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ALLOYS OF RHODIUM AND NICKEL

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The present invention relates to alloys of rhodium and nickel, and more particularly to a tarnish and corrosion resisting alloy containing rhodium and nickel, which is suitable for pen nibs and other uses where high stability and moderate cost are essential.

It is known that the writing fluids used in fountain pens have a strong corrosive action on the pen nib and that heretofore high grade pen nibs have been made almost entirely from carat gold alloys, particularly 14 k. gold, which withstood satisfactorily the corrosive action of the writing fluids. The use of gold pen nibs, however, was expensive and increased the cost of fountain pens considerably, especially in view of the recent increase in the price of gold. The art has been constantly endeavoring to reduce the cost of fountain pens and to produce pen nibs which were less expensive and could be manufactured more economically than gold pen nibs and which possessed the requisite tarnish and corrosion resistance, durability and other qualities of the gold nibs. Although many attempts have been made to provide the trade and the public with an alloy suitable for pen nibs having the required resistance to tarnish and corrosion, workability, strength, moderate cost, etc., none as far as we are aware has been wholly satisfactory and successful in practical, commercial and industrial use.

We have discovered that alloys of rhodium and nickel of certain composition are less expensive than gold alloys and possess such excellent resistance to tarnish and to corrosion, especially to ink corrosion, combined with suitable hardness, elasticity, workability, etc., as to be fully adapted for use in the production of high grade pen nibs and for other uses where high stability and moderate cost are essential.

It is an object of the present invention to provide an alloy containing rhodium and nickel, which is strong, hard, readily workable, and which can be easily soldered or welded to osmiridium alloys.

It is another object of the invention to provide an alloy containing rhodium and nickel, which possesses high resistance to tarnish and to corrosion, and which is not attacked by ordinary writing fluids.

A further object of the invention is to provide a white noble alloy containing rhodium and nickel, which is relatively inexpensive and which can be cast and fabricated easily and economically.

It is within the contemplation of the present invention to reduce the cost of high grade fountain pens by producing an alloy containing rhodium and nickel suitable for the production of pen nibs at a substantial saving in cost.

The invention further contemplates the provision of a noble white alloy of rhodium and nickel suitable for pen nibs and other uses where high stability and moderate cost are essential, which contains no gold, thereby offering an effective means for conserving gold and releasing it for essential monetary purposes.

It is also an object of the invention to provide a white noble alloy containing rhodium and nickel suitable for pen nibs and similar purposes, which can be made on an industrial scale, which can be handled, fabricated and worked with conventional appliances and equipment, and which is relatively cheap and permits wide commercial and industrial use.

Other objects and advantages of the invention will become apparent from the following description.

Generally speaking, the present invention contemplates providing an alloy containing rhodium and nickel, in which the rhodium content may vary from about 25% to about 80%. We have found that the rhodium-nickel alloys containing from about 25% to about 80% of rhodium have excellent physical properties, are easy to cast and to work, and are resistant to tarnish and to corrosion, particularly to ink corrosion. Special characteristics of the alloys are a high modulus of elasticity and a low density, as compared to known gold alloys. Pen nibs can be manufactured from the rhodium-nickel alloys of the present invention at a substantially less cost than gold pen nibs, can be soldered or welded to osmiridium tips easily and economically, and in actual use are entirely satisfactory and resist tarnish and the corrosive action of writing fluids indefinitely. Furthermore, their excellent physical properties and especially their high modulus of elasticity permits use of thinner sections than is possible with carat gold alloys, while their lower densities aid in lowering considerably the cost per nib over that of carat gold.

In general the tarnish and corrosion resistance of the rhodium-nickel alloys improves with increases in the rhodium content of the alloy. We have found that those alloys containing about 35% of rhodium with nickel constituting substantially the balance resist successfully the corrosive action of ink and are especially suitable for high grade pen nibs.

The alloys containing 35% or more of rhodium

are so noble that they are completely resistant to corrosion by strongly corrosive solutions such as 25% aqueous ferric chloride solutions or concentrated nitric acid. When the rhodium content of the alloys exceeds 60%, the alloys become resistant even to aqua regia. Of course, these alloys are not attacked by the ordinary writing fluids used in fountain pens.

