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METHOD OF BONDING POWDERED METALLIC MATERIAL

Original Filed July 22, 1936

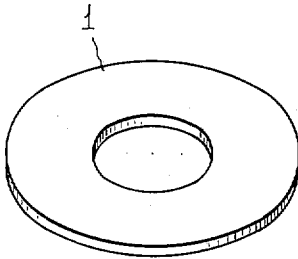


Fig. 1.

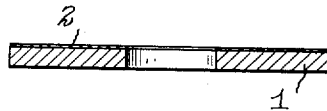


Fig. 2

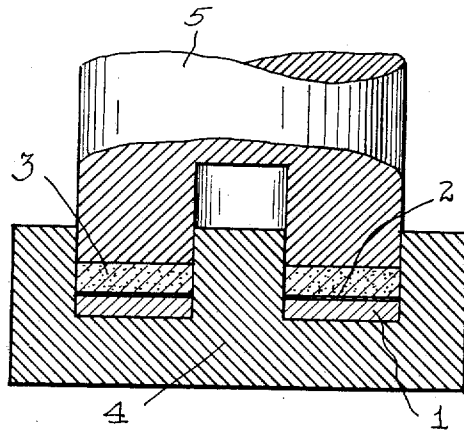


Fig. 3

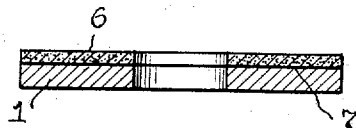


Fig. 4

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## UNITED STATES PATENT OFFICE

22,282

METHOD OF BONDING POWDERED  
METALLIC MATERIAL

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by mesne assignments, to S. K. Wellman Com-  
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Original No. 2,161,597, dated June 6, 1939, Serial  
No. 91,870, July 22, 1936. Application for re-  
issue June 5, 1941, Serial No. 396,786

4 Claims. (Cl. 29—189)

The present invention relates to a novel meth-  
od for bonding a powdered metallic material or  
mixture to a solid supporting body such as steel.

The general object and nature of the inven-  
tion is to provide such a bonding process which  
will produce an efficient and satisfactory union of  
the powdered material, in sintered form, to the  
solid material or steel.

A further object of the invention is to eliminate  
the formation of various oxides, metallic alloys,  
and other chemical compounds which hereto-  
fore have weakened and contaminated the bond  
or juncture between the sintered metallic mate-  
rial and the solid body so that a practical and  
commercially adaptable product was not ob-  
tainable.

Briefly outlined, the method embodying the  
principle of my invention comprises the initial  
step of properly cleaning, both mechanically  
and chemically, the surface of the supporting  
steel body, and then maintaining such cleaned  
surface in uncontaminated and protected condi-  
tion while the powdered metallic material, placed  
in contact therewith, is heated to a sintering tem-  
perature. The term "cleaning" as here used  
means the removal of all particles and films of  
foreign material from the surface of the steel and  
the maintaining of the cleaned surface in such a  
condition during the cleaning operation and im-  
mediately thereafter that it will not again im-  
mediately collect such foreign particles or films  
by oxidation.

To the accomplishment of the foregoing and  
related ends, said invention, then, consists of the  
steps hereinafter fully described and particularly  
pointed out in the claims, the annexed drawing  
and the following description setting forth in  
detail one approved method of carrying out the  
invention, such disclosed method however, con-  
stituting but one of the various ways in which  
the principle of the invention may be used.

In said annexed drawing:

Fig. 1 is a perspective view of a ring of the solid  
supporting metal body such as steel; Fig. 2 is a  
sectional view of the ring of Fig. 1, showing a  
layer of the protective material applied to the  
surface of the ring; Fig. 3 is a cross-sectional  
view of an apparatus illustrating the perform-  
ance of the sintering and bonding step of my  
process; and Fig. 4 is a sectional view of the fin-  
ished product.

The herein described and claimed method is  
particularly adaptable for the manufacture of  
composite metallic elements intended for use  
wherein the elements are subjected to rubbing

or frictional surface contact. Articles of manu-  
facture fabricated from the composite metallic  
elements produced by my process may take the  
form of brake linings, clutch facings, bearings,  
and the like. The particular article here de-  
scribed by way of exemplary illustration in the  
practice of my method is a clutch facing element  
in the form of a flat ring and consisting of the  
reinforcing supporting body 1 of solid metal such  
as steel with the layer 6 of sintered metallic pow-  
dered material boned thereto.

