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HIGH-TEMPERATURE ALLOY

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2 Claims. (Cl. 75—171)

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The present invention is a cast alloy which is particularly adapted for use under high stress and at the high temperatures and the extreme conditions encountered in the operation of gas turbines and the like.

One of the objects of the invention is the provision of a cast alloy adapted for use as bucket material in a turbo-supercharger or gas turbine. A further object is the provision of an alloy which has exceptional life when operated under high stress and at temperatures as high as 1800° F.

My improved alloy contains about 0.10 to 0.75% carbon, about 17 to 22% chromium, about 12 to 18% nickel, about 10 to 15% tungsten, about 0.5 to 2% columbium, not more than 1% manganese, not more than 1% silicon, not more than 3% iron with the balance cobalt except for incidental impurities. If desired a portion of the tungsten may be replaced by molybdenum. A preferred alloy composition consists of about 0.60% carbon, about 19% chromium, about 15% nickel, about 12% tungsten, about 1% columbium, about 0.8% silicon, about 0.7% manganese, about 2% iron, balance substantially all cobalt except for impurities.

This alloy is particularly adept to the current practice of precision casting by the "lost wax" process heretofore employed in the manufacture of dentures, ornaments and turbo-supercharger buckets. In such a process, a master heat is cast into remelt slugs which are again melted and cast into an investment mold which contains an exact image of the finished casting. However, if desired my improved alloy can be forged to thereby obtain refined physical properties provided the carbon is held to the low side of the previously stated range.

My improved cast alloy has superior properties where high temperatures, high loads and constant stress are limiting factors as in gas turbine buckets. In a life test on a supercharger wheel with buckets made from my improved alloy and which may be designated as alloy "A" the wheel operated for 135 hours with a nozzlebox temperature of 1800° F. This temperature is far higher than that generally encountered in present installations of turbo-superchargers. Under the same operating conditions the next best alloy tested and which may be designated as alloy "B," operated only 50 hours while an alloy "C," at present employed in supercharger bucket construction, operated only 6½ hours before failure.

So far as I am aware my improved alloy has higher stress-rupture values than any cast or

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forged material heretofore employed as a supercharger bucket material.

Comparative high temperatures stress-rupture results at 1500° C. and 1200° C. of alloys "A," "B" and "C" hereinbefore mentioned, are set forth in the following Table I. In the high temperature stress-rupture test, a test bar of known cross-sectional area is stressed by applying a constant load on the test bar for a long enough time at a constant temperature to cause the test bar to fracture. This is repeated with several loads which will give different time values to cause failure. The fracture time and stress vary as logarithmic functions. When such data is plotted, and by joining the plotted points, it is possible to select a specific stress-to-rupture value for any specific time value. For convenience in comparison, 10 hour, 100 hour, and 1,000 hour stress-to-rupture points have been tabulated as previously mentioned in Table I.

TABLE I

	10 hrs.	100 hrs.	1000 hrs.
STRESS RUPTURE AT 1500° F.			
	P. s. i.	*P. s. i.*	*P. s. i.*
Alloy A	42,225	32,833	27,000
Alloy B	29,600	23,100	17,700
Alloy C	27,400	18,300	11,500
STRESS RUPTURE AT 1200° F.			
Alloy A		73,000	54,000
Alloy B	66,000	55,600	45,000
Alloy C	70,000	51,900	44,200

Cyclic temperature stress-rupture tests in a corrosive atmosphere made up of the combustion products of ethyl aviation gasoline, also show the superiority of my improved alloy as compared to alloys "B" and "C." The cycling of temperature varied between 650° F. and 1500° F. The test values taken from plotted data provide 10 hr., 100 hr., and 1000 hr., values as set forth in the following Table II:

TABLE II

Cyclic stress-rupture corrosive atmosphere

	10 hrs.	100 hrs.	1000 hrs.
	P. s. i.	*P. s. i.*	*P. s. i.*
Alloy A	45,000	40,000	35,000
Alloy B	42,000	31,000	23,500
Alloy C	40,000	26,000	17,000

The above tests clearly indicate the unusual and superior high temperature properties of my improved alloy and indicate the possibility of re-rating present conditions of operation for superchargers to higher speeds and temperatures than have heretofore been considered possible.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An alloy containing 0.10 to 0.75% carbon, 17 to 22% chromium, 12 to 18% nickel, 10 to 15% of tungsten, 0.50% to 2% columbium, not more than 3% iron, not more than 1% of manganese and not more than 1% silicon with the balance cobalt.

2. An alloy containing 0.60% carbon, 19% chromium, 15% nickel, 12% tungsten, 1% columbium, 0.8% silicon, 0.7% manganese, 2% iron, balance cobalt except for impurities.

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