Aug. 21, 1956 E. J. VOSLER 2,759,846

METHOD OF IMPREGNATING POROUS METAL PARTS WITH A LOWER MELTING POINT METAL

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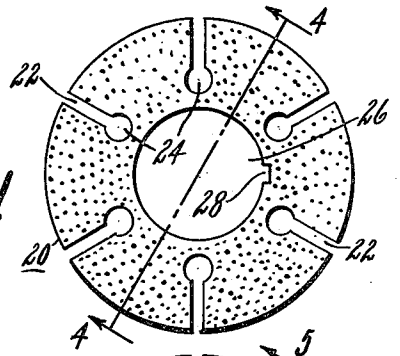


Fig. 1

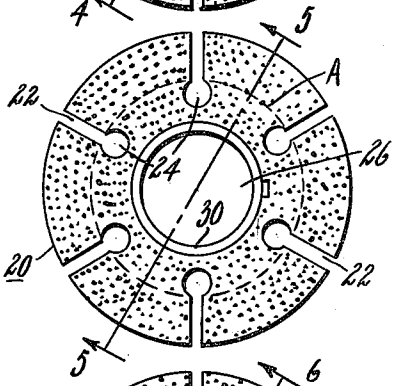


Fig. 2

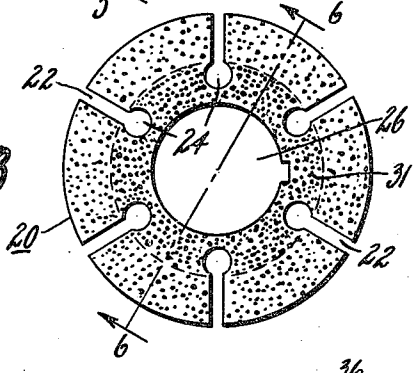


Fig. 3



Fig. 4



Fig. 5

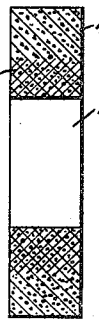


Fig. 6

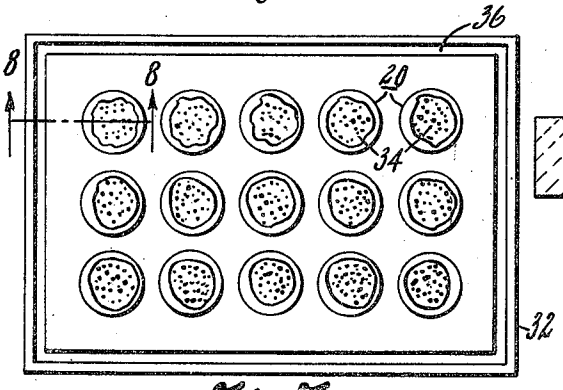


Fig. 7

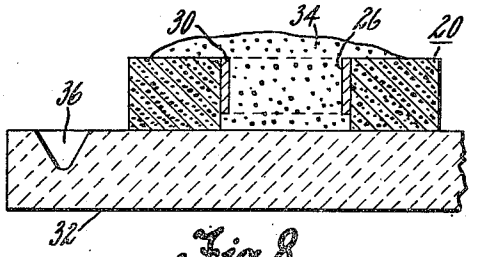


Fig. 8

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METHOD OF IMPREGNATING POROUS METAL PARTS WITH A LOWER MELTING POINT METAL

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6 Claims. (Cl. 117—37)

This invention relates to impregnation processes and is particularly concerned with controlled methods for impregnating porous metal articles with another lower melting point metal.

It is therefore the object of this invention to provide a method for impregnating porous metal articles with a lower melting point metal wherein the impregnation may be carried out under controlled conditions for producing articles of high quality at a minimum of expense. In carrying out this object it is a further object of the invention to provide a method for impregnating porous metal parts such as porous ferrous parts with a metal such as a cupreous metal which normally has a dissolving effect on the metal of the part wherein the impregnation is controlled to a point of entry where the dissolving action of the cupreous material is of little moment and wherein this dissolving action is greatly reduced due to the area of the portion infiltrated.

In carrying out the above object, it is a still further object of the invention to selectively impregnate a porous metal part with a lower melting point metal wherein the selective impregnation is accomplished by the predetermined position of the impregnating metal with respect to the part and wherein said predetermined position is established through the use of a mobile dam such as is formed by sand or the like.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figure 1 is a plan view of a typical type of porous metal part to be selectively impregnated.

Figure 2 is a view of said part with the impregnating metal in place prior to the actual impregnating step.

Figure 3 is a view of the finished article after the impregnating metal has been infiltrated into the porous metal article.

Figure 4 is a section taken on line 4—4 of Fig. 1.

Figure 5 is a section taken on line 5—5 of Fig. 2.

Figure 6 is a section taken on line 6—6 of Fig. 3.

Figure 7 is a plan view of a plurality of articles such as shown in Fig. 1 in place on a tray prior to the infiltration step.

Figure 8 is a fragmentary sectional view taken on line 8—8 of Fig. 7.

