

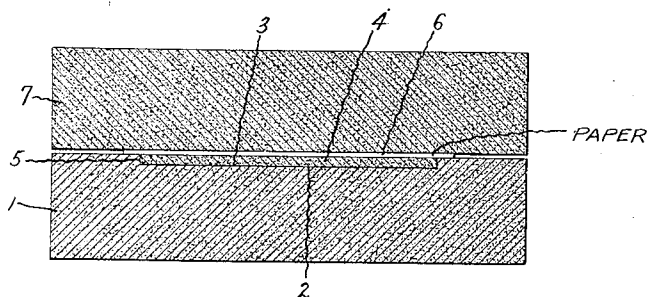
Jan. 30, 1945.

E. W. ENGLE

2,368,458

METHOD OF MAKING THIN WALLED SINTERED METAL ARTICLES

Filed June 19, 1943



Inventor:
Edgar W. Engle,
by *Harry E. Drumhams*
His Attorney.

UNITED STATES PATENT OFFICE

2,368,458

METHOD OF MAKING THIN-WALLED
SINTERED METAL ARTICLES

Edgar W. Engle, Huntington Woods, Mich., as-
signor to Carboloy Company, Inc., Detroit,
Mich., a corporation of New York

Application June 19, 1943, Serial No. 491,473

6 Claims. (Cl. 75—22)

The present invention is a method for manufacturing thin walled sintered articles and more particularly thin walled cemented carbide articles. Cemented carbides are sintered hard metal compositions containing one or more hard metal carbides and a cementing metal therefor, such as cobalt. Such compositions generally are pressed into a desired shape and thereafter sintered into a hard dense mass. However, when employing conventional methods of pressing and sintering, it is very difficult to obtain a uniform distribution of powder in thin layers, for example layers varying from a few thousandths of an inch up to $\frac{1}{8}$ of an inch thick and to provide for even, uniform pressure. Furthermore, any misalignment in a press or die results in a greater non-uniformity when pressing thin sections than when pressing thick sections. Also there is a very high percentage of breakage in thin pressed sections when they are transferred from the pressure die to the heat treating furnace. The difficulties involved in the production of thin cemented carbide articles are so great that heretofore such material has not been available on a commercial scale.

It is one of the objects of the present invention to provide a simple and relatively inexpensive process for the manufacture of thin metal plates or other articles from powdered material and particularly for the manufacture of thin cemented carbide articles such as strips and plates, as well as hollow cylindrical and cup-like articles having walls less than $\frac{1}{8}$ of an inch in thickness.

The novel features which are characteristic of my invention are set forth with particularity in the appended claims. My invention, itself, however, will best be understood from reference to the following specification when considered in connection with the accompanying drawing in which the single figure represents a cross section of a mold whereby my invention may be carried into effect.

Referring more particularly to the drawing, I have indicated at 1 a mold which may be made of graphite or other suitable refractory material such as alumina and the like. The mold preferably has a fine grain and low porosity and is provided with a channeled or cut away portion 2 the surface 3 of which is very smooth and capable of taking a high polish.

In making thin walled articles I employ finely divided ingredients, for example powdered material capable of passing through a standard 200 mesh screen and preferably through a standard 325 mesh screen. However, when for certain uses maximum physical properties are desired in the

finished product the fineness of the powdered ingredients should not exceed 10 microns in diameter and the greater number of grains preferably should be less than 1 micron in diameter.

The powdered material is mixed with an oil to provide a paste having a putty like consistency. The oil employed should be volatile at a temperature substantially below the sintering temperature of the particular cemented carbide being fabricated. Such volatilization also should be accomplished without decomposition or appreciable action on the powdered metal. In addition to being volatile with heat and nonacting with the powder, the oil should be capable of forming with the powdered material an unctuous paste which may be spread uniformly in a thin layer. An oil of this character is a commercially available lubricating oil known as Carolina No. 675 which is completely volatile at about 400° F.

In producing a thin flat plate, a layer 4 of the paste material is spread on the smooth polished surface 3 of the mold 1. To provide for a definite width and thickness of the plate and to permit easy spreading of the paste to a uniform thickness the channeled part 2 of the mold has side walls 5 the height of which is equal to the thickness of the paste to be spread in the channeled portion of the mold. The paste may be spread with any suitable means, for example with a spatula or it may be extruded into the channeled portion 2 of the mold. The spreading action may be assisted by gently tapping or vibrating the mold 1.

If desired, the paste material now may be pre-sintered in the mold 1. Under such circumstances there is somewhat of a tendency for the material being sintered to warp and break during the heat treatment. This difficulty may be the result of uneven removal of oil from the upper and lower layers of the paste. However, I have found that the tendency of the plate to break and warp may be minimized and more uniform results obtained if the upper surface of the paste 4 is covered with a thin sheet 6 of paper or like material which in turn is covered by a flat graphite or other refractory plate 7. The paper may be pressed onto the surface of the paste with a roller or other means. The plate 7 has substantially the same length and width as the mold 1 and is applied to the paper sheet as indicated on the accompanying drawing. This assembly is then heat treated.

