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DENTURE ALLOY

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U.S. Cl. 75—171 3 Claims

ABSTRACT OF THE DISCLOSURE

An alloy for dental appliances containing as essential ingredients 50% to 60% cobalt, 20% to 28% chromium, 10% to 20% nickel, 3.7% to 4.1% molybdenum and 0.18% to 0.22% carbon has high strength and improved elongation and toughness.

This invention pertains to an alloy having high strength and improved elongation and toughness that is particularly adapted for the production of cast dentures. More particularly, this invention concerns an alloy having as its principal constituents cobalt, chromium and nickel, and containing minor but critical amounts of molybdenum and carbon.

Cobalt-chromium alloys are widely used in the production of castings for denture appliances, either partial or complete. Dentists, dental technicians and patients have been dissatisfied with the performance of the available alloys because of certain inadequate physical properties. More specifically, due to the low elongation, inadequate toughness, and high hardness of the known chrome-cobalt alloys, minor but necessary adjustments required at the time of delivery to the patient are difficult and consume valuable chair time. The technician or dentist must be extremely cautious to avoid bending a clasp attachment through more than about a five to ten degree angle or breakage occurs. Moreover, the available alloys' lack of toughness is dramatically demonstrated by ready breakage of the dentures when accidentally dropped on the floor by the dentist or patient. Their inadequate toughness is also manifested, perhaps less dramatically, by the early breakage of the denture clasps due to stresses of ordinary use by the wearer. The problem is compounded by the fact that the clasp must have sufficient rigidity to retain the shape and position to which it has been adjusted and not be altered by the biting forces. The extreme hardness of the known alloys also is a serious problem because of the wear the denture causes to opposing teeth in contact therewith. Moreover, high hardness prevents slight adjustments of the clasp by grinding (occlusion).

The cobalt-chromium alloy of this invention alleviates the foregoing difficulties because of improved properties flowing from an unexpected critical combination of narrowly defined molybdenum and carbon contents.

In accordance with this invention, an alloy is provided containing as essential ingredients at least 50 and up to 60 but preferably up to 55 percent cobalt, 20 to 28 percent chromium, 10 to 20 percent nickel, 3.7 to 4.1 percent molybdenum and 0.18 to 0.22 percent carbon, said alloy having an elongation of at least ten percent and a toughness factor of at least 9000. The yield point of the alloy is greater than 50,000 p.s.i. and its hardness is not greater than about 310 DPH.

The percentage of elongation is a measure of the amount an alloy will increase in length as it is drawn from a zero to the breaking point. Percentage of elongation has a direct relationship to cold shaping of an alloy as in the use of pliers to shape wire into clasps. The yield point is an indication of the behavior of a clasp as well as the entire denture frame under biting forces, which forces can easily produce stresses above the yield strength

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of an alloy deficient in that property causing the denture to shift out of proper occlusal relationship to which it was originally designed. Toughness is the ability of an alloy to withstand sudden shocks and blows that stress the alloy beyond its yield point but within its breaking strength. It is also a measure of the reserve strength of an alloy in a dental structure such as would be required if the piece were dropped on a tile floor. The "toughness factor" is defined herein as the product obtained by multiplying the percentage of elongation and the ultimate tensile strength of the alloy in pounds per square inch. Ultimate tensile strength (UTS) is the greatest unit stress an alloy will withstand in tension to the point of breaking. Other physical properties which may be evaluated in describing the alloys embodied herein are as follows: Hardness is the resistance of an alloy to surface penetration and is a measure of surface wear effects. The hardness is determined herein as "Diamond Point Hardness" (DPH).

