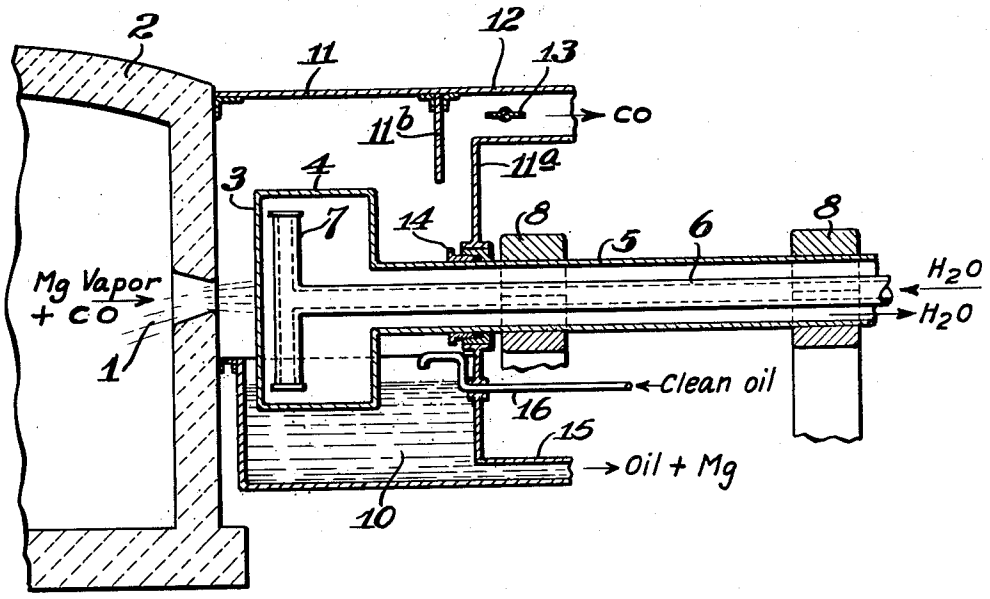
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APPARATUS FOR CONDENSING MAGNESIUM VAPOR

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WITNESSES

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APPARATUS FOR CONDENSING MAGNESIUM VAPOR

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8 Claims. (Cl. 266—1)

This invention relates to the condensation of magnesium vapors, and more especially to the condensation of metallic magnesium from a mixture of magnesium vapors and a gas reactive therewith.

Probably the first procedure suggested for the production of magnesium was that of electrothermic reduction of its compounds with carbonaceous reducing agents. Such a procedure has much to commend it from a theoretical standpoint, but electrothermic processes have not attained sustained commercial importance as applied to magnesium. In this process there is produced a mixture of magnesium vapor and carbon monoxide gas, in equimolecular proportions, according to the equation

$$MgO+C \rightleftarrows Mg+CO.$$

At elevated temperatures, for example, above about 2000° C., the reaction proceeds completely, or substantially so, to the right, but as the temperature is lowered there is a progressively greater tendency for the magnesium, both in the vapor and solid states, to be reoxidized by the carbon monoxide, i. e., decrease of temperature causes the reaction to proceed toward the left in the foregoing equation. It is only when the solid has been cooled to quite low temperatures that the reoxidation becomes so slight as to be unimportant. This situation has engendered grave difficulties in the condensation of magnesium from the reaction products because the reoxidation of the magnesium vapor has been so serious as to prevent economical practice from a commercial standpoint. Such reoxidation contaminates the magnesium with oxide, and it represents an added cost burden. In consequence of these and other factors magnesium has for many years been produced commercially by electrolytic methods.

It is among the major objects of this invention to provide an apparatus for condensing magnesium vapor, especially from a mixture thereof with a gas reactive therewith, which provides satisfactory condensation of the vapor to the solid state, effectively prevents reaction between the magnesium and accompanying gas, is simple and may be easily practiced in connection with desired electrothermic procedures and apparatus.

The invention may be described in connection with the accompanying drawing which schematically represents a longitudinal sectional view through an apparatus suitable for use in the practice of the invention.

The present invention is predicated upon the fact that the prejudicial reaction of magnesium vapor with a reactive gas, for example, with carbon monoxide gas, may be effectively prevented by cooling the mixture of vapor and CO gas from a temperature at which such reaction does not occur, so rapidly to such a low temperature as substantially to preclude the reaction. In my copending application Serial No. 664,932, filed April 7, 1933, I have described and claimed a method of condensing magnesium vapor according to which the vapor is impinged against a moving film, or curtain, of liquid inert to magnesium, preferably a thin film of liquid flowing over a stationary cooled surface. The present invention makes use of the gist of that disclosed in my aforesaid copending application, together with certain other features.

