

**(12) United States Patent**  
**Jervis**

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(54) **MEDICAL DEVICES INCORPORATING SIM ALLOY ELEMENTS**

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**Related U.S. Application Data**

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(51) **Int. Cl.<sup>7</sup>** ..... **A61B 17/56**

(52) **U.S. Cl.** ..... **606/78**

(58) **Field of Search** ..... 606/78, 60, 108, 606/62, 68, 200, 195, 198; 623/1

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,348,548	10/1967	Chardack .....	128/418
3,416,531	12/1968	Edwards .....	128/348
3,419,010	12/1968	Williamson .....	125/350
3,500,820	3/1970	Almen .....	128/303
3,516,412	6/1970	Ackerman .....	128/418
3,539,033	11/1970	Tafeen .....	128/221
3,558,369	1/1971	Wang et al. ....	148/11.5

3,605,725	9/1971	Bentov .....	128/2.05 R
3,620,212	11/1971	Fannon, Jr. ....	128/130
3,729,008	4/1973	Berkovits .....	128/418
3,740,839	6/1973	Otte et al. ....	29/628
3,757,768	9/1973	Kline .....	128/2 M
3,786,806	1/1974	Johnson et al. ....	128/92 YN
3,789,841	2/1974	Antoshkiw .....	128/2.05
3,857,391	12/1974	Lerner .....	128/127
3,868,956	3/1975	Alfidi et al. ....	128/345
3,889,666	6/1975	Lerner .....	128/127
3,890,977	6/1975	Wilson .....	604/281
3,939,828	2/1976	Mohr et al. ....	128/92 B
3,960,147	6/1976	Murray .....	128/92 B
4,033,331	7/1977	Guss et al. ....	128/2 M
4,035,007	7/1977	Harrison et al. ....	285/381
4,037,324	7/1977	Andreasen .....	433/24
4,080,706	3/1978	Heilman .....	29/173
4,149,911	4/1979	Claburn .....	148/11.5 R
4,170,990	10/1979	Baumgart et al. ....	128/92 YN

(List continued on next page.)

**FOREIGN PATENT DOCUMENTS**

8301576	5/1983	(AU) .
3086384	1/1985	(AU) .

(List continued on next page.)

**OTHER PUBLICATIONS**

Jackson, "55-Nitinol—The Alloy with a Memory: Its Physical Metallurgy, Properties, and Applications," NASA-SP5110 (1972).

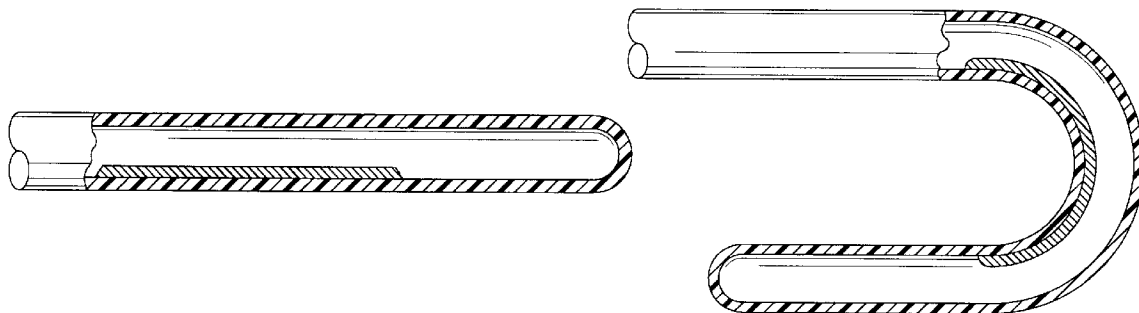
(List continued on next page.)

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(57) **ABSTRACT**

Medical devices which are currently proposed to use elements made from shape memory alloys may be improved by the use of stress-induced martensite alloy elements instead. The use of stress-induced martensite decreases the temperature sensitivity of the devices, thereby making them easier to install and/or remove.

