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[54] **COPPER INFILTRATING COMPOSITION FOR POROUS FERRUGINOUS PARTS**
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[56] **References Cited**
UNITED STATES PATENTS

3,307,924 3/1967 Michael 29/182.5

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ABSTRACT: Disclosed is an infiltrating composition for infiltrating iron compacts. The infiltrating composition is a conventional copper-based infiltrating powder containing a small amount of iron-chromium alloy as a release agent to prevent adhesion of the infiltrating slug residue to the infiltrated iron compact.

COPPER INFILTRATING COMPOSITION FOR POROUS FERRUGINOUS PARTS

This invention relates to a copper composition for infiltrating a porous mass of ferruginous material and to a process for using same.

In is common practice in preparing iron powder metallurgy parts to increase the strength of the iron powder compacts by infiltrating the iron compact matrix with another metal having a melting point lower than that of iron. This is generally done by placing an amount of the infiltrant metal on the surface of the iron compact in an amount sufficient to fill the voids in the iron matrix and then bringing the compact up to a temperature sufficient to cause the infiltrant metal to become molten and infiltrate the iron compact. In some applications the infiltrant is placed on the green compact of the iron powder and the resulting mass is heated to a temperature sufficient to sinter the iron while simultaneously infiltrating the sintered compact. This process is known in the art as "sintration" or "-sintrating." Although the resulting infiltrated compact has a final strength greater than that of a noninfiltrated sintered compact there is frequently a drawback in that the infiltrant residue adheres to the infiltrated compact and thus a further treatment is required to remove the residue. Additionally, the surface of the infiltrated part is often eroded or pitted during the infiltration. These problems are particularly acute in the case of copper-based infiltrants.

In the past, surface erosion of a ferruginous mass in the form of an iron compact in contact with a copper infiltrating composition has been reduced through the incorporation of a small amount of iron in the infiltrating composition. Additionally, a small amount of carbon in the infiltrating composition has been found to minimize adhesion of the infiltrating composition residue to the infiltrated part. Furthermore, adhesion of the infiltrant residue to the infiltrated part has been found to have been reduced by the incorporation of a substantial proportion (usually above 1 percent) of an impalpable refractory, "parting compounds", such as magnesium oxide or titanium dioxide into the infiltrating composition. Parting compounds in conventional infiltrating compositions in substantial amounts usually reduce the infiltrating efficiency and therefore increase the cost of manufacture.

The adhesion of the infiltrant residue to the infiltrated part necessitates costly removal and substantial erosion, discoloration or disfiguration of the resulting infiltrated part to the extent that it cannot be alleviated by these prior art techniques.

In commonly assigned U.S. Pat. No. 3,307,924 is disclosed an infiltrating composition consisting essentially of an intimate mixture of about 0.6–0.9 parts by weight of impalpable refractory, 0–1 part by weight of impalpable carbon, about 5–12 parts by weight of particulate iron having a particle size finer than 325 mesh and the balance finely divided copper on the basis of 100 parts by weight of infiltrating composition. These infiltrating compositions when infiltrated into a ferruginous mass in the conventional manner leave a residue which shrinks and warps in a way which reduces surface contact by the infiltrant and the infiltrated mass during and after the infiltrating process. The shrinkage and warpage yields a husklike residue having little surface contact with the resulting infiltrated part. Because of this reduced area and because of the low adherence of the residue remaining, the husk is usually easily removed from the infiltrated part.

While the invention disclosed in U.S. Pat. No. 3,307,924 is a substantial advance over the prior art techniques discussed above, a further advance has now been discovered which provides superior parting characteristics between the infiltrated part and the infiltrant residue. The infiltrant composition now discovered often leaves a residue which can be removed from the infiltrated part by the force of gravity when the part is tipped. Furthermore, little or no erosion of the infiltrated part is observed.

It has now been discovered that the parting characteristics of conventional copper infiltrating compositions (i.e., those containing at least about 85 percent by weight of copper and about 3–12 percent iron and usually at least about 90 percent copper and at least about 5 to about 8 percent iron) can be materially improved by incorporating therein about 0.1 to about 3 percent, and preferably about 0.5 to about 2 percent by weight of a particulate iron-chromium alloy containing about 5 to about 70 percent by weight of chromium. This iron-chromium alloy is effective with all conventional copper infiltrants that contain the conventional additives such as iron, carbon, refractory parting compounds and lubricants, although a particularly useful infiltrant composition consists essentially of an intimate physical blend of at least about 85 percent of copper powder, 3–12 percent iron powder, 0.1–2 percent of an impalpable refractory, 0–1 percent of impalpable carbon and 0.3–3 percent of particulate iron-chromium alloy said alloy containing about 5 to about 70 percent by weight chromium. These compositions materially reduce the tendency for adhesion and erosion. It is understood that these compositions can contain lubricants although lubricants are not conventionally reported as an infiltrant component.

