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METHOD OF MAKING COMPOSITE ARTICLES

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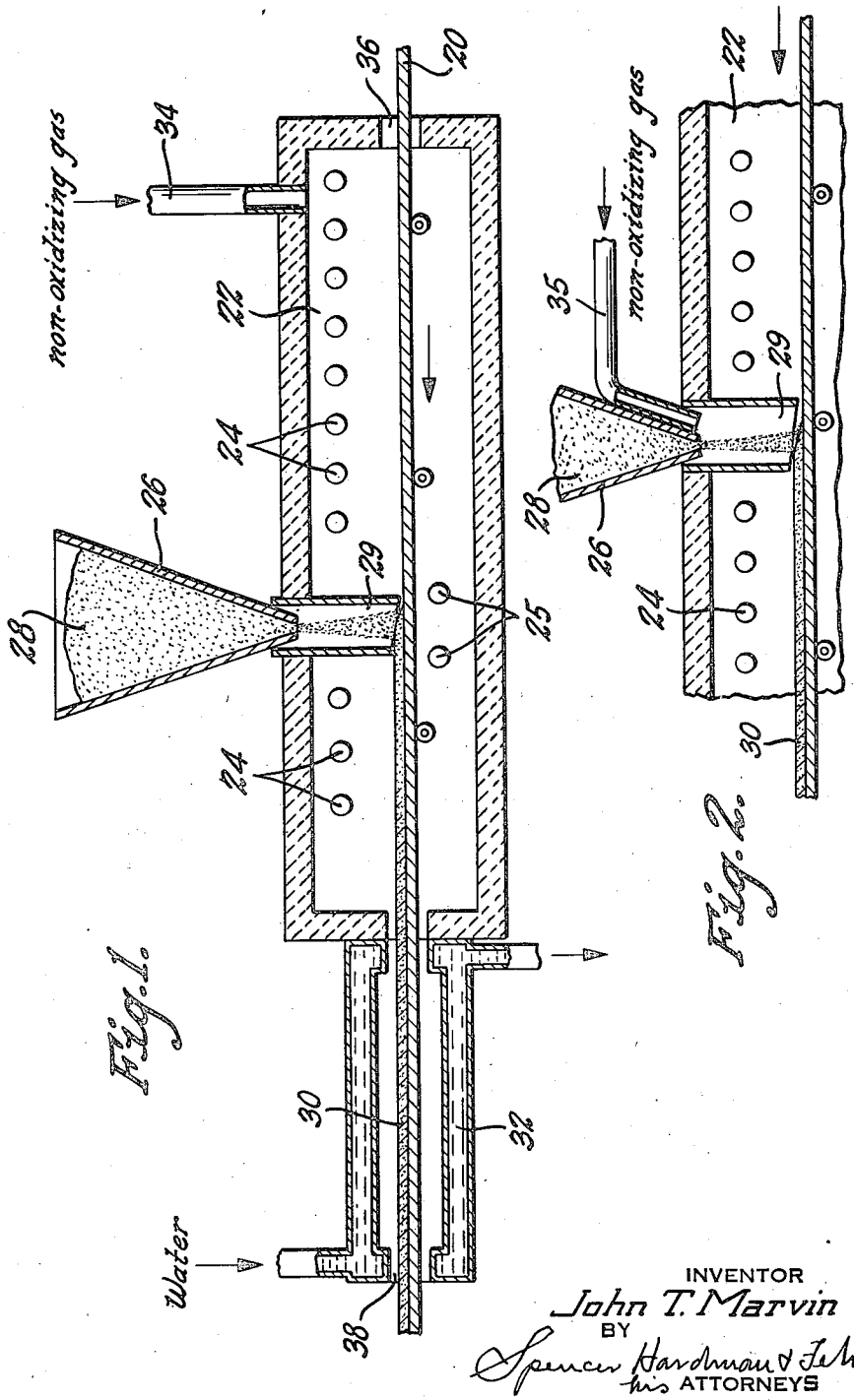


Fig. 1.

Fig. 2.

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METHOD OF MAKING COMPOSITE ARTICLES

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10 Claims. (Cl. 29—189)

This invention relates to a method of making composite metal articles and is particularly concerned with a method of applying a highly porous metal layer to a relatively more dense supporting member.

An object of the invention is to provide a method of applying metal powder in a loose non-compacted condition to the surface of a relatively more dense metal wherein the dense metal is first heated to a temperature sufficient to sinter the metal powder, so that when the metal powder is subsequently applied to the heated surface of the more dense metal it is bonded thereto and sintered together.

It is a further object in some cases to apply the metal powder continuously to the heated surface of strip material.

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

In the drawing:

Fig. 1 represents a diagrammatic view of one type of apparatus which may be used for continuously applying metal powder to heated strip material, and

Fig. 2 shows a modification in design which is particularly directed to the placement of the controlled atmosphere inlet.

