



[54] RATE RESPONSIVE CARDIAC PACEMAKER WITH TILT SENSOR

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Related U.S. Application Data

[60] Division of application No. 08/668,524, Jun. 28, 1996, Pat. No. 5,725,562, which is a continuation-in-part of application No. 08/413,733, Mar. 30, 1995, abandoned.
[51] Int. Cl.⁶ A61N 1/385
[52] U.S. Cl. 607/17
[58] Field of Search 607/17, 19; 128/920

References Cited

U.S. PATENT DOCUMENTS

4,257,423	3/1981	McDonald et al.	128/419
4,374,382	2/1983	Markowitz	128/696
4,428,378	1/1984	Anderson et al.	128/419
4,556,063	12/1985	Thompson et al.	128/419
4,771,780	9/1988	Sholder	128/419
4,846,195	7/1989	Alt	128/782
4,869,251	9/1989	Lekholm	128/419
5,010,893	4/1991	Sholder	128/782
5,031,618	7/1991	Mullet	128/419
5,233,984	8/1993	Thompson	128/419
5,354,317	10/1994	Alt	607/19

FOREIGN PATENT DOCUMENTS

0 414 928 A1	3/1991	European Pat. Off.	A61N 1/36
0 580 128 A2	7/1993	European Pat. Off.	A61N 1/39
37 09073A1	9/1988	Germany	A61M 5/16

WO 95/29734 9/1995 WIPO A61N 1/365
WO 96/30079 10/1996 WIPO A61N 1/365

OTHER PUBLICATIONS

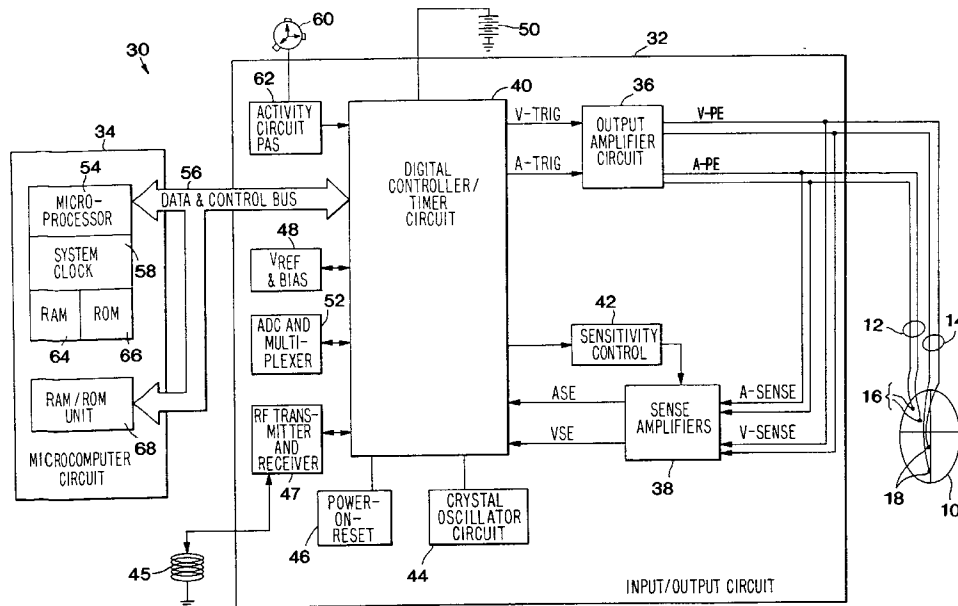
Airbags Boom When IC Accelerometer Sees 50 G Electronic Design Aug. 8, 1991.
A New Mechanical Sensor for Detectin body Activity and Posture, Sduitable Rate Responsive Pacing Eckhard Alt Nov. 1988 vol. 11.
Activity-Based Pacing: Compararison of a Devce Using Accelerometer Versus A Piezoelectric Crystal David W. Bacharach et al Pace vol. 15 Feb. 1992.