The iron-chromium alloy can be any alloy containing iron and about 5 to about 70 percent chromium. The alloys can also contain additional modifying metals such as nickel, molybdenum, manganese, copper, silicon, tantalum, wolfram, cobalt, zinc, tin, lead, vanadium and other metals commonly used in chromium-iron alloys. The combined content of such additional modifying metals should be maintained as low as possible to minimize "dilution" or interference with the function of the chromium and iron constituents. In the interest of economy and efficiency the combined total of such additional modifying metals should be maintained below 30 percent by weight and preferably less than 20 percent by weight of the alloy composition.

It is essential that the iron-chromium alloy have a melting point substantially above (e.g., at least about 100° F.) the infiltration temperature so that the alloy will remain solid and have no tendency to infiltrate the iron matrix.

Suitable chromium-iron alloys include the various stainless steels such as the "300" series stainless steels (e.g., stainless steel type 304, 316, 347, 302, 308, 321, etc.) the "400" series stainless steels (e.g., stainless steel type 403, 405, 406, 410, 430, 440, 420 etc.), types HC, HD, CH–10M and the like. Preferred stainless steel alloys have compositions generally within the weight percentage range of:

chromium	10–30%
nickel	0–20%
molybdenum	0–5%
carbon	0–0.2%
iron	balance

Other suitable alloys include those alloys designated "ferrochromium" alloys which are alloys of iron and chromium in various proportions. While these ferrochromium alloys can contain from about 5 percent by weight of chromium to about 70 percent by weight of chromium and still be suitable, a ferrochromium alloy containing 50 percent by weight of iron and 50 percent by weight of chromium is readily available and particularly effective.

The iron-chromium alloy can be incorporated into the infiltrating composition by physically blending the alloy with the copper, iron, carbon and other infiltrant components in a ball mill or other suitable blending device. It is understood that the infiltrant components other than the iron-chromium alloy can be agglomerated by sintering as disclosed in U. S. Pat. No. 3,307,924. The sintered agglomerates can then be blended with the iron-chromium alloy.

In practicing the present invention infiltration is carried out in the conventional manner such as by contact of the porous ferruginous workpiece or part with an infiltrant compact (hereinafter called "slug"), heating the part and slug to a temperature sufficient to cause infiltration of the copper from the slug to the part and removing the resulting husklike slug residue from the resulting infiltrated part. The infiltrating slug

and the ferruginous part ordinarily are enveloped in an innocuous atmosphere (e.g., a reducing atmosphere or a nonoxidizing atmosphere) during infiltration to prevent oxidation of the metals to their metal oxides.

As used herein the term infiltrating is used simultaneously with impregnating and investing and such terms refer to the flowing of molten copper infiltrant into porous ferruginous material. The porous ferruginous mass, e.g., iron, steel, stainless steel and the like is often the corresponding powder compressed into shapes such as gears, bushings, sleeves, rings and like useful forms. Herein, such porous ferruginous masses are referred to simply as iron compacts. Such iron compacts can be sintered prior to infiltration although simultaneous sintering and infiltrating is preferred in the interest of efficiency and economy.

For ease in handling, storage, and use the copper infiltrating composition (also referred to herein as the "infiltrant" or the "impregnant") is compressed e.g., at pressures from about 8 to 50 tons per square inch, into slugs of various shapes, e.g., briquettes, bars, blocks, rods, plates for stacking, etc.

The contact can be essentially between broad surfaces or be a line or points of infiltrant contacting a broader surface of the ferruginous mass. Placing such surfaces in contact enhances uniformity of infiltration as will be well recognized by those skilled in the art.

The finely divided copper for the infiltration mixture should have a particle size not substantially in excess of about 80 mesh to provide ready mixing with, and uniform distribution in the infiltrant ingredients, e.g., good copper-iron uniformity in preparing a sintered agglomerate of same ("mesh" as used herein is U.S. Standard Sieve Series). To enhance such uniformity and mixing a copper powder having a particle size such that virtually all particles pass 100 mesh is employed. For best uniformity such copper powder has between about 40–70 weight percent of particles finer than about 325 mesh.

