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METHOD FOR COATING METALS

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This invention relates to a flame spraying method and powder for coating metal surfaces and it more particularly relates to such a method and powder for coating cast iron surfaces.

The presence of nodules of graphite in cast iron makes it very difficult for an applied metal to wet and adhere to a cast iron surface. It has, therefore, been difficult to flame spray powders, such as nickel alloy powder, upon cast iron. The same problem exists relative to other metal surfaces, such as the common ferrous metals that are advantageously coated by flame spraying.

An object of this invention is to provide an effective method and powder for flame spraying metal surfaces.

Another object is to provide such a method and powder for dependably and effectively flame spraying cast iron surfaces.

In accordance with this invention fine alloy powders having a particle size of less than 325 mesh and of rounded configuration are sprayed and fused on a metal surface in a single step operation. Surprisingly these small particles do not oxidize as would be expected, but rather they exhibit high wetting, flow and bond characteristics. The powders may advantageously be applied to cast iron surfaces with an increased efficiency of deposition in contrast to conventional methods. The powders may be mixed with a similar but coarser nickel base alloy, or cobalt base alloy or ferrous base alloy where the finer particles comprise at least 30% by weight of the mixture.

The presence of the aforementioned fine particles enables certain alloys, such as nickel base, cobalt base or ferrous base alloys, having nearly as high a melting point as the parent metal and which are normally sluggish in deposition, to be deposited at lower base metal temperatures. Some of the effective nickel base alloys are NiB-1, NiB-2, NiB-3, and NiB-4 described in Table I, page 4, of the American Welding Society Specification A5.8-62T. These very fine mesh powders are coated on a metal surface, such as cast iron, by simultaneously spraying and fusing with, for example, an oxygen acetylene flame as a heat source such as that generated by the flame spraying torch recited in U.S. Patent No. 2,786,779 issued to A. Long et al. When the powders are separated by mesh size so that only powder smaller than 325 mesh is sprayed, the performance on cast iron is radically changed from that of coarser powders. The fine mesh powder deposits a fluid molten pool which wets the cast iron exceptionally well at a lower base metal temperature. This effect is observed with all of the aforementioned nickel base alloys, as well as with cobalt base and ferrous base alloys. Losses of metal powder due to overspraying the molten pool are reduced to a minimum with the very fine mesh powder. The reason for the improved performance on cast iron and for the increased deposition efficiency may be understood from the following explanation. Since the powders are heated in traversing the flame, the rate of heating is dependent on the surface area exposed to the flame for a given weight of powder. The rate of heating proceeds proportionally to the reciprocal of the length of sieve opening through which the powdered particles pass. A reduction of mesh size to below 325 mesh substantially increases the rate of temperature rise of the powder in the flame. Since the time to traverse the flame

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to the workpiece is substantially independent of particle size, the fine mesh powder is heated to substantially higher temperatures than coarser mesh powder. This results in molten droplets of greatly increased temperature and therefore much greater fluidity when the droplets contact the workpiece. It is probable that the greater speed of heating permits very few, if any, particles to reach the workpiece in the solid condition; therefore, losses in efficiency are reduced to a minimum.

The following table indicates the effects of using fine mesh powder on deposition efficiency. For purposes of evaluating the effect of fine mesh powder of NiB-1 mixtures this fine mesh nickel base alloy powder was added to conventional coarse NiB-1 powders.

Mixture	Fine NiB-1 (-325 Mesh), grams	Coarse NiB-1 (-150+200 Mesh), grams	Deposition Efficiency, percent
1	0	100	91.0
2	25	75	92.5
3	30	70	94.1
4	50	50	94.5
5	75	25	97.5
6	100	0	99.0

The tests were performed by spraying the respective mixtures on mild steel slugs, 3" x 3" x 1/4", on the 3" x 3" surface. As is readily apparent from the above table, the results are particularly effective when the fine particles comprise at least 30% of the mixture.

The following examples illustrate some of the fine mesh powders which meet the objectives of this invention as compared with similar coarse powders.

Example 1

	NiB-1 (-150 +200 mesh)	NiB-1 (-325 mesh)
Fluidity	Good	Excellent.
Wettability on cast iron	Poor	Good.
Deposition efficiency	91.5%	99%.

The composition of the NiB-1 of this example is 14.9% Cr., 4.3% Si, 3.4% B, 4.2% Fe, 0.68% C and balance Ni.

Example 2

	NiB-4 (-150 +200 mesh)	NiB-4 (-325 mesh)
Fluidity	Fair	Excellent.
Wettability on Cast Iron	Poor	Good.
Deposition efficiency	90%	98%.

The composition of the NiB-4 of this example is 3.54% Si, 2.02% B, 0.45% Fe, 0.04% C, and balance Ni.