In accordance with the present invention a stream of magnesium vapor is caused to impinge upon a cooled surface provided with a layer, e. g., a film, of liquid inert to magnesium and the surface is continuously moved to present fresh cooled areas and fresh liquid for continuously maintaining condensation. The invention is applicable to the condensation of pure, or substantially pure, magnesium vapor, but particularly is it applicable to the condensation of magnesium vapor from a mixture thereof with a gas reactive to magnesium, such as carbon monoxide. In the latter aspect of the invention the mixture is presented to the condensing operation at a temperature such that reaction does not occur, and heat is abstracted from the cooled surface at a rate such as to cool the magnesium so rapidly through the critical temperature range as to prevent reaction of the vaporous and condensed magnesium and the gas and to bring the solid to a temperature at which such reaction proceeds at a negligible rate.

In the preferred embodiment of the invention the stream of magnesium vapor is caused to impinge from a fixed point upon a surface of a rotating metallic drum the lower portion of which rotates in a bath of suitable liquid. Advantageously the drum is mounted so that its ends rotate in a plane normal to the direction of flow of the Mg vapor, the end adjacent the vapor stream forming the condensing surface. The condensing surface of the drum is cooled interiorly thereof by any suitable means. Thereby there is continuously presented to the impinging stream of magnesium vapor a fresh, cooled condensing surface with fresh liquid thereon, and by suitable provision for adequate abstraction of heat, through the interior cooling, and if desired

by refrigeration of the liquid, the vapor and resultant solid magnesium are cooled substantially instantaneously to such a low temperature that the reactive gas is substantially innocuous.

The invention is particularly applicable to the production of magnesium by electrothermic reduction of an oxygen compound of magnesium with carbon, for which reason it may be described further with reference thereto for purposes of illustration, but not by way of limitation. Having reference to the drawing, a mixture of magnesium vapor and CO issues in a stream from a port 1 in a wall of an electric reduction furnace 2, the mixture being produced at a temperature at which reoxidation does not occur, e. g., 2000° C. or higher, and it impinges against the end surface 3 of a drum 4 journalled for rotation by any suitable means, not shown. As shown in the drawing, the drum is mounted to bring its condensing surface as close as practicable to the source of the vapor-gas stream, and if desired it may be adjustably mounted to vary the distance according to need.

The drum is cooled interiorly in accordance with the invention, and in the preferred embodiment this is accomplished by mounting the drum concentrically on the end of a hollow trunnion 5 of relatively large diameter through which there extends a conduit 6 for conveying water to a spray head 7 facing condensing surface 3 against which it distributes cooling water. Trunnion 5 is conveniently mounted in bearings 8. The water collects in the bottom of the drum and overflows through the trunnion 5 in the annular space surrounding conduit 6. The trunnion is rotated, to rotate the drum, by any suitable means, not shown.

The lower portion of the drum projects into a bath of a suitable liquid 10, so as to be continuously bathed therein, and as the drum rotates it carries a film of liquid 10 distributed on condensing surface 3 upwardly into the region of the impinging vapors, and likewise continuously returns the liquid to the bath. Any suitable liquid which is inert to magnesium under the conditions of operation may be used, although advantageously a hydrocarbon oil, such as kerosene or the like, is used. Such oils not only afford desirable properties for condensation, but also provide a protecting film over the condensed particles, and they also are adapted to provide effective protective atmospheres in other operations.

Access of air to the vapors is, of course, to be avoided. To this end the apparatus is enclosed in a housing 11 whose bottom and side walls may, if desired, cooperate to form, in effect, a tank for holding liquid 10. The residual gas is withdrawn through a pipe 12 provided with a damper 13 for regulating gas flow, to provide a slight back pressure and thus prevent entry of air into the housing. To further exclude air, trunnion 5 is mounted in a suitable packing gland 14 associated with wall 11a of the housing.

In the practice of the invention the stream of Mg vapor and CO gas issues from port 1 and impinges against surface 3 where the magnesium is instantly condensed and cooled to a temperature at which CO has no effect upon it, e. g., 150° C. or lower. The necessary cooling may be effected wholly or primarily through the cooling water projected against the inner side of the condensing surface from spray head 7, the cooling effect being controllable through the volume of water used and by supplying it in a refrigerated state if need be. The cooling effect may be augmented by cooling liquid 10, as by refrigerating coils, not shown, disposed in the bath, or in a manner presently to be described.

In order to separate any solid matter from the residual gas prior to its escape, there may be provided one or more baffles 11b arranged in front of the gas outlet to conduit 12. Solids carried by the gas thus are separated by impingement on the baffle, fall into the bath, and are recovered together with magnesium condensed on drum face 3.

