United States Patent Office

2,955,934

Patented Oct. 11, 1960

2,955,934

HIGH TEMPERATURE ALLOY

Charles H. Emery, Lockport, N.Y., assignor to Simonds Saw and Steel Company, Fitchburg, Mass., a corporation of Massachusetts

No Drawing. Filed June 12, 1959, Ser. No. 819,838

3 Claims. (Cl. 75—134)

The present invention relates to so-called high temperature alloys and particularly to wrought alloys for use in fabricating mechanical structures subjected to operating temperatures above 1500° F. and generally at temperatures in the range 1700° F. to 2200° F.

The alloys of the present invention, in addition to resistance to high temperature without substantial distortion and loss of mechanical strength, must withstand the action of various atmospheres tending chemically to degrade the alloys including oxidizing atmospheres, reducing atmospheres and carburizing atmospheres, and changes from one to the other, including so-called neutral atmospheres.

Further, the alloys of the present invention, under the physical and chemical environment mentioned above, withstands usual corrosive influences encountered at the high temperature such as the action of oxygen and acidic materials generally found associated with products of combustion of the usual solid, liquid and gaseous fuels, and more importantly, these alloys resist excessive absorption of elements as for instance carbon, which would result in deterioration of the inherent characteristic of the alloy to carry high loads at high temperature and to resist high temperature deformation.

A particular advantage of the alloys of the present invention resides in the fact that in ultimate use, the alloy may be and preferably is employed in the wrought condition rather than as a casting, since such alloys possess hot ductility and can therefore be worked in various mill forms. In addition, the alloys of the present invention possess sufficient cold ductility to permit cold forming.

The various objectives, advantages and characteristics are present in the improved alloys within the broad composition limit as follows: nickel, 35% to 55%; chromium, 15% to 30%; and less than 6% each of molybdenum and tungsten, either combined or separately; less than 5% cobalt, with silicon, carbon and manganese not exceeding 1.75%, 0.20% and 2.0%, respectively, the remainder being essentially iron.

It is believed that the general level of resistance to corrosion and carburization are probably established by the nickel-chromium content and relationship, and that the silicon enhances the two resistance characteristics mentioned, and probably in part, regulates the characteristic forgeability of the alloy.

In considering the overall properties of the alloy, it is felt that molybdenum and tungsten, either separately or in combination, contribute primarily to the high temperature strength of the alloy by reason of the formation of temperature-stable carbide complexes and solid solution strengthening of the matrix of the alloy.

It is further believed that both tungsten and molybdenum augment corrosion resistance, particularly oxidation resistance, with tungsten appearing to be somewhat superior in this respect. It is believed that the presence of cobalt is advantageous and, by reason of its solubility in the matrix, contributes to solid solution strengthening.

In Table I there is listed a series of alloys of the present invention which were subjected to various tests listed below:

Table I

Alloy	C	Si	Mn	Ni	Cr	Mo	W	Co
A	.08	1.22	1.03	44.80	25.02	4.80	------	------
B	.09	1.23	1.09	44.80	25.42	2.90	2.98	2.82
C	.09	1.33	1.13	49.27	27.52	------	5.08	------
D	.11	1.23	1.04	42.00	22.55	3.04	2.99	2.85
E	0.08	1.29	1.17	45.19	25.23	2.89	3.10	------

Test samples were made of the above alloys of the present invention, the ultimate analysis of which is shown above in Table I, and the samples subjected to the usual mechanical strength tests to determine the ultimate tensile strength expressed in pounds per square inch, percent elongation in two inches and the percent reduction in area at rupture. Table II shows these data obtained upon the above samples at 1800° F. and Table III, at 1950° F.

Table II

[Tested at 1800° F.]

Alloy	Ultimate Strength, p.s.i.	Elongation, percent in 2 in.	Reduction Area, Percent
A	15,900	35	35
B	17,800	41	34
C	16,200	46	35
D	16,700	40	36
E	17,100	40	36

Table III

[Tested at 1950° F.]

Alloy	Ultimate Strength, p.s.i.	Elongation, percent in 2 in.	Reduction Area, Percent
A	10,600	49	38
B	11,300	45	35
C	9,900	45	37
D	10,500	47	39
E	10,900	46	36

Weighed samples of the alloys of Table I were subjected to 25 cycles of heating in air to 2150° F. with a 2-hour hold at that temperature and subsequent quenching in oil. After 25 cycles of this treatment the specimens were descaled and weighed and, from the loss in weight, this determined calculation made for corrosion expressed in the usual manner as inches penetration per month.

Table IV

[25 cycles of oxidation at 2150° F.]

Alloy	Inches Penetration Per Month
A	.0076
B	.0063
C	.0060
D	.0085
E	.0064

Although broad limits of alloying constituents have been given above, in accordance with the present invention, a preferred, somewhat narrower range of alloying constituents is as follows: Ni—42% to 50%; chromium—20% to 30%, with molybdenum up to 6%; tungsten—up to 6%, whether used separately or in combination; cobalt—up to 5%, the alloy requiring an alloying constituent selected from the group consisting of molybdenum and tungsten, and generally relatively low carbon in the neighborhood of 0.10%, and silicon not exceeding

1.75%, and manganese not exceeding 2%, the remaining being essentially iron.

What is claimed is:

1. An alloy containing nickel in the range 42% to 50%; chromium in the range 20% to 30%; an alloying constituent selected from the group consisting of tungsten and molybdenum each constituent not exceeding 6%; cobalt not exceeding 5%; with silicon, carbon and manganese not exceeding 1.75%, 0.20%, and 2.0%, respectively, the remainder being essentially iron.

2. An alloy containing nickel in the range 35% to 55%; chromium in the range 15% to 30%; about 3% each of molybdenum, tungsten and cobalt; with silicon, carbon and manganese not exceeding 1.75%, 0.20%, and

2.0%, respectively, the remainder being essentially iron.

3. An alloy containing nickel in the range 35% to 55%; chromium in the range 15% to 30%; about 3% each of molybdenum and tungsten; with silicon, carbon and manganese not exceeding 1.75%, 0.20%, and 2.0%, respectively, the remainder being essentially iron.

References Cited in the file of this patent

UNITED STATES PATENTS

1,489,243	Girin	Apr. 8, 1924
1,983,415	Strosacker et al.	Dec. 4, 1934
2,174,025	Wise et al.	Sept. 26, 1939