Workers in the art of cobalt-chromium denture alloys have believed that decreasing the contents of molybdenum and carbon reduces the hardness of the alloy while at the same time reducing its strength. It has now been discovered that in the alloy of the present invention, having the aforementioned specifically defined ranges of molybdenum and carbon, hardness is advantageously limited while the strength is excellent. This new alloy has a hardness no greater than about 310 (DPH), an ultimate tensile strength of at least 85,000 p.s.i. and which may reach as high as about 105,000 p.s.i., and a yield strength of at least 50,000 p.s.i. and up to about 60,000 p.s.i. As mentioned previously, the elongation is at least 10%, but in the preferred alloys can range to about 15%; the toughness factor is at least 9000 and can range up to about 13,000. This remarkable toughness feature is demonstrated by the fact that clasp attachment elements are highly adjustable, e.g., through an angle of from about forty to sixty degrees compared to only five to ten degrees of adjustment permitted without breakage for prior known alloys.

In addition to the aforementioned essential elements, other metallic and non-metallic elements may be incorporated in the alloy, some present as accidental impurities. Iron content should not exceed 2%; manganese content should not exceed 1%; silicon content should not exceed 1%; boron content should not exceed 0.01%; and sulfur content should not exceed 0.02%. Phosphorus contamination should be avoided as this element causes hardness and embrittlement.

The chromium content of the alloy should not be materially reduced not increased beyond the aforementioned ranges. An alloy having a low chromium content readily corrodes and high chromium causes brittleness. Increased cobalt content produces a harder alloy, whereas increased nickel content produces a softener material. The alloy of this invention, however, provides an excellent balance of properties. As is known in the art, molybdenum and tungsten are substantial equivalents in cobalt-chromium alloys, although in the present invention somewhat inferior results are obtained by such a substitution. When a portion of the molybdenum requirement of the alloy is replaced by an equivalent amount of tungsten, hardness is increased and castability is reduced; however the toughness value of the alloy, although somewhat reduced, is sufficient for the uses intended.

The examples next set forth illustrate the properties of the claimed alloy and the criticality of the ranges of essential components. All alloys were made under argon atmosphere using conduction type heating units. The alloys were cast by normal dental techniques in ethyl silicate type investments at 1600° F. under argon atmosphere and bench-cooled in the mold. Table I describes compositions wherein the amounts of critical elements, especially molybdenum and carbon, are outside the essential ranges claimed. The physical properties of these alloys, summarized in Table II, show that the alloys fail to meet the desired criteria in one or more respects, i.e., in sufficient toughness, inadequate yield strength, low elongation and/or undesirable hardness. For instance, the alloys of Examples 9 and 10 contain the claimed amounts of Mo, Ni and Co, but carbon contents are outside the critical range; the alloys of Examples 11 and 12 contain the proper amount of carbon, Ni and Co, but the Mo content is not in the claimed range. On the other hand, the alloy of Example 8 that contains the proper amounts of Mo and carbon but the improper amounts of cobalt and nickel shows inferior properties. The alloy of Example 13, a composition as disclosed by E. R. Touceda in U.S. 2,103,500, has a very low and unacceptable yield strength. The alloy of Example 14, a composition as described by E. M. Prosen in U.S. 2,674,571, has poor elongation and toughness.

TABLE I

	Alloy composition, weight percent								
	Co	Cr	Ni	Mo	C	Fe	Si	Mn	W
Example No.:									
1	56.25	26.8	9.73	4.20	0.21	1.00	0.80	0.65	------
2	63.65	26.7	2.53	4.20	0.21	1.00	0.80	0.65	------
3	66.25	24.1	2.53	4.20	0.21	1.00	0.80	0.65	------
4	61.4	26.7	2.87	5.53	0.30	1.52	0.71	0.85	------
5	62.5	30	------	5.0	0.40	1.0	0.50	0.50	------
6	59.6	30	2.0	5.5	0.50	1.2	0.50	0.70	------
7	52.0	28.3	13.7	3.65	0.26	1.15	0.36	0.50	------
8	68.25	22.73	2.38	3.9	0.20	0.92	0.76	0.60	------
9	53.03	26.86	14.86	3.9	0.10	0.32	0.46	0.42	------
10	51.43	25.0	17.4	3.85	0.35	1.05	0.42	0.42	------
11	51.50	26.23	17.76	2.75	0.20	0.86	0.27	0.42	------
12	52.65	24.50	15.58	5.00	0.20	1.00	0.47	0.57	------
13	32	26	38	4.00	------	------	------	------	------
14	61.53	27.66	2.7	4.27	0.22	1.27	0.56	0.66	1.05

