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METHOD OF IMPREGNATING POROUS METAL PARTS

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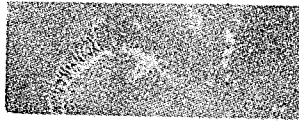


Fig. 1

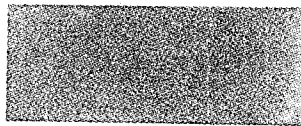


Fig. 2

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METHOD OF IMPREGNATING POROUS METAL PARTS

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11 Claims. (Cl. 75-22)

This invention relates to the impregnation of porous metal parts with another lower melting point metal and is particularly concerned with the impregnation of porous iron parts with copper.

Iron and copper are only slightly soluble in one another. Investigation has shown however, that iron will alloy with approximately 5% copper at temperatures in the neighborhood of 1950 to 2050° F. Thus, when impregnating porous iron parts with copper for making metal parts having desired characteristics, there is difficulty in the impregnation due to this dissolving action between the two metals. This dissolving action shows up as a pitting and channeling in the surface of the finished article, which is very undesirable and which results in poor appearance, low tensile strength and elongation in the finished article.

It is an object of this invention, therefore, to provide a method of impregnation of porous iron parts with copper whereby the pitting may be eliminated, thereby increasing the tensile strength and elongation of the part and improving the surface characteristics thereof.

In carrying out the above object, it is a further object of the invention to provide sufficient iron in the copper used to impregnate the porous iron to satisfy this dissolving action whereby the dissolving action of the copper on the porous iron part is eliminated and a satisfactory article is obtained.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein preferred embodiments of the present invention are clearly shown.

In the drawing:

Fig. 1 is a photograph of the surface of a porous iron part that has been impregnated with copper. This photograph shows pits or channels on the surface of the part caused by the dissolving action of the iron by the copper, and,

Fig. 2 is a photograph of the surface of a similar porous iron part impregnated with copper containing 5% iron wherein the surface is continuous and non-interrupted by pits or channels.

In the conventional methods of making porous iron parts impregnated with copper, iron powder, either comminuted iron, electrolytic iron, sponge iron, iron from reduced oxides and the like, is briquetted under desired pressures, for example, from 20,000 to 60,000 per sq. inch, into desired shapes. These briquettes are then sintered un-

der non-oxidizing conditions at temperatures in the neighborhood of 2,050° F. for approximately one half an hour whereupon the sintered article is cooled under non-oxidizing conditions and presents a porous iron article, the porosity of which varies in accordance with the grain size of the powder used and the briquetting pressure used in making the briquette. This procedure is well-known in the art and further discussion thereof will, therefore, be unnecessary.

After the porous iron article has been formed and sintered it is next impregnated with copper. Copper impregnation of porous iron has been known for some time in the art and disclosed by a number of patentees. This impregnation is usually carried out by one of two methods. First, immersion of the porous iron article in molten copper held at a temperature slightly above the melting point of copper which is 1981° F. The iron part, after complete immersion, has the pores thereof filled with molten copper, due to capillarity and if desired, a vacuum may be applied to further expedite the impregnation. Then the iron part is removed from the copper and allowed to cool whereupon the copper solidifies within the pores. The other method of impregnating parts, as known in the art, is to place a piece of copper on top of the iron part and then heat the assembly to a temperature in excess of the melting point of copper whereupon the copper is drawn into the pores of the iron by capillarity.

In both of these methods of impregnation, the copper, at a temperature in excess of its melting point, has a dissolving action on the iron and, therefore, when the surface of the impregnated iron part is polished, pits and channels are apparent which reduce the tensile strength and elongation and are undesirable from the standpoint of surface appearance.

In my process, I propose to eliminate these pits and channels so as to produce a part, which when the surface is polished, has an appearance similar to that shown in Fig. 2. In order to accomplish this end, I propose to satisfy the dissolving action of the copper on iron prior to the contacting of the iron part with copper. This is accomplished by adding controlled quantities of iron to the copper. This addition satisfies this dissolving action so that when the copper in the molten condition contacts the iron part, no further dissolving action is apparent.