Example 3

	Nickel-Boron- Silicon Alloy (-150+200 mesh)	NiB-4 (-325 mesh)
Fluidity	Poor	Good.
Wettability on Cast Iron	Poor	Good.
Deposition efficiency	89%	97%.

The composition of the alloy of this example is 1.5% B, 2.6% Si, 0.5% Fe, 0.03% C, and balance Ni.

Example 4

	Cobalt base alloy (-150 +200 mesh)	Cobalt base metal (-325 mesh)
Fluidity.....	Poor.....	Good.
Wettability on Cast Iron.....	Fair.....	Excellent.
Deposition efficiency.....	85%.....	96%.
Oxidation on Deposit.....	Medium amount..	Minimal.

The composition of the alloy of this example is 3.0% Ni, 28.0% Cr, 1.0% Si, 2.0% B, 2.0% Fe 1.0% C, 4.5% W, and balance Co.

An advantageous composition of an alloy meeting the objectives of this invention is:

Constituent	Range to Preferred Range		Example
Cr.....percent..	2.5-20.0	4.5-16.0	14.9
Si.....do.....	0.5-6.0	2.5-5.0	4.3
B.....do.....	0.5-5.0	1.0-4.0	3.4
Fe.....do.....	0.2-6.0	0.3-4.5	4.2
C.....do.....	0.01-.85	0.3-0.7	.68
Ni.....do.....	Balance	Balance	Balance

Another advantageous composition of an alloy meeting the objectives of this invention is:

Constituent	Range to Preferred Range		Example
Si.....percent..	1.0-6.0	3.0-4.0	3.54
B.....do.....	0.5-5.0	1.5-2.5	2.02
Fe.....do.....	0.3-3.0	0.4-0.9	.45
C.....do.....	0.01-0.35	0.01-0.10	.04
Ni.....do.....	Balance	Balance	Balance

Another advantageous composition of an alloy meeting the objectives of this invention is:

Constituent	Range to Preferred Range		Example
B.....percent..	0.7-3.5	1.1-2.0	1.5
Si.....do.....	1.0-4.0	2.0-3.0	2.6
Fe.....do.....	0.2-0.7	0.3-0.6	.5
C.....do.....	0.01-0.35	0.01-0.10	.03
Ni.....do.....	Balance	Balance	Balance

Another advantageous composition of an alloy meeting the objectives of this invention is:

Constituent	Range to Preferred Range		Example
Ni.....percent..	0.1-4.0	0.5-3.2	3.0
Cr.....do.....	23.0-30.0	26.0-30.0	28.0
Si.....do.....	0.2-2.5	0.7-1.3	1.0
B.....do.....	0.7-4.0	1.5-2.2	2.0
Fe.....do.....	0.2-3.0	1.0-2.5	2.0
C.....do.....	0.5-2.5	0.8-1.5	1.0
W.....do.....	0.5-8.0	4.0-6.0	4.5
Co.....do.....	Balance	Balance	Balance

What is claimed is:

1. A method of coating a metallic surface comprising the step of simultaneously depositing and fusing an alloy powder on the metallic surface by spraying said powder through an oxy-acetylene flame, said alloy powder consisting of particles and at least 50 percent by weight of said particles having a particle size below 325 mesh, said

alloy powder being selected from the group consisting of nickel and cobalt alloy powders.

2. The method of claim 1 wherein 100 percent of said particles have a particle size below 325 mesh.

3. The method of claim 1 wherein 75 percent of said particles have a particle size below 325 mesh.

4. A method as set forth in claim 1 wherein said alloy essentially consists of the following constituents in the indicated ranges of percentages by weight:

Constituents:	Range
Chromium	2.5-20.0
Silicon	0.5-6.0
Boron	0.5-5.0
Iron	0.2-6.0
Carbon	0.01-0.85
Nickel	Balance

5. A method as set forth in claim 1 wherein said alloy essentially consists of the following constituents in the indicated ranges of percentages by weight:

Constituents:	Range
Silicon	1.0-6.0
Boron	0.5-5.0
Iron	0.3-3.0
Carbon	0.01-0.35
Nickel	Balance

6. A method as set forth in claim 1 wherein said alloy essentially consists of the following constituents in the indicated ranges of percentages by weight:

Constituents:	Range
Nickel	0.1-4.0
Chromium	23.0-30.0
Silicon	0.2-2.5
Boron	0.7-4.0
Iron	0.2-3.0
Carbon	0.5-2.5
Tungsten	0.5-8.0
Cobalt	Balance

7. A method as set forth in claim 1 wherein said alloy essentially consists of the following constituents in the indicated ranges of percentages by weight:

Constituents:	Range
Boron	0.7-3.5
Silicon	1.0-4.0
Iron	0.2-0.7
Carbon	0.01-0.35
Nickel	Balance

8. A method as set forth in claim 1 wherein said metallic surface is cast iron.

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