Aug. 25, 1942. J. T. MARVIN 2,293,843

METHOD OF MAKING POROUS ARTICLES

Filed March 27, 1940

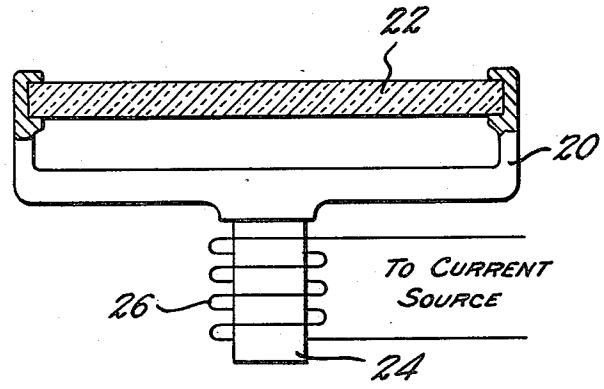


Fig. 1.

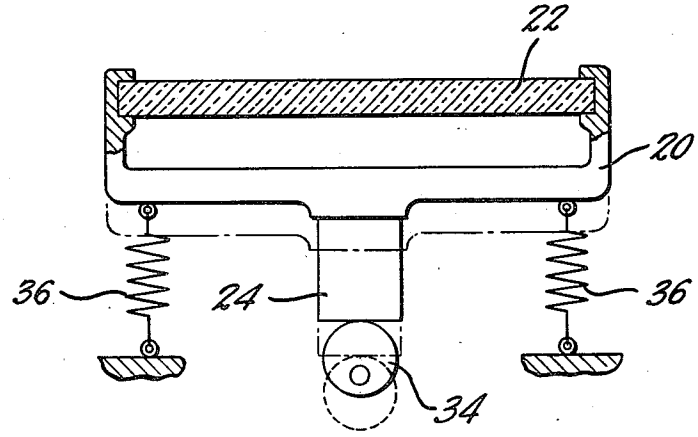


Fig. 2.

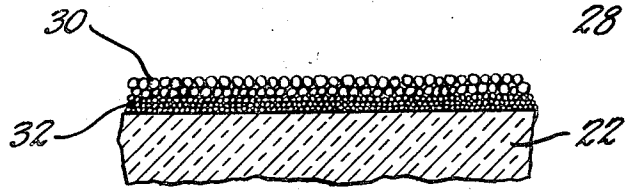


Fig. 3.

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METHOD OF MAKING POROUS ARTICLES

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Application March 27, 1940, Serial No. 326,229

6 Claims. (Cl. 29—189)

The present invention is directed to a method for making porous metal articles and is particularly concerned with a method of making porous metal articles having varying porosities throughout the cross-section thereof.

It is an object of the invention to provide a method wherein the disposition of metal powder particles of varying grain size is accomplished by means of segregation. In carrying out the above object it is a further object to cause said segregation by means of vibrations produced either by mechanical or electrical means.

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 is clearly shown.

In the drawing:

Fig. 1 illustrates one form of apparatus which may be used to segregate metal powders.

Fig. 2 shows another type of apparatus for segregating metal powders and Fig. 3 shows an enlarged fragmentary cross-sectional view of supporting surface with a segregating powder metal layer thereon.

This invention is concerned with a method for producing articles as disclosed in Serial No. 326,235, filed March 27, 1940, now matured into Patent No. 2,267,918, granted Dec. 30, 1941, wherein porous sheet-like metal articles are disclosed which have different porosity at one side of the sheet than on the other side thereof. That is, the porosity through a cross-section of the porous metal varies. In Serial No. 326,220, filed March 27, 1940 assigned to assignee of the present invention, a method is disclosed whereby coarse powder metal particles may be deposited upon a supporting surface and finer metal particles may be deposited thereon for making a particular type of layer. In this invention the disposition of the varying grain size particles is reversed and the finer metal particles are supported directly on the supporting surface and in turn support the coarser metal particles.

To accomplish this disposition in the metal particles, I utilize the segregation thereof whereby the fine particles migrate toward the bottom or toward the supporting surface and the coarser particles find their way to the top of the metal powder layer.

In Fig. 1, a cradle or support 20 is utilized to carry a plate 22 which may be made of a non-adhering material such as graphite, chromium plated steel, wherein the surface thereof has been oxidized, or, carrying a refractory layer, or a sheet of refractory material. The cradle 20 has a downwardly extending plunger 24 thereon which is surrounded by a coil 26 which in turn is connected to an alternating current source. Thus, when current is supplied to the coil 26, the cradle 20 is alternately raised upwardly and pulled downwardly, suitable dampening means or limiting means being provided so that the amplitude of the vibration of the cradle may be controlled. The frequency of vibration and the amplitude is controlled by the frequency and strength of the current and it is also contemplated that in place of the single coil a pair of coils may be provided which are connected to direct current souces of opposite polarities, or a single coil may be used with a direct current source, wherein reversing polarity is provided. Also an interrupter in the circuit may be used wherein mechanical means are used to cause movement in one direction.

Metal powder is spread uniformly on the supporting surface or plate 22 and comprises powder of varying grain size, for example, ranging from 80 to 200 mesh. The plate is then vibrated in a single plane, to cause the metal particles to segregate and assume positions as noted in Fig. 3, wherein the metal powder layer 28 has the coarse particles 30 supported upon the finer particles 32.

In some cases it may be desirable to bond the metal powder layer directly to the supporting surface for uses such as are contemplated in Serial No. 85,297 now matured into Patent No. 2,198,253, assigned to assignee of the present invention. In this instance, the supporting surface 22 may be steel, iron, nickel, copper, or copper plated steel, as the case may be.