In the immersion process, I simply add iron to the molten copper under suitable atmospheric conditions whereupon the iron is dissolved. The

iron is added in sufficient quantity to satisfy the dissolving action of the copper on the iron part to be impregnated whereby the impregnated part is free from pits. When operating at impregnating temperatures in the neighborhood of 2050° F., I have found that the addition of from 3 to 6% iron yields satisfactory results. It is apparent that the quantity of iron added depends on the temperature of the copper and therefore in all cases I propose to add sufficient iron to satisfy this dissolving action. In the second method of impregnation heretofore mentioned, I utilize a mixture of copper and iron powders. This method of impregnation is more desirable since it is possible to add an excess of iron, for example, 4 to 8% iron powder to copper and spread the desired amount of the mixture on top of the part to be impregnated and then heat the part with the copper and iron powder thereon to a temperature in the neighborhood of 2050° F. whereupon the copper dissolves the iron powder to the limit of its dissolving action and impregnates the iron part and the excess iron powder remains as a dust on the part and can be readily brushed therefrom after cooling.

In order to facilitate operations and expedite the production of parts by these methods, I further propose to simultaneously sinter and impregnate the part. In this instance, the iron powder briquette has spread thereon a copper-iron mixture in the desired quantity and is then placed in a sintering furnace at a temperature of 2,050°, whereupon the iron powder in the briquette is sintered together and the copper-iron mixture is melted and drawn into the part as it is sintered to impregnate the same. Obviously, any excess iron powder mixed with the copper powder, remains as a dust and can be removed after cooling. It is manifest that the extent of impregnation may readily be controlled by predetermination of the weight of copper powder used. If a copper-iron powder mixture is not desired, an alloy of copper and iron in strip form can be utilized wherein the copper is in the neighborhood of 95% and the iron 5%. Desired lengths of the strip may be cut off, placed on the iron briquette prior to sintering and impregnation thereof.

Any of these embodiments can be practiced with great ease and success and will produce articles free from pits and having considerably greater tensile strength and elongation than articles impregnated by other known methods. For example, I have found that a sintered porous iron article briquetted at 60,000 per sq. inch and impregnated by the prior art methods at 2050° F. with 25% of copper has a tensile strength in the order of 45,000 per sq. inch with an elongation of 5%. Whereas a similar briquette of iron powder sintered and impregnated at 2050° F. with 25% copper, having 5% iron added thereto, has a tensile strength of 60,000 per sq. inch and an elongation of 10%. Thus by practicing my improved method, iron parts impregnated with copper will show an improvement of 33% in tensile strength and 100% in elongation. Both samples above referred to were cooled to obtain maximum ductility.

Simultaneous sintering and impregnation can be practised by using either the immersion or the contact method in either case the time required is best arrived at by trial so that proper sintering is accomplished. In both cases, impregnation will be complete by the time sintering is completed. The contact or second method,

is usually preferred since the degree of impregnation can be controlled by the amount of copper used whereas in the immersion method the impregnation will always be substantially complete as there is always an excess of the impregnant present.

While the embodiment of the present invention as herein disclosed, constitutes preferred forms, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In the method of making composite articles of porous iron wherein the part is sintered and simultaneously impregnated with copper and wherein the iron article, after impregnation thereof, is free from pits and channels, the steps comprising; briquetting iron powder under a suitable pressure into a desired shape, contacting the briquette with copper which includes iron in a quantity at least equal to the quantity of iron which will be dissolved by said copper at the impregnating temperature, sintering the briquette with the copper-iron in contact therewith at a temperature in the neighborhood of 2050° F. for a time sufficient to cause the briquetted iron powder to bond together and form a porous article and simultaneously to cause the copper to flow by capillarity into the pores of the porous iron article for substantially impregnating the same, said sintering and impregnation taking place under suitable conditions of atmosphere, and then cooling the impregnated iron part under suitable conditions.