Impregnation of porous metal articles is a well-known art and is used to a considerable extent in order to reduce or eliminate the porosity of said articles and to strengthen said articles either all over their entire extent or at selected portions only thereof. This is accomplished by the infiltration of a lower melting point metal into the pores of the porous metal article whereby the pores are filled either partially or completely. This increases the strength of the article in tension or compression and the extent of the increased strength is controlled by the extent of impregnation.

In many instances, for example in gears, cams and the like, the increased strength is only required at selected portions of the article. For example, in a gear, it is often desirable to impregnate the tooth portions or the hub portion since the main body of the gear has sufficient strength, due to its dimensions, to carry the required load whereas the teeth, due to their relatively smaller cross-sectional area, require increased strength for the purposes of use.

In the Lenel Patent No. 2,561,579, a selectively impregnated porous ferrous gear is disclosed wherein copper or cupreous material is impregnated at selected portions thereof to strengthen those portions only. In copending application, S. N. 303,441 and Patent 2,606,831, methods for controlling impregnation are discussed. In this application and Patent 2,606,831, other phases of the problem are disclosed wherein, for example, when porous iron is impregnated with copper, the extent of the dissolving action of copper on iron at the impregnating temperatures is controlled by various means. In certain applications of these impregnating principles, I have found that the extent of the dissolving action of the cupreous material on the ferrous part, for example, may be minimized considerably if the point of entry of the impregnating metal is increased in area whereby the concentration of the cupreous metal is relatively lower with respect to the ferrous material.

Stated differently, if a large quantity of copper, for example, is to be impregnated into an iron part, the dissolving action thereof is considerable if all of the copper enters through a small area of the iron part. On the other hand, if the copper is uniformly distributed over a large area, as shown in the copending Houck application S. N. 303,417, the extent of the dissolving action is greatly lessened and in many cases the dissolving action is of little moment from a commercial viewpoint.

In the present instance, I have found that it is possible to impregnate the porous ferrous part with cupreous material wherein the extent of the dissolving action is minimized and reduced and wherein said dissolving action is localized to certain specific and predetermined areas wherein machining operations are subsequently to be carried out, thereby eliminating the pitted areas where the impregnation entry took place. In order to localize this area to a predetermined portion of the article, it is necessary to utilize some sort of a mobile dam and to this end, I have found that ordinary sand or equivalent refractory grannular materials are very suitable.

Referring to the drawings, it will be seen that Fig. 1 is illustrative of one type of porous metal part which may be impregnated. Here, a compressor rotor is shown at 20 having radial slots 22 therein which terminate in enlarged circular portions 24 adjacent a bore 26. The bore includes a keyway 28 which may be used to attach the rotor to a shaft, not shown. The radial slots 22 accommodate slidable vanes, not shown, when the rotor is installed in a pump or compressor. The enlarged circular portions 24 are used for clearance and lubricating purposes.

This type of rotor may be formed from porous metal very satisfactorily and at greatly reduced costs over solid metal. However, it has been found that the strength of the rotor adjacent the enlarged circular portions 24 at the root of the vane grooves or slots 22 may be insufficient for certain purposes and therefore, it is often desirable to increase the strength of the rotor around the bore 26 and including the enlarged circular portions 24 at the inner end of the vane slots 22. This may be accomplished by impregnating the rotor 20 with another metal wherein the impregnation is selectively controlled to the desired area, which preferably falls within the dotted

line marked "A" in Fig. 2. It has been found that a porous ferrous rotor may have the tensile strength of selected portions thereof nearly doubled through impregnation with a cupreous metal.

In order to selectively impregnate and uniformly distribute the impregnant metal, the said metal is preferably formed into a ring shape which is loosely pressed within the bore **26**. Such a ring is shown at **30** in Fig. 2. It will be noted from Fig. 5 that the ring **30** is not of the same lateral dimension as the rotor **20**, for purposes to be described hereinafter.

In order to localize and predetermine the point of entry of the impregnating metal into the porous metal part I place a plurality of the parts such as shown at **20** upon a tray **32**, as shown in Fig. 7. This tray may be made from a variety of materials although ordinary graphite serves the purpose quite well. After the parts **20** are placed on the tray **32**, the impregnating metal preferably in the form of rings **30** is positioned within the bore **26** of each part, whereupon sand as shown at **34** in Fig. 8 is poured within the bore of each part. The sand, being mobile, flows freely beneath the ring **30** and acts as a complete dam toward undesirable movement of the impregnating metal after it is melted. The tray **32** with the parts **20** thereon, including the impregnating metal and the sand, is then passed through a furnace maintained at a suitable temperature above the melting point of the impregnating metal and below the melting point of the porous metal.

When the impregnating metal becomes molten, it is drawn by capillarity into the pores of the porous metal article to selectively impregnate a predetermined portion **31** corresponding to that area within the dotted line marked "A" in Fig. 2. This area is determined by the amount of impregnating metal furnished with respect to the porosity of the part to be impregnated. These factors are best determined by trial in order to obtain the desired extent and degree of impregnation.