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[57] ABSTRACT

A method of and apparatus for pacing a patient's heart at a pacing rate dependent on patient activity and posture particularly during stair climbing. A dual chamber, rate responsive pacemaker for pacing a patient's heart includes at least one DC accelerometer mounted in the pacemaker pulse generator for implantation such that the sensitive axis of the DC accelerometer is sensitive to the effects of gravity during forward lean of the patient characteristic of stair climbing posture. The DC and AC signal outputs of the accelerometer are processed to develop a tilt signal and an activity signal. A target rate control signal is derived from the activity signal dependent on the level of activity. A stair climbing rate is selected for controlling the physiologic pacing rate between a lower and an upper pacing rate in the presence of an activity signal indicative of a patient walking rate and a tilt signal value falling within a tilt window. The target rate control signal is used to control the pacing rate if the activity signal is indicative of faster patient movement, e.g. running, or if the tilt signal is outside the tilt window indicating that the patient is either upright or prone.

8 Claims, 11 Drawing Sheets



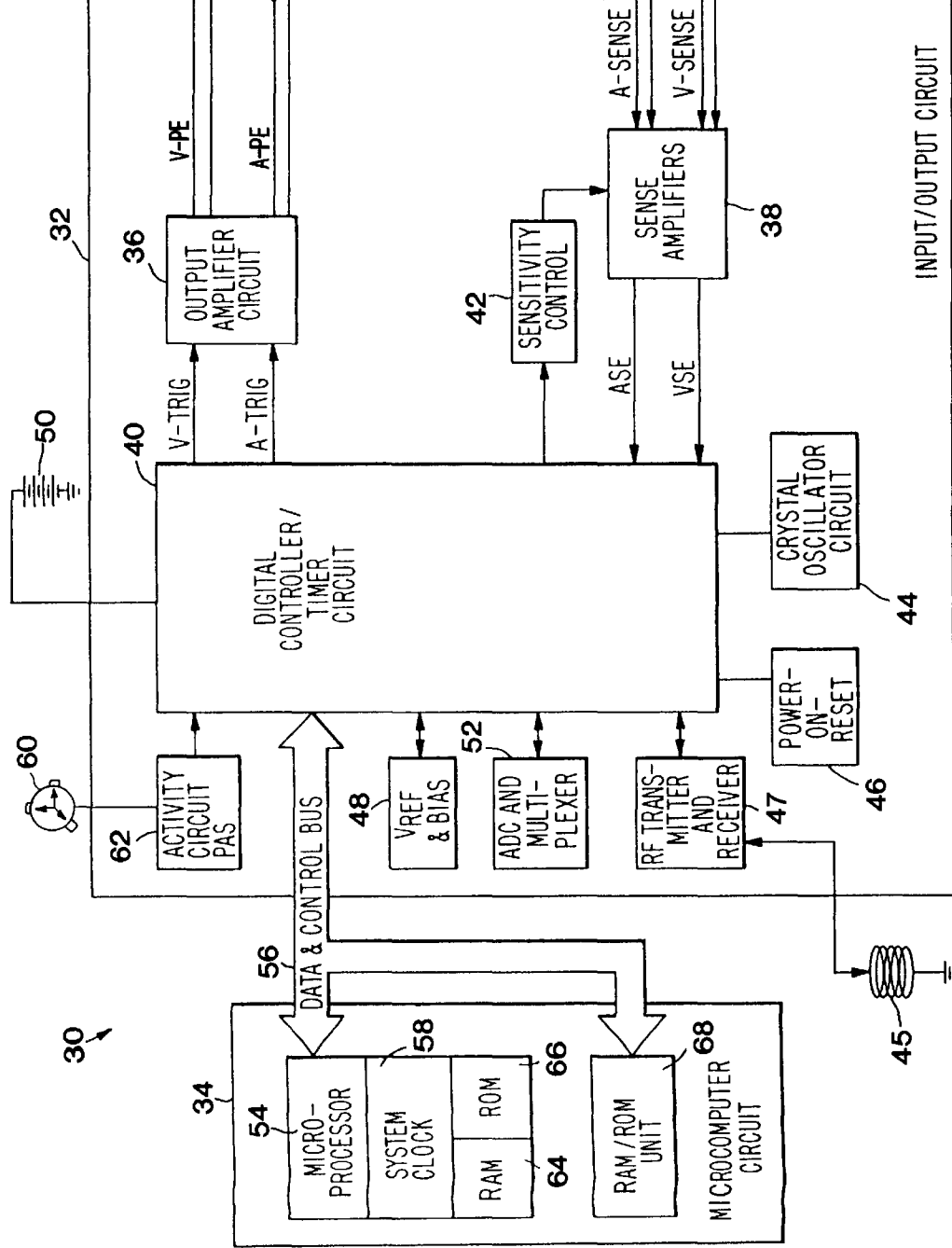


FIG. 1

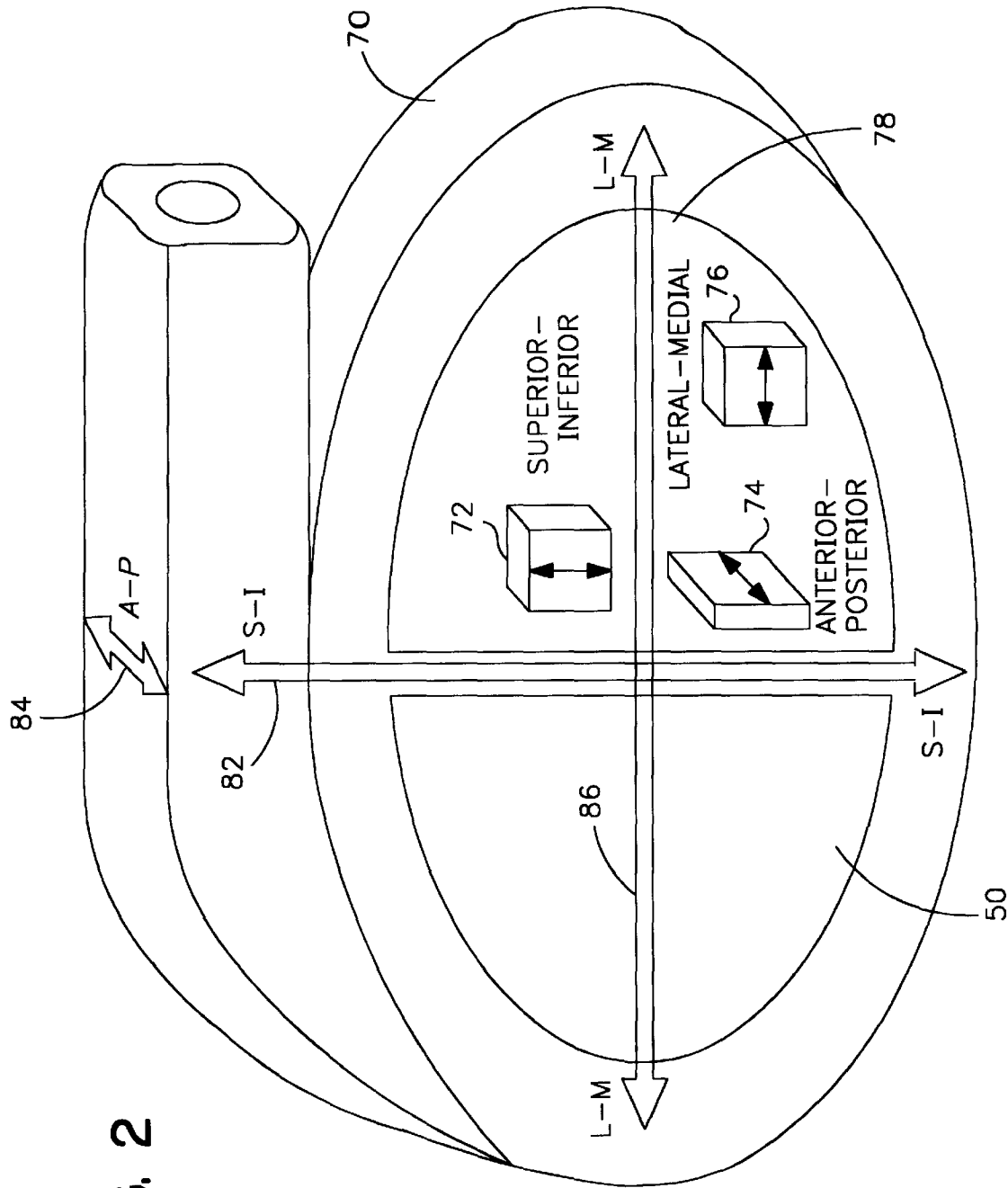


FIG. 2

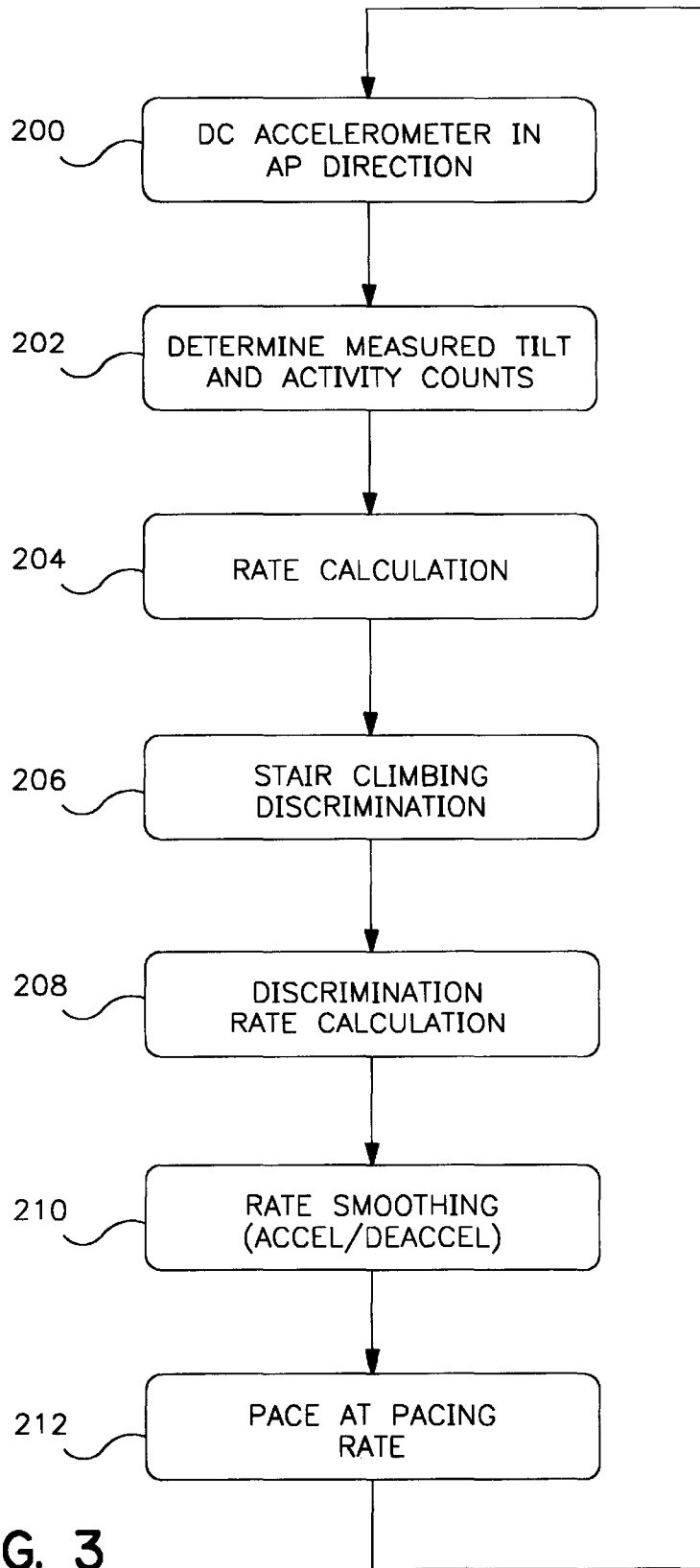
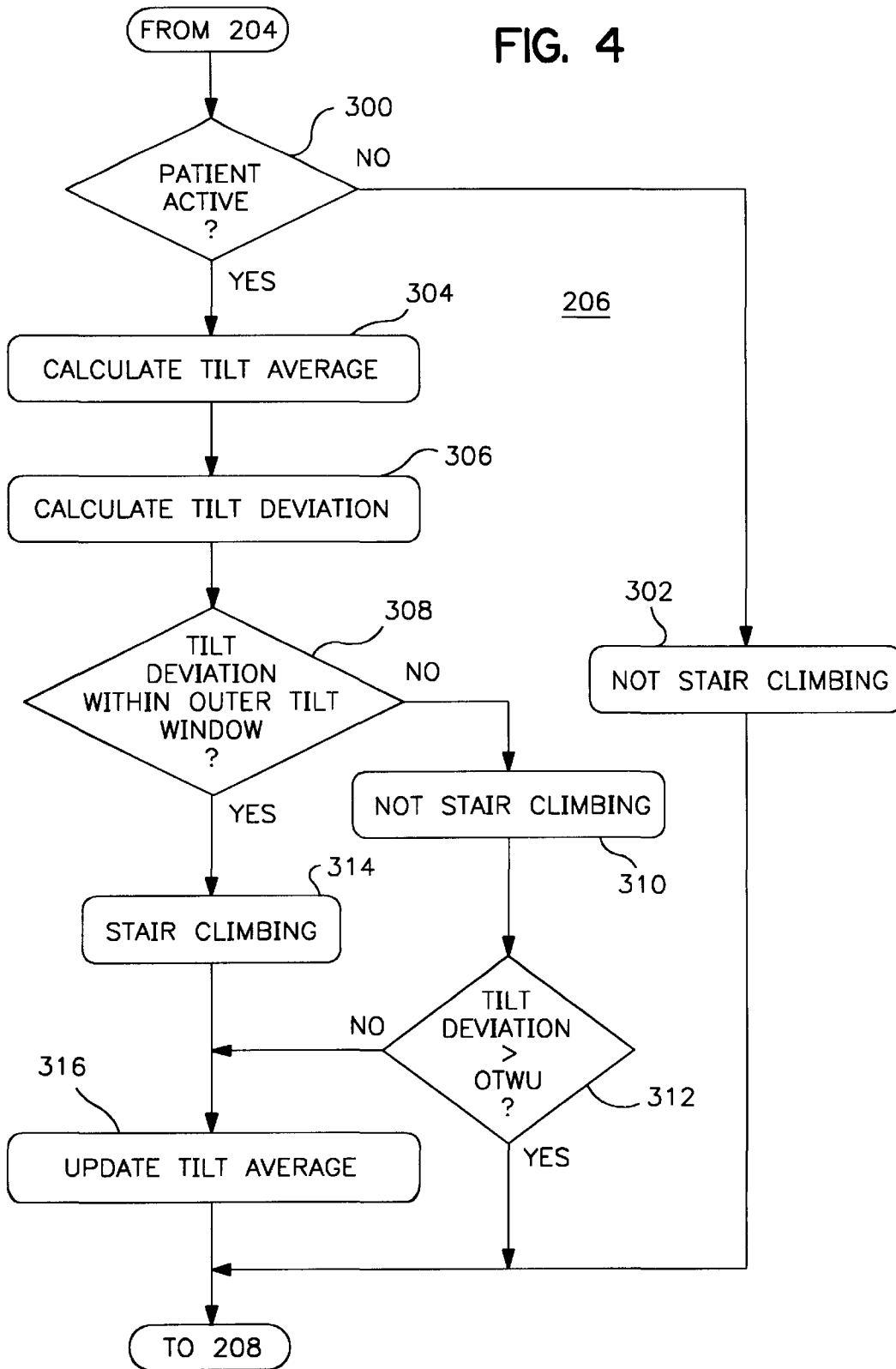


FIG. 3

FIG. 4



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