

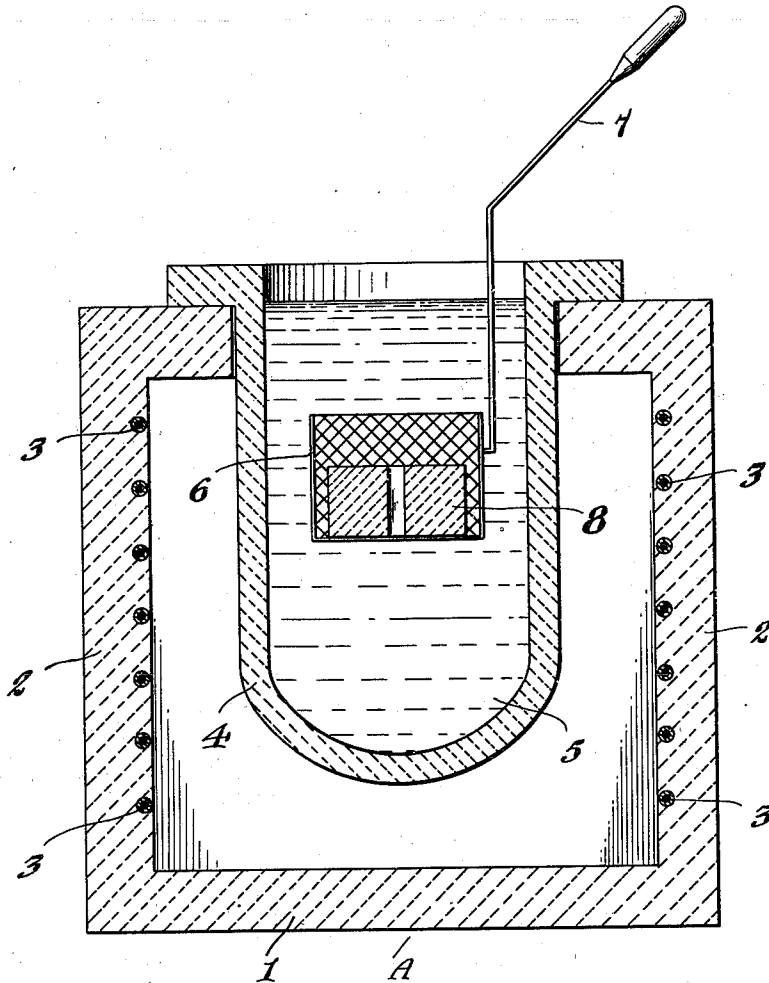
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METHOD OF MAKING ABRASIVE ARTICLES

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METHOD OF MAKING ABRASIVE ARTICLES

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This invention relates to the forming of articles from metal powders with intermixed abrasive. The invention is especially concerned with the metal bonding of diamonds, but it may also be applied to the bonding of other abrasives and other non-metallic substances.

The object of the invention is to greatly shorten the time required for sintering metal-bonded abrasive articles, and to make possible the use of relatively simple and inexpensive sintering apparatus as compared with that used previously. This and other objects will be apparent from the following description.

In the metal bonding of diamonds and other abrasives, the abrasive particles are mixed with metal powders of the desired character, the mixture is subjected to heavy pressure in a mold of the desired shape, and the resulting compacted shape is sintered in a furnace provided with an inert atmosphere to protect it from oxidation. The total time the articles are in the furnace often amounts to two hours or more, and provision must be made to cool the articles in a non-oxidizing atmosphere to prevent oxidation of the metal bond.

This invention materially shortens the time required for sintering the article, insures uniformity of treatment of successive pieces and of different parts of the same piece, and is carried out by simple apparatus. It comprises forming a mixture of diamonds or other abrasive with powdered metal or metals, and compressing it to the desired shape under heavy pressure. The compressed article is then sintered in a liquid bath, such as a molten inorganic salt, held at the sintering temperature, by being dipped into said bath directly. It is held in the bath for sufficient time to allow the bond metal to sinter to the desired degree, after which it is withdrawn and allowed to cool to room temperature, or it may be quenched in a cooling fluid.

The retained salt on the article and in the pores thereof seals it from the atmosphere when it is withdrawn from the bath, thereby preventing oxidation thereof during cooling. After cooling of the sintered article, it is boiled in a solvent suitable for the salt employed as the sintering bath to remove the retained salt from the pores of the article.

The invention will be more clearly understood by reference to the accompanying drawing, in which the figure is a schematic view, in cross-section, of a furnace, liquid sintering bath pot, and work-holding means.

The figure depicts a furnace A having a refractory bottom 1 and side walls 2 with embedded electrical resistance heater wire 3. It should be understood, however, that any other type of heating means can be employed in the furnace. Supported in the furnace is a pot 4 having therein a

fused bath 5 of the particular salt or salts desired, the bath being maintained at the desired temperature by the furnace, which may be regulated manually or automatically by well-known means. A pressed article 8, composed of a mixture of metal powder and abrasive particles is placed in the open screen basket 6, made of heat-resistant material, and the basket and the contained article 8 lowered into the bath by the handle 7 on the basket. The basket may be kept stationary in the bath, or it may be agitated somewhat to insure stirring of the bath and a uniform temperature of the article at all points.

After a suitable time, which varies, as above indicated, with the size of article 8, the temperature of the sintering bath, the type of metal employed for the bonding material, etc., the basket is withdrawn from the bath and the sintered article allowed to cool. The article is then boiled in a suitable solvent for the salt to remove the salt from the pores thereof.

