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(54) **METHOD FOR PRODUCING
NANO-PARTICLES OF MOLYBDENUM
OXIDE**
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5,514,350 A 5/1996 Kear et al. 422/198
5,665,277 A 9/1997 Johnson et al. 264/6
5,698,483 A 12/1997 Ong et al. 501/12
5,788,738 A 8/1998 Pirezada et al. 75/331
5,804,151 A 9/1998 Sweetser et al. 423/58
5,820,844 A 10/1998 Khan et al. 423/606
5,851,507 A 12/1998 Pirezada et al. 423/659
5,874,684 A * 2/1999 Parker et al.
5,879,715 A 3/1999 Higgins et al. 424/489
5,922,299 A 7/1999 Bruinsma et al. 423/335

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* cited by examiner

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(52) **U.S. Cl.** **423/606**
(58) **Field of Search** 423/592, 606

(57) **ABSTRACT**

Apparatus for producing nano-particles comprises a furnace defining a vapor region therein. A precipitation conduit having an inlet end and an outlet end is positioned with respect to the furnace so that the inlet end is open to the vapor region. A quench fluid port positioned within the precipitation conduit provides a quench fluid stream to the precipitation conduit to precipitate nano-particles within the precipitation conduit. A product collection apparatus connected to the outlet end of the precipitation conduit collects the nano-particles produced within the precipitation conduit.

(56) **References Cited**
U.S. PATENT DOCUMENTS
4,865,832 A 9/1989 Kamijyo 423/606
5,045,516 A 9/1991 Vogel et al. 502/309
5,185,133 A 2/1993 Scheftic et al. 423/53
5,472,749 A 12/1995 Dravid et al. 427/580

9 Claims, 3 Drawing Sheets