

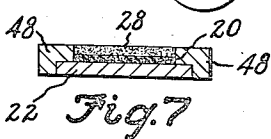
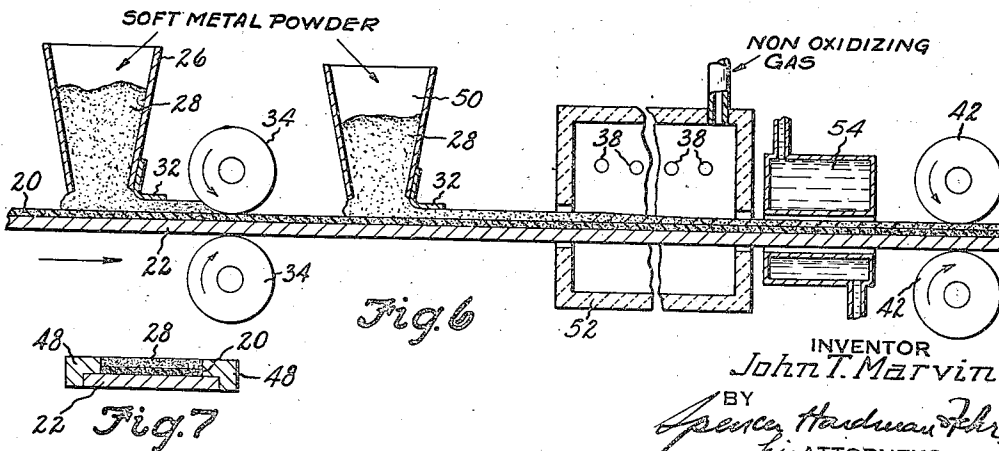
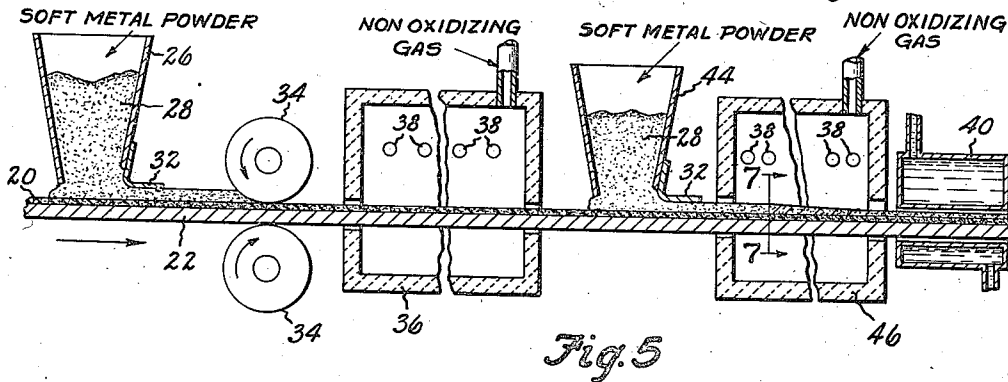
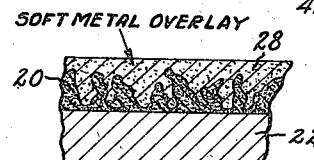
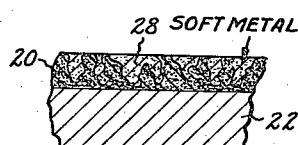
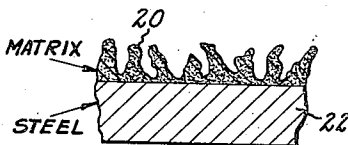
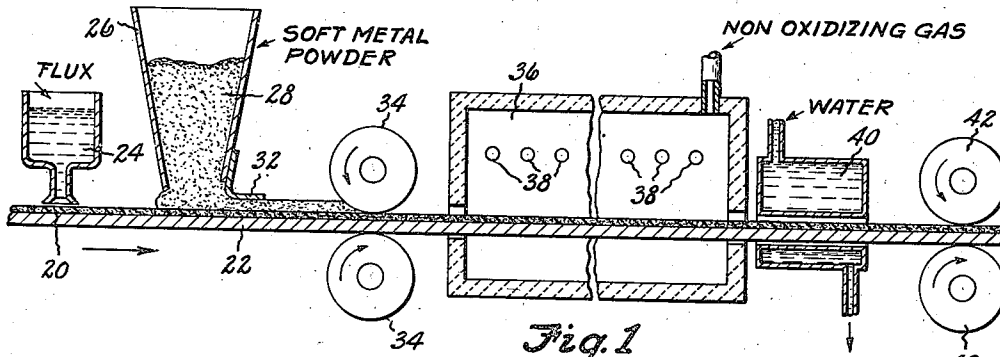
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2,241,095