2. In a method for impregnating a porous iron article with copper, the steps of providing a porous iron part made from briquetted iron powder, heating the part in contact with copper which has sufficient iron associated therewith to satisfy the dissolving action of copper on iron, for a time and at a temperature sufficient to cause the copper to flow into the pores of the iron part for substantially impregnating the same without dissolving any of the iron in the part.

3. In a method for impregnating porous iron articles with copper, the steps of: providing a porous iron part made from briquetted iron powder, immersing the part in molten copper, which has sufficient iron dissolved therein to satisfy the dissolving action of the copper on the iron, for a time and at a temperature sufficient to cause the copper to flow into the pores of the iron part for substantially impregnating the same without dissolving any substantial portion of the iron in the part.

4. The method as claimed in claim 3, comprising the added step of sintering the iron part simultaneously with the impregnation thereof.

5. In a method for impregnating porous iron with copper, the steps of; providing a porous iron part made from briquetted iron powder, placing copper in solid form on said part in a desired quantity so as to provide sufficient copper in the iron after impregnation, said copper having iron associated therewith in quantities sufficient to satisfy the dissolving action of copper on iron, heating the iron part with the copper impregnant thereon for a time and at a temperature sufficient to cause the copper to flow into the pores of the iron part for substantially impregnating the part without dissolving any substantial portion of the iron in the part.

6. The method as claimed in claim 5, together with the added step of simultaneously sintering the iron part during the heating step.

7. In the method of making iron parts, having a substantial proportion of copper dispersed therethrough, without pits and channels therein whereby the tensile strength and elongation are markedly improved, the steps of; briquetting iron powder into a shape of the parts desired, heating the briquetted part in contact with copper which has sufficient iron associated therewith to satisfy the dissolving action of copper on iron for a time and at a temperature above the melting point of copper and sufficient to cause the copper to flow into the pores of the iron part for substantially impregnating the same without dissolving any substantial proportion of the iron in the part.

8. In the method of making iron articles, having a substantial proportion of copper dispersed therethrough, without pits and channels therein whereby the tensile strength and elongation are markedly improved, the steps of; briquetting iron powder into a shape of the part desired, heating the briquetted part in contact with copper which has sufficient iron associated therewith to satisfy the dissolving action of copper on iron for a time and at a temperature above the melting point of copper and sufficient to cause the copper to flow into the pores of the iron part for substantially impregnating the same without dissolving any substantial proportion of the iron in the part, and simultaneously sintering the iron powder in the part by maintaining the part at the impregnating temperature for a period sufficient to cause bonding together of the particles of iron.

9. In the method of making strong iron particles free from pits and channels and having a substantial proportion of copper dispersed therethrough in the unalloyed condition, the steps of; briquetting iron powder into a briquette of the

desired shape, immersing said briquette in a molten bath of copper maintained at a temperature above 2,000° F. and well below the melting point of iron, said bath having sufficient iron dissolved therein to satisfy the dissolving action of copper on iron maintaining the briquette in said bath for a time sufficient to impregnate the briquette with the copper and simultaneously to cause the iron particles in the briquette to sinter together, and then removing the sintered and impregnated briquette and cooling the same, all of said heating and cooling steps taking place under suitable conditions of atmosphere to prevent oxidation of the bath and of the briquette.

10. In the method of making strong iron articles free from pits and channels and having a substantial proportion of copper dispersed therethrough in unalloyed condition, the steps of; briquetting iron powder into a part of the desired shape, placing copper on said briquetted part, said copper having in the neighborhood of 5% iron associated therewith, heating the part with copper-iron thereon at a temperature of about 2050° F., for a period sufficient to cause the iron particles in the briquetted part to sinter together into a porous framework and simultaneously to cause the copper and iron placed on the part to melt and flow uniformly into the pores of said porous iron part, said heating step being carried out under non-oxidizing conditions, and then cooling the article under suitable atmospheric conditions.

11. The method as claimed in claim 10, together with the added step of controlling the quantity of copper used in impregnation by supplying a predetermined quantity only.

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