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WEAR-FACING ALLOY

John P. Broderick, Bayside, Daniel Paul Tanzman, Far Rockaway, and Frederick T. Wishnie, Seaford, N.Y., assignors to Eutectic Welding Alloys Corporation, Flushing, N.Y., a corporation of New York

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7 Claims. (Cl. 75—159)

This is a continuation-in-part of application Serial No. 300,077, filed August 5, 1963, now abandoned.

This invention relates to an alloy for applying a wear resistant overlay upon a metal surface, and it more particularly relates to a copper-nickel type of such an alloy which is suitable for application by flame spraying and for use as a matrix for hard paritcles.

Various copper-nickel alloys have been extensively used for applying overlays to various parent metals. These alloys may also serve as a matrix for hard particles, such as tungsten carbide. Nickel-silver and other brass types of alloys have also been used as such overlaying alloys, but their zinc content is subject to fuming and vaporization when heat is applied. This vaporization of zinc, particularly in flame spraying, is a health hazard to operating personnel because of its poisonous nature, and it also materially reduces the zinc content in the ultimate alloy. This adversely affects the physical characteristics of the ultimate deposit, namely its hardness and abrasion and wear-resistance. These existing alloys and hard particles incorporated in them are also susceptible to deterioration when heated and must be protected by a flux when exposed to heat which necessarily occurs when the hard particles are captured within the matrix alloy to form a composite rod and when the matrix with or without hard particles is deposited upon a parent metal. The melting temperature of available overlaying alloys is also relatively high.

An object of this invention is to provide an efficient non-fuming alloy suitable for use as an overlaying metal independently or in conjunction with hard particles.

Another object is to provide such an alloy that has a relatively low melting temperature, is advantageous for flame spray application and whose deposit is tough and machinable; and

A further object is to provide such an alloy that is self-fluxing and compatible with a wide range of base metals.

In accordance with this invention a matrix alloy incorporates the following constituents in the indicated ranges of percentages by weight and more particularly the indicated intermediate ranges which provide particularly effective alloys of this type.

Constituent	Broad Range	Intermediate Range
Nickel	15.0–40.0	20.0–25.0
Silicon	1.0–5.0	3.0–4.0
Boron	0.15–2.50	0.25–0.5
Manganese	0.20–2.00	0.5–1.0
Copper	Balance	Balance

A minor part of the above composition, for example, part of its silicon and manganese constituents, may be replaced by elements that improve fluidity, such as tin and/or phosphorus. These elements may replace up to approximately one-fifth by weight of the silicon and manganese. The fluidizing agent may, for example, include approximately 95% by weight of tin and 5% by weight of phosphorus. The presence of tin and/or phosphorus also reduces the liquidus temperature of the alloy to a very low range between 1700–1850° F. The basic alloy without the fluidizing additive has a liquidus temperature of approximately 1950° F., which is still relatively low in comparison to that of other copper-nickel alloys.

Despite the boron and possible tin content of the alloy of this invention, it is remarkably tough and ductile with a hardness ranging from 22–28 Rockwell C and a high percentage of elongation ranging from 10 to 15% with excellent machinability. The absence of zinc makes this alloy compatible with an extremely wide range of ferrous and non-ferrous parent materials and makes it applicable thereto as an overlay by all types of heating processes including flame spraying without the emission of any poisonous fumes. Another unexpected advantage of the alloy of this invention is its self-fluxing ability which is so effective that it is deposited efficiently in practice without applying any external fluxing agent. The exact reason for this remarkable self-fluxing action is not completely understood, but it might be in part attributable to the silicon and boron content. Although one skilled in this art would have believed that these elements would make a copper-nickel alloy system very brittle, the resultant alloy of this invention is remarkably ductile. This is another very unexpected advantage which might possibly be a result of the formation of intermetallic compounds.

The alloy of this invention are very suitable for use as a matrix alloy for depositing hard particles upon a parent metal to provide highly abrasion and wear-resistant cutting surfaces. This makes them very useful for applying overlays to tools for drilling, boring, reaming, and coring, bucket teeth and all sorts of well drilling and mining equipment. When used as a matrix, this alloy is soft enough to preferentially wear to leave edges of the carbide particles protruding in effective cutting positions.

Refractory carbides which may be used in the present invention include carbides of titanium, zirconium, vanadium, chromium, molybdenum, tungsten, tantalum and columbium. These refractory carbides may be used alone or in combination with each other. Tungsten carbide is particularly effective. Cast tungsten carbide provides high resistance to abrasion and wear.

The particle size of the refractory carbides varies depending on the ultimate utility desired. Particle sizes 5/16" to 3/8" and angular in shape are used for superior cutting and drilling performance. Carbide particles in the 20 to 40 mesh range are employed for wear and abrasion resisting applications.

The percentage ratios of refractory carbide particles to matrix alloy depend on the individual requirements of the user. As little as 10 percent carbide particles on a weight basis is effective. The maximum carbide particle contents is limited by the requirement to have sufficient matrix alloy to firmly bond the particles. As little as 5 percent matrix alloy on a weight basis has been found useful for some applications. Generally, a proportion of between 60 and 75 percent carbide particles to 25–40 percent matrix alloy on a weight basis is used. An example of an effective composite rod utilizes 65% by weight of cast tungsten carbide particles with 35% by weight of the following, Example A, matrix alloy.

