

**United States Patent** [19]  
**Gaudet et al.**

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- [54] **MEASURING FOOT CONTACT TIME AND FOOT LOFT TIME OF A PERSON IN LOCOMOTION**
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- [73] Assignee: **Personal Electronic Devices, Inc.**, Wellesley Hills, Mass.
- [21] Appl. No.: **08/942,802**
- [22] Filed: **Oct. 2, 1997**
- [51] **Int. Cl.**<sup>7</sup> ..... **G01C 22/00; G04F 10/00**
- [52] **U.S. Cl.** ..... **702/176; 702/141; 702/160; 702/142; 368/10; 235/105**
- [58] **Field of Search** ..... **702/160, 176, 702/144, 141, 142, 149; 368/10; 235/105**

5,323,650	6/1994	Fullen et al.	73/172
5,343,445	8/1994	Cherdak	368/10
5,357,696	10/1994	Gray et al.	36/136
5,361,778	11/1994	Seitz	128/779
5,422,628	6/1995	Rodgers	340/573
5,437,289	8/1995	Liverance et al.	128/779
5,452,269	9/1995	Cherdak	368/10
5,485,402	1/1996	Smith et al.	364/566
5,526,290	6/1996	Kanzaki	364/565
5,541,860	7/1996	Takei et al.	364/566
5,583,776	12/1996	Levi et al.	364/450
5,623,944	4/1997	Nashner	128/779
5,636,146	6/1997	Flentovet al.	364/569
5,720,200	2/1998	Anderson et al.	73/172
5,724,265	3/1998	Hutchings	364/565

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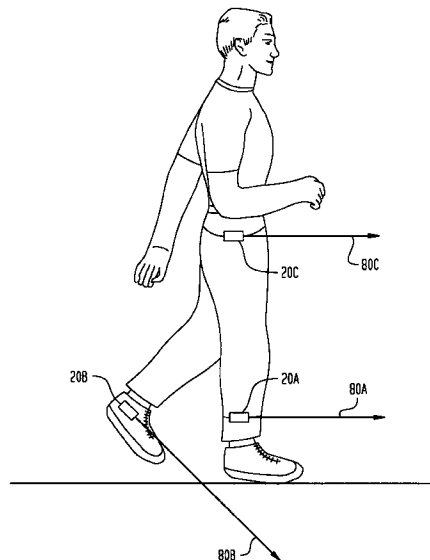
[57] **ABSTRACT**

The time period that a foot is in contact with the ground during a stride taken by a user, and the period that the foot is not in contact with the ground between strides taken by the user are determined by processing and analyzing the output signal of an accelerometer. The accelerometer is mounted on the user such that its acceleration sensing axis senses acceleration in a direction substantially parallel to the bottom of the user's foot. The output of the accelerometer is high-pass filtered, amplified, and fed to the input of a micro-controller, which monitors the signal for positive and negative signal spikes that are indicative, respectively, of the moment that the foot of the user leaves the ground and the moment that the foot impacts with the ground. By measuring time intervals between these positive and negative spikes, average "foot contact times" and "foot loft times" of the user may be calculated. To derive the pace of the user, the average foot contact time is multiplied by a first constant if it is less than 400 milli-seconds (ms) and is multiplied by a second constant if it is greater than 400 ms. This pace value may, in turn, be used to calculate the distance traveled by the user.

[56] **References Cited**  
 U.S. PATENT DOCUMENTS

3,972,038	7/1976	Fletcher et al.	340/189
3,974,491	8/1976	Sipe	340/272
4,408,183	10/1983	Wills	340/323
4,409,992	10/1983	Sidorenko et al.	128/782
4,499,394	2/1985	Koal	310/330
4,578,769	3/1986	Frederick	364/565
4,649,552	3/1987	Yukawa	377/24
4,651,446	3/1987	Yukawa et al.	36/132
4,745,564	5/1988	Tennes et al.	364/566
4,763,287	8/1988	Gerhaeuser et al.	364/561
4,771,394	9/1988	Cavanagh	364/561
4,774,679	9/1988	Carlin	364/550
4,814,661	3/1989	Ratzlaff et al.	310/328
4,830,021	5/1989	Thornton	128/707
4,855,942	8/1989	Bianco	364/561
4,956,628	9/1990	Furlong	340/323
5,033,013	7/1991	Kato et al.	364/561
5,186,062	2/1993	Roost	73/865.4
5,269,081	12/1993	Gray	36/136
5,285,586	2/1994	Goldston et al.	36/137