The magnesium vapor is condensed to the solid state and in part falls into the bath and in part is carried into it by the film of oil adhering to surface 3, where it is washed off. The condensed metal collected in the liquid bath is then recovered, for instance, by withdrawing the metal in suspension in the oil through a conduit 15 and separating the two materials, as by means of a filter press, not shown, the clean oil being returned for further use through another conduit 16. If desired the oil may be refrigerated in this operation, for instance by passing it through suitable refrigerating means after it has been freed from the metallic magnesium which it carries.

Oxidation of the metallic vapor due to the oxygen of the atmosphere is prevented by housing 11 which acts to prevent air from reaching the hot vapor. The carbon monoxide gas remaining after condensation escapes through a pipe 12, the opening being controlled by damper 13 so that there is always sufficient carbon monoxide pressure within the housing to prevent inward seepage of air.

It will be recognized that the invention is not restricted to the particular apparatus shown, nor to the condensation of magnesium vapor in admixture with carbon monoxide gas, but that it is applicable not only to condensation of the metallic vapor from mixtures with other reactive gases, but also to the condensation of substantially pure magnesium vapor, for example, derived from a distillation process.

This application is a division of my copending application Serial No. 706,358, filed January 12, 1934, entitled Method of and apparatus for condensing magnesium vapor.

According to the provisions of the patent statutes, I have explained the principle and operation of my invention, and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. Apparatus for condensing magnesium vapor, comprising a rotatably mounted drum, means operably connected to the drum for rotating it, means for directing a stream of magnesium vapor against a surface of the drum, means for providing said surface with a film of liquid inert to magnesium, means for cooling said surface interiorly of the drum, and means for collecting the magnesium condensed on the drum.

2. Apparatus for condensing magnesium vapor, comprising a housing, a drum rotatably mounted therein, means operably connected to the drum for rotating it, means for directing a stream of magnesium vapor within said housing against a surface of the drum, means for providing said surface with a film of liquid inert to magnesium, means for cooling said surface interiorly of the

drum, and means for collecting the magnesium condensed on the drum.

3. Apparatus for condensing magnesium vapor, comprising a housing, a drum rotatably mounted in the housing, means operably connected to the drum for rotating it, means for directing a stream of magnesium vapor within the housing against a surface of the drum, a bath of liquid inert to magnesium through which the lower part of said drum moves, means for continuously circulating a cooling fluid through the drum, and means for collecting the magnesium condensed on the drum.

4. Apparatus for condensing magnesium vapor, comprising means for forming and directing a stream of magnesium vapor, a drum mounted to rotate on an axis parallel to that of said stream and to present an end thereof adjacent said means for impingement of said stream thereon, a housing enclosing said means and drum, means operably connected to the drum for rotating it, a container of liquid below said drum through which its lower portion moves, means for circulating a cooling fluid through the drum, and means for collecting magnesium condensed on the drum.

5. Apparatus for condensing magnesium vapor, comprising a source of magnesium vapor, a housing associated with said source to prevent access of air into the housing, a drum rotatably mounted in the housing, means operably connected to the drum for rotating it, means for directing a stream of magnesium vapor from said source into said housing against a surface of said drum, a container of liquid inert to magnesium disposed within said housing below said drum for rotation of the lower portion of the drum therethrough to provide said surface with a film of said liquid, and means for cooling said surface interiorly of the drum.

6. Apparatus for condensing magnesium vapor, comprising means for forming and directing a stream of magnesium vapor, a drum mounted to rotate on an axis parallel to that of said stream and to present an end thereof adjacent said means for impingement of said stream thereon, a housing enclosing said means and drum to prevent access of air, means operably connected to the drum for rotating it, a container of liquid below said drum through which its lower portion moves, means for circulating a cooling fluid through the drum, and means for collecting magnesium condensed on the drum.

7. Apparatus for condensing magnesium from a mixture of magnesium vapor and carbon monoxide, comprising an electric furnace adapted to produce said mixture and having an opening in one wall for passage of the mixture therethrough, a drum rotatably mounted to present a surface adjacent said opening for impingement of said mixture thereon, means operably connected to said drum to rotate it, a container of liquid inert to magnesium mounted below said drum for rotation of the lower portion of the drum therethrough to provide said surface with a film of said liquid, means for cooling the drum interiorly, a housing enclosing said drum and opening to prevent access of air, and means associated with the housing for withdrawing carbon monoxide remaining after condensation of magnesium vapor admixed therewith.

8. An apparatus according to claim 7, said drum presenting an end surface to said opening for impingement and condensation of magnesium vapor thereon.

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