UNITED STATES PATENT OFFICE.

HEINRICH LEISER, OF CHARLOTTENBURG, BERLIN, GERMANY.

PROCESS FOR THE MANUFACTURE OF SOLID BODIES FROM POWDER.

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To all whom it may concern:

Be it known that I, Dr. HEINRICH LEISER, a subject of the King of Prussia, residing at Charlottenburg, Berlin, in the Empire of Germany, have invented a new and useful Process for the Manufacture of Solid Bodies from Powder, of which the following is a specification.

My invention relates to a process for making solid shapes (such as bars, plates, cups, pots, a. s. o.) of any convenient size from metal powder, and more particularly from powders of the heavy metals and metals having a high melting point.

According to my invention even powders of the metals having the highest melting points, such as for instance tungsten or molybdenum, which melt far above 2500 degrees C., can be formed into shapes of any description at low costs and at commercial temperatures, that is to say, in a gas furnace, without having recourse to extraordinary heating means such as the electric arc.

Heretofore it has been proposed to make solid shapes from metallic powders by subjecting pure crystalline metal powder or pure non-crystalline metal powder (such as amorphous or colloidal metal powder) to heavy pressure in a mold and heating the molded shape to a temperature approaching the melting point of the constituents of the mixture. These processes have proved to be non-commercial on account of the high temperatures necessary in order to obtain solid coherent bodies, and further on account of the apparent impossibility of obtaining at such temperatures shapes of predetermined configuration, the metal or metals when heated to near the melting point shrinking to such an extent that the heated shape will take up much less room than before and will moreover show a great number of cracks and fissures, which tend to make it unsuited for further use.

According to another method plastic masses containing the metal in a colloidal state have been subjected (either alone or mixed with powders of other metals) to high pressure and in order to convert the colloidal metal into the crystalloidal state, the molded mass has then been heated to a temperature corresponding to the melting point, for instance by passing an electric current through the mass. With this method also a shrinkage of the shapes obtained is unavoidable; moreover this method is limited to the use of peptisated colloidal metals, which can only be obtained at high costs, and the temperature applied, in the case of metals having a high melting point, is not commercial.

I have now ascertained that the conversion of the ordinary amorphous metal powders, into the crystalline modification takes place at a temperature far below the melting point of the metals employed and in almost all cases at a temperature below one half of the melting temperature. Thus the temperature of conversion of amorphous tungsten into crystalline tungsten takes place at between 1100 and 1400 degrees C., the melting point of tungsten being somewhere between 2900 and 3000 degrees C. The temperature of conversion of amorphous iron into crystalline iron is about 500 degrees C., the melting temperature of iron being above 1200 degrees C.

I have further ascertained that the ordinary amorphous metals while being converted into crystalline metals exert a remarkable binding effect upon any crystals of the same or any other metal which may be present. It is well known, that crystalline powder of hard metals, even if subjected to high pressure, has no cohesion of its own and, in order to obtain shapes from such crystalline powder, either some softer metal must be admixed to it, to act as a binding medium, or the compressed powder must be sintered at a temperature approaching its melting point. It is further known that if amorphous metal powder is subjected to high pressure and heated so as to convert it into crystalline metal, the compressed shape will shrink enormously during the heating and the body obtained will show a great number of cracks and fissures.

According to my invention however, if crystalline metal powder, such as for instance crystalline tungsten powder, is mixed

with some of the ordinary amorphous powder, and this mixture is then subjected to heavy pressure and heated to convert the ordinary amorphous metal into crystalline metal, then the non-crystalline particles in being aggregated to form fresh crystals will bind together the crystalline particles already present in the mixture with such force that the body obtained after heating will show a comparatively high mechanical resistance.

As the conversion of the amorphous metal into the crystalline metal takes place even at comparatively low temperatures, the shapes obtained at such low temperatures will not shrink at all, but will, after heating, completely fill the mold in which the original mixture had been compressed.

