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(54) **VIRTUAL TRANSLATION LOOKASIDE BUFFER**

FOREIGN PATENT DOCUMENTS

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EP	0473913	3/1992
EP	0602867	6/1994
EP	0892521	1/1999
EP	0930567 A3	7/1999
EP	0961193	12/1999

(Continued)

OTHER PUBLICATIONS

- TITLE: Capability-Based Addressing, Author: Fabry, ACM, 1974.*
 TITLE: The architecture and operational characteristics of the VMX Host machine, Author: Frieder, IEEE, 1982.*
 TITLE: VM/4: ACOS-4 /Virtual Machine Architecture, author :Nanba, IEEE, 1985*
 TITLE: Architectural Support for Translation Table Management in Large Address Space Machine, author: Huck et al, ACM, May 1993.*
 TITLE: Eliminating the Address Translation Bottleneck for Physical Address Cache, author: Chiuch et al, ACM, 1992.*
 TITLE: Disco: Running Commodity Operating Systems on Scalable Multiprocessors, author: Bugnion et al, ACM, Oct. 1997.*

(Continued)

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(58) **Field of Search** **717/134, 136, 717/138, 139, 140, 148, 151; 711/118, 202–209, 6; 718/1; 709/1, 100; 707/206**

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,699,532 A	10/1972	Schaffer et al.
3,996,449 A	12/1976	Altanasio et al.
4,037,214 A	7/1977	Birney et al.
4,162,536 A	7/1979	Morley
4,207,609 A	6/1980	Luiz et al.

(Continued)

(57) **ABSTRACT**

In one embodiment, a method for supporting address translation in a virtual-machine environment includes creating a guest translation data structure to be used by a guest operating system for address translation operations, creating an active translation data structure based on the guest translation data structure, and periodically modifying the content of the active translation data structure to conform to the content of the guest translations data structure. The content of the active translation data structure is used by a processor to cache address translations in a translation-lookaside buffer (TLB).

30 Claims, 15 Drawing Sheets