**22 Claims, 4 Drawing Sheets**



## U.S. PATENT DOCUMENTS

4,197,593	4/1980	Kaster et al.	3/1.5
4,198,081	4/1980	Harrison et al.	
4,205,293	5/1980	Melton et al.	337/140
4,230,123	10/1980	Hawkins, Jr.	128/658
4,233,690	11/1980	Akins	623/2
4,307,723	12/1981	Finney	128/349 R
4,310,354	1/1982	Fountain et al.	75/211
4,378,811	4/1983	Levitan	128/757
4,401,433	8/1983	Luther	604/159
4,411,655	10/1983	Schreck	604/165
4,425,908	1/1984	Simon	128/1 R
4,427,000	1/1984	Ueda	128/6
4,452,236	6/1984	Utsugi	128/4
4,485,805 *	12/1984	Foster, Jr.	606/195
4,485,816	12/1984	Krumme	128/334 R
4,490,112	12/1984	Tanaka	433/20
4,494,531	1/1985	Gianturco	128/1 R
4,505,767	3/1985	Quin	148/402
4,509,517	4/1985	Zibelin	128/319
4,512,338	4/1985	Balko et al.	128/1 R
4,543,090	9/1985	McCoy	604/95
4,556,050	12/1985	Hodgson et al.	128/1 R
4,586,335	5/1986	Hosoda et al.	60/528
4,601,283	7/1986	Chikama	128/4
4,616,656	10/1986	Nicholson et al.	128/360
4,665,906	5/1987	Jervis	128/92 YN
4,925,445	5/1990	Sakamoto et al.	
5,190,546	3/1993	Jervis	606/78
1001034	12/1976	(CA)	128/93

## FOREIGN PATENT DOCUMENTS

2703529	3/1978	(DE)	
3225151A1	1/1984	(DE)	
102685	5/1983	(EP)	
0105669	4/1984	(EP)	
0129634	1/1985	(EP)	
0132344	1/1985	(EP)	
0140621	5/1985	(EP)	
0145166	6/1985	(EP)	
8211061	12/1983	(FR)	
1600000	10/1981	(GB)	F16L/21/00
2106190	4/1983	(GB)	
2114005	8/1983	(GB)	128/92 YN
56-28980	7/1981	(JP)	
57-10163	2/1982	(JP)	
57-75647	5/1982	(JP)	
57-95452	6/1982	(JP)	
57-119744	7/1982	(JP)	
5825140	2/1983	(JP)	
5829443	2/1983	(JP)	
41546	3/1983	(JP)	
44047	3/1983	(JP)	
50951	3/1983	(JP)	
5841546	3/1983	(JP)	
5844047	3/1983	(JP)	
5850951	3/1983	(JP)	
58133225	8/1983	(JP)	
6220827	4/1984	(JP)	
5997115	6/1984	(JP)	
6045356	3/1985	(JP)	
100956	6/1985	(JP)	
6476824	3/1989	(JP)	
940759	11/1980	(SU)	128/92 YN
850067	7/1981	(SU)	128/92 YN
1110447	8/1984	(SU)	128/92 YN
1113110	9/1984	(SU)	128/92 YN

## OTHER PUBLICATIONS

Mazer, "Therapeutic Embolization of the Renal Artery with Gianturco Coils: Limitations and Technical Pitfalls," *Radiology*, 138:37-46 (Jan. 1981).

Perkins, "Shape Memory Effects in Alloys," Plenum Press, NY 1975. (pp. 29-59, Rodriguez article; pp. 59-89, Shimizu article; pp. 273-304, Perkins article.)

Robinson, "Metallurgy: Extraordinary Alloys that Remember their Past," *Science*, vol. 191, No. 4230 (May, 1976).

Wagner, "What You Can Do with that 'Memory Alloy,'" *Materials Engineering*, 70 (1969) Oct. pp. 28-31.

Wasilewski, "The Effects of Applied Stress on the Martensitic Transformation in TiNi," *Metallurgical Transactions*, 2: Nov. 1971, pp. 2973-2981.

Wayman, "Some Applications of Shape-Memory Alloys," *Journal of Metals*, Jun., 1980, pp. 129-137.

Physik in Unserer Zeit, 1977, Nr. 2, Verlag Chemie GmbH, Seite 33, and translation thereof.

Dotter, Charles T., Transluminal Expandable Nitinol Coil Stent Grafting: Preliminary Report, *Radiology*, vol. 147, pp. 259-260.

Cragg, et al., *Radiology*, (Apr. 1983) vol. 147, pp. 261-263.

Schetky, L. McDonald, "Shape Memory Alloys," *Scientific America*, Nov. 1979, pp. 74-82.

Buehler, et al., "55-Nitinol Unique Wire Alloy with a Memory," *Wire Journal* Jun. 1963, pp. 41-49.

Portsmann, et al., "P Wave Synchronous Pacing Using Anchored Atrial Electrode Implanted Without Thoracotomy", Jul. 1972, *The American Journal of Cardiology* vol. 30, pp. 74-76.

Baumgart, et al., "Memory Alloys-Properties, Phenomenological Theory and Applications", 1976 (Reference #1 from Opposition).

Bennsmann, et al., "Study of the Memory Alloy Nickel-Titanium and Observations on its Application in the Field of Medicine", 1979 (Reference 2 from Opposition).

Bennsmann, et al., "Osteosynthesis Staples Made of Nickel-Titanium, Manufacture Preliminary Experiments and Clinical Use Thereof", 1982 (Ref. #3 from Opposition).

