

UNITED STATES PATENT OFFICE

2,681,276

PEN NIB ALLOY

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No Drawing. Application July 20, 1950, Serial No. 175,025

4 Claims. (Cl. 75-171)

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This is a continuation-in-part of application Serial No. 750,894, filed May 27, 1947, now abandoned.

This invention relates to alloys characterized by a high degree of corrosion resistance, and, more particularly, to nickel-base alloys containing effective amounts of chromium, molybdenum, and cobalt.

Although the alloys comprising the present invention are well adapted for many varied uses, they will be particularly described in connection with their use in the manufacture of pen nibs in order to more correctly set forth the present invention. It is common knowledge that many inks, more especially the blue-black or permanent type, contain mineral acids, such as hydrochloric acid, sulphuric acid, iron salts, or other corrosive chemicals. As pen nibs, and especially fountain pen nibs, are generally in contact with ink at all times, the constant corrosive action of the ink brings about such an impairment of the nib that it must be replaced. As a result, attempts have been made to produce an alloy which is highly resistant to the corrosive components of inks, in order to insure a writing tool of efficient and dependable performance and of unlimited durability. While there are a number of commercial alloys which are recognized as being highly resistant to corrosion, there are few which are satisfactory as pen nibs under actual service conditions.

Steps in the manufacture of pen nibs include rolling the metal to the required thickness, die-cutting blanks therefrom, and then raising such blanks to the desired curvature. It is of considerable commercial importance that the pen nib alloy have the property of being easily cold-rolled and cold-formed, in order that the nibs may be produced economically in large quantities.

It is, therefore, an object of this invention to provide an alloy having high resistance to chemical corrosion, particularly mineral acids and salts of iron, such as iron chloride and iron sulfate.

Another object of this invention is to provide a corrosion-resistant alloy capable of being readily cold-worked.

Still another object of this invention is to provide an alloy which resists oxidation even at high temperatures.

A further object of this invention is to provide a corrosion-resistant alloy of superior hardness, which will maintain its strength and hardness even after prolonged exposure to elevated temperatures of the order of 1800° F.

A still further object of this invention is to pro-

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vide a pen nib which will resist the most corrosive inks, which has good wearing qualities, and which, in addition, is readily formed.

Yet another object of this invention is to provide a nickel-base alloy containing chromium in the range of 33 to 40% which is sufficiently ductile to be cold-formed.

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

It has been found that nickel-base alloys containing from 33 to 40% chromium, 5 to 10% molybdenum, and 1 to 10% cobalt have certain properties admirably suiting them for the production of pen nibs. Such alloys are highly resistant to chemical corrosives, especially the action of mineral acids, have high hardness and strength which is unaffected by prolonged exposure to temperatures of the order of 1800° F., and may be readily cold-worked or formed. Although the above broad ranges disclose the operable limits of the alloy, it is preferred to restrict the addition metals to about 35 to 40% chromium, 6 to 8% cobalt, and 7 to 10% molybdenum. Two alloys which illustrate preferred embodiments of the present invention, especially adapted for use in the production of pen nibs, are as follows:

	Cr	Co	Mo	Ni
	Percent	Percent	Percent	Percent
Alloy A.....	35	7.8	10	47.2
Alloy B.....	40	7.2	10	42.8

The extremely high resistance to corrosion of the present alloys, as compared to other corrosion-resistant alloys, is made evident from the data tabulated in Table I hereinafter set forth. In this table, examples of the corrosion resistance of alloys comprising the present invention (alloys A and B) are compared with the corrosion resistance of certain other alloys (alloys C, D, E, F, and G) which are well known for their general high corrosion resistance, and one of which has been used for the manufacture of pen nibs. The corrosion test solution was composed of 500 cc. hydrochloric acid, 500 cc. water, and 10 g. ferric sulphate which solution is used by some pen nib manufacturers as an accelerated test for ink corrosion. The drastic effect of this solution on familiar alloys indicates the severity of the test. The alloys described below were immersed in the test solution at 100° F. for one hour, after which loss of weight was calculated.

Table I

Alloy	Chemical Composition, Percent					Corrosion Rate, gm./ cm. ² /hr. $\times 10^3$
	Cr	Ni	Co	Mo	Other	
A	35	47.2	7.8	10		3
B	40	42.8	7.2	10		3
C	18-20	14 max.		3-4	Balance Fe	40
D		58-60	20		0-2 Mn; 20 Fe	101
E		Bal.		23 max.	7 max. Fe	85
F	18 max.	Bal.		20 max.	6 max. W; 7 max. Fe	56
G		85-90			3 Cu; 10 Si; bal. Fe	63

Heretofore, the most satisfactory pen nib material in regard to corrosion resistance was a stainless steel alloy, the composition of which is given in the above table as alloy C. When tested under severe corrosion conditions, as with the solution noted above, it was found that alloys A and B which embody the present invention were each about 15 times more resistant than alloy C, and about 30 times more resistant than a well-known iron-nickel-cobalt alloy, alloy D, which is noted for its resistance to corrosion. Alloys E, F, and G are also examples of nickel-base alloys which are well known for their corrosion resistance. Alloy F has been described as even being resistant to wet chlorine. All of these alloys E, F, and G were almost 20 times more susceptible to corrosion than either alloy A or B.