METHOD OF MAKING POROUS METAL STRUCTURES

Filed Feb. 1, 1940



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METHOD OF MAKING POROUS METAL STRUCTURES

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14 Claims. (Cl. 29—189)

This invention relates to a method for impregnating highly porous metal matrices made from sintered metal powder and is particularly concerned with the method wherein a substantial portion of impregnating metal is mechanically forced into the pores of the matrices.

An object of the invention is to provide a method for impregnating a porous metal sponge made from sintered metal powder wherein a low melting powdered impregnating metal is spread on the sponge and is mechanically forced into the pores of the sponge and is then subsequently heated for causing integration of the impregnated metal powder whereby the impregnated metal is mechanically held within the pores of the sponge.

It is a further object in some cases to provide sufficient metal powder upon the matrix or sponge so that upon subsequent heating an overlay is provided above the surface of the sponge.

It is a still further object in some cases to adjust the mechanism for compressing the low melting metal powder into the matrix in such a manner that the high points of the matrix are simultaneously flattened or mushroomed and the matrix is thereby sized.

In carrying out the above objects it is another object in some cases to provide pressure rolls for rolling the impregnated metal matrix after the heating step or steps in order to further compress the material.

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 diagrammatic view showing apparatus which may be used to carry out the method described herein.

Fig. 2 is an enlarged cross sectional view showing a porous metal matrix bonded to a steel back.

Fig. 3 is a view similar to Fig. 2, wherein the matrix has been impregnated with metal powder and has been rolled so as to flatten the high points of the matrix.

Fig. 4 is a view similar to Fig. 2 wherein the matrix has been impregnated with metal powder in sufficient quantities to provide an overlay over the highest points of the matrix.

Fig. 5 is a diagrammatic view showing another type of apparatus for applying impregnating metal to a porous metal sponge wherein the final article has an overlay of the impregnated metal thereon.

Fig. 6 is a view showing diagrammatically another type of apparatus for impregnating and forming an overlay on porous metal sponge; and

Fig. 7 is a view taken on the line 7—7 of Fig. 5, showing the means provided for preventing the molten impregnating metal from flowing off the surface of the matrix.

In Patent No. 2,198,253, assigned to the assignee of the present invention, a method is described wherein a highly porous metal matrix may be provided that is bonded to a steel supporting back or the like. In the above referred to application reference is made to a method for impregnating a matrix with a soft bearing metal and it is to this step that the present invention is particularly directed. In Patent No. 2,198,253, it is proposed to immerse the matrix in molten impregnating metal whereby the molten metal flows into the pores of the matrix substantially filling the same whereupon the matrix with the impregnated metal therein may be cooled to freeze the molten metal. This impregnating step is preferably carried out in a vacuum. The invention described herein carries out this impregnating step by another method with satisfactory results to form an impregnated matrix similar in character to the impregnated matrix formed by following the method described in Patent No. 2,198,253. While the drawing shows apparatus for impregnating porous metal bonded to steel, it is obvious that similar expedients could be resorted to for impregnation of porous metal bodies which are not bonded to steel in which case the porous metal bodies would necessarily have to be supported upon a non-porous non-adhering body. A method for making highly porous metal bodies which are not bonded to steel is described in Patent No. 2,157,596, assigned to the assignee of the present invention.

