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METALLIC POWDER COMPOSITION

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This invention relates to metallic powders such as are used for the production of electrical brushes, porous bearings and similar articles, and has particular reference to a new and novel compound powder which displays the property of not segregating, whereby uniform metal distribution may be obtained in the finished article, this desirable property being obtained without sacrificing the other desirable properties of the powder. The invention also contemplates the control of the apparent density of the metal powders. Specifically, it contemplates the addition of very small quantities of thin liquids to these powders to prevent segregation during storage and use, and/or to regulate the apparent density.

In the manufacture of carbon brushes, the so-called oil-less bearings, and similar molded products, metallic powders are blended and compressed, with or without heat, to obtain the desired molded objects. Various powders may be used, copper, lead, tin, zinc, carbon and graphite being among the most common. These powders comprise particles of varying sizes; and the individual particles in any one powder vary in size and apparent gravity as much as they vary in these particulars from particles of the other powders. We have found that even in an uncompounded powder, particles of 30 micron or less diameter tend to dust up, and separate from the coarser particles. This tendency is aggravated where powders of different sorts are used; and it is particularly bad where the blend is with powders of considerably different gravity and different mean particle size, e. g. copper and tin. This dusting and segregation occurs to some extent even in storage, but the tendency is aggravated considerably by mechanical treatment such as shaking, or mechanical conveying.

In the manufacture of electrical brushes, where conductivity and strength are of prime importance, the presence of segregated zones of coarse and fine material is particularly objectionable. This is particularly true since most brushes are compounded of various ingredients of varying electrical conductivity, and of different mean particle size; so that the zones differ not only in grain size, but also in chemical constitution. As a result, electrical conductivity varies in different sections of the brush, and the tensile strength is of course that of the weakest zone.

In the manufacture of powdered metal objects such as bearings, the objections to segregation are no less striking. These objects are generally made by compressing the blended powder in dies, and then sintering. Segregation not only gives differences in physical properties due to zoning, but even more serious difficulties due to the formation of different alloys at different zones in the sintering operation. Another important point is the difficulty with "green growth." When pressure is applied to metallic powder in the order of twenty tons per square inch, as is the case with these moldings, and then released, there is a tendency to expansion, this increase in size being known as "green growth." Other things being equal, large particle powder will give greater green growth than small particle powder; so that segregation results not only in a slight change in the dimensions of the molded object, but also in a change which is not entirely uniform.

In the normal use of pure metal powders or blends of metal powders and other ingredients such as carbon, graphite, etc., the apparent density, all other factors beings equal, plays an important role in the production of equal weight and size pressed metal powder objects such as bearings, bushings, rings, plates, brushes, electrical contact points, etc. Up to the present time any changes in the apparent density of various lots or shipments of metal powder blends has necessitated the operator to adjust the so-called well depth of the die to compensate for variations in apparent density.

Another means of compensating for this variation in apparent density has necessitated the introduction of complex weighing devices, thus enabling equal weight additions to the die in view of maintaining constant weight pressed metal objects.

The general methods of apparent density control have been limited to the particle size and particle size distribution, and to the shape and porosity of the powdered material. For example, a solid spherical shape powder will have a greater apparent density than porous spherical shape powder, all other factors being equal. Similarly, an irregular shape particle size will not pack as closely as a spherical, cubic, etc., shaped particle of equal screen size or particle size distribution.

In attacking this problem of segregation, we were faced with the further difficulty that any solution to the problem preferably should not affect the molding or other properties of the metallic powder. In particular, it is important, in order to get satisfactory molding, that the powder pour like a liquid; and it is common practice to measure this flow of the powder by passing it through an orifice of restricted diameter, and determining the equivalent of viscosity in a liquid by allowing a standard amount to flow through

the standard orifice. In overcoming the tendency to segregate, in a satisfactory fashion, the flow must not be lost.

We have discovered that the tendency of the metallic powder to separate can be substantially overcome, and the apparent density regulated, without destroying the flow by incorporating with the powder a small amount of a liquid which has a viscosity no higher than that of S. A. E. #10 lubricating oil (about 90 seconds Saybolt at 130° F.). For overcoming the tendency to separate it has been found that percentages of liquids between 0.0025 and 0.03 are effective in preventing segregation without stopping the flow. This same range also gives an effective control of the apparent density of the metal powder although if apparent density control is the only consideration, smaller amounts will result in a reduction in apparent density over the untreated powder. Likewise if in the apparent density control flow is not important, further reduction in apparent density may be obtained if desired, by addition of the liquid up to 0.05% and even up to 0.1%. Ordinarily, however, no more than 0.05% will be added and the preferred range for both segregation and apparent density control is between 0.0025 and 0.03% of liquid based on the powder.

