

# United States Patent [19]

[11] **Patent Number:** 5,565,658

**Gerpheide et al.**

[45] **Date of Patent:** Oct. 15, 1996

[54] **CAPACITANCE-BASED PROXIMITY WITH INTERFERENCE REJECTION APPARATUS AND METHODS**

4,371,746	2/1983	Pepper, Jr.	178/18
4,476,463	10/1984	Ng et al.	178/187
4,845,682	7/1989	Boozer et al.	342/16 X
5,053,757	10/1991	Meadows	178/18 X
5,305,017	4/1994	Gerpheide	345/174

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[21] Appl. No.: **351,008**

[22] Filed: **Dec. 7, 1994**

[57] **ABSTRACT**

**Related U.S. Application Data**

Apparatus and method for a capacitance-based proximity sensor with interference rejection. A pair of electrode arrays establish a capacitance on a touch detection pad, the capacitance varying with movement of a conductive object near the pad. The capacitance variations are measured synchronously with a reference frequency signal to thus provide a measure of the position of the object. Electrical interference is rejected by producing a reference frequency signal which is not coherent with the interference.

[63] Continuation-in-part of Ser. No. 193,275, Feb. 8, 1994, Pat. No. 5,478,170, which is a continuation of Ser. No. 914,043, Jul. 13, 1992, Pat. No. 5,305,017.

[51] **Int. Cl.<sup>6</sup>** ..... **G08C 21/00**

[52] **U.S. Cl.** ..... **178/19; 345/174**

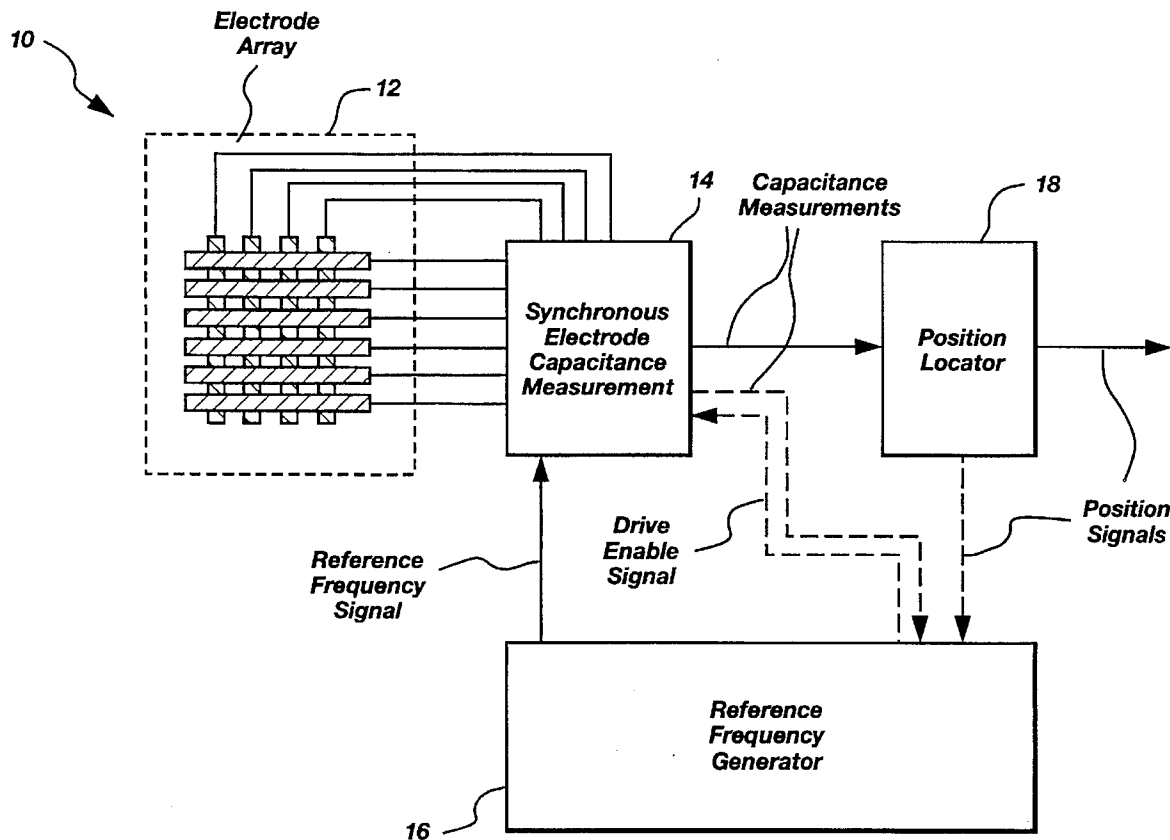
[58] **Field of Search** ..... 178/18, 19, 20; 345/168, 173, 174; 328/5; 342/16

