United States Patent [19]

Morita et al.

[54] **PHASE DIFFERENCE MEASURING APPARATUS AND MASS FLOWMETER THEREOF**

[75] Inventors: **Akira Morita**, Tokyo; **Hiroyuki Yoshimura**, Kanagawa, both of Japan

[73] Assignee: **Fuji Electric Co. Ltd.**, Kawasaki, Japan

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[30] **Foreign Application Priority Data**

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Mar. 22, 1995	[JP]	Japan	7-062675
Mar. 22, 1995	[JP]	Japan	7-062676

[51] **Int. Cl.**^{6} G01R 25/00; G01F 1/84

[52] **U.S. Cl.** 324/76.52; 73/861.356

[58] **Field of Search** 324/76.52, 76.53, 324/76.55, 76.68; 73/861.356, 861.355; 364/510, 484

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,513,385	5/1970	Pascoe	324/76.52 X
3,895,294	7/1975	Vinding	324/76.52 X
4,934,196	6/1990	Romano .	
5,050,439	9/1991	Thompson	73/861.356
5,052,231	10/1991	Christ et al. .	
5,069,074	12/1991	Young et al.	73/861.356
5,460,033	10/1995	Lew et al. .	
5,469,758	11/1995	Kalotay	73/861.356

FOREIGN PATENT DOCUMENTS

4205300	7/1993	Germany .	
4319344	1/1995	Germany .	
8802105	3/1988	WIPO .	

Primary Examiner—Michael Brock
Attorney, Agent, or Firm—Greer, Burns & Crain, Ltd.

[57] **ABSTRACT**

A phase difference measuring apparatus for accurately measuring the phase difference (fine time difference) of two signals with the same frequency with a reduced number of bits for A/D conversion is disclosed. In addition to output signals of an upstream side pickup and a downstream side pickup of a mass flowmeter, an output signal of the upstream side pickup or the downstream side pickup is supplied to a comparator, a PLL circuit, an antialiase filter, a sample and hold circuit, and an A/D converter. These circuits quantize these signals and send the quantized signals to a band pass filter. The band pass filter extracts a predetermined signal component and outputs it to a DFT. The DFT performs complex Fourier transformation on the input signal. Thus, the phase difference between two signals with the same frequency (such as an upstream side pickup signal and a downstream side pickup signal) can be accurately detected with a reduced number of bits for each of the A/D converters.