Results of hardness tests, conducted at room temperature on samples of the present alloy after exposure to prolonged effects of high temperature, are shown in Table II. The alloy used in these tests is of the composition described in Table I as alloy A, and was cold rolled prior to exposure to the elevated temperature.

Table II

Temperature	Rockwell "A" Hardness				
	0 Hrs.	10 Hrs.	25 Hrs.	60 Hrs.	100 Hrs.
1,000° F.	68	69	69	69	69
1,400° F.	68	70	71	72	72
1,800° F.	68	68	68	66	62

The data illustrates two valuable properties of the new alloy. First, the alloy possesses a very substantial hardness, a rating of Rockwell "A" 68 being quite high for a nickel-base alloy. Secondly, most metals will withstand high temperatures for only a very limited amount of time without softening. The alloy of this invention shows no appreciable change in hardness after as much as 100 hours of exposure to high temperatures.

During the tests at elevated temperatures, a high degree of resistance to oxidation was demonstrated by the alloy described, as evidenced by a very thin, tightly adherent oxide layer.

In practice, the alloy may be prepared in a number of ways apparent to those skilled in the art, but one method in particular which was found to be quite satisfactory was carried out as follows:

Cobalt, molybdenum, and chromium of ordinary commercial purity were used. Electrolytic nickel was used in the present instance, and nickelous oxide in the amount of 0.08% of the nickel was added to the charge to eliminate hydrogen. After the nickel, cobalt and nickelous oxide were melted together, about .01% of calcium-silicon alloy containing about 30% calcium was added to the melt as a deoxidizer.

Chromium was next added, then molybdenum, and the melt heated to about 2800° F. and cast. Final deoxidation was effected just before casting by adding another .01% of the calcium-silicon deoxidizer.

The metal was cast into slabs, and after surface irregularities had been scalped, the slabs were hot-rolled at 2200° F. to desired thickness, care being taken to make only light reductions in the initial passes of hot-rolling.

After slight scale from hot-rolling was removed by an electrolytic pickle, cold-rolling was done in the usual manner. The alloy was then annealed for at least 2 hours at 2200° F.

The above procedure can, of course, be widely varied without materially affecting the final alloy. For example, a pure grade of nickel may be used in place of electrolytic nickel. In place of the calcium-silicon deoxidizer, aluminum and boron may be employed. Boron, added as a 20% nickel-boron alloy, is particularly effective as a deoxidizer. However, only the minimum quantity necessary to clear the surface of the melt should be used (usually .01% or less), for in excess, the boron forms borides with the alloy constituents making the alloy brittle and unworkable. Instead of removing the scale formed in hot-rolling by electrolytic pickling, sand blasting may be used.

It is evident, of course, that the present alloys can be used in the construction of articles of all types in which resistance to chemical corrosion, and especially to mineral acids, resistance to oxidation and maintenance of hardness and strength after exposure to high temperatures, are desired. Examples of such articles are furnace framework, heat engines, chemical equipment, etc.

What is claimed is:

1. A nib for a writing instrument made from an alloy consisting essentially of 33-40% chromium, 5-10% molybdenum, 1-10% cobalt, and the balance nickel, except for incidental impurities; said alloy being characterized by sufficient workability to be cold rolled to a thickness suitable for use as a pen-nib blank, and then raised to a desired curvature, and having a corrosion rate of about 3 grams per square centimeter per hour $\times 10^3$ when immersed in a solution of 500 cc. HCl, 500 cc. H₂O, and 10 grams Fe₂(SO₄)₃.
2. A nib for a writing instrument made from an alloy consisting essentially of 35-40% chromium, 7-10% molybdenum, 6-8% cobalt, and the balance nickel, except for incidental impurities; said alloy being characterized by sufficient workability to be cold rolled to a thickness suitable for use as a pen-nib blank, and then raised to a desired curvature, and having a corrosion rate of about 3 grams per square centimeter per hour $\times 10^3$ when immersed in a solution of 500 cc. HCl, 500 cc. H₂O, and 10 grams Fe₂(SO₄)₃.
3. An alloy consisting essentially of 33-40% chromium, 5-10% molybdenum, 1-10% cobalt,

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and the balance nickel except for incidental impurities; said alloy being characterized by sufficient ductility to be cold formed, by a Rockwell "A" Hardness of about at least 68 when cold rolled, and by a Rockwell "A" Hardness of about at least 62 when thereafter subjected to a temperature of from 1000° F. to 1800° F. for from 10 hours to 100 hours.

4. An alloy consisting essentially of 35-40% chromium, 7-10% molybdenum, 6-8% cobalt, and the balance nickel, except for incidental impurities; said alloy being characterized by sufficient ductility to be cold formed, by a Rockwell "A" Hardness of about at least 68 when cold rolled, and by a Rockwell "A" Hardness of about at least 62 when thereafter subjected to a temperature of from 1000° F. to 1800° F. for from 10 hours to 100 hours.

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