Referring to the drawing, 20 designates a long length of strip material such as steel, copper plated steel, copper, nickel, iron or any of the commercial metals. Strip 20 passes into a sintering furnace 22 which is heated by means of electrical heating elements 24, or by any other suitable heating device. The strip 20, as it moves through the furnace 22, is heated to the desired temperature, and during its progress through the furnace passes beneath a hopper 26 which is filled with powdered metal 28. The hopper 26 may be water cooled if desired to reduce the heating effect on the metal powder. The powdered metal 28 falls from the hopper by gravity through passage 29, and is somewhat preheated, and then falls upon the moving heated surface of strip 20 in the form of a substantially uniform layer. The hopper is preferably closed to the atmosphere. The passage 29 is provided to prevent drafts from disrupting the uniformity of distribution of the falling powder. The walls of passage 29 may be water-cooled and if desired the non-oxidizing atmosphere can be admitted into said passage by means of pipe 35 to prevent excessive heating thereof, as shown in Fig. 2. The strip 20 is preferably maintained in its heated condition for a short period after passing beneath the hopper to assure that the powdered metal is brought up to the desired temperature and sintered together, and likewise bonded to the surface of the strip to form a porous metal layer 30. It is apparent that the mass of the strip is much greater than the mass of the powder, and therefore the strip is not appreciably cooled by the application of the powder thereon. If desired, heating elements 25 may be placed beneath the strip to maintain the temperature thereof constant. After the powdered metal 28 is sintered into the porous metal layer 30, the strip passes through a water cooled chamber 32 and thence into the atmosphere of the surrounding environment. In order to prevent scaling on the surface of the strip, and likewise to prevent oxidation of the metal powder, the furnace 22 and cooling chamber 32 are provided with a non-oxidizing atmosphere which is admitted to the furnace through pipe 34. The pressure of the incoming non-oxidizing atmosphere is preferably maintained in excess of atmospheric pressure so that there is an outward leakage thereof through the entrance 36 and exit 38 of the furnace, thereby preventing the ingress of atmospheric gases. The non-oxidizing atmosphere may be any of the well known sintering atmospheres such as: hydrogen, carbon monoxide, incompletely burned natural gas, or it can be some inert gas such as, nitrogen, mixed with any of the above mentioned gases.

The use of the walls of passage 29 within the furnace, prevents direct heat acting upon the falling powder. The invention also contemplates the use of pressure rolls mounted within the furnace. In this instance the porous metal layer is compacted by rolls whereby the porosity of the porous metal layer is decreased and controlled. If desired, these rolls may be mounted in the cooling chamber 32 or outside of the furnace, but it is apparent that greater pressure will be required to control the porosity of the porous metal layer when rolling the same in a cooled condition than when rolling the layer while hot.

If desired, the strip 20 may be heated electrically, as by passing a current through the strip and utilizing the resistance thereof, or by induction heating whereby the strip passes through an electromagnetic field of the desired intensity. Likewise, the herein described methods of heating may be applied to an intermittent process rather than a continuous one, wherein the article to be heated is not strip material.

It is apparent that many types of metal powder may be applied to the surface of relatively more dense metal articles by the process herein described. For example, copper powder, iron powder, nickel powder, aluminum powder, bronze powder, mixtures of copper and iron, copper and nickel, copper and tin, and in fact practically any type of metal powders which will form a porous metal layer of the desired constituency. In order to clarify the method, the following example is given for illustrative purposes only. A clean steel strip **20** is passed into a sintering furnace **22** and is heated to a temperature of 2000° to 2100° F., whereupon the strip **20** passes beneath hopper **26** and a mixture of copper and nickel powders is deposited thereon. One of such mixtures may comprise 40% nickel and 60% copper. The strip with the powdered metal layer thereon then passes through the remainder of the furnace **22**, which passage preferably requires from 5 to 15 minutes during which period the copper-nickel mixture alloys together to form a highly porous layer which is bonded to the surface of the steel strip. The composite strip is next cooled and removed from the furnace. In each instance of sintering metal powders by this method, it is desirable to bring the steel strip to a temperature intermediate the melting points of the components of the mixture of the metal powders, when mixtures of powders are being sintered, and to a temperature slightly below the melting point of a metal powder when a single metal is being sintered. It is manifest that substantially inert ingredients may also be added to the metal powder mixture if desired, some of such ingredients being, for example, graphite, if the finished element is to be used for anti-frictional purposes, or some abrasives, such as silica, alundum, asbestos etc., if the element is to be used for frictional purposes.