Because of the fact that the sintering heat is transmitted to the compressed article by a liquid of high specific heat as compared with a gaseous atmosphere as used in prior art sintering methods, the article is heated up to sintering temperature in the liquid bath at a much faster rate than it would be in a furnace employing such gaseous atmosphere, and thus the heating period is materially shortened. The liquid salt bath has a high heat content, so that its temperature remains substantially constant even though the process may be carried out continually on a series of articles, which involves the intermittent introduction of cold, pressed, unsintered articles and intermittent withdrawal of sintered articles. Because the molten salt at all points in the bath is at substantially the same temperature, the heat is applied uniformly at all points over the outer surface of the article. Thus there results from the present method a uniformity of sintering of the article regardless of its shape or of how it was placed in the bath.

To illustrate the method clearly, the following specific examples are given. Variations are possible, and the invention is limited only by the scope of the appended claims.

Example 1

As a bonding material, a mixture of	
	Per cent by weight
Powdered copper	75-95
Powdered tin	5-25

is employed. To this is added the abrasive grit, which is thoroughly mixed therewith.

The abrasive can be 100-grit diamonds and constitute 3% or more by weight of the total mix. The abrasive content can also be considered as a percentage by volume of the total, fully compressed mixture; on this latter basis, a conven-

lent range of abrasive content is from 5 to 50% by volume.

The mixture of metal powder and abrasive is poured into a mold, and compressed to the form desired at a suitable pressure, which may range from 10,000 to 75,000 p. s. i. or above. In some instances, a pressure of 30,000 p. s. i. is employed. After being compressed to shape, the article is sintered for 5 minutes in a molten salt bath composed of

	Parts by weight
NaCl -----	1
CaCl ₂ -----	2

the temperature of which is held at 800° C.

As above indicated, the time of sintering and the temperature of the bath may vary, depending on the size of the article and the condition of the bond required; in general, the time may be chosen between 1 and 10 minutes, and the temperature between 750° C. and 850° C. The diamond grit size and quantity given in this and subsequent examples are merely illustrative. It is obvious that both may be varied widely, depending on the type of article desired.

After the article is sintered, it is submerged in boiling water or the like for 20-30 minutes, after which it is rinsed in more boiling water to remove as much as possible of the fused salt from its pores.

Example 2

As a bonding material, the following mixture is employed:

	Percent by weight
Powdered copper -----	80-85
Powdered iron -----	5-10
Powdered tin -----	Approx. 10

The abrasive can be 100-grit diamonds and constitute 3% or more by weight of the total mixture, as in Example 1. The bonding material constituents are mixed dry, and to this are added the abrasive particles. The mixture is compressed to shape, as in Example 1, and is sintered by being submerged in a molten sodium cyanide bath at a temperature of approximately 815° C. for from 2 to 5 minutes. To clean the salt from the sintered article, the latter is boiled in water and rinsed.

Instead of a cyanide bath, there may be used, when higher percentages of iron and lower percentages of copper are employed in the bonding material, a molten borax or a molten sodium aluminum fluoride bath, since whereas sodium cyanide decomposes at 870° C. and a borax bath decomposes at about 1200° C., the NaAlF₆ bath does not decompose at 1370° C. After sintering, the article is treated by a suitable solvent for the salt to remove it from the pores of the article.

Example 3

As a bonding material, a mixture of

	Percent by weight
Powdered copper -----	85-90
Powdered lead -----	7-10
Powdered tin -----	Approx. 1½

is used. The abrasive, which can be the same in character and amount as in Example 1, is in-

timately mixed with the powdered metals, the mixture is compressed and sintered in the same bath as that in Example 1 at 760° C. for a sufficient time interval to sinter the metal to develop the desired strength.

It is obvious that any desired shape of metal-bonded abrasive article may be made by use of the method of this invention. It is also obvious that any desired abrasive may be used as the abrasive element of the article. Among such abrasives are diamonds, boron carbide, silicon carbide, alumina, either the white or brown varieties, or other natural or manufactured substance.

Having thus fully described the invention, we claim:

1. The method of forming metal-bonded abrasive bodies, which comprises preparing a mixture of metal powder and abrasive grit, compressing said mixture to the desired shape, and submerging the compressed shape in a molten salt bath to heat and sinter the metal powder, thereby to form a cemented metal matrix containing the abrasive grit.

2. The method of forming metal-bonded abrasive bodies, which comprises preparing a mixture of metal powder and abrasive grit, compressing said mixture to the desired shape, submerging the compressed shape in a molten salt bath to heat and sinter the metal powder, and agitating the article while in the bath, thereby to form a cemented metal matrix containing the abrasive grit.

3. The method of forming metal-bonded abrasive bodies, which comprises preparing a mixture of metal powder and abrasive grit, compressing the mixture to the desired shape, and heating the compressed shape in a molten salt bath with the molten salt contacting the shape over substantially its whole surface to sinter the metal powder, thereby to form a cemented metal matrix containing the abrasive grit.

4. The method of forming metal-bonded abrasive bodies, which comprises preparing a mixture of metal powder and abrasive grit, compressing the mixture to the desired shape, and heating the compressed shape in a molten salt bath with the molten salt contacting the shape over substantially its whole surface to sinter the metal powder, thereby to form a cemented metal matrix containing the abrasive grit, removing the sintered shape from the salt bath, and when it is cool, dissolving and removing the salt from the surface and pores of the shape by use of a suitable solvent.

5. The method of forming metal-bonded abrasive bodies, which comprises preparing a mixture of metal powder and abrasive grit, compressing the mixture under a pressure of at least 10,000 p. s. i. to shape it to the desired form, and heating the compressed shape in a molten salt bath with the molten salt contacting the shape over substantially its whole surface to heat and sinter the metal powder thereby to form a cemented metal matrix containing the abrasive grit.

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