**38 Claims, 13 Drawing Sheets**



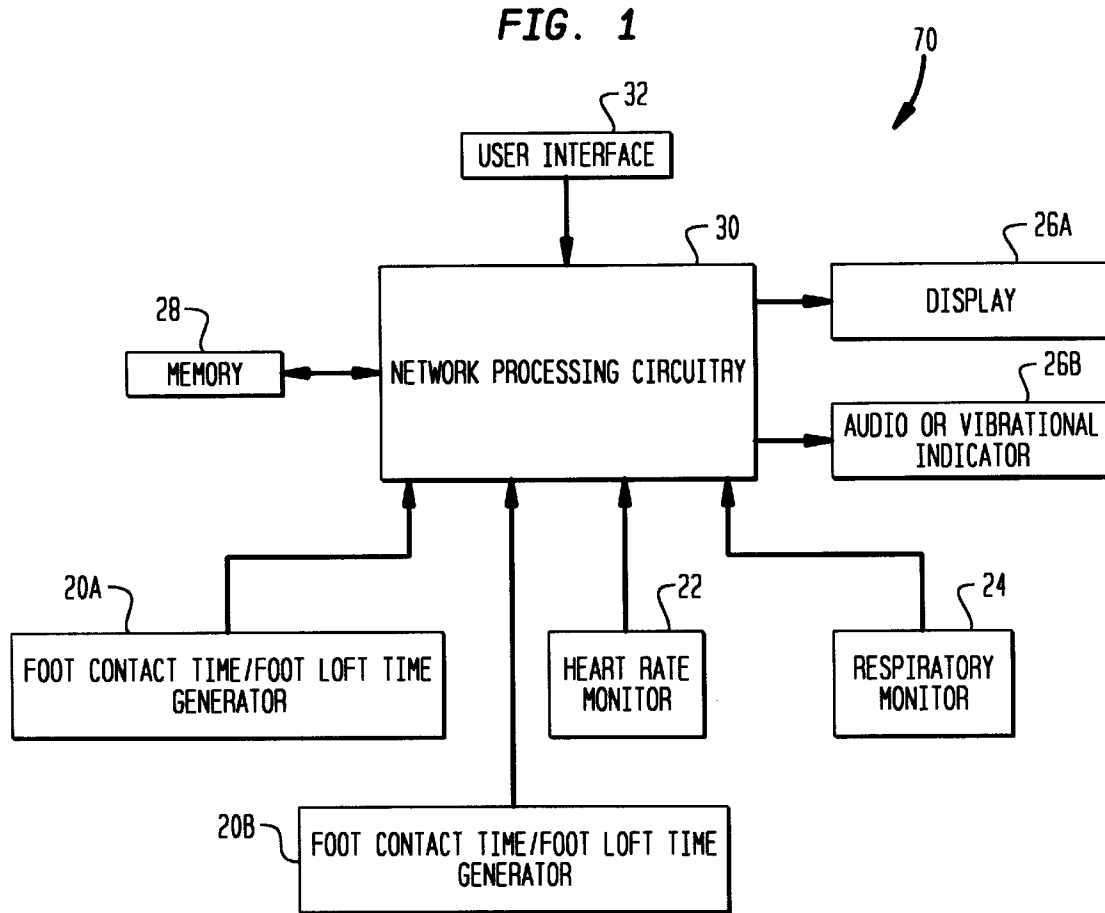


FIG. 2

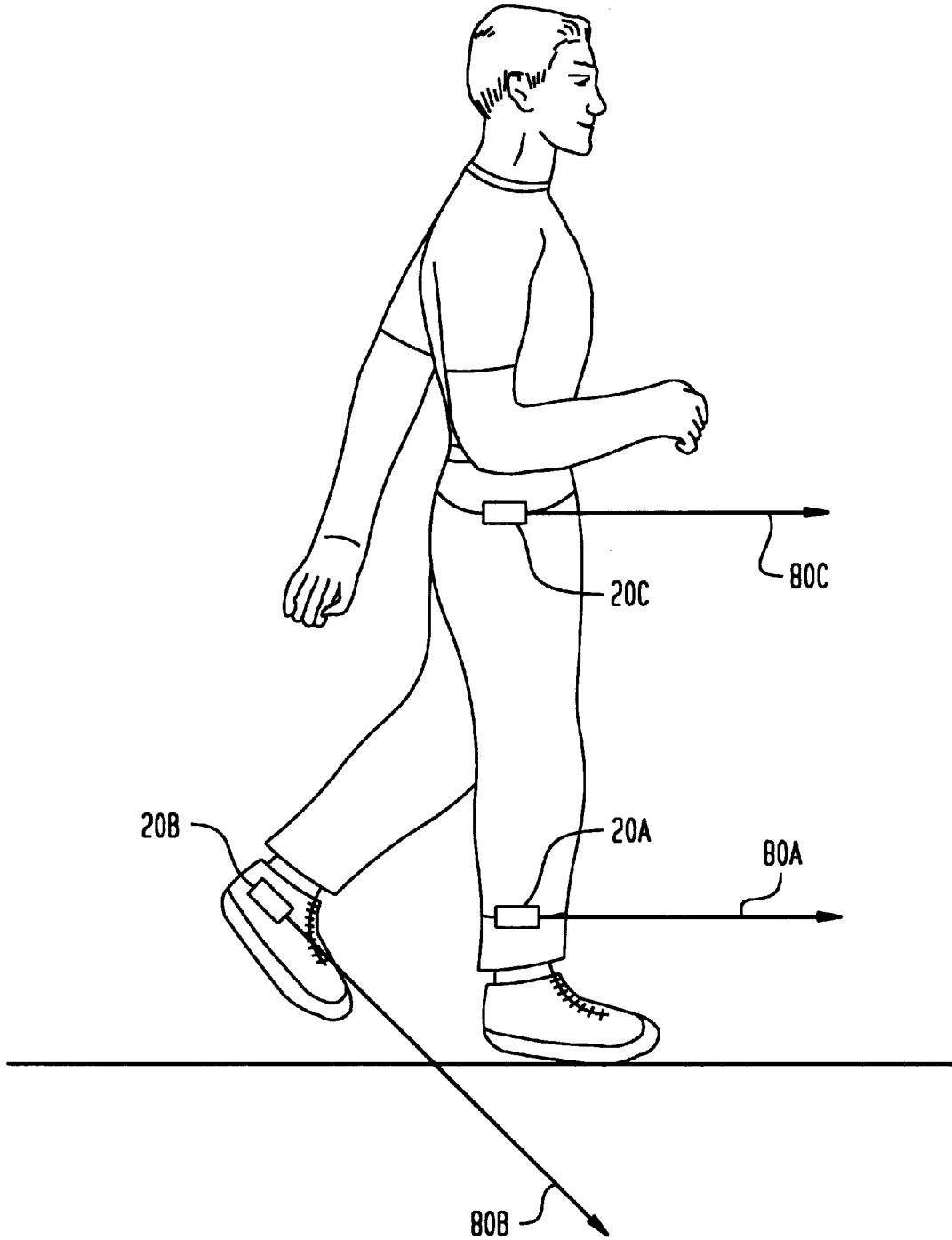