It will be noted from Fig. 8 that since the ring of impregnating metal does not extend entirely through the bore **26** of the part **20**, the sand **34** forms a dam therebeneath. This prevents pudding of the impregnating metal when it becomes molten and possible leakage thereof outwardly from the bore, since the same formed by the sand actually confines the molten metal to the exact portions of the part to be impregnated where it must enter said part.

In all instances, the predetermined distribution of the metal used in the infiltration process minimizes deleterious effects thereof upon the porous metal and thus, if the impregnating metal has a tendency to dissolve, pit or channel the porous metal part, this distribution reduces such effects considerably. On the other hand, if the impregnating metal does not have any deleterious effects upon the part being impregnated, the use of the sand dam localizes and confines the impregnating metal to those exact portions where impregnation is to be carried out, thereby reducing the quantity of impregnating metal which must be used to accomplish the desired end. This is apparent since, if the impregnating metal is permitted to flow away from the part desired to be impregnated, more impregnating metal is requried to yield the desired density in the selected portions to be infiltrated.

It is preferred that a channel or groove **36** be provided around the periphery of the tray **32** to more or less confine excess sand from running off the edges of the tray during the heating operation. Since the quantity of sand is not at all critical, there are many instances where excess sand falls upon the tray per se, and the use of this groove prevents this excess sand from falling off the tray.

A specific example of an impregnation process of the type described concerns the use of a porous ferrous part which is to be impregnated with cupreous material, for

example, a 90% copper, 10% tin material which is formed into a ring **30** and placed within the bore of the porous ferrous part, dammed up with sand and then run through a furnace maintained at a temperature above 1950° F. and well below the melting point of the porous ferrous part. This temperature is maintained for a period sufficient to cause the cupreous material to melt and to be drawn into the pores of the porous ferrous part, usually about twenty minutes. During this operation, it is preferred that the atmosphere within the furnace be of a nonoxidizing and preferably reducing character such as is well known in the art.

When ferrous parts are impregnated with cupreous metals wherein the dissolving action presents a problem, the procedures discussed in Bourne Patent 2,401,221 may be used successfully although as previously stated the predetermined distribution of the cupreous metal generally lessens the seriousness of the problem.

If pure copper is to be used in the impregnation step, the temperature within the furnace should be above 1981° F. On the other hand, if lead is to be the impregnating metal, a temperature above the melting point of the lead is all that is required.

Using the same technique, cupreous articles may be impregnated with lower melting point metal such as lead and its alloys, the invention being sufficiently broad to encompass any combination of metals wherein the impregnant metal has a lower melting point than the metal within the porous metal part.

When shapes other than that disclosed are to be impregnated, the impregnant metal should be formed into the required shape to closely follow the contour of the part at the point of desired entry.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a method of impregnating porous metal parts wherein the extent of the impregnation is to be localized to a predetermined area of the part the steps of; placing the part upon a non-adhering supporting surface, placing a predetermined quantity of impregnating metal in the solid state in juxtaposed relation to the portion of the part to be impregnated, confining the position of said impregnating metal by pouring a loose mobile granular refractory substance therearound to confine the impregnating metal into position with respect to the part to be impregnated, and then heating the part to a temperature above the melting point of the impregnating metal and below the melting point of the part, in a suitable atmosphere for a time sufficient to cause infiltration of the molten impregnating metal into the part, and finally cooling the impregnated part and removing same from the mobile substance.

2. In a method of selectively impregnating localized portions of a porous metal part with a lower melting point metal in predetermined quantities the steps comprising; placing the porous part to be impregnated upon a non-reactive supporting surface, supplying a predetermined quantity of impregnating metal in the solid state in a predetermined state of distribution in juxtaposed relation with respect to that portion of the part to be selectively impregnated, pouring loose sand around said impregnating metal and said part for maintaining the position of said impregnating metal relative to said part when said impregnating metal becomes molten, heating the part, impregnating metal and sand upon said supporting surface to a temperature in excess of the melting point of the impregnating metal and well below the melting point of the porous metal part, in a suitable atmosphere and for a time sufficient to cause the impregnating metal to become molten and to be drawn into the pores of the porous metal part at said selected and predetermined portions thereof by capillarity, cooling the impregnated part and sand upon said supporting

surface, and then removing the impregnated part from the supporting surface and the sand.

3. The method as claimed in claim 2 wherein the porous metal part is of a ferrous metal and the impregnating metal is a cupreous material.

4. The method as claimed in claim 2 wherein the porous metal part is a porous ferrous part and the impregnating metal is selected from that class of materials consisting of lead and lead alloys.

5. The method as claimed in claim 2 wherein the porous metal part is a porous ferrous part and the impregnating metal is copper.

6. The method as claimed in claim 2 wherein the porous metal part is a cupreous part and the impregnating metal is a metal selected from the class of metals consisting of lead and lead alloys.

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