11 Claims, 22 Drawing Sheets

FIG. 1

PRIOR ART
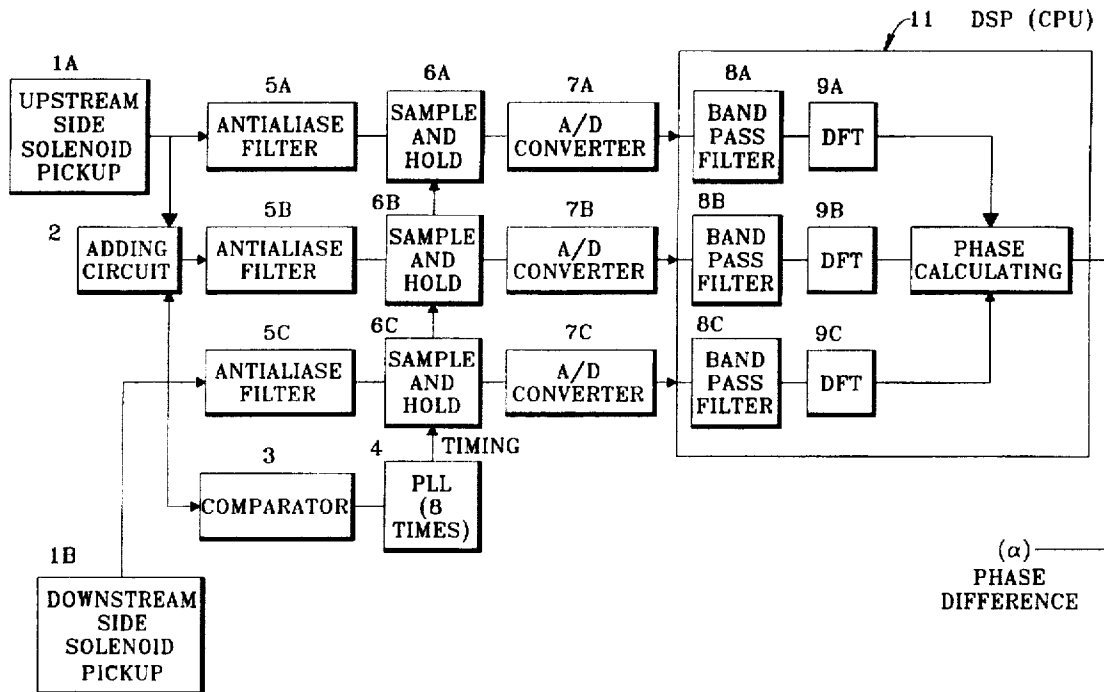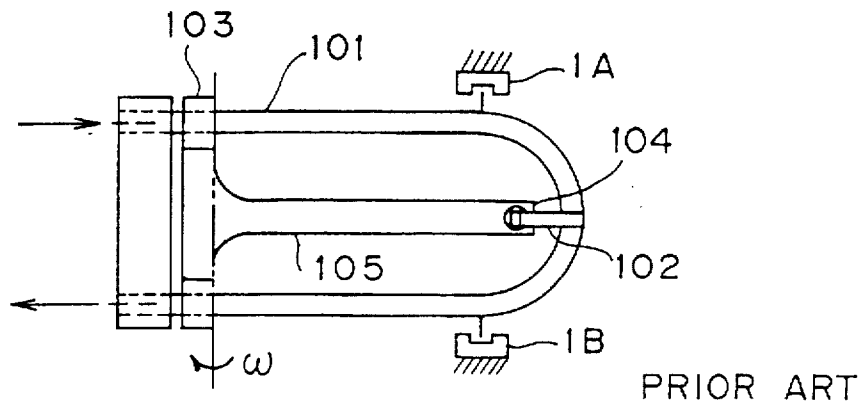
FIG. 2
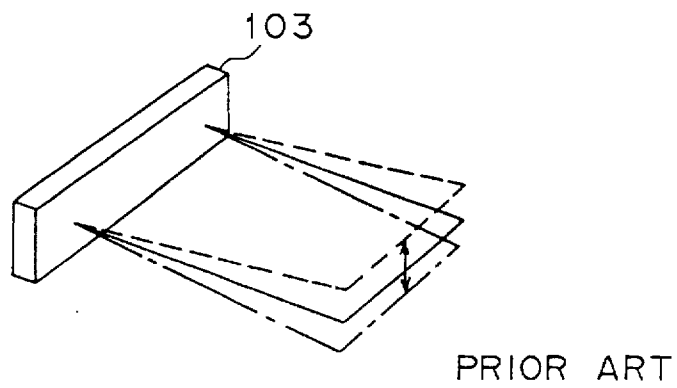
PRIOR ART