Baumgart, et al., "Mechanical Problems in the Use of the Memory Effect for Osteosynthesis Plates", 1977 (Ref. #4 from Opposition).

Suzuki, Yuchi, Shape Memory and Super-Elasticity Effects in Ni-Ti Alloys. (Translation provided).

Kirk-Othmer, *Encyclopedia of Chemical Technology*, 3rd Ed., vol. 20, pp. 7-26-7-36.

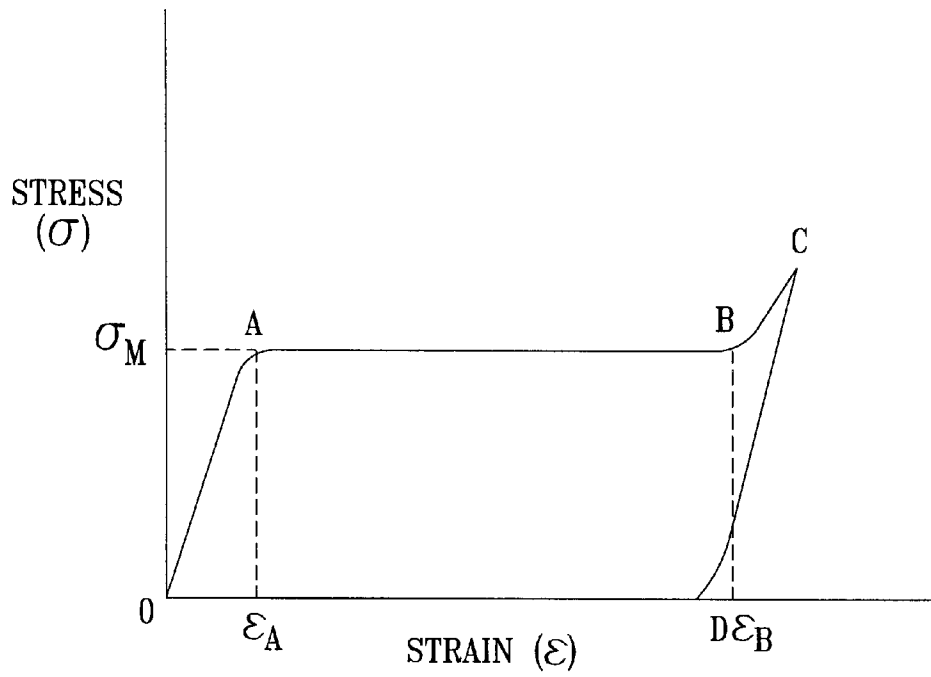
Ling, et al., Variation in the Shape Recovery Temperature in Ni-Ti Alloys, *Mat's Sc. & Eng.*, vol. 48, pp. 241-247 (1981).

Watanabe, Studies on New Superelastic Ni-Ti Orthodontic Wire, *J. Jap. Soc. for Dental Apparatus & Mat's.*, vol. 23, No. 61, pp. 47-57 (1981).

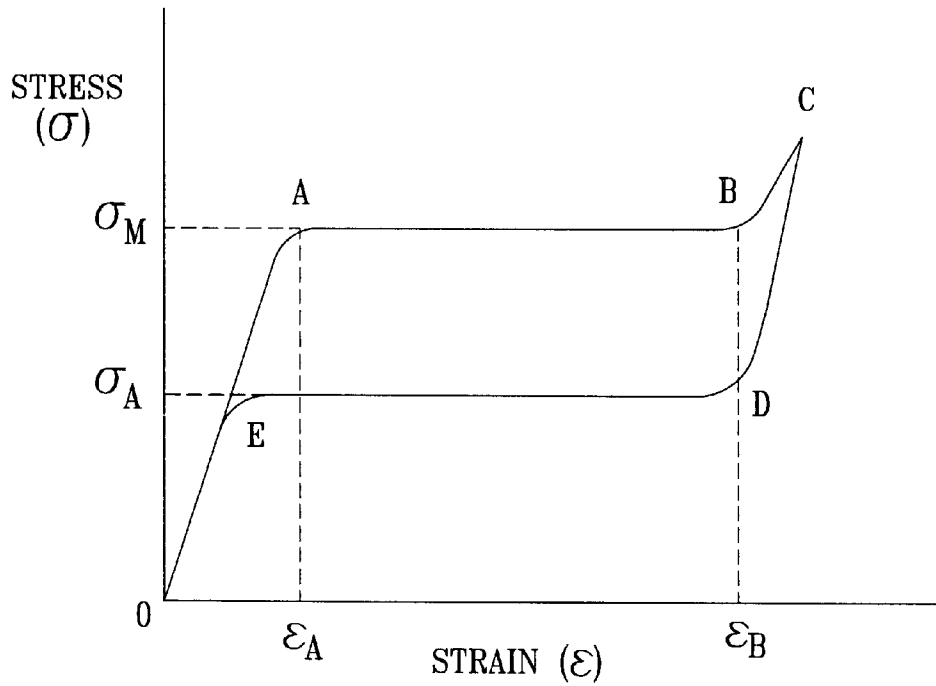
Oonishi, *Clinical Magazine: Orthopaedic Surgery*, 32, p. 1180 (1981).

