keeping the particles under reduced pressure and in the presence of a non-oxidizing gas nearly at boiling temperature of metallic magnesium, to cause the discrete solid particles to coalesce together.

6. A process of producing magnesium in compact form which comprises evolving magnesium vapor from magnesium containing material, then rapidly cooling the magnesium vapors to produce finely divided magnesium powder, recovering the said magnesium powder and heating it, in the presence of a non-oxidizing gas, to a temperature capable of effecting, by local volatilization, coalescence of the magnesium particles without causing distillation of the coalescent magnesium mass.

7. A process of producing magnesium in compact form which comprises evolving magnesium vapor from magnesium containing material by thermal reduction, then rapidly cooling the magnesium vapors to produce finely divided magnesium powder, recovering the said magnesium powder and heating it, in the presence of a non-oxidizing gas, to a temperature capable of effecting, by local volatilization, coalescence of the magnesium particles without causing distillation of the coalescent magnesium mass.

8. A process of producing magnesium which comprises heating a mixture of magnesium containing material and carbonaceous reducing material to produce, besides carbon monoxide, magnesium vapors, then suddenly chilling the magnesium vapors, in the presence of a reducing gas, to transform the vapors into finely divided solid magnesium, recovering the solid magnesium, and then keeping it in the presence of a non-oxidizing gas at a temperature capable of effecting, by local volatilization, coalescence of the magnesium particles without causing distillation of the coalescent magnesium mass.

9. A process of producing magnesium which comprises heating a mixture of magnesium containing material and carbonaceous reducing material to produce, besides carbon monoxide, magnesium vapors, then suddenly chilling the magnesium vapors, in the presence of a reducing gas to transform the vapors into finely divided solid magnesium, recovering the solid magnesium, and then keeping it under reduced pressure and in the presence of a non-oxidizing gas at a temperature capable of effecting, by local volatilization, coalescence of the magnesium particles without causing distillation of the coalescent magnesium mass.

10. A process of producing magnesium in compact form which comprises extracting magnesium in the form of vapor from its compounds by thermal reduction in an electrical furnace, then shock cooling the vapors of magnesium by subjecting it to the action of a cooling agent unreactive with metallic magnesium, separating the finely divided solid magnesium from the reaction gases, and then keeping it in the presence of a non-oxidizing gas at a temperature capable of effecting, by local volatilization, coalescence of the solid magnesium particles without causing distillation of the coalescent mass.

11. A process of producing magnesium in compact form which comprises extracting magnesium in the form of vapor from its compounds by thermal reduction in an electrical furnace, then shock cooling the vapors of magnesium by subjecting the same to the action of a cooling agent unreactive with metallic magnesium, separating the finely divided solid magnesium from the reaction gases, and then keeping the recovered magnesium particles under reduced pressure and in the presence of a non-oxidizing gas at a temperature capable of effecting, by local volatilization, coalescence of the solid magnesium particles without causing distillation of the coalescent mass.

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