In the practice of my process, the first step  
consists of mechanically and chemically clean-  
ing the surface of the steel supporting body 1.  
Such cleaning is effected by any of the custom-  
ary methods such as grinding, abrading, polish-  
ing, machining, sand blasting, pickling, or a com-  
bination thereof. After such cleaning of the sur-  
face of the steel ring 1 has been accomplished,  
the surface is covered with a protective coating  
capable of remaining stable at all elevated tem-  
peratures. By the term "elevated temperature"  
is meant that temperature at which the bonding  
is begun between the powdered composition and  
the steel and also the temperature at which all of  
the oxygen entrapped in the powdered material  
or carried on the surface of the steel or coming  
from any compound which would give off oxy-  
gen has been dissipated or combined so that it  
will not be able to prevent bonding of the mate-  
rial to the steel. The term "protective coating"  
is used herein to refer to a coating which will re-  
main protective up to the temperature referred  
to as an elevated temperature, which is the tem-  
perature at which the bonding between the steel  
and the compound begins, that is, the tempera-  
ture at which all of the oxygen, which might  
otherwise prevent bonding, has been dissipated  
or combined. Particularly suitable for the pur-  
pose of supplying such protective coating is a  
"flash coat" of copper plating. In order to pro-  
duce such a flash coating of copper on the sur-  
face of the steel ring 1, the latter is placed in  
an electrolytic deposition bath and allowed to re-  
main at least until there is produced a copper  
color on the steel surface.

The protective coating 2 applied to the steel  
ring 1 may also consist of a non-reactive mate-  
rial, such as a high flash point oil, which will  
remain protective and will not become complete-  
ly decomposed or gaseous until subjected to a  
temperature above that herein referred to as an  
elevated temperature.

The steel ring 1 with its protective coating 2  
is next placed in a forming die, consisting of the

female die member 4 and the male die member or plunger 5, with the layer of powdered metallic material 3 superimposed on the steel ring 1. The assembled elements in the apparatus shown in Fig. 3, consisting of the steel ring 1, the protective coating 2 and the layer of powdered metallic material 3 are then subjected to pressure and a temperature sufficient to sinter the powdered material 3 and to thereby bond the layer to the steel ring 1. One method of compressing and sintering the powdered material and the steel supporting layer is more particularly described and claimed in my co-pending application "Method of making composite metallic elements," filed July 22, 1936, Serial No. 91,869 (United States Patent 2,156,611).

The resultant product of the above described process is shown in Fig. 4, and consists of the layer of sintered, powdered metallic material 6 strongly bonded to the steel layer 1 along the bonding line 7. The metallic powdered material 3 may consist of a mixture of a base metal such as aluminum or copper with smaller proportions of other materials such as tin and lead and also relatively inert material such as powdered silica, magnesia, talc, graphite or silicon carbide. The use of a protective coating 2, consisting of a flash coat of copper, is particularly desirable in the performance of my process where a copper base metallic powder is used, and almost mandatory in case a high carbon steel is used. Of the relatively inert materials above specified as suitable constituents of the powdered material, graphite is especially desirable to be used when a protective coating of copper is employed for the steel.

The fine particles of the powdered material contain a substantial amount of oxygen and nitrogen in the form of air, some entrained in the mixture and some contained by surface adhesion on the particles, which if allowed to come in contact with the cleaned surface of the steel layer 1 during the heating step, will prevent the formation of an efficient and satisfactory bond due to chemical reaction of the faces to be bonded with these gases. Furthermore, the protective coating of copper plating 2 prevents any of the constituents of the powdered material 3, such as tin, from contacting the surface of the steel layer 1 and in turn alloying with the iron in the steel, which alloy would also be of a brittle and non-ductile nature susceptible of fracture upon flexing of the finished composite element. As will be noted from the illustration of Fig. 4, the layer 2 of copper plating disappears after the heating and sintering of the powdered material 3, since it is absorbed by the copper already present in the powdered mixture, leaving the direct bonding line 7 between the steel layer 1 and the sintered layer 6.

The provision of the protective coating 2 in the performance of the above described method, whether it be in the nature of the copper plating, the high flash point oil, or a similar material capable of remaining stable at an elevated temperature, prevents the entrapped oxygen in the powdered material 3 from coming in contact with the cleaned steel surface during heating and sintering, so that the bonding line is not contaminated and the efficiency of the bond is not destroyed.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the process herein disclosed, provided the step or steps stated by the following claims or the equivalent of such stated step or steps be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A method of bonding powdered metallic material to a ferrous metal support comprising the steps of providing a mechanically and chemically clean surface on the support, covering such surface with a thin protective coating capable of protecting the ferrous metal of the support from oxidation up to an elevated temperature, holding a body of the powdered material having a metal base with a melting point not lower than that of aluminum in contact with the said coating, and effecting substantially complete diffusion of the coating and sintering of base metal of the powdered material directly to the ferrous support by suitably heating the assembled support, coating and powdered material, the said coating serving during the heating to protect the clean surface of the ferrous support from the action of oxygen in the body of powdered material and the diffusion of said coating permitting a strong bond resistant to high temperatures to be formed directly between the ferrous support and the high melting point base metal of said body.

2. A method as claimed in claim 1 comprising the step of covering the clean surface of the ferrous metal support with a protective coating of metal.

3. A method as claimed in claim 1 comprising the steps of covering the clean surface of the ferrous metal support with a protective coating of copper, and effecting substantially complete diffusion of said coating into the base metal of the powdered material in the heating of the assembled support, coating and powdered material.

4. A method as claimed in claim 1 comprising the step of covering the clean surface of the ferrous metal support with a protective coating of high flash-point oil.

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