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(12) **United States Patent**
Estes

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(54) **MEASUREMENT WHILE DRILLING
SPONTANEOUS POTENTIAL INDICATOR
USING DIFFERENTIAL MAGNETOMETERS**

(56) **References Cited**

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(57) **ABSTRACT**

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A drilling system, method and drilling apparatus for determining a parameter of a formation at a downhole location is disclosed. A member having a longitudinal axis is disposed in a borehole at the downhole location. A first magnetometer and a second magnetometer are disposed at an axial location of the member as separate azimuthal locations around the member and oriented tangential to a circumference of circle in a plane transverse to a longitudinal axis of the member. Magnetic fields resulting from a current flowing longitudinally through the member due to a spontaneous potential in the formation are measured to determine the spontaneous potential. The parameter of the formation is determined from the determined spontaneous potential.

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G01V 3/26 (2006.01)

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CPC . **G01V 3/08** (2013.01); **G01V 3/265** (2013.01)

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G01V 3/18; G01V 3/20; E21B 47/00; E21B
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See application file for complete search history.

20 Claims, 6 Drawing Sheets

