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Singh et al.

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(54) **METHOD AND SENSOR FOR SENSING CURRENT IN A CONDUCTOR**

5,489,821 A \* 2/1996 Crockett ..... 315/151  
5,512,821 A \* 4/1996 Ando ..... G01N 27/82  
324/225  
5,586,064 A \* 12/1996 Grupp ..... 702/190  
5,615,075 A 3/1997 Kim

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(Continued)

FOREIGN PATENT DOCUMENTS

DE 10233279 A1 2/2004  
JP 2004056924 2/2004

(Continued)

OTHER PUBLICATIONS

John Deere, John Deere Inverter, photographs of production unit (4 pages), date unknown but believed to be commercially available before invention of present invention.

(Continued)

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CPC ..... **G01R 15/181** (2013.01); **G01R 19/0007** (2013.01); **G01R 31/42** (2013.01)

(58) **Field of Classification Search**

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USPC ..... 324/227, 228, 226  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,394,288 A 7/1968 Dadok  
4,710,667 A \* 12/1987 Whiteley ..... 310/268

(57)

**ABSTRACT**

A sensor comprises an inductor for sensing an alternating current signal component of an observed signal. The inductor comprises a substrate, conductive traces associated with different layers of the substrate, and one or more conductive vias for interconnecting the plurality of conductive traces. A magnetic field sensor senses a direct current signal component of the observed signal. A first filtering circuit has a high-pass filter response. The first filtering circuit is coupled to the inductor to provide a filtered alternating current signal component. A second filtering circuit has a low-pass filter response. The second filtering circuit coupled to the magnetic field sensor to provide a filtered direct current signal component. A sensor fusion circuit determines an aggregate sensed current based on the filtered alternating current signal component and the filtered direct current signal component.

**22 Claims, 12 Drawing Sheets**