We have discovered that the addition of palladium to the rhodium-nickel alloys improves the properties and especially the corrosion resistance thereof. Thus, we found that palladium may be added to further improve the homogeneity of the alloy when desired. Where the rhodium content of the alloy is slightly too low to give complete passivity to very active corrosives and a small amount of pitting would result, we found that the introduction of a small amount of palladium to the binary rhodium-nickel alloy will further ennoble the alloy and prevent pitting. With the addition of larger quantities of palladium and when a considerable percentage of the nickel is replaced by the palladium, the alloys are still further ennobled and are adapted for those uses where resistance to highly corrosive media is derived. We found that as high as 55% of palladium may be added advantageously to rhodium nickel alloys. The composition of most useful rhodium-nickel alloys containing palladium may vary from about 25% to about 80% (expressed in weight percent) of rhodium, from about 20% to about 75% nickel and may contain up to about 55% palladium. The hardness of the alloys containing palladium varies with the combined rhodium plus palladium content of the alloy from about 80 to about 100 Rockwell B hardness. An alloy containing about 40% rhodium, 20% palladium and 40% nickel is suitable for uses where severe corrosion conditions are encountered.

Part of the rhodium may be replaced atom for atom by platinum or iridium, although this increases the cost of the alloy over that of the binary rhodium-nickel alloy. Molybdenum or tungsten may be added to harden the alloy. When adding molybdenum or tungsten, we have discovered that the resistance of the alloy to corrosion by chlorides is also increased. A part of the nickel may be replaced by cobalt, iron, or copper, but such additions usually result in some degradation of the casting, physical or corrosion properties of the alloy and are not generally advantageous.

By controlling the composition or the proportion of the ingredient of the alloy of the present invention, as hereinabove more fully described, the alloy may be made to possess a wide range of physical and chemical properties and be adapted for a large number of uses and applications. Thus, the alloy may be employed for uses other than pen nibs where high stability, corrosion and erosion resistance and an excellent white color coupled with moderate cost are essential. In connection with the application of the new alloy to chemical work its peculiar resistance to chlorides is notable and particularly valuable for it will remain substantially unattacked where numerous other corrosion resisting alloys, particularly those relying upon chromium for passivity, are wholly destroyed. The resistance to nitric acid becomes complete at 25% rhodium or below and remains high throughout the range of compositions contemplated by the present invention. The high melting point and nobility of the new alloy render it particularly useful for dental uses such as tooth pins, lingual bars and for electrical uses such as electrodes in electrochemical apparatus and the like. The brilliant whiteness of the high rhodium content alloys particularly those containing 65% to about 80% rhodium and their resistance to corrosive influences and freedom from tarnishing on outdoor exposure suggest their use for reflectors in searchlights and optical instruments and the like.

In preparing the rhodium-nickel alloys of the present invention, we have found that certain impurities and especially sulphur or sulphurlike impurities are harmful and render the alloy unworkable and difficult to cast. We discovered that if the rhodium-nickel alloys of the composition described are properly melted and are kept free from oxygen, sulphur, tellurium, selenium and similar elements, the alloys possess a high degree of ductility and can be cast and rolled without difficulty. Thus, we found that the addition of sufficient amounts of suitable deoxidizing and desulphurizing elements such as magnesium, zinc, manganese, silicon, boron, barium, calcium, titanium, zirconium and the like improves the casting and working properties of the alloys. A low carbon content of the alloy is also desirable in achieving maximum ductility.

In manufacturing the rhodium-nickel alloys of the present invention, we prefer to melt the pure component metals preferably in a high frequency furnace. In this melting it is desirable to employ a carbon free crucible lined with a suitable magnesia refractory or, if preferred, with lime. When the melt has been completed, the alloy is allowed to solidify in the crucible. The solid alloy is then remelted and a sufficient amount of a suitable desulphurizing and/or deoxidizing agent is added, for instance 0.1% of magnesium may be added as a nickel-magnesium alloy, and is then cast into a suitable graphite mold. The alloy may then be hammered and annealed at 900° C.– 1000° C. in hydrogen and rolled in the usual manner.