It will be apparent from the disclosure herein set forth, that the present method proposes an inexpensive procedure whereby metal powder may be applied to the surface of relatively more dense metal articles and bonded thereto by an alloy bond in the form of a porous layer. The preheating of the strip **20** under non-oxidizing conditions cleans the surface thereof and thus prepares the same for the metal powder by burning off extraneous material such as oil films, dust etc. This is especially true if the atmosphere is reducing in nature since any oxide present is reduced, thus facilitating bonding of the porous metal to the strip. Likewise, the powdered metal is reduced in this atmosphere. In this manner the strip is "fluxed" by the gaseous medium. Bonding can be accomplished when using inert atmospheres, but the surface of the strip must be clean before entry into the furnace. It is to be understood that the invention is not limited to a continuous method, but in its broad sense contemplates the bonding of metal powder to a relatively more dense metal article, wherein the dense metal article is heated to a predetermined temperature prior to the application of the metal powder, said temperature being sufficient to cause the metal to bond thereto. Obviously, if a porous metal layer is not desired, the powder may be applied quite thin so as to merely provide a roughened surface. Such an application being especially desirable in preparing metal surfaces for the subsequent application of Bakelite or other plastics.

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, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. The steps in a continuous method of applying a porous metal layer upon a strip of steel or the like comprising, continuously passing strip material into a sintering furnace, heating the strip under suitable conditions to a temperature sufficient to cause metal powder to bond thereto, applying metal powder in a uniform non-compacted layer, whereby the metal powder is heated to the temperature of the strip and is thereby sintered together and simultaneously bonded to the surface of the strip and then cooling the composite strip so formed.

2. The steps in a continuous process of applying a porous metal layer upon the surface of a more dense relatively non-porous supporting back, comprising, continuously passing the supporting back material into a sintering furnace for heating the supporting back under suitable conditions to a temperature sufficient to cause metal powder to bond thereto without melting the metal powder, applying a loose non-compacted uniform layer of metal powder upon the heated supporting back material whereby the powder is sintered together and bonded to the supporting back, and then cooling the integrated porous layer and supporting back.

3. The steps in a continuous method of applying a porous metal layer upon a strip of steel or the like comprising, progressively heating a portion of the strip under suitable conditions to a temperature approaching, but less than, the melting point of the porous metal layer, applying powdered metal in a loose non-compacted layer upon the heated surface of the strip, whereby the powdered metal is sintered together into a porous metal layer and simultaneously is bonded to the surface of the strip, and then cooling the strip with the porous layer thereon.

4. The steps in a continuous process of applying a porous metal layer upon the surface of a more dense relatively non-porous supporting back, comprising, continuously passing the supporting back material into a sintering furnace for heating the supporting back under suitable conditions to a temperature sufficient to cause metal powder to bond thereto without melting the metal powder, applying a loose non-compacted uniform layer of metal powder upon the heated supporting back material whereby the powder is sintered together and bonded to the supporting back, compacting the porous metal layer while hot, and then cooling the layer and its supporting back.

5. The method of applying a porous metal layer upon a surface of a more dense relatively non-porous supporting member comprising the steps of, heating the supporting member to a predetermined temperature below the melting point of the metal powder to be applied thereon but to a sufficient temperature to cause the metal powder to bond thereto in an atmosphere which has a fluxing effect upon the metal for removing oxides and the like therefrom, and then applying metal powder in a loose non-compacted condition to the surface of the member, whereby the metal powder is heated to substantially the temperature of the member and is thereby sintered together into a porous layer and simultaneously bonded to the surface of the strip.

6. The steps in the continuous method of applying a porous metal layer upon a strip of steel

or the like comprising, continuously passing strip material into a sintering furnace wherein the strip is heated to the temperature sufficient to cause metal powder to bond thereto, continuously fluxing the surface of the strip by means of an atmosphere which is non-oxidizing in nature for preparing the surface of the strip for the metal powder, applying metal powder in a uniform non-compacted metal layer to the surface of the strip whereby the powder is sintered together into a porous layer and simultaneously bonded to the surface of the strip, and then cooling the composite strip so formed.

7. The method of applying a porous surface layer to solid metal articles, comprising the steps of, heating a solid metal article under suitable atmosphere conditions to a temperature sufficient to cause the surface of the article to be cleaned by action of the atmosphere thereon, said heating causing the article to obtain sufficient temperature for causing metal powder to bond thereto, applying metal powder in the loose non-compacted condition to the surface of said article while maintaining the article at substantially the desired temperature for sintering the powder together into a porous metal layer which is bonded to the surface of the article, and then cooling the surfaced article.

8. The method as defined in claim 5, including the added step of compacting the porous metal layer for controlling the porosity thereof.

9. The steps in the continuous method of applying a porous metal layer upon a strip of steel or the like comprising, continuously passing strip material into a sintering furnace wherein the strip is heated to the temperature sufficient to cause metal powder to bond thereto, continuously fluxing the surface of the strip by means of an atmosphere which is non-oxidizing in nature for preparing the surface of the strip for the metal powder, applying metal powder in a uniform non-compacted metal layer to the surface of the strip whereby the powder is sintered together into a porous layer and simultaneously bonded to the surface of the strip, and then compacting the composite strip for controlling the porosity of the porous metal layer.

10. The method as defined in claim 3 wherein the metal layer is rolled after cooling of the strip for controlling the porosity thereof.

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