Patented Sept. 19, 1933 1,927,626

UNITED STATES PATENT OFFICE

1,927,626

METALLIC MATERIAL

William G. Calkins, Detroit, Mich., assignor to Chrysler Corporation, Detroit, Mich., a corporation of Delaware

No Drawing. Application November 9, 1929 Serial No. 406,165

4 Claims. (Cl. 75—1)

The present invention relates to the fabrication of metallic articles of manufacture from powdered or finely divided particles of metal.

I have found that metal may be powdered or finely divided and compressed into desired shape to form various articles of manufacture. An article formed from a powdered metal or a combination of various powdered metals will not ordinarily possess any great amount of strength. It is, therefore, desirable to sinter the article thus formed, which causes it to become a coherent solid mass. This may be accomplished by heating the article without thoroughly melting it. The article may be sintered in an open furnace, but one very desirable method of sintering is by subjecting the article to a heated bath, such as a cyanide bath, a borax bath or a sodium aluminum fluoride bath. A cyanide bath prevents oxidation of the minute particles which compose the article and by preventing oxidation the particles are more firmly united together, producing a stronger structure than structures which have oxides between the metallic particles.

Various metals may be combined in order to secure different desired results. For instance, copper may be combined with iron or the iron particles may be copper plated. In this manner, articles of manufacture which are normally made of copper may be fabricated of a combination of iron and copper without in any way impairing the efficiency of the article and at the same time materially reducing the cost thereof. The degree of hardness of the finished product may be largely controlled by the proportions of the different metals used. Small percentages of tin may be used advantageously in some instances to reduce the hardness of the finished article.

One result of the fabrication of an article of manufacture from powdered or finely divided iron or other metal is that a porous structure results. This porous structure is naturally much lighter than a solid or cast structure and is subject to saturation with oil. I have found that structures of this character will absorb as high as 60% of their volume of oil.

This characteristic makes such a structure of particular advantage in the construction of bearings or frictional resisting surfaces, such as the outer periphery of pistons used in internal combustion engines.

The following description specifically defines a method and a composition for forming cylindrical bushings or bearings from powdered metal, but it is to be understood that the invention is not limited to that specific article of manufacture.

Bearings have heretofore been made of soft metal, such as babbitt, bronze and lead or tin alloys, but such bearings are not porous and do not absorb lubricant. Such bearings are usually soft and do not withstand heavy pressures.

The composition which I have selected for illustrating a form of my invention consists essentially of powdered iron, powdered copper, powdered tin and stearic acid. The proportions of the elements vary according to the desired hardness of the bearing. These elements are thoroughly mixed and compressed in a suitable mold to the desired shape, hereinafter referred to as a briquette. In compressing a mixture without stearic acid the friction of the powdered metal on the mold walls necessitates greater pressure. A lubricant in the powdered metal is, therefore, important to reduce the frictional resistance during the compression operation as well as during the mold stripping operation which removes the briquette from the mold. Liquid lubricants, when mixed with the powdered composition, reduce the frictional resistance, but make the powder wet when used in too large quantities, which is undesirable for pouring the compound into the mold. A small percentage, however, such as three-fourths of one percent, may be used with very satisfactory results.

Solid dry lubricants, such as stearic acid, palmitic acid, powdered paraffin and powdered waxes form very satisfactory lubricants and produce a dry mixture which easily flows into the mold. In order to properly mix these dry solid lubricants with the powdered metal, I have found that it is desirable to dissolve the solid lubricants in a volatile solvent, such as ether, benzine, alcohol, etc. In this manner it is possible to quickly and thoroughly mix the dry lubricant with the powdered metal. When the mixture is allowed to stand, the solvent, preferably ether, evaporates leaving the lubricant properly mixed.

Graphite may be used as a lubricant, but inasmuch as it does not burn out when the briquette is sintered, it lowers the structural strength of the finished article. Stearic acid burns out of the mixture just as soon as it is placed in a hot cyanide bath, leaving the powdered metal free from any element which would tend to reduce its strength.

