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COBALT ALLOYS

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The instant invention relates to improved cobalt alloys and the method of making the same. More particularly, it relates to the addition of small amounts of various selected materials to cobalt and cobalt-base alloys whereby alloys having markedly improved physical and metallurgical properties are obtained.

It is well known among cobalt metallurgists that the commercial grade metal and various alloys produced therefrom are practically impossible to forge. This serious defect arises from the fact that the metal and the alloys are so-called "hot short," i.e., they are extremely brittle at elevated temperatures. We have discovered a method whereby such defect may be cured, and it is to such method and the novel compositions resulting therefrom that the instant invention is primarily directed.

Although we are not completely certain of the underlying reason for the hot shortness of commercial cobalt materials, our best evidence points to the fact that the presence of sulfur is the cause. Most likely, in even minute amounts, there is formed a low-melting, brittle cobalt-sulfur eutectic phase which appears along grain boundaries and causes the hot shortness. We, of course, do not wish to be limited to such theory, for it should be evident that no matter what the underlying reasons be, our compositions present a definite improvement in this art. Commencing with such sulfur eutectic theory we reasoned that the addition to the cobalt melt of selected elements which negate the sulfur effects would improve the physical properties of both cobalt per se and cobalt base alloys, and regardless of the validity of the original theory, we have found that the addition of materials selected initially to combine with the sulfur substantially eliminated the hot short defect. Following such theory it was felt that if there is added to the cobalt melt another element which strongly combines with sulfur to form a comparatively high melting compound, the sulfide phase will appear not at the grain boundaries, but distributed within the grains where its detrimental effects are only slight. Perhaps this theory is not correct, but the beneficial effects of our additives are substantial, as will be seen below.

In view of the foregoing, a primary object of the instant invention is to provide forgeable cobalt alloys.

Another object of our invention is to provide a method of producing forgeable cobalt alloys.

A further object of our invention is to provide readily forged cobalt alloys from commercial quality cobalt.

Still another object of our invention is to provide cobalt alloys which may be utilized in elevated temperature operations.

Yet another object of our invention is to provide cobalt alloys which are not "hot short."

Other objects, features and advantages of the instant invention will become apparent to those skilled in this art from the following detailed disclosure thereof.

We have found that the following additives in small amounts achieve the purposes of our invention: cerium, mischmetal, and niobium. Such materials, either singly or in combination, may be added to cobalt or cobalt-base alloys to vastly improve the properties thereof.

In all of our work, the results of which are presented below, a single base material was used, viz., a good grade of commercially pure cobalt rondells. Chemical analysis of this material indicated that the sulfur content was 0.01% by weight or less. We utilized two methods of melting, as follows:

(*a*) Arc melting in a water cooled copper crucible in an argon atmosphere to yield pancake shaped buttons weighing 250 grams; and

(*b*) Induction melting under vacuum in a refractory ceramic crucible to yield cast ingots of cylindrical shape, each weighing approximately 1000 grams.

Both types of ingot developed extensive intergranular fractures when we attempted to hammer forge them at 1100° C. Furthermore, our attempts to forge the arc melted ingots at 700° C. were likewise unsuccessful. Prior working of the ingots by a pressing technique also did not render them forgeable.

We then used the identical arc melting procedures to make melted buttons containing additions of the following:

0.4% Ce
0.1% Ce
1.0% mischmetal
0.4% mischmetal
0.2% mischmetal
0.2% Mn, 0.2% Ti, 0.2% Al

In addition, various cobalt alloys shown in Table I were similarly prepared.

Although "mischmetal" is undoubtedly well known among those skilled in this particular art, for the sake of clarity, this is an alloy of rare earth metals containing about 50% cerium, the balance being lanthanum, neodymium and similar metals.

Following formation of the buttons, they were readily forged to ⅝" bar stock.

The following table presents some of our data and illustrates the remarkably good results of our invention.

TABLE I

Tensile properties of cobalt-base alloys

Alloy (wt. percent)	Room Temperature		1,700 F.	
	UTS (p.s.i.)	Reduction in Area (percent)	UTS (p.s.i.)	Reduction in Area (percent)
Co—0.4 mischmetal	124,000	28	16,100	20
Co—0.5Zr			17,500	83
Co—10Al—0.4Ce	138,000	12	10,700	[1] 88
Co—2Ta—0.4Ce	125,000	24	10,700	32
Co—6Ta—0.4Ce	158,000	20	26,100	72
Co—10Ta—0.4Ce	163,000	12	21,500	88
Co—5V—0.4Ce	127,000	20	11,600	44
Co—5W—0.4Ce	140,000	24	23,300	32
Co—1Nb	127,000	22	21,000	82
Co—3Nb	177,000	17	26,400	62
Co—5Nb	123,000	20	17,900	82

[1] Specimens did not fracture.

NOTE.—Specimens tested as forged, treated 24 hr. at 1700° F. and air cooled.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the instant invention.

We claim as our invention:

1. A forgeable alloy consisting of from 0.1% to 0.4% cerium, the balance consisting essentially of cobalt.

2. A forgeable alloy consisting of from 0.2% to 1.0% mischmetal, the balance consisting essentially of cobalt.

3. A forgeable alloy consisting of from 1.0% to 5.0% niobium, the balance consisting essentially of cobalt.

4. A forgeable alloy consisting of 5.0% of a metal selected from the class consisting of vanadium and tungsten and mixtures thereof, 0.1% to 0.4% cerium, the balance consisting essentially of cobalt.

5. A forgeable alloy consisting of 5.0% vanadium, 0.1% to 0.4% cerium, the balance consisting essentially of cobalt.

6. A forgeable alloy consisting of 5.0% tugnsten, 0.1% to 0.4% cerium, the balance consisting essentially of cobalt.

7. A forgeable alloy consisting of 10.0% aluminum, 0.1% to 0.4% cerium, the balance consisting essentially of cobalt.

8. A forgeable alloy consisting of from 2% to 10.0% tantalum, 0.1% to 0.4% cerium, the balance consisting essentially of cobalt.

9. A forgeable alloy consisting of an alloying material selected from the group consisting of the following in the stated amount by weight: cerium, 0.1% to 0.4%, mischmetal, 0.2% to 1.0%, niobium, 1% to 5%, and mixtures thereof, balance cobalt.

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