In making the infiltration composition particulate iron which is finer than 325 mesh, i.e., all particles pass through a 325-mesh U. S. Standard Sieve, is preferred to avoid adhesion of infiltrant residue to the infiltrated compact, although particulate iron having a particle size larger than 325 mesh can also provide satisfactory results. Additionally such particulate iron promotes effective coalescence of the slug residue in service, that is, provides good husk formation; and iron at least this critically small quickly and effectively satisfies the dissolving power of copper for iron during infiltration, so that even the initial copper entering the iron compact will not erode the infiltration surface of such compact. For retained freedom from husk adherence along with advantageous husk development, iron powder having a particle size finer than about 400 mesh is used.

According to conventional practice the infiltrating composition should contain about three to 12 weight parts iron. An infiltrant composition of less than about 3 weight percent iron can produce, upon infiltration, a powdery, diffuse residue which can lead to undesirable adherence of residue particles to the iron compact. On the other hand, greater than about 12 weight percent iron is uneconomical because such iron does not infiltrate. For best husk formation and for most economical operation, about 5 to 10 weight percent iron is used in the infiltrant.

When a sintered agglomerate is prepared and the agglomerate then mixed with other infiltrant ingredients including the iron-chromium alloy, some to all of the copper or iron or both can be preformed, or formed in situ during sintering, from a suitable metal-providing powder such as an oxide of the metal, oxide-yielding compound of the metal, or mixture thereof. Thus, suitable materials which can be used in place of copper metal include cupric carbonate including its malachite, azurite and chessylite forms, cupric hydroxide, cuprous oxide including paramelaconite and tenocite, and their mixtures. Likewise, suitable iron-providing powders which can be used in place of iron metal include ferrous carbonate, hydrated ferrous carbonate, tetra carbonyl iron, nona carbonyl iron, ferrous hydroxide (including goethite), ferrous oxide, ferric oxide (including hematite as well as limonite and other hydrated ferric oxides, e.g., the α, δ and γ forms), and mixtures thereof.

It should be understood that the finely divided copper and iron, including their copper-providing and iron-providing substances, can contain trace proportions of impurities, as for example, silicon, sulfur, phosphorus and the like, as well as trace to minor proportions, i.e., up to 5 weight percent, of metals such as tin, manganese, zinc and the like which can alloy with the iron and the copper, or both. Thus, preferred metallic iron powder includes mill scale reduced in the presence of a small amount of $BaCO_3$ energizer, hydrogen reduced mill scale, carbonyl iron, and reduced mixtures of carbon and mill scale, all of which often contain small proportions of such metals and impurities. Generally the metals contained in the infiltrant in greater than trace amounts are those which alloy with copper. The alloy can effect a reduction in the copper surface tension and thus enhance infiltration and/or increase the strength of the infiltrated copper matrix.

To prevent oxidation of the powders in sintering, an inert atmosphere or a reducing atmosphere is employed. Additionally, such an atmosphere aids in removing films of adsorbed gas from particle bonding surface, thus improving interparticle contact and assisting the autogenous particle bonding. Suitable reducing atmospheres include cracked ammonia, hydrogen, mixtures of hydrogen and carbon monoxide, and gaseous mixtures such as reducing gas derived from hydrocarbons, blue water gas, carbureted water gas, oil gas, and producer gas, i.e., gases usually rich in hydrogen and carbon monoxide, and further containing hydrocarbons, e.g., methane, ethylene, and the like. Advantageously, for efficient reduction the reducing gas has a dew point below about 75° F., and preferably much lower for most effective reduction. Suitable inert gases include nitrogen and argon. Preferably, because of the economy afforded through ready availability, reducing gas derived from hydrocarbons is used.