The method described herein is particularly applicable to the impregnation of highly porous metal bodies wherein a simultaneous sizing of the porous metal layer is desired. As shown in Fig. 1, a porous metal matrix 20 preferably bonded to a steel supporting back 22 is preferably passed under a fluxing mechanism 24 and a suitable flux such as ammonium chloride, zinc chloride, resin and alcohol or any of the commercial fluxes is sprayed into the matrix, or the flux may be mixed in the dry state with the powdered metal, such fluxes as ammonium chloride or resin, being suitable for this purpose. It is to be understood that this fluxing step facilitates the impregnation, although the step in itself is not always necessary provided a clean matrix is pro-

vided. After being fluxed, the porous metal matrix 20 on strip 22 passes under a hopper 26 which contains powdered metal 28. The metal 28 is preferably lead, lead-tin, lead-antimony, lead-tin-antimony, tin, antimony, and combinations thereof or any other suitable soft metal. The metal powder 28 in hopper 26 falls upon the surface of the matrix by gravity and is smoothed into a uniform layer thereon by a smoothing device 32. The powdered matrix 20 supported on strip 22 next passes between a pair of pressure rolls 34 which compress the powdered metal into the pores of the matrix, substantially filling the same and, if desired, the rolls 34 may be set in such a manner as to cause compression of the matrix layer itself, as noted in Fig. 3. In other words, the peaks of the matrix are flattened and mushroomed to further lock the powder 28 within the pores of the matrix and to make the matrix of uniform thickness. If desired, the strip with the powder thereon may be vibrated, either mechanically or magnetically to cause a portion of the powder to flow into the pores of the matrix prior to the rolling operation, although this step is optional. The strip 22 with the matrix layer 20 thereon next passes into a suitable furnace 36 preferably heated by electrical elements 38 or by other suitable means. The furnace 36 is maintained at a temperature above the melting point of the soft metal powder, thereby causing the powder which is held within the pores of the matrix 20 to become molten. Non-oxidizing gas should be supplied to the furnace to prevent any oxidation of the soft metal powder upon heating thereof. The pressure of the non-oxidizing gas should be sufficient to cause a slight leakage thereof from the entrance and exit of the furnace. The impregnated strip next passes through a water cooled chamber 40 where the impregnated metal is chilled and solidified within the pores of the matrix 20. The strip passes out of the chamber 40 and then may be compressed by roll 42 if desired. This last step is optional and may or may not be resorted to according to the particular material desired. If it is desired to provide an overlay of soft metal above the matrix the apparatus, as shown in Fig. 5, may be used wherein the strip passes through a similar process, as shown in Fig. 1, and upon cooling, passes under a second hopper 44 with additional soft metal powder 28 therein. The hopper 44 provides additional powder on top of the already cooled impregnated matrix whereupon the strip passes through a second furnace 46 to cause the impregnated metal plus the newly applied overlay to become molten and integrated whereupon the entire strip is cooled. In order to prevent the overlay metal layer from running off the surface of the strip, sides 48 may be provided for the strip which hold the molten overlay metal in place until it has been chilled in the cooling chamber similar to that shown in Fig. 1.

Fig. 6 shows still another type of apparatus which may be used to form an overlay on the matrix metal. In this case the second hopper 50 is provided which uniformly distributes additional metal powder on the surface of the strip after the first layer of metal powder has been compressed into the pores of the matrix. In this case, a furnace 52 is utilized to melt and integrate the overlay metal with the impregnated metal. Expedients, such as sides 48, are provided to prevent dissipation of the molten overlay layer whereby the layer is held in place until it is chilled in the cooling chamber 54.

