United States Patent [19]

Ciccone et al.

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[54] **MACROCYCLIC AMINE COMPLEXES FOR LIGAND EXTRACTION AND GENERATION**

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[51] **Int. Cl.**[5] **C25B 1/02**

[52] **U.S. Cl.** **204/129**; 204/130; 204/182.3; 204/233; 204/235; 423/219; 423/579; 544/4; 544/7; 544/64; 544/66; 546/2; 548/101; 548/108; 548/109; 548/402; 556/14; 556/16; 556/45; 556/49; 556/50; 556/110; 556/113; 556/146

[58] **Field of Search** ..... 204/129, 130, 180.1, 204/182.3, 182.5, 233, 235, 252, 263, 266; 261/161, DIG. 28; 422/48; 423/219, 579; 544/4, 66, 7, 64; 546/2; 548/101, 108, 109, 402; 556/13, 14, 16, 42, 44, 45, 49, 50, 110, 113, 146, 138

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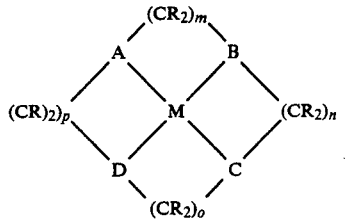
[57] **ABSTRACT**

Methods and apparatus for electrochemical extraction of a ligand such as molecular oxygen from a first fluid environment and for release of a ligand such as molecular oxygen, as well as ligand carrier compounds therefor comprising macrocyclic amines having the general formulas:



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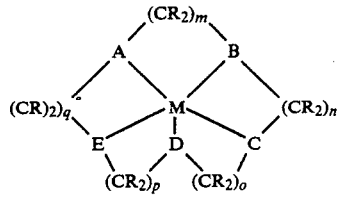

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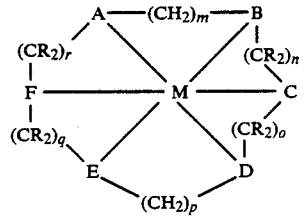
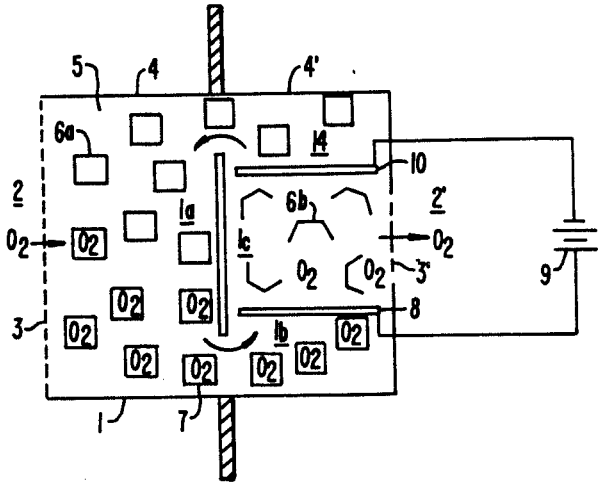


where:

A, B, C, D, E, and F are each nitrogen, oxygen, sulfur, or phosphorous;

m, n, o, p, q, and r are each typically 2, 3, 4, 5, or 6;

the R substituents are each generally H or short chain (linear or branched) alkyl, although R_2 may represent ketyl (=o); and

M is a suitable transition metal ion.

20 Claims, 6 Drawing Sheets