FIG. 3

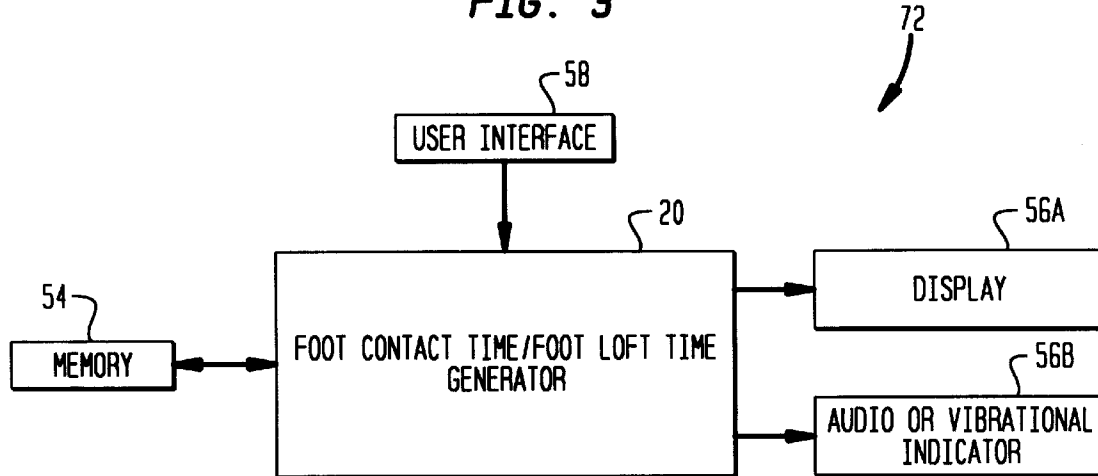


FIG. 4

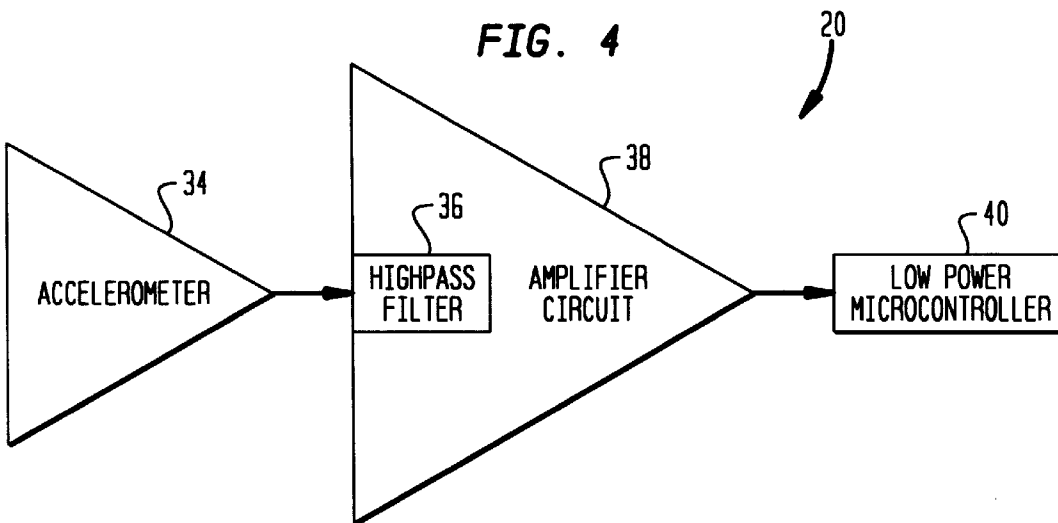