Another method of applying the overlay contemplates the application of the overlay metal in the molten state upon the impregnated surface of the matrix. Apparatus for accomplishing this method is not shown as it is well known in the art.

The matrix layer is preferably formed from metal powder of fairly large mesh size, for example, 150 to 200 mesh wherein each particle of metal is preferably spherical in shape. Thus when the matrix has been formed the pores thereof are of a maximum size and the entrance to the pore cavities and the pore cavities themselves are more or less uniform and devoid of overhanging ledges. When a matrix is formed from spherical powder of this type it is more facile to roll the metal impregnating powder into the pores, although it is to be understood that any type of metal powder can be utilized with a commercial degree of success, such powders falling into the classes of comminuted materials, electrolytic powders, reduced oxides, and the like. Spherical powders are made by well known methods, such as by atomizing molten metals etc. The impregnating powder is preferably of a much smaller mesh than the powder used to form the matrix. Thus if a 150 mesh powder is used in the matrix layer, it is preferable to use 250-300 mesh soft metal powder, since it is a relatively simple matter to cause the fine impregnating powder to flow into the pores when the surface entries of the pores are of considerably larger size than the cross section of the particles of impregnating metal powder. This fact coupled with the mechanical forcing of the powder into the pores tends to insure substantially complete impregnation. When flux is used the flux is dissipated during the heating step.

As preferred in the majority of cases, the heating and cooling operations are carried out in non-oxidizing atmospheres and it is preferable to use soft metal powders substantially free from oxides since these oxides tend to hinder the wetting action of the molten metal and thereby hinder the flowing of the metal in the molten state within the pores of the matrix.

From the method described herein it is apparent that the particular metals used in the matrix are of relatively slight importance and can be selected from the classes including copper, copper-tin, copper-tin-zinc, iron, iron-copper, aluminum, aluminum-copper, copper-nickel, tin-nickel, and in fact any of the metal powders, or combinations thereof, which form a matrix having the desired composition, texture and structure. The impregnating metal powder obviously must be of lower melting point than the metal matrix and this fact is the only limiting requirement on the powder, although for obvious reasons low melting point powders such as tin, lead and antimony, either as separate powders or pre-alloyed powders, are preferred.

The rolling step accomplishes the dual purpose of mechanically forcing the metal powder into the pores of the matrix and also sizing the matrix layer to the desired thickness. This sizing step which occurs substantially simultaneously with the mechanical forcing of the metal powder into the matrix causes a locking action of the matrix on the powder whereby the metal powder upon becoming molten fills the pores and then upon freezing is mechanically held therein even though no alloying action takes place between the impregnating metal and the metal of the matrix. In this connection it should be noted

that when the impregnating metal has a dissolving action upon the metal of the matrix, for example, a copper matrix impregnated with a high tin content metal, that the heating step should be carried out at a sufficiently low temperature and for a sufficiently short time to prevent dissolution of the matrix due to the dissolving action of the impregnating metal. In each case, therefore, it is apparent that the heating step need only be carried out at a temperature slightly above the melting point of the impregnating metal.

While the process as illustrated is directed to a continuous process, it is obvious that an analogous procedure may be resorted in an intermittent process, wherein separate pieces of the porous metal matrix are used and wherein the soft metal powder is spread in a uniform layer thereover and then forced therein. In other words, the method is quite well suited to a continuous or intermittent process of impregnation.

While the embodiments of the present invention as herein disclosed, constitute 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 a method for making composite material, the steps comprising: providing a highly porous matrix by sintering a loose layer of non-compacted metal powder upon a supporting member, distributing a uniform layer of soft low melting point metal powder upon said matrix, compressing the metal powder to force a substantial portion thereof into the pores of the matrix, and then heating the material under suitable conditions and at a temperature above the melting point of the metal powder and below the melting point of the matrix to cause the metal powder to melt and flow into the pores of the matrix whereby a composite article is produced having the matrix thereof impregnated with the soft metal.