The parting compound, otherwise referred to herein as the "refractory" is a material which is virtually incapable of oxidizing iron and copper at temperatures up to about 2,350° F., as well as being a material virtually incapable of reduction by hydrogen at such temperature. Suitable compounds include oxides and mixed oxides of aluminum, barium, beryllium, calcium, cerium, hafnium, magnesium, strontium, thorium, titanium and zirconium, carbides of aluminum, beryllium, boron, titanium, silicon, and tungsten, and nitrides of boron and titanium as well as mixtures of these oxides, mixed oxides, carbides and nitrides. Specifically included are the mixed oxides, such natural refractory minerals as feldspar, aluminum silicates, micas, kaolins, talcs and various clays such as bentonite and china clay. Thus, although silicon oxides alone are not generally useful owing to their reactivity with the iron during infiltration, oxides in combined form, e.g., aluminum silicates can be used. Because it works well in the infiltrant and is readily obtainable in suitably fine form titanium dioxide is preferred.

The refractory should be impalpable in use, i.e., have virtually all particles passing 250 mesh with not substantially more than about 10 weight percent of such particles being retained at 325 mesh. This ensures good mixing with the other infiltrant ingredients, and also, where a sintered agglomerate is used, insures good entrapment of these particles by the agglomerate particles. Additionally, the refractory assists in preventing erosion of the ferruginous material by the molten infiltrating metal and the impalpable character of the refractory can enhance this refractory benefit. Preferably, for best entrapment, all to substantially all refractory particles have diameter in at least one dimension of less than about 1 micron.

The infiltrating composition should contain between about 0.1 to about 2 percent by weight of refractory. Using less than about 0.1 weight percent can lead to some erosion of the iron compact at the impregnating surface, caused by molten infiltrating copper. Using greater than about 2 weight percent of

refractory can retard sintering efficiency and thus can lead to poor husk development. Preferably, for best husk development without compact erosion between about 0.7–1.2 weight percent of refractory is used.

When the iron compact being infiltrated contains iron in the presence of carbon, the infiltrant should also contain carbon to satisfy the carbon-dissolving power of the iron in the infiltrant. This prevents alloying of the infiltrant iron with the carbon in the iron compact, which alloying can form an adherent infiltrant residue and further can erode the infiltrating surface of the compact. To prevent such alloying between about 0.15 to 1 weight percent of carbon is used in the infiltrant. Using less than about 0.15 weight percent can lead to some erosion of the iron compact, while using greater than about 1 weight percent simply adds further carbon to the mixture without significant corresponding benefit and is therefore uneconomical.

According to conventional practice the carbon should be impalpable in nature and intimately mixed in the infiltrating composition to satisfy the dissolving power of the infiltrant iron for carbon during infiltration. The carbon can be simply blended with the other ingredients, e.g. the refractory, copper, iron-chromium alloy, and iron, or refractory, iron-chromium alloy and sintered agglomerate. When a sintered agglomerate is used, the carbon can be readily distributed with the iron-chromium alloy during blending.

To enhance segregation resistance in mechanical mixtures, the carbon particles have a particle size in the same general range as for the refractory, which size has been discussed hereinabove.

The infiltrating composition can contain minor amounts, e.g., up to one weight part, of a lubricant which augments the ejection of the infiltrating composition slug from the compacting die. During infiltration the lubricant volatilizes without interfering with infiltration. Suitable lubricants include alkyd resins; metal salts of fatty acids of glyceride oils such as zinc stearate and lithium stearate or oleate; polyethylene glycols; fatty acids of glyceride oils, e.g., stearic acid, palmitic acid, oleic acid and the like. The proportion of lubricant is based on the overall weight of the infiltrating composition. Accordingly, one part by weight of lubricant refers to the proportion of one part by weight of lubricant per 100 parts of infiltrant. The exemplary compositions herein therefore contain more than 100 total weight parts when a lubricant is employed.

Infiltration is carried out at a temperature reaching or slightly surpassing the melting point of copper (i.e., 1,980° F.). For efficient impregnation a temperature between about 2,000° F. and 2,350° F. is employed. At temperatures less than about 2,000° F. molten copper may resolidify and terminate infiltration due to increase in solidification temperature as a result of alloying primarily with iron. At temperatures greater than about 2,350° F. the dissolving power of copper for iron rapidly increases and thus accentuates the possibility of surface erosion of the iron compact by the molten infiltrating copper. The iron-chromium alloy must have a liquidus temperature well above the particular infiltrating temperature employed. This temperature is usually at least about 100° F. above the infiltrating temperature, although the ordinary stainless steels mentioned above have much higher liquidus temperatures. For most efficient infiltration with freedom from iron compact erosion it is preferred to infiltrate at a temperature between about 2,000°–2,200° F. (e.g. 2,050° F.).