In the heat treating process the covered mold is placed in a furnace provided with a non-oxidizing atmosphere such as hydrogen and having a

low temperature which is gradually raised to the desired temperature of about 1000° C. or if desired the loaded mold is passed slowly into the heated zone of the furnace. The charge in the mold is thus heated or presintered at a temperature which will develop sufficient strength in the charge to permit careful handling after it has been cooled. The temperature to which the charge in the mold is heated at this point is below that at which a reaction will take place with the graphite since any such reaction will result in sticking, warping, carbon absorption, and other detrimental effects. During this heat treatment the oil within the charge is completely volatilized and the paper strip becomes charred and is removed easily.

After the plate 4 has been presintered the mold 1 or similar molds are coated on the polished surface 3 with a thin layer of a non-carbonaceous refractory powder such as aluminum oxide and the presintered plate placed on the oxide-coated surface and heated in a non-oxidizing atmosphere, for example hydrogen. The plate is gradually brought to a temperature sufficiently high to provide maximum consolidation in the sintered plate. A composition consisting of about 91 tungsten carbide and 9% cobalt generally would be sintered at about 1400 to 1500° C. This final sintering temperature will vary somewhat depending upon the nature of the material being sintered but will be about equal to the temperature employed with material which is pressed and sintered in the well known manner. The final sintering is accompanied by a shrinkage in the sintered material which should be uniform but which will vary with the composition and physical condition of the starting metal powders.

Although I have illustrated my invention particularly in connection with cemented carbides, it is not limited to such material but may be applied to the production of thin structures of any metal composition which is customarily produced by sintering the powdered ingredients thereof. Also, if desired, my process may be employed to advantage in the manufacture of diamond impregnated cemented carbides since the diamonds may be positioned easily in the paste material. Also, if desired, the surface 2 of the mold may be provided with serrations to provide the sintered plate during the presintering operation with a file like surface.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of making thin metal structures which comprises mixing the metal in finely divided condition with an oil to provide an unctuous paste, said oil being volatile at a relatively low temperature without decomposition and non-reactive with the powdered metal, spreading the paste thus formed on a mold and in a layer of predetermined thickness, and thereafter sintering the powdered material in a non-oxidizing atmosphere.

2. The method of making thin cemented car-

bide structures which comprises mixing the metal in finely divided condition with an oil to provide an unctuous paste, said oil being volatile at a relatively low temperature without decomposition and non-reactive with the powdered metal, spreading the paste thus formed upon the polished surface of a mold, and thereafter heating the paste material at a temperature of about 1000° C. said mold having means for controlling the thickness of the paste material.

3. The method of making thin cemented carbide metal structures which comprises mixing the metal in finely divided condition with an oil to provide an unctuous paste, said oil being volatile at a relatively low temperature without decomposition and non-reactive with the powdered metal, spreading the paste thus formed in a layer of predetermined thickness on a mold, covering the surface of the paste material with paper, placing a refractory plate on said paper and heating the assembly to a temperature of about 1000° C.

4. The method of making thin cemented carbide structures which comprises mixing the metal in finely divided condition with an oil to provide an unctuous paste, said oil being volatile at a relatively low temperature without decomposition and non-reactive with the powdered metal, spreading the paste thus formed in a layer of predetermined thickness in a cut-away portion of a graphite mold, said cut-away portion having a polished surface and heating the paste to a temperature of about 1000° C. to thereby volatilize the oil and pre-sinter the powdered metal.

5. The method of making a sintered cemented carbide metal plate which comprises placing a layer of metal paste consisting of a mixture of powdered metal and an oil volatile at a relatively low temperature without decomposition and non-reactive with the powdered metal in a channeled portion of a graphite mold so that it fills but does not extend beyond said channeled portion, placing a thin sheet of paper on said paste, superimposing a flat graphite plate on said paper, heating the assembly in a reducing atmosphere at about 1000° C. and thereafter sintering the metal plate thus formed in a non-oxidizing atmosphere at a temperature of about 1400 to 1500° C.

6. The method of making a sintered cemented carbide metal plate which comprises placing in a channeled portion of a refractory mold a layer of metal paste consisting of a mixture of finely divided cemented carbide ingredients and an oil which is volatile at about 400° F. without decomposition and non-reactive with the cemented ingredients, said paste filling but not extending beyond said channeled portion, superimposing a refractory plate on said mold so as to cover said paste without applying pressure thereto, the surface of said plate opposite said paste being flat and smooth, and thereafter heating the paste to volatilize the oil and sinter the powdered metal.

EDGAR W. ENGLE.