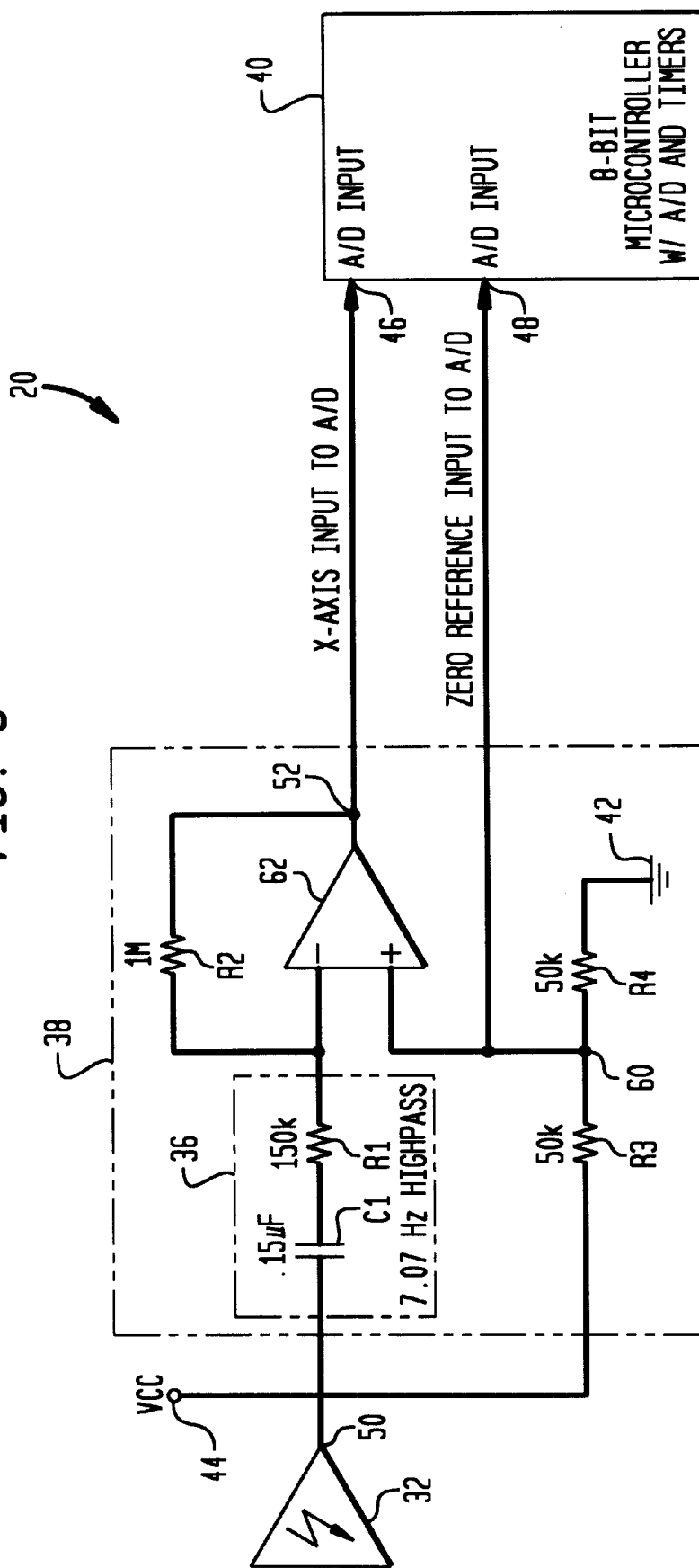


FIG. 5



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