Sullivan Variable Stiffening Device for Colonoscopy, *Gastrointestinal Endoscopy*, vol. 36 No. 6, pp. 642-643 (1990).

\* cited by examiner

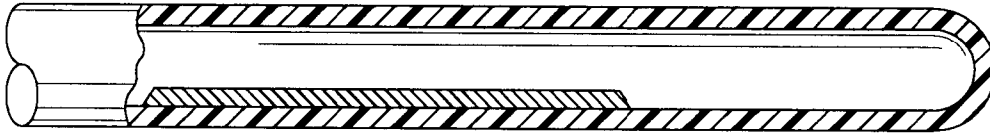


*FIG. 1*

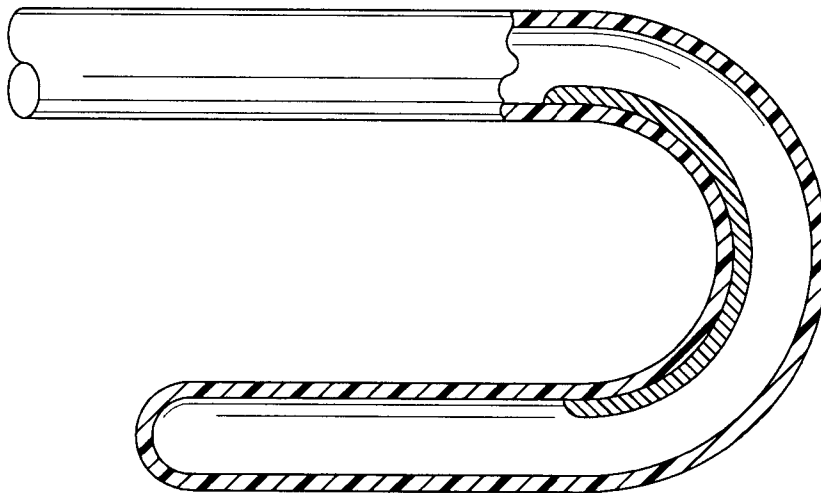


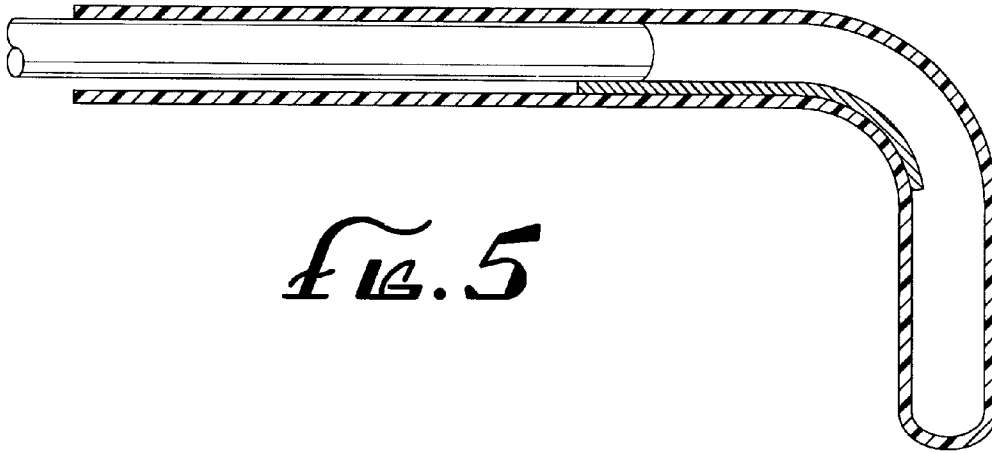
*FIG. 2*

*FIG. 3*

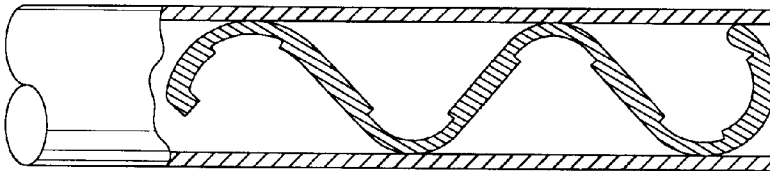


*FIG. 4*





*Fig. 5*



*Fig. 6*

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