Patented Feb. 2, 1943 2,310,061

UNITED STATES PATENT OFFICE

2,310,061

POROUS METAL

Orville R. Bowen, Dayton, Ohio, assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

No Drawing. Application March 6, 1941, Serial No. 381,968

2 Claims. (Cl. 75—22)

This invention relates to the method of making porous metal parts and is particularly concerned with the admixture of metallic salts, and the like with the metal powder prior to sintering thereof.

An object of the invention is to provide a die lubricant in the form of a metal salt which when mixed with metal powder and sintered will decompose without excessive fuming or smoking and leave a residue of substantially pure metal.

Another object of the invention is to utilize salt such as copper carbonate, nickel carbonate, iron carbonate, metallic sulphates, nitrates, hydroxides, bicarbonates and the like as addition agents which act as die lubricants and which in many cases increase the strength of the sintered article.

Further objects and advantages of the present invention will be apparent from the following description.

In the past it has been found necessary to add a die lubricant to the mixture of metal powders which are to be briquetted; such die lubricant aiding in the briquetting operation and prolonging the life of the dies. Die lubricants have usually been fatty acids and metallic salts thereof. Such fatty acids when decomposed during the sintering period leave a residue of carbon, which residue is included between the grains of the metal powder since each grain is substantially coated with the die lubricant thereby causing an imperfect bond due to the inclusion of free carbon between the grains. Other die lubricants, such as zinc stearate, have the added disadvantage of fuming and forming metallic oxides which are deposited on the inside of the furnace and remaining as residues in the sintered parts. Likewise all of the fatty acids or salts thereof break down into amorphous carbon which causes the briquette to have a stained or darkened appearance at the surface thereof.

This invention is particularly concerned with a new and more desirable type of die lubricant which has the dual function of acting as a lubricating medium during the briquetting operation and likewise increases the strength of the sintered article. I have found that from ½ to 1½% of suitable salts when added to metal powders act as a die lubricant and markedly increase the strength of the sintered article.

It is preferred to use a metallic salt wherein the metal of the salt is one of the metals used in the composition of the porous metal articles, for example, when forming a bronze article it is desirable to use a copper salt; when forming an iron article an iron salt; when forming a copper article either a copper or nickel salt, etc. Care should be taken in each case to choose a salt wherein the metal thereof, if oxidized, is easily reduced in the sintering atmosphere utilized, thus eliminating salts of the type of zinc and tin wherein the oxides thereof are difficult to reduce in conventional sintering atmospheres such as incompletely burned natural gas, diluted hydrogen atmospheres, cracked ammonium atmospheres and the like. The acid radical in each of these salts should also be chosen from the group which preferably completely decomposes with gaseous components upon heating, whereby no extraneous residues remain in the briquette after sintering. One acid radical which is particularly desirable is the carbonate radical. It will be observed that copper carbonate for example, breaks down upon heating, in two steps wherein copper oxide and carbon dioxide are formed in the first step and wherein the copper oxide is reduced leaving a residue of pure copper which goes into the composition in the second step. This is true of other metal carbonates mentioned as well as bicarbonates. In some cases it may be desirable to use sulphates and nitrates. In each case the gas which is evolved, namely sulphur dioxide and nitrogen dioxide, has a fluxing action on the metal particles and when small quantities of the metallic salts in the order of ½ to 1½% are used this fluxing action is, in many cases, beneficial.

Another broad class of compounds which does not form any inclusion such as free carbon upon decomposition is the metal hydroxides which break down into a metal, oxygen and water vapor.

When using copper carbonate in the amount of 1% of the weight of the metal mixture I have found that the strength of the finished sintered articles are increased from 25% to 30% over similar articles using zinc stearate, or stearic acid, as a die lubricant. In each case, the mixture was 90–10 copper-tin mixture with 2% graphite and the die lubricant added in quantities of 1%. The term die lubricant is meant to be generic to all compounds which reduce die wear. In the case of metallic salts, the addition thereof prevents galling of the die as the salt is interposed between the die wall and the pressed metal powder thereby preventing actual metal to metal contact and resulting cohesion. The inclusion of these various lubricants also reduces the stripping pressure or pressure required to remove the briquetted article from the die by reducing friction and

thereby preventing galling of the die barrel and/or punch.

It should be understood that the carbon inclusion coming from die lubricant is different than the free graphite which may be added to powder metal mixtures prior to the briquetting. In the latter case, the free graphite is held as inclusions surrounded by the porous metal whereas the die lubricant when properly mixed is coated over the surface of each grain and forms a microscopic layer thereover. Upon sintering this compound is, for the most part, boiled out onto the surface where it decomposes into amorphous carbon and gaseous components, the carbon product staining the outer surface of the article. It is apparent that any lubricant that does not boil out but decomposes within the briquette will form a microscopic amorphous carbon layer that may retard bonding.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, 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. In the method of making porous metal articles the steps comprising; mixing copper and tin powders in suitable proportions, to subsequently form a bronze, with from one-half to one and one-half percent of copper carbonate which acts as a die lubricant and reduces friction at the die surfaces, forming the mixture into an article of the desired shape by briquetting, and then sintering the formed article for a time, temperature and in an atmosphere suitable for causing the copper and tin to alloy together to form a bronze and simultaneously decomposing the copper carbonate into a gaseous component and pure copper which copper enters into the alloying reaction, whereby an article of homogeneous character is formed without extraneous, non-metallic components being present at certain of the boundaries between various particles of metal.

2. In a method of making porous bronze articles, the steps comprising, mixing copper and tin powders in suitable proportions to form subsequently a desired bronze, adding from one-half to one and one-half percent of a copper salt taken from the class consisting of copper carbonate, copper bicarbonate, copper sulphate and copper nitrate, which copper salt acts as a die lubricant and reduces the friction at the die surfaces during the formation step, forming said mixture of metal powders and said copper salt into an article of the desired shape by the application of the desired pressure, and then sintering the formed article for a time, temperature and in an atmosphere suitable for causing the alloying of the copper and tin to form a bronze and for simultaneously causing decomposition of the copper salt into pure copper and a gaseous component, said pure copper entering into the alloying reaction with the tin whereby an article of homogeneous character is formed without the introduction of extraneous, non-metallic elements being present on certain of the grain boundaries of the articles.

ORVILLE R. BOWEN.