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WORKING MAGNESIUM.

No Drawing. Original application filed November 1, 1922, Serial No. 598,292. Divided and this application filed December 31, 1924. Serial No. 759,146.

My invention relates to the production of formed shapes of metallic magnesium. The invention is based upon my discovery of a novel method whereby loose or loosely coherent masses of crystallized magnesium can be consolidated and formed into structurally sound and commercially useful shapes.

In the processes that have heretofore been employed for utilizing the magnesium as obtained from the electrolytic reduction process, it has been necessary at some stage to handle the metal in molten form. Magnesium is exceedingly active chemically and at temperatures slightly above its melting point, 651° C., will combine with both oxygen and nitrogen of the air. In fact, it is very difficult, even with the most careful melting, to prevent burning at the surface of molten magnesium. The non-metallic impurities introduced in this way exert a marked influence on the physical and chemical properties of the metal when present in only a very limited degree.

In my co-pending application, Serial No. 598,292, filed November 1, 1922, and of which this application is a division, I have disclosed a process of producing sublimed magnesium in a crystallized form and substantially free from non-metallic inclusions. Briefly, the invention there disclosed consists in placing in one end of a closed retort, crude metallic magnesium or magnesium scrap, such as castings, alloys, etc., and then heating the said metal at a temperature of about 300 to 651° C. for a suitable period, say, 5 to 6 hours, while maintaining an absolute pressure of 0.5 to 0.2 mm. of mercury in the retort. Under such conditions, the magnesium will rapidly sublime and condense in the cooler end of the retort in the form of a loosely cohering mass of aggregated crystals. When the sublimation is completed and the apparatus cooled somewhat the crystallized masses can be removed in a suitable manner. Analysis of the crystals of magnesium made in this way has shown a magnesium content as high as 99.989%. The crystallized mass will show fully developed, bright metallic crystal faces of magnesium. The crystals vary in size and some may have crystal faces as large as one-fourth of a square inch in area or more. Being coherent, the masses can be readily handled, but since they are only loosely coherent, they can be readily broken into pieces of suitable size for future use.

In using the term "crystallized magnesium", I have reference to a product produced by a process wherein the crystals are free, at least in part, to grow and assume their typical external shape.

Magnesium which has solidified from the liquid state is crystalline, of course, but not crystallized in the sense here employed. It is composed of closely coherent grains having an internal crystalline structure but which when forming were not free to grow and assume their typical external shape.

Crystal metal as produced by my process can be made exceedingly pure. By virtue of the absence of reactive agents, such as nitrogen and oxygen, the crystallized mass is substantially free from inclusions of oxides and nitrides. In certain cases where the crude or scrap magnesium which is to be sublimed contains zinc or other relatively volatile metal, some of this metal may be found alloyed in the sublimed crystals. In some cases this alloying may be permissible or even desirable and the crystal masses so obtained may be employed in my present process just as are the crystalline aggregates of pure magnesium, since they are substantially free from non-metallic impurities. In general, however, where the hardness of the crystals has been increased by alloying, higher pressure will be required.

If only prior methods were available for working this new product into useful shapes, then much of the advantage of its high purity would be sacrificed during the necessary melting process. I have discovered, however, that my crystallized magnesium is sufficiently plastic and free from impurities, so that under suitable conditions of temperature and pressure the crystals will flow and weld together into a structurally sound metal body. Loose fragments of suitable size can be placed in the chamber of an extrusion press, for example, and expressed directly through the die opening into any of the customary structural shapes, such as wire, bars, tubes, rods, etc. The best results will be obtained when the metal is extruded within a temperature range of about

300 to 425° C. In general, it will be found desirable to employ a high extrusion pressure in order to more perfectly weld the crystal fragments together.

In order to obtain sufficient pressure within the preferred temperature range and also in order to obtain a smooth surface on the extruded product, I have found it desirable to effect a high reduction from the cross-sectional area of the extrusion cylinder to that of the extruded product. This reduction should be preferably about 99% or higher.

I have extruded crystallized magnesium from a 3 inch diameter cylinder into wire 30 mils in diameter at a temperature of about 375° C. and a pressure of about 80,000 pounds per square inch. This wire had a smooth surface, a tensile strength of about 35,000 pounds per square inch and an elongation of about 3% in 2 inches. These properties are as good as though the wire was extruded under the same conditions of temperature and pressure from the cast billet.

Other methods of consolidating the crystal aggregates may be employed. For example: The crystals can be compressed into briquets or other forms at a temperature of about 200° C. or higher to give a substantially chemically pure metal in a marketable form. Since my process avoids melting, the product is substantially as free from oxides, nitrides and other impurities as the crystallized metal from which it is produced. My process is also economical since it eliminates the large losses usually unavoidable in the melting and casting of magnesium.

By the term "magnesium", I comprehend not only the metal itself, but also such alloys of magnesium as have substantially the same physical properties as the metal and therefore lend themselves to the same treatment.

I claim:

1. A method of working crystallized magnesium into commercial forms comprising subjecting the crystallized metal at a temperature below its melting point to such pressure as will cause the crystals to flow together and unite in a strongly coherent product.

2. A method of die-expressing magnesium into commercial form, comprising subjecting crystallized magnesium in a pressure chamber while at a temperature between about 300° C. and 425° C. to such pressure as will cause the crystallized particles to unite and plastically flow out of the chamber through an aperture.

3. A method of plastically working magnesium into commercial forms comprising subjecting crystallized aggregates of magnesium substantially free from non-metallic inclusions and at a temperature below the melting point of the metal to such pressure as will cause the said aggregates to flow together and form a metallic body having substantial strength.

4. A method of plastically working magnesium into commercial forms comprising subjecting particles of magnesium substantially free from non-metallic inclusions and at a temperature below the melting point of the metal to such pressure as will cause the particles to flow together and form a metallic body having substantial strength.

5. A method of die-expressing magnesium into commercial forms comprising subjecting crystallized magnesium in a pressure chamber while at a temperature below its melting point to such pressure as will cause the crystallized particles to unite and plastically flow out of the chamber through an aperture.

6. A method of producing structurally sound forms from crystallized particles of magnesium produced by sublimation, comprising die-expressing said particles from a pressure chamber, the ratio of cross-sectional area of this chamber to that of the die opening being so adjusted that a reduction in excess of about 99% is effected.

7. A formed shape of structurally sound metallic magnesium, having substantial strength and ductility, and composed of plastically deformed and strongly coherent pressure welded crystals of sublimed magnesium.

8. A formed shape of metallic magnesium, substantially free from inclusions of oxides and nitrides and composed of plastically deformed and pressure welded crystals of sublimed magnesium.

In testimony whereof I affix my signature.

HERMAN E. BAKKEN.