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

4,237,421 12/1980 Waldron ..... 325/5

**14 Claims, 8 Drawing Sheets**



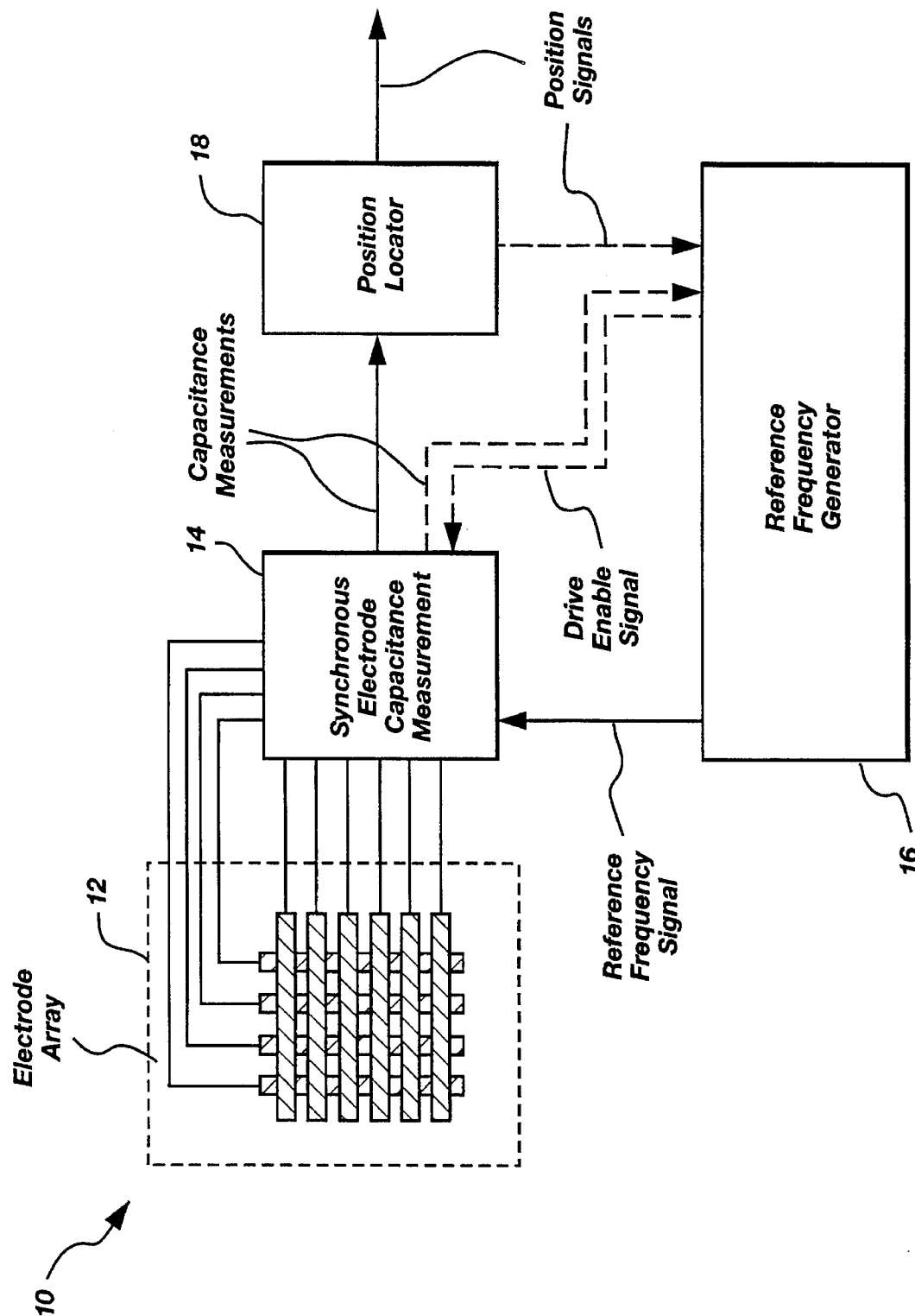


Fig. 1

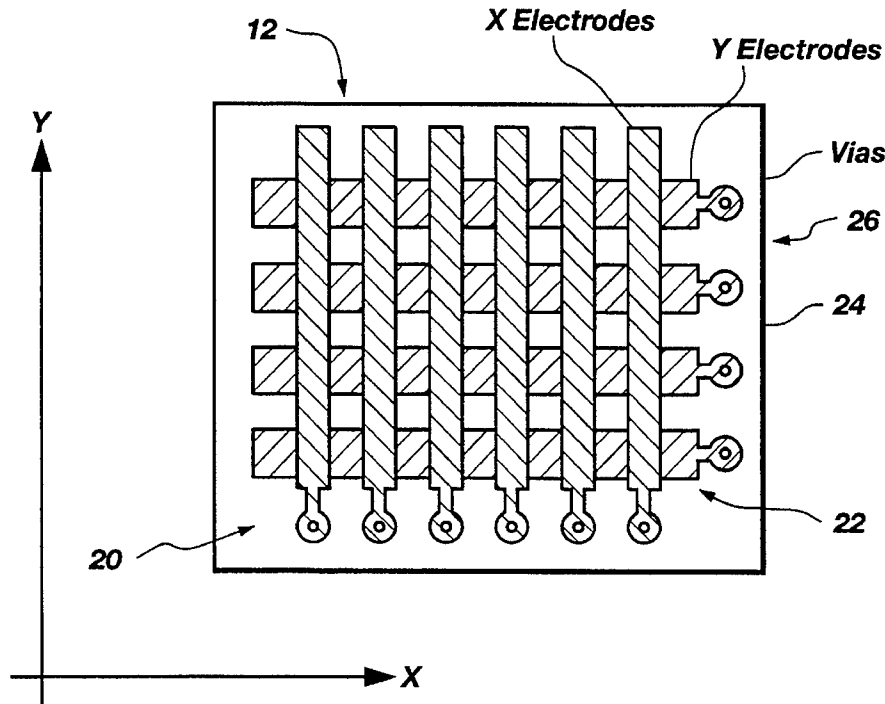


Fig. 2a