The matrix alloy of this invention does not emit any poisonous fumes because of its lack of zinc content, and its physical properites are as good or better than that of alloys incorporating zinc, which has been previously deemed essential in such a product. The self-fluxing ability of alloy is also remarkable compared to that of other alloys containing as much as 3–5% by weight of boron. The reason for this unexpected phenomenon is not known.

No flux is therefore necessary during the ultimate deposition and also when hard particles are captured in the matrix to form a composite rod. It is also compatible

with previously deposited copper-nickel alloys including brass or other such alloy systems incorporating zinc. This makes it possible to use it for repairing overlays made by other types of matrix alloys.

Particularly effective examples of such a matrix alloy are as follows:

Example A

Constituents:	Percentages by weight
Nickel	23.00
Silicon	3.45
Boron	0.47
Manganese	0.75
Copper	Balance

Example B

Nickel	23.00
Silicon	2.75
Boron	0.47
Manganese	0.60
Tin	0.81
Phosphorus	0.04
Copper	Balance

The alloy system of this invention can be utilized in all forms including rod, powder mesh for spraying or in a paste form in conjunction with various binders. These binders are for example organic binders, such as polyethylene, mineral oil or acrylics, and they also may be silicate type binders such as those of the water-soluble type. Such a paste may be applied to the parent material surface which is then heated directly or indirectly by any heating method to form a tough durable wear-resistant overlay.

As a spray powder it may be advantageously utilized in particle sizes ranging from 100–325 mesh. In the powdered form it may also be combined with borate and borate-fluoride type fluxes, particularly for application to parent materials that are oxidized or otherwise difficult to wet such as chromium oxide coated metals.

It may be applied to all ferrous and non-ferrous materials whose melting temperatures are high enough to permit the overlay to be applied without melting the parent material. The melting temperature of aluminum is accordingly a little too low to be coated by this alloy, but it can be applied to cast iron. The low melting temperatures of the alloy of this invention ranging from 1700–1950° F., which is quite low in comparison to other copper-nickel alloys which melt at 2000° F. and higher, is therefore very significant.

The alloy system of this invention may be formulated as a homogeneous powder or it may be compounded as a heterogeneous powder from powders of various alloy systems that contribute to form the specified overall chemistry. This alloy may also be applied in the form of a rod which is usually used bare without any external fluxing agent. However under certain conditions it can also be coated with a flux compatible with its copper-nickel alloy system, or cast in the form of a bare rod which is used in conjunction with a separate compatible flux.

This alloy in its lower melting ranges is very useful for application to relatively low melting temperature metals such as brass, and it therefore is quite useful for hardfacing the seats of copper or bronze valves and the facing of bronze resistance welding tips for spot welding where a low coefficient of friction and high hardness are desirable. It also can be used for application to rollers in steel mills to form an extremely tough and durable surface upon them.

In capturing hard particles in the matrix alloy to form a composite rod, the hard particles may be dispersed in various types of molds such as graphite, steel or ceramic either solid or water cooled. The carbides may be fluxed with a dry flux or paste before heat is applied to prevent them from oxidizing. However if the matrix alloy is incorporated in the mold before heat is applied, its remarkable self-fluxing ability can protect the hard carbide particles. The alloy also may be flame sprayed over carbide particles.

The composite product may be manufactured for example by heating the mold incorporating hard particles and matrix alloy in a batch type furnace to bring the alloy up to its melting point. "Heat may be applied by any type of source such as oxy-fuel gas, inducting heating and the like." The absence of any volatile constituents in the matrix alloy prevents its physical properties from being affected when exposed to heat during fabrication and ultimate deposition. Its high retention strength and preferential wear with respect to hard particles makes it extremely effective for applying wear-resistant cutting overlays to a wide variety of drilling, mining and construction equipment.

What is claimed is:

1. A wear resistant alloy consisting essentially of the following constituents in the indicated ranges of percentages by weight:

Constituents:	Range
Nickel	15.0–40.0
Silicon	1.0–5.0
Boron	0.15–2.50
Manganese	0.20–2.00
Copper	Balance

2. A wear resistant alloy consisting essentially of the following constituents in the indicated ranges of percentages by weight:

Constituent:	Range
Nickel	20.0–25.0
Silicon	3.0–4.0
Boron	0.25–0.5
Manganese	0.5–1.0
Copper	Balance

3. A wear resistant alloy as set forth in claim 1 wherein up to approximately one-fifth by weight of the manganese and silicon constituents are replaced by a fluidizing agent selected from the group consisting of tin and phosphorus and mixtures thereof.

4. A wear resistant alloy as set forth in claim 3 wherein said fluidizing agent consists essentially of approximately 95% by weight of tin and 5% by weight of phosphorus.

5. A composite hard surfacing rod comprising hard particles incorporated within a matrix metal alloy consisting essentially of the composition set forth in claim 1.

6. A rod as set forth in claim 5 wherein said hard particles are carbides.

7. A rod as set forth in claim 6 wherein said carbides comprise tungsten carbide.

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DAVID L. RECK, *Primary Examiner.*

HYLAND BIZOT, R. O. DEAN, *Assistant Examiners.*