Generally, the infiltration is done in conventional manner. Advantageously, the ferruginous mass and superimposed infiltrant body are enveloped in an innocuous atmosphere such as an inert gas or reducing atmosphere, or atmosphere consisting of mixtures of same.

Suitable reducing atmospheres for infiltration are those which are also useful in the sintering of the copper-iron agglomerate and include hydrogen, cracked ammonia and the like. Inert gases for the infiltrating atmosphere are nitrogen, argon and the like. These gases prevent deleterious metallic oxidation and enhance removal of adsorbed gaseous films.

The following examples show ways in which this invention has been practiced, but should not be construed as limiting the invention. Hereinbelow and in the examples all parts are parts by weight, all percentages are percentages by weight, and all temperatures are in degrees Fahrenheit unless otherwise specifically shown.

In the examples the elemental copper powder used had, typically, density of 2.8 g./cc., a copper content of 99.3 percent, and an H_2 loss of 0.4 percent with a trace of the copper particles remaining on a 325-mesh sieve.

The iron powder used in the infiltrant had typically 0.60 percent hydrogen loss, 0.03 percent carbon, and a density of 0.85 percent g./cc.

The iron used in the iron compacts to be infiltrated had 100 percent of the particles passing 80 mesh and were essentially carbon free (i.e., contained 0.005 percent carbon).

The iron-chromium alloys have the particle size and composition indicated in table I and table II, the particle size is not particularly critical as long as the particles are on the order of the average particle size of other infiltrant components (i.e., not substantially greater than 80 mesh). For some presently unexplained reason an iron-chromium alloy having a particle size of −100 mesh (with a substantial fraction +325 mesh) is more effective than the same alloy having a particle size of −325 mesh.

The composition of the iron-chromium alloys used in the examples are as follows:

TABLE I

	Stainless steel			Ferro-chromium
	304	316	410	
Cr, percent	18–20	16–18	11. 5–13. 5	50
Ni, percent	8–11	10–14		
Mo, percent		1. 75–2. 75		
C, max	0. 08	0. 1	0. 15	
Fe	Balance	Balance	Balance	50%

The titanium dioxide refractory used had 99.99 percent of the particles passing 325 mesh and 50 percent of the particles with diameter in at least one dimension of less than 0.3 microns. The carbon used to form carbon-containing infiltrants was a graphite having a maximum residue of 2 percent retained on 325 mesh. All infiltrant bars contained 0.5 percent of conventional zinc stearate.

In these examples the infiltrating slug and the iron compact to be infiltrated were compressed into small bars of the size specified for ASTM Test B 378–65 Transverse Rupture Strength of Sintered Metal Friction Parts. The iron compact was compressed to a green density of 6.3 g./cc. from 16 grams of a mix of 99 percent iron and 1 percent graphite plus 1 part by weight of zinc stearate.

The infiltrant slug was compressed to a green density of 6.6 g./cc. from 4 grams of the infiltrating composition specified in table II.

The sintration (sintering and infiltration simultaneously) was accomplished in a 4-inch wide continuous mesh-belt electric muffle furnace. The furnace atmosphere was a reducing atmosphere comprising in volume percentage 20 percent carbon monoxide, 40–45 percent hydrogen, 35–40 percent nitrogen and 0.4 percent methane having a dew point of +25° to 35° F.

The slug was placed on the iron compact and the two were maintained in the furnace at 2,030° F. for 15 minutes. The efficiency of infiltration is calculated as follows:

$$\text{Efficiency (percent)} = \frac{\text{Weight of infiltrant slug less weight of slug residue} \times 100}{\text{Weight of infiltrant slug}}$$

The following rating system is used for comparing erosion and adhesion.

Erosion	Adhesion	Rating
none	none	1
trace	trace	2
moderate	moderate	3
severe	severe	4

TABLE II

Example	1	2	3	4	5	6	7
Infiltrant composition (parts by weight):							
Copper powder	90.0	91.2	95.0	95.0	95.0	95.0	95.0
Iron powder	7.0	5.5	5.0	5.0	5.0	5.0	5.5
TiO_2 powder	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Graphite powder	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Zinc stearate	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iron chromium-alloy:							
304 Stainless Steel (−100 mesh)			2.0				
316 Stainless Steel (−325 mesh)							
316 Stainless Steel (−100 mesh)	1.7	2.0		2.0	3.0	1.0	2.0
410 Stainless Steel (−100 mesh)							
Ferrochromium (−100 mesh)							
Chromium metal (−100 mesh)							
Results:							
Adhesion	1	1	1	1	1	2	2
Erosion	2	1	1	1	1	1	2
Infiltration efficiency (percent)	85.25						
Infiltrated density (gms./cc.)	7.36						
Transverse rupture strength (p.s.i.) (ASTM B 378-65)	156,000						
Dimension change of infiltrated part from die size (percent)	+0.33						
Hardness (Rockwell B)	95						

