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ADDITION OF ELEMENTAL SULFUR TO FERROUS POWDER TO PREVENT GALLING DURING THE BRIQUETTING OPERATION

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This invention relates to powder metallurgy and is particularly concerned with briquetting procedures and compositions for improving such procedures when used with ferrous metal powders.

It is an object of the invention to provide a composition which will eliminate galling of briquetting dies and will improve the accuracy with which ferrous parts may be briquetted.

In carrying out the above object, it is another object to provide a ferrous metal powder mix including a small quantity of an antigalling agent such as finely divided sulfur which addition tends to lubricate the die during briquetting of the powder and prevents galling without having any deleterious effects on the completed part after sintering.

Another object of the invention is to provide a method and means for briquetting articles from ferrous metal powders wherein articles having a high length to diameter ratio and, particularly, wherein the wall thickness of the articles is relatively thin, may be briquetted without galling of the die. Articles of this composition strip from the briquetting die with great difficulty and tend to gall the die due to the fact that the briquetting operation is carried out with a high speed stroke which aggravates the galling action.

Further objects and advantages of the present invention will be apparent from the following description wherein preferred embodiments of the present invention are clearly shown.

In the manufacture of ferrous articles from briquetted metal powders, it has long been a problem to strip said articles from the die after they have been briquetted. This problem is aggravated as the length to diameter ratio increases and as the wall thickness of the part decreases. For example, in the manufacture of a cylinder liner, as disclosed in copending application Serial No. 851,753, filed November 9, 1959, in the name of Theodore W. Kunzog, and assigned to the assignee of the present invention, great difficulty is experienced in the stripping operation and, furthermore, due to the use of fast-acting presses, there appears to be a decided tendency toward galling of the part and attendant injury to the die.

A powder mix used in the manufacture of such a part may consist of iron powder with 1 part of graphite added together with the usual die lubricant, for example, 1 part of zinc stearate. These ingredients, in a homogeneous mixture, are briquetted in a standard briquetting die under pressure ranging from 45,000 to 80,000, preferably 60,000 pounds per square inch, for example, and, in each instance, such a part is difficult to strip from the die without injury to the part or to the die.

Various expedients have been used to overcome these difficulties. Different grades of graphite have been used and the usual lubricant, namely, the zinc stearate, has been increased from 1% to 2% and the graphite has likewise been increased up to 6% but, in no case has the condition been visibly improved.

I have found that, if sulfur powder of relatively fine mesh is added to the mix in quantities of from .25% to 2%, the part not only briquettes well but is easily stripped from the die and, upon subsequent sintering, at conventional temperatures in the order of 2050° F. for from 20 to 30 minutes, only a small part of the sulfur is lost and the remaining sulfur combines with the iron to improve the machinability thereof. The combined sulfur in the part does not detract markedly from any of the physical characteristics thereof. I have found also that, while additional sulfur, over 2%, is not harmful, amounts above 2% do not improve the condition and, therefore, this appears to be a satisfactory top limit for practical purposes. A preferred range is from .25% to 1.5%. The low limit of .25% is a minimum at which the sulfur functions to prevent galling.

It is my theory that the sulfur, in finely divided form, for example, —200 mesh, acts as a die lubricant and that the sulfur actually melts within the powder as it is being briquetted. I have measured temperatures of the dies during the operation and find that the surface temperatures closely approach and actually exceed the melting point of sulfur at the surface thereof during ejection of parts from the die and, therefore, I believe that the sulfur actually melts and aids in lubricating the part during both briquetting and ejection whereby galling is eliminated.

To further this theory, I have attempted to utilize similar quantities of sulfur previously combined with iron wherein Swedish sponge iron having sulfur therein in the quantity of 1% was briquetted and ejected in a similar die. In this instance, although the part showed improved machinability, the galling effects were in no way lessened and the previous problems were still apparent.

Specifically, the sulfur can be added to any ferrous metal mixture wherein galling is experienced during the briquetting of the mixture. For example:

100 parts by weight of atomized iron powder, 100 mesh
0 to 6 parts graphite (artificial or natural, 100% through a 100 mesh screen, 95% through a —325 mesh screen)
0 to 2 parts zinc stearate
.25% to 2% by weight of the iron of sulfur (preferably —200 mesh)

A preferred formulation contemplates 100 parts iron powder 100 mesh, 1 part sulfur, 1.5 parts graphite and 1 part zinc stearate. In any of the above formulations, in place of atomized iron powder, Swedish sponge iron powder may be substituted in full or in part. Also, carbonyl iron powder or reduced oxide iron powder may be used.

The graphite may vary as required for physical characteristics in the part being made or may be left out entirely, if the properties which it imparts are not desired or required. Similarly, in place of zinc stearate, other metallic salts of fatty acids may be used as die lubricants to enhance the briquetting operation and are usually desirable in metal powder mixes. This die lubricant may be used when desired or other lubricants for facilitating the briquetting may be substitued therefor. The sulfur is sufficient to lubricate the die and permit briquetting and ejecting therefrom without galling irrespective of the organic lubricant.

Sulfur powder much larger than 200 mesh is not as desirable since there is a tendency for the sulfur to exude from the surface of the part during sintering which is not apparent when using a 200 mesh or finer powder. The antigalling qualities, however, are present regardless of the size of the powder.

It is understood that, in all of the foregoing examples, small quantities of a conventional alloying ingredient may be present if desired. For example, such materials as nickel, copper, manganese, molybdenum, etc., in quantities not in excess of 10% by weight of the article may be included. It is understood that the term "ferrous"

is of sufficient scope to include alloying ingredients and deviations in carbon content as defined herein.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. For use in powder metallurgy, a powdered ferrous mixture for preventing galling during subsequent briquetting operations, consisting essentially of a ferrous metal powder and elemental sulfur in quantities of at least .25% to 2% of the ferrous metal used.

2. For use in powder metallurgy, a powdered ferrous mixture for preventing galling during subsequent briquetting operations, consisting essentially of ferrous metal powder and elemental sulfur in quantities of 1% of the iron used in the part.

3. For use in powder metallurgy, a powdered ferrous mixture for preventing galling during subsequent briquetting operations, consisting essentially of iron as a major portion of the mixture together with elemental sulfur in quantities of from .25% to 1.5% of the iron.

4. For use in powder metallurgy, a powdered ferrous mixture for preventing galling during subsequent briquetting operations, consisting essentially of iron as a major portion of the mixture and elemental sulfur having a mesh size of not greater than 200 in quantities of 1% of the iron.

5. In a method of preparing a ferrous metal powder mix having antigalling properties during the briquetting thereof, the steps comprising; adding powdered elemental sulfur to a ferrous metal powder, thoroughly mixing the powdered ingredients, filling the powdered material into a die, briquetting the powdered material under high pressures sufficient to form a self-sustaining mass, and then ejecting the part from the die wherein both the part and the die are free from galling.

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