AEC-NASA TECH BRIEF

Excellent Spring Properties Developed in Two Nickel Alloys for Use at Cryogenic Temperatures

The problem:

Alloy steels currently used for high performance springs are brittle at cryogenic temperatures. More ductile alloys generally do not possess acceptable spring properties and suffer excessive permanent set at the extreme low temperatures. Some precipitation hardened spring alloys were too brittle at −320°F.

The solution:

Cold working and aging of nickel alloys.

How it's done:

Test specimen pins, 4 inches by 0.50-inch diameter, of two commercially available nickel alloys were used in these tests. Each specimen had the same degree of cold work.

The heat treatment and response of the test specimen pins 4 inches by 0.50-inch diameter are listed in Table 1.

TABLE 1—HEAT-TREAT RESPONSE (0.50-inch Diameter Pins)

ALLOY	HARDNESS AFTER COLD WORK (Rc)	FIRST AGING	SECOND AGING	FINAL HARDNESS (RC)
Specimen 1	43/45	1300° F/8 hrs.	1100° F/10 hrs.	53
Specimen 2	38/40	1375° F/24 hrs.	1250° F/16 hrs.	51

Test specimen pins with a 0.20-inch diameter, prepared from the 0.50-inch diameter pins, cold worked and aged as in Table 1, were additionally tested with the results shown in Table 2.

In the 20 to 30 percent cold reduced condition (specimens used in Table 2), these alloys can be coiled into springs and, with the properties shown, are acceptable for use in a cryogenic environment.

TABLE 2 (0.20-inch Diameter Pins)

ALLOY	TEST TEMP (°F)	PROPORTIONAL LIMIT (KSI)	YIELD STRESS (KSI)	ULTIMATE TENSILE (KSI)	ELONGATION (%)	REDUCTION AREA (%)
Specimen 1	Room Temp	211	286	289	6	28
	Room Temp	218	284	287	6	29
	−320°	250	342	350	7	23
	−320°	247	328	339	8	26
Specimen 2	Room Temp	-	248	260	8	24
	Room Temp	-	260	275	8	24
	−320°	200	286	324	12	27
	−320°	196	276	318	12	27

(continued overleaf)

Notes:

1. The aging cycles in Table 1 were not optimized for maximum hardness or strength.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   AEC–NASA Space Nuclear Propulsion Office
   U.S. Atomic Energy Commission
   Washington, D.C. 20545
   Reference: B67-10349

Patent status:

No patent action is contemplated by AEC or NASA.

Source: I. M. Rehn and P. P. Dessau
of the Aerojet-General Corporation
under contract to
AEC–NASA Space Nuclear Propulsion Office
(NUC-10084)