One desirable mixture may be expressed as 80 to 85 per cent copper, 5 to 10 per cent iron, approximately 10 per cent tin, about 1 per cent stearic acid and a suitable volatile solvent for the stearic acid. To this compound 1 to 2 per cent graphite may be added. This composition, when

thoroughly mixed, is dry and may be readily poured into a mold. A forming pressure is applied to the mold, compressing the powdered composition into a briquette under a pressure of approximately 30,000 pounds per square inch. The pressure, however, may vary from 10,000 pounds per square inch to 75,000 pounds per square inch. The briquette is then removed from the mold, placed on suitable containers and heated during a non-oxidizing or reducing treatment such as by submerging the article in a cyanide bath for one to two minutes at a temperature of approximately 1500° Fahrenheit. The briquette is then a hard, porous structure.

After the article is removed from the cyanide bath it is submerged in boiling water for a period of from twenty to thirty minutes, after which it is rinsed in boiling water to insure complete removal of all the cyanide. When the articles are rinsed they are allowed to dry. The heat within the article, caused by the boiling water, will ordinarily be sufficient to dry them.

If the articles are to be used as bearings it is necessary to remove all air, water, etc., from the bushings and to fill to capacity the pores of the bushings with a lubricant such as oil. This process is accomplished by means of a vacuum. The bearing is placed in a high vacuum and submerged in hot oil at a temperature of approximately 250° Fahrenheit for a period of about thirty minutes. This temperature is to be above the boiling point of water to insure the complete removal of water.

The machining of the bearing is important, as it is necessary to maintain a very complete porosity of the frictional surface. Boring is preferred to grinding. When cylindrical bearings are machined, the inner periphery of which is the frictional surface, the outer periphery may be ground as it is unnecessary to retain the porosity of that surface, but the inner periphery should be bored, preferably by a diamond point. Grinding partially closes the pores and when it is desired to completely close the pores, the surface may be coated, either by plating with a metal, or by lacquering. When the pores in the outer periphery are closed, such as by plating, the oil in the bearing is prevented from leaving the bearing at that surface and flows only in a direction through the frictional surface or to the inner periphery. This is particularly desirable to prevent the oil from being thrown outward by centrifugal force when the bearing is rotated.

The bearing may be machined before the oil is impregnated into it, but it has been found that the bearing is more porous before it is machined and it absorbs the oil more quickly. The percentage of voids in a bushing formed in this manner will exceed 15%. The bearing is much lighter and it absorbs approximately 40% of its volume of oil so that the structure is inherently lubricated at all times.

An article of manufacture may be composed of a high percentage of iron and a small percentage of copper. When such a composition is compressed into a briquette, high temperatures are required to sinter the briquette. It is, therefore desirable to sinter such a composition in a molten cryolite or a sodium aluminum fluoride bath. A cyanide bath decomposes at about 1600° Fahrenheit and a borax bath decomposes at about 2200° Fahrenheit. A sodium aluminum fluoride bath does not decompose at 2500° Fahrenheit and is, therefore, a desirable sintering bath for a composition containing metals having a high melting point. The temperature of a sodium aluminum fluoride sintering bath may be maintained above the melting point of copper and below the melting point of iron without decomposing the bath.

I desire it to be understood that I have herein described the method of forming only one article of manufacture which may be fabricated from powdered or finely divided metals. Various articles may be fabricated of the same or different metals in the same manner and many changes may be made in the method without departing from the spirit of my invention, and it is my intention to cover by the appended claims such changes as may be made in the composition, method, process or product herein described.

What I claim is:

1. The method of forming an article of manufacture which consists in mixing powdered metals including copper and iron together, compressing the mixture to a briquette form, and sintering the briquette in a sodium aluminum fluoride bath.

2. The method of forming an article of manufacture which consists in mixing powdered iron and at least one additional powdered metal together, compressing the mixture to a briquette form, sintering the briquette in a sodium aluminum fluoride bath at a temperature above the melting point of the said additional powdered metal, but below the melting point of iron.

3. The method of forming a bearing which consists in mixing powdered metals including copper and iron together, adding stearic acid dissolved in a volatile solvent to the mixture, drying the mixture, compressing the mixture to a briquette form, and sintering in a sodium aluminum fluoride bath.

4. The method of forming a bearing which consists in mixing together 80 to 85 percent powdered copper, 5 to 10 percent powdered iron, approximately 10 percent powdered tin, and approximately 1 percent stearic acid, compressing the mixture into a briquette, and sintering the briquette in a sodium aluminum fluoride bath maintained at a temperature above the melting point of tin and below the melting point of copper.

WILLIAM G. CALKINS.