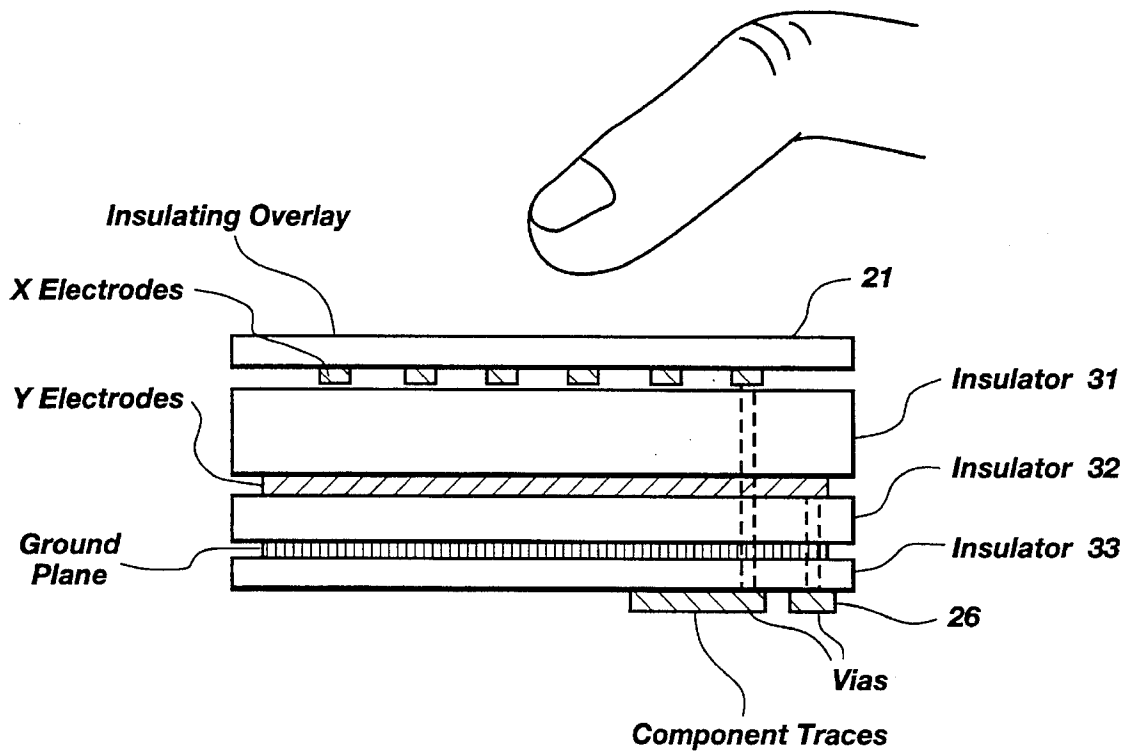


Fig. 2b

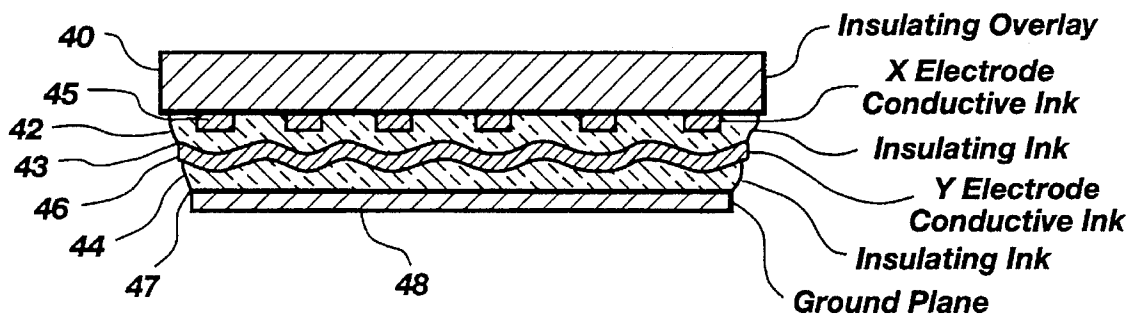


Fig. 3a

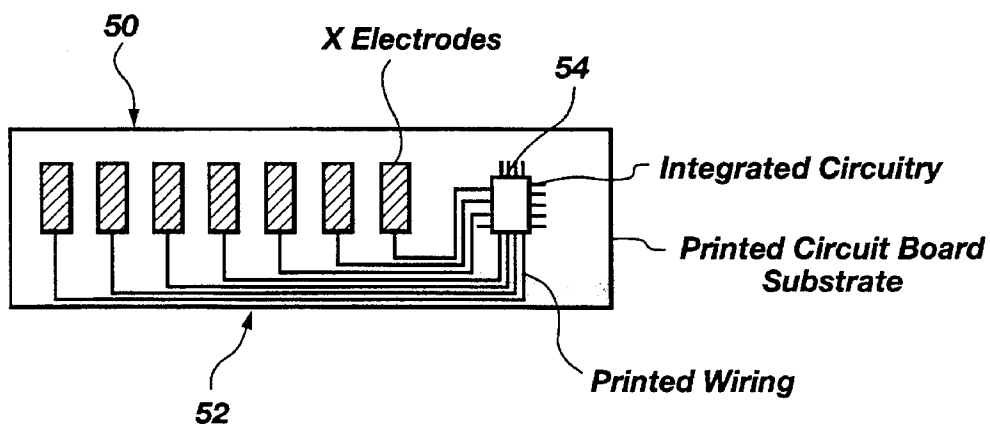


