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POROUS METAL STRUCTURE

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This invention relates to an improved composition for the manufacture of porous metal structures and to the method of making such structures.

More specifically, the invention relates to an improved porous bearing composition and method of making porous bearings and particularly to the provision of an improved lubricating agent in compositions of this kind which materially improves the character of the final products.

In manufacturing porous metal structures, such as porous bearings, it is the practice to compress mixtures of porous metals into briquette form and to then sinter the briquette in a reducing atmosphere at a temperature above the fusion temperature of one of the powdered metal components and below the fusion temperature of the other.

Comparatively high pressures are employed during the briquette forming operation, and in order to subject all portions of a charge of such powdered metal composition to substantially uniform pressure and to prevent excessive wearing and scoring of the dies used in such operations, it is desirable to include a lubricant in the composition.

One of the main objects of this invention is to provide a lubricating agent for this purpose which has a substantially greater lubricating capacity than the agents heretofore employed and which is also adapted to serve as a flux during the sintering operation.

Other objects of the invention are to provide an improved method of making porous metal structures; to provide an improved lubricating agent in powdered metal compositions from which such structures are formed which decomposes during the sintering operation and from which at least some of its elements are liberated so as to produce additional voids in the structure; to provide a lubricating agent of this character which is not hygroscopic and which therefore does not become sticky or tend to lump when exposed to a humid atmosphere; and to provide a lubricating agent which is not sensitive to humidity changes and which has, while even in humid atmosphere, the lubricating capacity required to provide uniformity of strength and compactness in substantially long and thin wall porous metal structures.

Further objects of this invention are to provide an inorganic lubricating agent for this purpose which is substantially free from soot producing elements, such as carbon, so as to prevent discoloration of the structure during the sintering operation; and to provide an inexpensive lubricating agent of this kind which is particularly adapted to be distributed uniformly throughout a mixture of powdered metals.

In manufacturing porous metal bearings or other porous metal structures in accordance with the invention, the powdered metals, such as copper and tin, are thoroughly mixed together with powdered graphite, and a lubricating agent, preferably comprising boracic acid, is incorporated in the mixture. Boron or other derivatives of boron, such as borax, potassium tetra borate, sodium tetra borate, and boron oxides, may be used for this purpose if desired. Boracic acid is, however, particularly desirable because it decomposes at the sintering temperatures employed without liberating soot forming elements or otherwise discoloring the final product. During the sintering operation, the boron derivative acts as a flux and causes a substantially integral union of the juxtaposed surfaces of the particles of metal.

Briquettes having substantially the size, shape, and contour desired in the final product are then formed by compressing the above composition between suitable dies under a pressure of substantially 40,000 pounds per square inch. The boracic acid or other derivative of boron which is thoroughly distributed throughout the powdered metal composition, serves as a lubricant during the briquetting operation. It reduces the frictional resistance to relative movement of the powdered metal particles, resulting in a substantially uniform distribution of the pressure applied during this operation, and it prevents excessive wear and scoring of the surfaces of the dies. The uniform distribution of pressure throughout the body of the composition produces substantially uniform compactness at all portions of the structure and renders it possible to compress the powdered composition into the form of substantially long thin wall structures, thereby producing a structure having substantial mechanical strength.

The briquettes are then placed in a furnace having either a reducing or a non-oxidizing atmosphere and they are sintered at substantially 1500° F. This temperature, which is somewhat higher than the melting point of the tin and lower than the melting point of copper, causes the tin particles to rigidly fuse and bond the powdered metal particles together.

During the sintering operation the boracic acid is decomposed and water is liberated in the form of vapor. The liberation of some of the elements

of the boracic acid aids in producing voids in the structure which add materially to the porosity thereof. In the case of bearings, the resulting porous structures are then quenched in oil so as to substantially saturate the pores thereof.

A suitable copper-tin composition may be formed by mixing together substantially 10 parts by weight of powdered tin, 1½ parts of powdered graphite, 1 part of powdered boracic acid, and 87 parts of powdered copper. Other combinations of powdered metals, such as copper and powdered iron, may also be used. A suitable copper-iron composition may be formed by mixing together substantially 15 parts by weight of powdered copper, 1½ parts of powdered graphite, 1 part of boracic acid, and 82 parts of powdered iron. The form of powdered iron known as sponge iron has been found to be particularly suitable for this purpose. Compression of the copper-iron composition to briquette form may be accomplished with pressures of substantially 90,000 pounds per square inch, and the sintering operation may be conducted at substantially 2150° F. in a reducing atmosphere.

The boracic acid remains in a substantially dry finely divided state regardless of the humidity of the atmosphere to which it is subjected. Therefore, all tendency of the lubricant to become sticky or to lump when exposed to highly humid or normal atmosphere is eliminated. The absence of carbon and other soot producing elements in the decomposition products prevents discoloration of the structure during the sintering operation and the fluxing properties of the lubricating agent result in the formation of exceptionally strong bonds between the particles of the powdered metals which materially improve the mechanical strength of the final product.

Although but several specific embodiments of the invention are herein set forth, it is understood that various changes in the steps of the method and in the composition employed may be made without departing from the spirit of our invention, and it is not our intention to limit its scope other than by the terms of the appended claims.

What we claim is:

1. A composition for the manufacture of porous metal bearings including a mixture of powdered tin, powdered copper, and powdered graphite, and a lubricating agent comprising powdered boracic acid.

2. The method of forming an article of manufacture which consists in mixing powdered graphite and powdered copper with a powdered metal selected from the group of metals consisting of tin and iron, thoroughly distributing boracic acid throughout said mixture, compressing the mixture to a briquette form, and sintering the briquette to form a hard porous structure and to simultaneously decompose said boracic acid and volatilize some of the elements thereof.

3. The method of forming an article of manufacture which consists in mixing together powdered tin, powdered copper, and powdered graphite, distributing powdered boracic acid throughout said mixture, compressing said mixture to briquette form, and sintering the briquette in a reducing atmosphere to form a hard porous structure and to simultaneously drive off some of the elements of said boracic acid and to effect the solution of the oxides of said powdered metals in the remaining boron compound.

4. A composition for the manufacture of porous metal articles including a mixture of powdered graphite, powdered copper and a powdered metal selected from the group of metals consisting of tin and iron, and a lubricating agent disposed throughout said mixture comprising boracic acid in finely comminuted state.

5. A composition for the manufacture of porous metal bearings including a mixture of powdered copper, powdered iron, and powdered graphite, and a lubricating agent distributed throughout said mixture comprising boracic acid.

6. The method of forming an article of manufacture which consists in mixing together powdered iron, powdered copper, and powdered graphite, distributing powdered boracic acid throughout said mixture, compressing said mixture to briquette form, and sintering the briquette to form a hard porous structure and to simultaneously drive off some of the elements of said boracic acid.

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