2. In a method as claimed in claim 1 wherein the impregnated matrix is compacted after heating.

3. In a method as claimed in claim 1 wherein the matrix is fluxed prior to the distribution of the soft low melting point metal powder thereon.

4. In a method for making composite material, the steps comprising: providing a highly porous matrix bonded to a non-porous supporting member by sintering a loose layer of non-compacted metal powder upon said supporting member, distributing a uniform layer of soft low melting point metal powder upon said matrix surface, compressing the metal powder to force a substantial portion thereof into the pores of the matrix, and then heating the supporting member, matrix and metal powder under suitable conditions and at a temperature above the melting point of the metal powder and well below the melting point of the metal of the matrix for causing the metal powder to melt and flow within the pores of the matrix, whereby the matrix is impregnated with the soft metal.

5. The method as claimed in claim 4 wherein the compression of the metal powder is accomplished by passing the supporting member with the powder thereon between pressure rollers whereby the powder is forced into the pores of the matrix and the high points of the matrix are simultaneously mushroomed so that the matrix is of a substantial uniform thickness throughout.

6. The method as claimed in claim 4 wherein

sufficient soft metal powder is distributed upon the matrix to provide an overlay after the heating step.

7. The method as claimed in claim 4 wherein additional metal powder is applied subsequent to the compressing step and before the heating step.

8. In a continuous method for making composite strip stock, the steps comprising: continuously providing a highly porous matrix bonded to a non-porous strip of steel or the like by continuously sintering a loose layer of non-compacted metal powder upon said strip, continuously distributing a soft low melting point metal powder upon said matrix layer, continuously compressing the metal powder to force a portion thereof into the pores of the matrix, and then heating the strip under suitable conditions at a temperature above the melting point of the metal powder and well below the melting point of the metal of the matrix to cause the metal powder to melt and flow within the pores of the matrix and whereby strip stock is formed wherein the matrix is impregnated with the soft bearing metal.

9. The method as claimed in claim 8 wherein sufficient soft low melting point metal powder is distributed upon the matrix to provide an overlay of the metal powder after the heating step.

10. The method as claimed in claim 8 wherein the compressing step is carried out under conditions of pressure sufficient to cause a mushrooming effect upon the matrix metal at the high points thereof to mechanically lock the metal powder within the pores.

11. In a method of making composite stock including a layer of highly porous metal made from sintered non-compacted metal powder bonded to a layer of a more dense metal wherein the porous metal layer is impregnated with a soft bearing metal, the steps comprising: mechanically forcing powdered soft bearing metal into the interstices of the porous metal layer for simultaneously impregnating the porous metal layer and for sizing said layer, and then heating the composite stock to a temperature sufficient to melt the soft bearing metal but well below the melting point of the porous metal whereby the soft bearing metal and the porous metal are integrated.

12. In the method for making composite material including a relatively thin highly porous metal layer made from non-compacted sintered metal powder which layer is bonded metallurgically to a strong, more dense metal supporting back, the step comprising: mechanically forcing soft bearing metal in powdered form into the pores of the porous metal matrix under high pressure for impregnating the porous metal layer with soft bearing metal.

13. In the method for making composite material the steps comprising, providing a highly porous metal matrix by sintering together a loose layer of non-compacted metal powder, distributing a soft low melting point metal powder upon said matrix, and then mechanically forcing said powdered soft metal into the pores of the matrix for substantially filling the pores of the matrix with soft metal.

14. In the method of making composite material the steps comprising, providing a highly porous metal matrix by sintering together a loose layer of non-compacted metal powder, dis-

tributing a soft low melting metal powder upon said matrix, and then forcing said soft low melting metal powder into the pores of the matrix by means of pressure applied for substantially filling the pores of the matrix with the soft metal and for simultaneously sizing the

matrix whereby the soft metal powder is mechanically locked within the matrix due to the mushrooming effect at the high points of the matrix.

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