As the amorphous powder in being converted into the crystalline state undergoes a considerable contraction in this sense that a number of amorphous particles combine to form a crystal, a shape containing a great percentage of non-crystalline metal will after heating be more or less porous. Therefore, in order to produce dense products, the crystalline powder must by far prevail in the mixture, and in order to produce a product absolutely void of pores, 95 to 98 per cent. of crystalline powder and only 2 to 5 per cent. of amorphous powder must be used.

For some purposes metallic bodies having a great porosity are required, such as for instance for use as contact bodies for catalytical processes. According to my process it is easy to make such bodies by molding and heating a mixture of crystalline powder and amorphous powder, in which the latter is present to the extent of 10 to 20 per cent. By compressing and heating a mixture of less than 80 per cent. of crystalline iron powder and more than 20 per cent. of amorphous iron powder, iron shapes can be produced, which on account of their reduced specific gravity can advantageously be used for lifting magnets.

According to one modification of my process 4 to 8 per cent. of amorphous metal powder are suspended in water and 92 to 96 per cent. or crystalline metal powder are added. After stirring the mixture and allowing the metal to settle, the amorphous metal is deposited upon and between the crystalline particles, so that by this method an intimate mixture of the crystalline and amorphous metals can be obtained. The liquid is then removed in any convenient manner and the dry metallic residue is molded by pressure and heated to convert the amorphous metal into crystalline metal.

The term amorphous metal as used in this specification and in the claims is meant to designate the ordinary dry non-crystalline metal in contradistinction to the so-called colloidal modifications, which, as a rule, contain water more or less firmly bound.

I claim:

1. The process for making solid shapes from metal powders, which consists in molding a mixture of crystalline and amorphous metal powder, in which the crystalline metal predominates, and heating the molded mixture to convert the amorphous metal into crystalline metal.

2. The process for making solid metallic shapes which consists in preparing a mixture of crystalline and amorphous metal or metals in powder form, the crystalline metal predominating, subjecting said mixture to pressure in a mold and heating it to convert the amorphous metal into crystalline metal.

3. The process for making solid shapes from metals having a high melting point, which consists in preparing a mixture of crystalline and amorphous powders of the said metal or metals, the crystalline powder predominating in the mixture, subjecting said mixture to heavy pressure in a mold, and heating the pressed mixture to convert the amorphous metal into crystalline metal.

4. The process for making solid metallic shapes which consists in preparing a mixture of crystalline and amorphous metal or metals, more than 80 per cent. of the mixture being crystalline metal, subjecting said mixture to heavy pressure in a mold and heating the pressed mixture to convert the amorphous metal into crystalline metal.

5. The process for making solid metallic shapes which consists in heating a compressed mixture of more than 90 per cent. of crystalline metal powder and less than 10 per cent. of amorphous metal powder to convert the amorphous metal into crystalline metal.

6. The process for making solid shapes from tungsten powder which consists in subjecting to pressure in a mold a mixture of crystalline tungsten powder and amorphous tungsten powder, the crystalline tungsten predominating, and heating the compressed mixture to convert the amorphous tungsten into crystalline tungsten.

7. The process for making solid metallic shapes which consists in subjecting to heavy pressure a mixture of crystalline metal powder and amorphous metal powder, the crystalline metal predominating, and heating the compressed mixture at a temperature at which its amorphous constituent is converted into crystalline metal.

8. The process for making solid shapes from tungsten powder which consists in subjecting to pressure in a mold a mixture of crystalline tungsten powder and amorphous tungsten powder, the crystalline predominat-

ing, and heating the compressed mixture at less than 2000 degrees C.

9. The process for making solid metallic shapes which consists in suspending amorphous metal powder in a liquid, adding thereto crystalline metal powder, stirring the mixture, removing the liquid, molding the metallic residue by pressure and heating to convert the amorphous metal into crystalline metal.

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Witnesses:
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