The term "desulphurizing element" is herein used to mean an element which will fix not only sulphur but also the sulphur group elements comprising selenium and tellurium.

We have found that some lots of commercial rhodium yield brittle alloys presumably due to the presence of a trace of sulphur group elements such as tellurium. We have found that if such rhodium is purified prior to alloying with the nickel, it produces ductile alloys. Thus the rhodium may be purified chemically. We have also discovered that the rhodium may be purified by melting it prior to the addition of nickel and by subjecting it to alternate oxidation and reduction over a period of about 30 minutes. The rhodium is then allowed to solidify, the nickel is added and the whole is then melted, treated with a suitable deoxidizer, such as magnesium or the like, and cast. The subsequent treatment may be as in the first example. We have found that the alloys of rhodium and nickel of the present invention prepared according to the precautions given hereinabove possess a high degree of ductility; are easily cast, and can be worked and fabricated into various forms and shapes easily and economically. Furthermore, the alloys are strong, sufficiently hard, have a high modulus of elasticity, can be welded readily, for instance to osmiridium alloys, and possess high resistance to tarnish and to corrosion.

The following table sets forth by way of example the composition, the comparative cost per unit weight and per unit volume, and the hard-

ness of some useful alloys of the present invention and of a known 14 kt. white gold alloy.

	Weight		
Rh	37	Cost/oz.	$16.65
Ni	63	Cost/cc.	5.32

Rockwell B hardness, annealed—80

Rh	35.9	Cost/oz.	$16.25
Mo	6.7	Cost/cc.	5.18
Ni	57.4		

Rockwell B hardness, annealed—92

Rh	28.4	Cost/oz.	$16.20
Pd	14.7	Cost/cc.	5.28
Ni	56.9		

Rockwell B hardness, annealed—88

Rh	64	Cost/oz.	$28.90
Ni	36	Cost/cc.	10.10

Rockwell B hardness—92

14 k. white gold

Au	58.33	Cost/oz.	$20.40
Cu	17.97	Cost/cc.	8.36
Ni	17.70		
Zn	6.00		

Rockwell B hardness, annealed—94

It is to be observed that the present invention provides a new noble white alloy containing rhodium and nickel, which is relatively inexpensive, easy to cast and work, which has sufficient hardness, strength and good wearing qualities, which has a high modulus of elasticity and low density, and which is resistant to tarnish, to corrosion, and especially to corrosion by writing fluids.

It is further to be noted that the rhodium-nickel alloys of the present invention are especially suitable for pen nibs, that high grade pen nibs can be manufactured from the alloys at a substantially less cost than gold pen nibs, can be soldered or welded to osmiridium tips easily and economically, and in actual use are entirely satisfactory and resist tarnish and the corrosive action of writing fluids indefinitely.

Furthermore, it is to be observed that the alloy of the present invention has a brilliant white color, that by properly controlling the composition thereof, as hereinabove more fully described, may be made to resist corrosion by chlorides, concentrated nitric acid and even aqua regia, and accordingly may be employed for uses other than pen nibs, where high stability, corrosion and erosion resistance, and an excellent white color coupled with moderate cost are essential.

Moreover, it is to be noted that the invention provides a relatively inexpensive noble white alloy suitable for pen nibs and other purposes where high stability and moderate cost are essential, which contains no gold, thereby offering an effective means for conserving gold and releasing it for essential monetary purposes.

Although the present invention has been described in conjunction with preferred embodiments, it is understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand.

We claim:

1. A corrosion resistant alloy composed of about 25 to 65% of rhodium and the balance consisting of substantially all nickel, said alloy being corrosion resistant to writing fluids.

2. A corrosion resistant alloy composed of about 35% rhodium and the balance consisting of nickel, said alloy being corrosion resistant to writing fluids.

3. A corrosion resistant alloy composed of about 65% rhodium and the balance consisting of nickel, said alloy being corrosion resistant to writing fluids.

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