

EXHIBIT 1

Apple Patent

United States Patent [19] [14] Patent Number: **6,119,214**
Dirks [45] Date of Patent: **Sep. 12, 2000**

[54] **METHOD FOR ALLOCATION OF ADDRESS SPACE IN A VIRTUAL MEMORY SYSTEM**
 [75] Inventor: **Patrick W. Roushan Dirks**, San Jose, Calif.
 [73] Assignee: **Apple Computer, Inc.**, Cupertino, Calif.

[21] Appl. No.: **09/228,637**
 [22] Filed: **Apr. 29, 1994**
 [51] Int. Cl.⁷: **G06F 12/06; G06F 12/12**
 [52] U.S. Cl.: **713/206; 711/159; 711/209**
 [58] Field of Search: **395/486; 497/103; 395/412; 449; 497/01; 497/02; 600**

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Primary Examiner—Jack A. Lutz
Attorney, Agent, or Firm—Harris, Drans, Souder & Matheis, L.L.P.

[57] **ABSTRACT**

A memory manager for a virtual memory system maintains three lists of virtual addresses: those which are free to be mapped to a program, those which are currently mapped but no longer being used, and those which are being removed from a page table, i.e. unmapped. The allocation of free addresses to programs occurs in parallel with the removal of old entries from the page table, such that new free addresses are guaranteed to be available at all times. Each time that a new address is allocated to a program, a limited number of entries in the page table are examined, to determine whether the addresses associated with these entries are no longer in use, and the entries can be removed from the page table. By the time that all of the available addresses in the free list have been allocated, the entire page table will have been examined and all addresses which are no longer in use will have had their corresponding page table entries removed, so that they are available as free addresses. As a result, a constant supply of free addresses are provided with only a limited amount of processing time at regular intervals during the operation of a computer.

23 Claims, 7 Drawing Sheets

$$k = \frac{\text{total number of page table entries}}{\text{maximum number of active threads}}$$

Formula for dynamically determining maximum number to remove

Maximum number to remove

Nemes '663 Patent – Fig. 5

United States Patent [19] Patent Number: 4,996,663
 Nemes [45] Date of Patent: Feb. 26, 1991

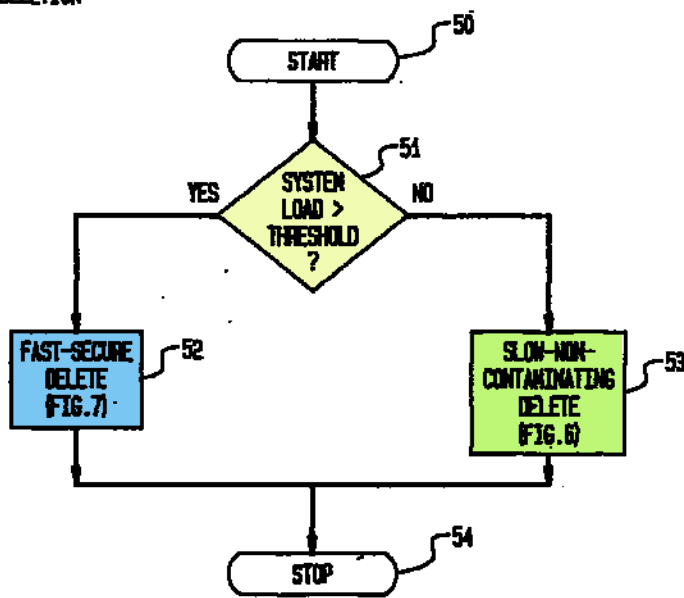
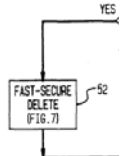
[54] METHODS AND APPARATUS FOR DECONTAMINATING HASH TABLES
 [75] Inventor: Richard M. Nemes, Iro
 [73] Assignee: Bell Communications Research, Livingston, N.J.
 [21] Appl. No.: 151,638
 [22] Filed: Feb. 2, 1988
 [51] Int. Cl. 2: G06F 12/00
 [52] U.S. Cl. 364/90
 [58] Field of Search: 364/90, 364/907, 364/200, 364/205, 364/206, 364/207, 364/208, 364/209, 364/210, 364/211, 364/212, 364/213, 364/214, 364/215, 364/216, 364/217, 364/218, 364/219, 364/220, 364/221, 364/222, 364/223, 364/224, 364/225, 364/226, 364/227, 364/228, 364/229, 364/230, 364/231, 364/232, 364/233, 364/234, 364/235, 364/236, 364/237, 364/238, 364/239, 364/240, 364/241, 364/242, 364/243, 364/244, 364/245, 364/246, 364/247, 364/248, 364/249, 364/250, 364/251, 364/252, 364/253, 364/254, 364/255, 364/256, 364/257, 364/258, 364/259, 364/260, 364/261, 364/262, 364/263, 364/264, 364/265, 364/266, 364/267, 364/268, 364/269, 364/270, 364/271, 364/272, 364/273, 364/274, 364/275, 364/276, 364/277, 364/278, 364/279, 364/280, 364/281, 364/282, 364/283, 364/284, 364/285, 364/286, 364/287, 364/288, 364/289, 364/290, 364/291, 364/292, 364/293, 364/294, 364/295, 364/296, 364/297, 364/298, 364/299, 364/300, 364/301, 364/302, 364/303, 364/304, 364/305, 364/306, 364/307, 364/308, 364/309, 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FIG. 5
HYBRID DELETION

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HYBRID DELETION



Decision based on system load

If heavy load, don't delete expired records yet

If not heavy load, delete all expired records