Fig. 3b

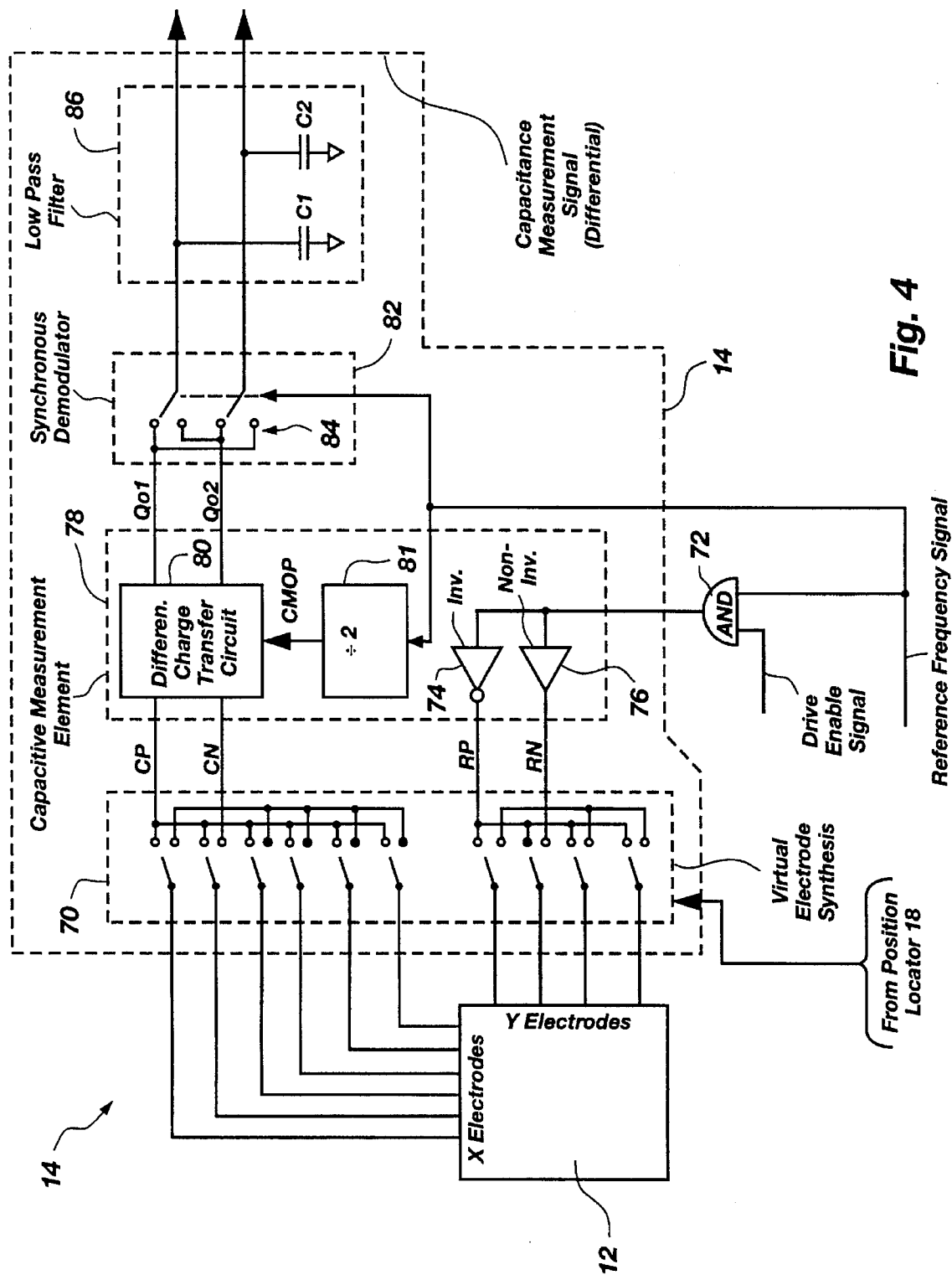


Fig. 4

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