Furthermore, we prefer to work with very thin liquids with viscosities of the order of kerosene, because as the viscosity increases, the ability to disperse throughout the mass lessens. With liquids whose viscosity is higher than that of #10 S. A. E. motor oil, the liquid will not disperse through the powder, but will ball the powder up locally, and destroy the flow without overcoming the tendency to segregation. Heavier liquids may be used only by blending with other liquids so that the actual liquid added is of sufficiently low viscosity.

Another qualification which the liquid should possess is that it shall not react with the powder. For this reason, water, acids and unstable chlorinated hydrocarbons should not be used.

While volatile liquids such as benzol, petroleum, ether, etc., function efficienly so long as they remain in the mass, their rapid evaporation takes them from the approved list. A slowly evaporating liquid such as kerosene, however, remains in the powder during storage, and evaporates from the molded article after manufacture; such a liquid is clearly preferable to a volatile liquid.

We have obtained elimination of segregation without loss of flow with volatile liquids like gasoline, benzol, petroleum ether, ethyl alcohol and ethyl acetate, with fixed liquids such as linseed oil, cottonseed oil and pine oil, and with slow evaporating liquids such as kerosene, petroleum naphtha and xylene, provided the amounts of liquid were kept low. Similar good results were obtained with a 50-50 blend of #20 S. A. E. lubricating oil and gasoline, the viscosity of the mixture being sufficiently low. It has been found preferable, however, to use a white mineral oil having a viscosity of #10 S. A. E. or less.

As an example of our invention, we blended 90 parts of a copper powder of a mean particle size of 30 microns diameter with 10 parts of a tin powder of 10 micron size. The mixture was flowed through an 0.075 inch diameter opening in a glass funnel similar in principle to the hour glass egg timing device. The funnel was fixed to a wooden frame in which a constant vibration was induced through a bell transformer, buzzer and rheostat set-up. The time required for 10 grams to be discharged from the funnel with the 0.075 inch diameter opening was 12 seconds. On shaking a bottle containing the two powders, segregation occurred visibly; the gray tin powder partially separated from the reddish copper powder, and was visible on the top of the red mass.

The copper-tin mixture was then treated with varying percentages of kerosene, and tested for segregation and flow, with the following results:

	Segregation	Time of flow
		Seconds
Blend straight	Very marked	12
.0025 kerosene	Slight	20
.0050 kerosene	None	40
.0075 kerosene	do	50
.01 kerosene	do	60
.015 kerosene	do	100
.02 kerosene	do	180
.03 kerosene	do	Nil

It will be observed from the above table that as little as .0025% addition of kerosene practically eliminated the tendency toward segregation and that above 0.03% there was a total loss of flow, and that for best results in both flow properties and prevention of segregation the amount should not be over 0.01%.

The above mixture, when made up into a bearing, had a considerably higher mechanical strength than a bearing similarly made from untreated powder.

A copper powder-carbon mixture, similarly treated with 0.01% kerosene, gave similar improved results over an untreated mixture.

The following example well illustrates how the apparent density of metal powders has been adjusted through this wetting with very small quantities of organic liquids.

A batch of pure copper powder substantially all passing a 100 mesh sieve and approximately 55% passing a 325 mesh sieve with an apparent density as determined in the Scott Volumeter of 48.0 grams per cubic inch. The apparent density may be varied through a good wetting of this powder as follows through varied additions of triethanol amine:

Percent triethanol amine blended into powder	Apparent density in grams per cubic inch
0.0000	48.00
0.0022	42.80
0.0031	42.20
0.0051	40.40
0.0077	38.80

While we have shown but a few applications of our invention, it is applicable generally to the treatment of metal powders to reduce segregation and insure uniformity. We do not limit ourselves to the particular metal powders shown, but consider the invention to be applicable broadly to powdery mixes containing substantial percentages of any metal powders, with or without the presence of a non-metal such as carbon or the like.

This application is a continuation in part of application Serial No. 60,888, filed January 25, 1936.

We claim:

1. A substantially dry, non-segregating, free-flowing metal powder containing throughout a liquid non-reactive with the metal powder in a quantity about 0.0025 to 0.03% by weight.

2. A substantially dry non-segregating, free-flowing metal powder containing throughout a

liquid non-reactive with the metal powder in a quantity about 0.0025 to 0.03% by weight, said liquid being a slowly evaporating liquid which will remain in the powder during storage and having a viscosity no higher than that of #10 S. A. E. lubricating oil.

3. The method of controlling the apparent density and of retarding segregation without destroying the property of free flowing of a metal powder which comprises incorporating throughout the powder up to 0.03% by weight of a liquid non-reactive with the powder.

4. The method of controlling the apparent density and of retarding the segregation of a metal powder which comprises predetermining the desired apparent density of the powder and incorporating throughout the powder an amount up to 0.1% of a liquid necessary to give the desired apparent density, said liquid being non-reactive with the powder, and having a viscosity no greater than #10 S. A. E. lubricating oil.

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