



US006327791B1

(12) **United States Patent**
Norcross et al.

(10) **Patent No.:** **US 6,327,791 B1**
(45) **Date of Patent:** **Dec. 11, 2001**

(54) **CHAIN CODE POSITION DETECTOR**

(75) Inventors: **Richard J. Norcross**, Darnestown, MD (US); **David P. Engvall**, St. Joseph, MO (US); **W. Robert Bunch**, Ashburn, VA (US)

(73) Assignees: **The Government of the United States as represented by the Secretary of Commerce; National Institute of Standards and Technology**, both of Washington, DC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/590,895**

(22) Filed: **Jun. 9, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/139,447, filed on Jun. 16, 1999, and provisional application No. 60/138,244, filed on Jun. 9, 1999.

(51) **Int. Cl.⁷** **G01B 11/02**

(52) **U.S. Cl.** **33/706; 33/710**

(58) **Field of Search** 33/706, 707, 703, 33/705, 710, DIG. 3

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,797,614	7/1957	Heidenhain .	
3,702,471	11/1972	Kennedy et al. .	
4,461,083	* 7/1984	Ernst	33/707
4,465,373	8/1984	Tamaki et al. .	
4,560,870	12/1985	Ramamurti .	
4,602,436	7/1986	Ernst .	
4,603,480	8/1986	Sakagami .	
4,628,201	12/1986	Schmitt .	
4,628,298	12/1986	Hafle et al. .	
4,631,519	12/1986	Johnston .	
4,720,699	1/1988	Smith .	
4,778,273	10/1988	Michel	33/707

4,786,891	11/1988	Ueda et al. .	
4,799,798	1/1989	Erb .	
4,879,555	11/1989	Ichikawa et al. .	
4,901,073	2/1990	Kibrick .	
4,933,673	6/1990	Ishizuka et al. .	
4,947,166	8/1990	Wingate et al. .	
4,951,048	8/1990	Ichikawa et al. .	
5,023,434	6/1991	Lanfer et al. .	
5,171,983	12/1992	Roberts et al. .	
5,239,297	8/1993	Kley .	
5,251,012	10/1993	Riegger et al. .	
5,260,769	* 11/1993	Ieki et al.	33/707
5,404,226	* 4/1995	Kellner	33/707
5,511,321	4/1996	Nelle .	
5,539,993	7/1996	Kilpinen et al.	33/706
5,553,390	9/1996	Ernst et al.	33/706
5,574,445	11/1996	Maresca et al. .	
5,598,268	1/1997	Kellner .	
5,640,008	6/1997	Bosch et al. .	

(List continued on next page.)

OTHER PUBLICATIONS

PCT/US00/16370, International Search Report Sep. 19, 2000.

Primary Examiner—Christopher W. Fulton

(74) *Attorney, Agent, or Firm*—Senniger, Powers, Leavitt & Roedel

(57) **ABSTRACT**

A position detector for sensing the position of a movable member which moves along an axis relative to a stationary member. A nonrepeating N bit chain code embodied in a scale on the movable member runs along the axis. A detector fixed to the stationary member is positioned to sense a portion of the chain code. The detector has K elements (K>>N) generating a plurality of signals. A controller determines the position of the movable member relative to the stationary member as a function of the signals.

35 Claims, 11 Drawing Sheets

