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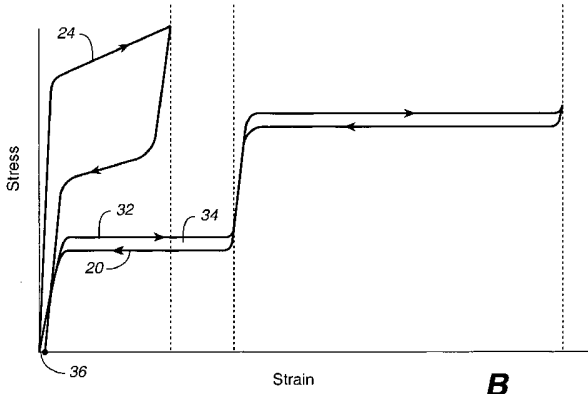
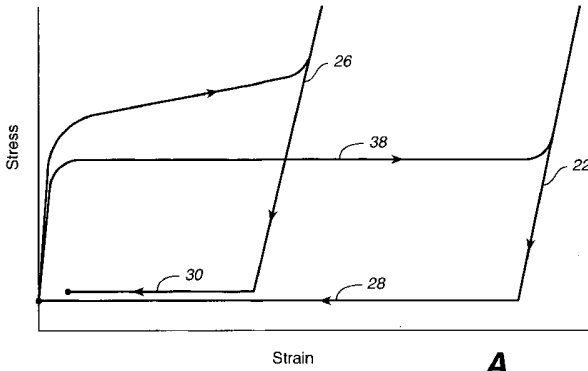
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(54) Title: SINGLE CRYSTAL SHAPE MEMORY ALLOY DEVICES AND METHODS



(57) Abstract: Devices and methods of making devices having one or more components made of single crystal shape memory alloys capable of large recoverable distortions, defined herein as "hyperelastic" SMA. Recoverable strains are as large as 9 percent, and in special circumstances as large as 22 percent. The alloys typically have stress-strain curves (20, 22) as depicted graphically in Figure 1. Hypeelastic SMAs exhibit no creep or gradual change during repeated cycling because there are no crystal boundaries. Hyperelastic properties are inherent in the single crystal as formed; no cold work or special heat treatment is necessary. Alloy components are Cu-Al-X where X may be Ni, Fe, Co, or Mn. Single crystals are pulled from melts as in the Stepanov method and quenched by rapid cooling to prevent selective precipitation of individual element components. Conventional methods of finishing are used.



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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
 IPC: **C22C 9/01(2006.01);C22F 1/08(2006.01);C30B 29/52(2006.01),33/02(2006.01),33/08(2006.01)**

USPC: 117/939;148/402,435,562,563;623/1.18
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 U.S. : 117/939; 148/ 402, 435, 562, 563; 623/1.18

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 WEST--search terms = (shape memory near single crystal) or hyperelastic

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-------------|---|----------------------------------|
| X — Y | US 5,640,217 A (HAUTCOUER et al.) 17 June 1997 (17.06.1997), see entire document. | 1-6, 28, 29 — 33-35, 46 |
| X — A | US 6524309 B1 (WATRELOT et al.) 25 February 2003 (25.02.2003), see entire document. | 1, 7-10, 15, 47-49 — 11-14 |
| X — Y | JP 2000-185999 A (TOKIN Corp) 04 July 2000 (04.07.2000), see Abstract and Table 1. | 1-6, 16-19 — 33-35, 46 |
| X | WO 02/069750 A1 (BARSAMIAN) 12 September 2002 (12.09.2002), see entire document. | 1-6, 36-40, 45 |

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| Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201 | Authorized officer Roy V King DEBORAH A. THOMAS PARALEGAL SPECIALIST Telephone No. 571-272-1700 <i>DUT</i> |

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C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|--|-----------------------|
| Y | US 6515382 B1 (ULLAKKO) 04 February 2003 (04.02.2003), see entire document. | 33-35 |
| Y | US 5899818 A (ZIDER et al.) 04 May 1999 (04.05.1999), see entire document. | 45, 46 |
| A | JP 58-088200A (MITSUI ENG & SHIPBUILDING CO) 26 May 1983 (26.05.1983), see Abstract. | 1-49 |