Example	8	9	10	11	12	13	14	15
Infiltrant composition (parts by weight):								
Copper powder	95.0	95.0	95.0	95.0	90.0	90.0	90.0	95.0
Iron powder	5.0	6.0	5.0	6.0	7.0	7.0	7.0	5.0
TiO_2 powder	1.0	1.0	2.0	1.0	1.0	1.0	1.0	1.0
Graphite powder	0.15	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Zinc stearate	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iron-chromium alloy:								
304 Stainless Steel (−100 mesh)								
316 Stainless Steel (−100 mesh)	2.0	2.0	1.0					
316 Stainless Steel (−325 mesh)				2.0				
410 Stainless Steel (−100 mesh)					1.7			
Ferrochromium (−100 mesh) (50% Cr/50% Fe)						1.7		
Chromium metal (−100 mesh)							1.7	
Results:								
Adhesion	1	1	1	1	1	1	4	3
Erosion	2	1	1	1	2	2	2	1
Infiltration efficiency (percent)					84.50	80.50	86.25	
Infiltrated density (gms./cc.)					7.35	7.32	7.39	
Transverse rupture strength (p.s.i.) (ASTM B 378-65)					159,200	152,800	155,800	
Dimension change of infiltrated part from die size (percent)					+0.32	+0.28	+0.32	
Hardness (Rockwell B)					94	94	95	

The foregoing data illustrates how the invention can be practiced in conjunction with conventional infiltrating compositions.

Examples 1, 2, 4, 5, 6, 7, 8, 9, 10 and 11 illustrate how the invention can be practiced utilizing Type 316 stainless steel as the iron-chromium alloy at representative levels of concentration and particle size. The overall infiltrating composition is also varied.

Example 3 illustrates the effectiveness of Type 304 stainless steel in practicing the present invention.

Example 12 illustrates the effectiveness of Type 410 stainless steel in practicing the present invention.

Example 13 illustrates the effectiveness of a ferrochromium alloy (50 percent by weight chromium/50 percent by weight iron) in practicing the present invention.

Examples 14 and 15 are control experiments for the purpose of comparison. Example 14 illustrates that chromium metal per se does not give desirable results from an adhesion and erosion standpoint. Example 15 illustrates a typical infiltrating composition that does not contain any iron-chromium alloy.

Having thus described the invention, what is claimed is:

1. In a copper composition for infiltrating porous ferruginous material said composition containing at least about 85 percent by weight particulate copper and about 3–12 percent by weight of particulate iron, the improvement wherein said composition further contains about 0.1 to about 3 percent by weight of a particulate iron-chromium alloy, said alloy containing between about 5 percent and about 70 percent by weight of chromium.

2. The composition of claim 1 which further contains up to about 1 percent by weight of impalpable carbon.

3. The composition of claim 1 which consists essentially of an intimate physical blend of at least about 85 percent copper powder, 3–12 percent iron powder 0.1–2 percent impalpable refractory, 0–1 percent impalpable carbon and 0.1 to 3 percent of said iron-chromium alloy.

4. The composition of claim 3 wherein said particulate alloy has a particle size passing 80 mesh.

5. The composition of claim 3 which contains at least about 90 percent copper and about 5 to about 8 percent iron on a weight basis.

6. The composition of claim 5 which contains about 0.5 to about 2 percent by weight of said iron-chromium alloy.

7. The composition of claim 3 wherein said iron-chromium alloy has a composition within the weight percent range of about chromium 10–30 percent, nickel 0–20 percent, molybdenum 0–5 percent, carbon 0–0.2 percent, iron balance.

8. The composition of claim 7 wherein said alloy is a 300 series stainless steel alloy.

9. The composition of claim 7 wherein said alloy is a 400 series stainless steel alloy.

10. The composition of claim 3 wherein said alloy is 50 percent iron and 50 percent chromium.

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