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(54) **SYSTEMS AND METHODS FOR MONITORING METAL RECOVERY SYSTEMS**

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This patent is subject to a terminal disclaimer.

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**C22B 7/00** (2006.01)  
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CPC ..... **C22B 7/007** (2013.01); **C22B 3/04** (2013.01); **C22B 15/0065** (2013.01); **C22B 3/02** (2013.01);

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(Continued)

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,587,620 A 6/1971 Berthold  
3,993,293 A 11/1976 Mukae et al.  
(Continued)

**FOREIGN PATENT DOCUMENTS**

GB 1404243 8/1975

**OTHER PUBLICATIONS**

International Search Report and Written Opinion dated Jan. 19, 2016 from corresponding International Application PCT/US2015/050015.

(Continued)

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(57) **ABSTRACT**

Various embodiments provide a leaching solution monitoring module comprising a first leaching solution distribution system interface, a flow meter in fluid communication with the first leaching solution distribution system interface, the flow meter in fluid communication a 3-way pressure regulator, and a second leaching solution distribution system interface in fluid communication with the 3-way pressure regulator.

**20 Claims, 6 Drawing Sheets**