After segregation of the metal powdered layer, the supporting plate 22 is removed from cradle 20 and placed in a sintering furnace where it is heated under non-oxidizing conditions for a time and at a temperature sufficient to cause the metal powder particles to bond together and form a porous layer having different porosities at either side thereof, after cooling, the porous metal layer may be removed therefrom. When the supporting plate 22 is made of metal, the porous layer is bonded thereto.

Fig. 2 illustrates another type of apparatus which may be used to accomplish the same purpose as the apparatus in Fig. 1. In this instance, the vibration of the cradle 20 is accomplished by mechanical means, for example, a rotating cam 34 which actuates the plunger 24. In this case, the cradle 20 is preferably carried by means of springs 36 attached to a stationary member so that the cradle 20 follows the movements of the

cam 24. The amplitude of the vibration is controlled by the eccentricity of the cam 34 and the frequency of the vibration is controlled by the speed of rotation of cam 24. It is apparent that the apparatus shown in Figs. 1 and 2 is diagrammatic and may be modified to suit the particular application to which it is to be applied.

In all of the embodiments the use of pre-alloyed metal powder is preferred, since segregation will occur between powder of varying density, that is to say, if a bronze layer is desired, and copper and tin powders are mixed, the constituent metals themselves will segregate even if the grain size is the same. For this reason it is preferred that the constituent metals are attached to one another prior to disposition of plate 22. This may be accomplished by pre-alloying the metal powder either completely or incompletely so that a constituent rich surface of the low melting constituent is present on each particle of powder, thus if copper is used, a tin surface is present thereon. Powders of this type are disclosed in co-pending application Serial No. 322,753, assigned to assignee of the present invention.

The particular metal powders to be used are of slight importance and may include pure copper, pure nickel, pure iron or the powder may be pre-alloyed particles including copper-nickel, copper-tin, iron-copper, nickel-tin, copper-tin-antimony, etc. It is to be understood that the particular metal powder used is of little importance and forms no part of this invention.

For illustrative purposes only the following example is given to show that preferred times and temperatures used during the sintering process. Metal powder particles ranging from 80 to 200 range are provided with a composition of 90% copper and 10% tin, the tin being in the form of a constituent rich surface on the copper particles, these particles are disposed upon a plate 22 of graphite in a uniform layer and are then segregated thereon by means of vibrating the plate in cradle 20. The plate with the segregated layer thereon is then placed in a sintering furnace and heated for a period of from 10 to 20 minutes according to the degree of alloying desired at temperatures from 1500 to 1800° C. The sintering step is carried out under non-oxidizing conditions and the metal powder particles become bonded together at their contacting surfaces and form a porous layer having different porosities at either side thereof, due to the different grain size powders which have become segregated upon the supporting plate. After cooling, which is preferably carried out under non-oxidizing conditions, the porous plate may be lifted from the supporting surface and put to its specific use.

While the disclosure has been directed to pre-alloying powders when two or more metals are used, it is apparent that if the metal powder constituents are not of greatly different density, that the pre-alloying is unnecessary, this condition being best determined by experiment.

Sintering temperatures, when using pure metal powders, should be held slightly below the melting point of the metal, while when utilizing pre-alloyed metal powders, the sintering temperatures should be held intermediate the melting points of the low melting metal and the high melting metal, such sintering temperatures being well-known in the art.

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. A method of making porous metal sheet material wherein the porosity at one side of the sheet is different than the porosity at the other side of the sheet, comprising the steps of, distributing a layer of non-compacted metal powder upon a supporting surface, said powder including particles of different grain sizes, agitating the supporting surface with the metal powder thereon for causing segregation of the metal particles, whereby the smaller particles migrate toward the supporting surface and the larger particles, migrate in the opposite direction, and then heating the supporting surface with the metal powder thereon for sintering the metal powder together, into a strong porous structure which has a different porosity at one side thereof than at the other side of said sheet.

2. The method as defined in claim 1, wherein the agitation is accomplished by mechanical means.

3. The method as defined in claim 1 wherein the agitation is accomplished by electrical means.

4. The method as claimed in claim 1, wherein the agitation is accomplished by means of vibration in one plane only.

5. The method of making composite sheet material wherein a porous metal layer having a different porosity at one side thereof than at the other side is bonded to a supporting surface of a more dense metal, comprising the steps of, distributing a non-compacted layer of metal powder having a different grain size upon the surface of a more dense metal support and then vibrating the support for causing segregation of the metal particles whereby the finer metal particles migrate toward the more dense metal supporting surface and the coarser particles migrate away from said surface, and then heating the more dense metal supporting surface with the segregated powder metal layer thereon under non-oxidizing conditions and for a time and at a temperature sufficient to cause the powder metal particles to sinter together into a strong porous layer having less porosity at the side adjacent the supporting surface than at the other side thereof and simultaneously causing the porous layer to bond in situ to the supporting surface.

6. In a method for making a metal powder layer having a different porosity at one side thereof than at the other side, that step of vibrating a layer of metal powder of varying grain size upon a supporting surface for a time sufficient to cause the metal powder particles of different grain size to segregate upon the supporting surface whereby the porosity of the layer adjacent the supporting surface is less than the porosity at the other side of the layer.

JOHN T. MARVIN.

CERTIFICATE OF CORRECTION.

Patent No. 2,293,843. August 25, 1942.

JOHN T. MARVIN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 49, for "1800° C." read --1800° F.--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of November, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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