TABLE II

	Physical properties				
	UTS p.s.i.×10^3	Yield strength (0.1%), p.s.i.×10^3	Elongation, percent	Toughness factor	Hardness DPH
Example No.:					
1	99	70.5	6.5	6,440	320
2	104	73	8.5	8,830	360
3	90	62.5	8.5	7,650	350
4	103	82	2.0	2,060	378
5	93.2	72	1.5	1,400	375
6	118	71.5	1.5	1,770	395
7	94.5	59.5	8.0	7,550	325
8	110	77	7.5	8,250	355
9	79	57	8.3	6,557	------
10	92	58	7.5	6,900	------
11	98	60	4.0	3,920	------
12	95	70	7.0	6,650	------
13	70	36	19.5	13,650	------
14	85	70	5.5	4,765	------

Representative alloys of the invention are delineated by their composition in Table III and their physical properties are shown in Table IV, particular attention being directed to the high toughness factors and percent elongations, good yield strengths, and optimum hardness.

TABLE III

	Alloy composition, weight percent							
	Co	Cr	Ni	Mo	C	Fe	Si	Mn
Example No.:								
15	50	25	19	3.75	0.2	1.0	0.54	0.6
16	52	26.1	14.2	4.0	0.22	1.2	0.58	0.7
17	52	23.1	17.2	4.0	0.22	1.2	0.58	0.7
18	50.3	24.8	18.4	3.7	0.18	0.84	0.72	0.57
19	53.25	25.73	14.25	3.9	0.2	0.92	0.76	0.60
20	53.25	22.73	17.38	3.9	0.2	0.92	0.76	0.60
21	50	25	18.5	3.9	0.2	0.1	0.7	0.7

TABLE IV

	Physical properties				
	UTS p.s.i.×10^3	Yield strength (0.1%), p.s.i.×10^3	Elongation, percent	Toughness factor	Hardness DPH
Example No.:					
15	90	59.5	10.2	9,170	270
16	97.5	60	10	9,750	300
17	86.1	54.5	14.6	12,600	290
18	90	59.5	10.2	9,180	270
19	97.5	60	10	9,750	300
20	86.1	54.5	14.5	12,500	290
21	104	59.8	12.2	12,700	310

I claim:

1. An alloy consisting essentially of 50% to 60% cobalt, 20% to 28% chromium, 10% to 20% nickel, 3.7% to 4.1% molybdenum and 0.18% to 0.22% carbon, said alloy having an elongation of at least ten percent and a toughness factor of at least 9000, the toughness factor being the product obtained by multiplying the percentage of elongation and the ultimate tensile strength of said alloy in pounds per square inch.

2. An alloy in accordance with claim 1 wherein the cobalt content is 50% to 55%.

3. A denture casting made from the alloy of claim 1.

References Cited

UNITED STATES PATENTS

2,103,500 12/1937 Touceda ------------ 75—171
2,156,757 5/1939 Grossman ------------ 75—171

RICHARD O. DEAN, Primary Examiner

U.S. Cl. X.R.

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(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,544,315 Dated December 1, 197

Inventor(s) Kamal Asgar

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 67, after "zero", insert --load--;

Column 2, line 49, "n ot", should read --nor--;

Column 3, Table II, line 51, 5th column, last number "4,765" should read --4,675--;

Column 4, Table III, line 15, 7th column, last number "0.1" should read --1.0--.

SIGNED AND
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(SEAL)
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