FIG. 3

PRIOR ART
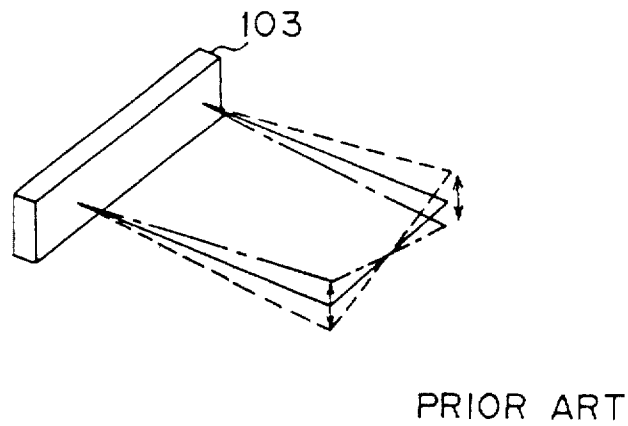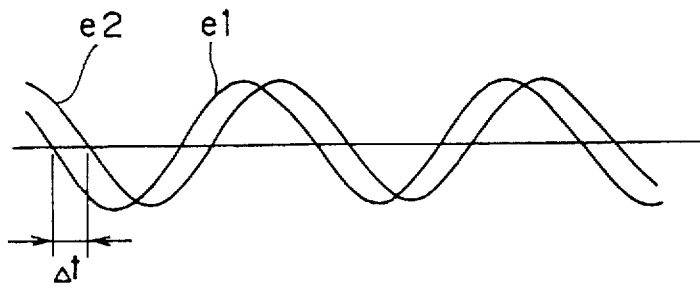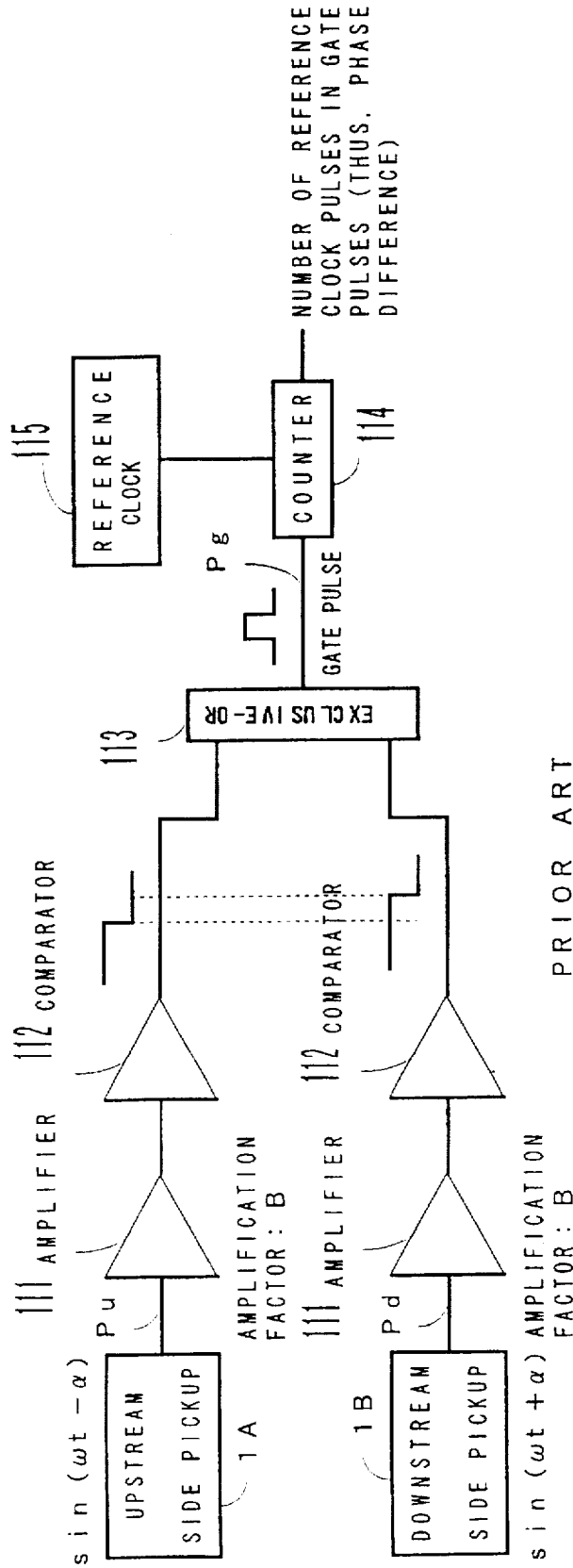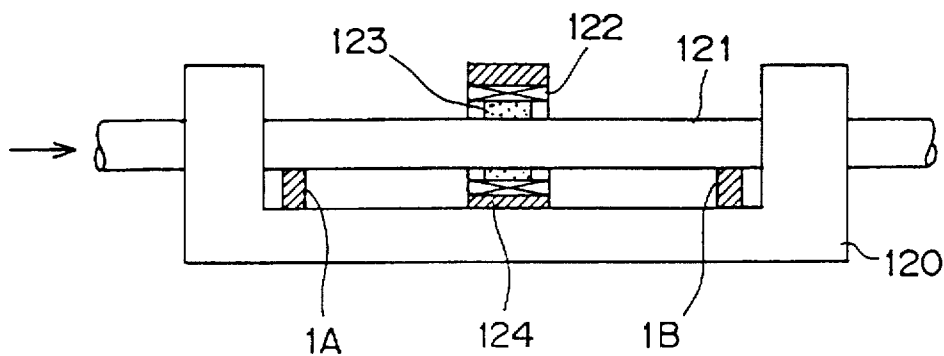
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FIG. 4

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F I G. 5

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FIG. 6

DOCKET ALARM

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