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Wakeman et al.

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[54] **FORWARDING DATABASE CACHE FOR INTEGRATED SWITCH CONTROLLER**

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[73] Assignee: **National Semiconductor Corporation**, Santa Clara, Calif.

[21] Appl. No.: **538,321**

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[51] **Int. Cl.**^{6} **H04Q 11/04**

[52] **U.S. Cl.** **370/422**; 370/397; 395/200.2; 395/200.12

[58] **Field of Search** 370/422, 428, 370/395, 396, 397, 382, 401, 402; 395/200.02, 200.12

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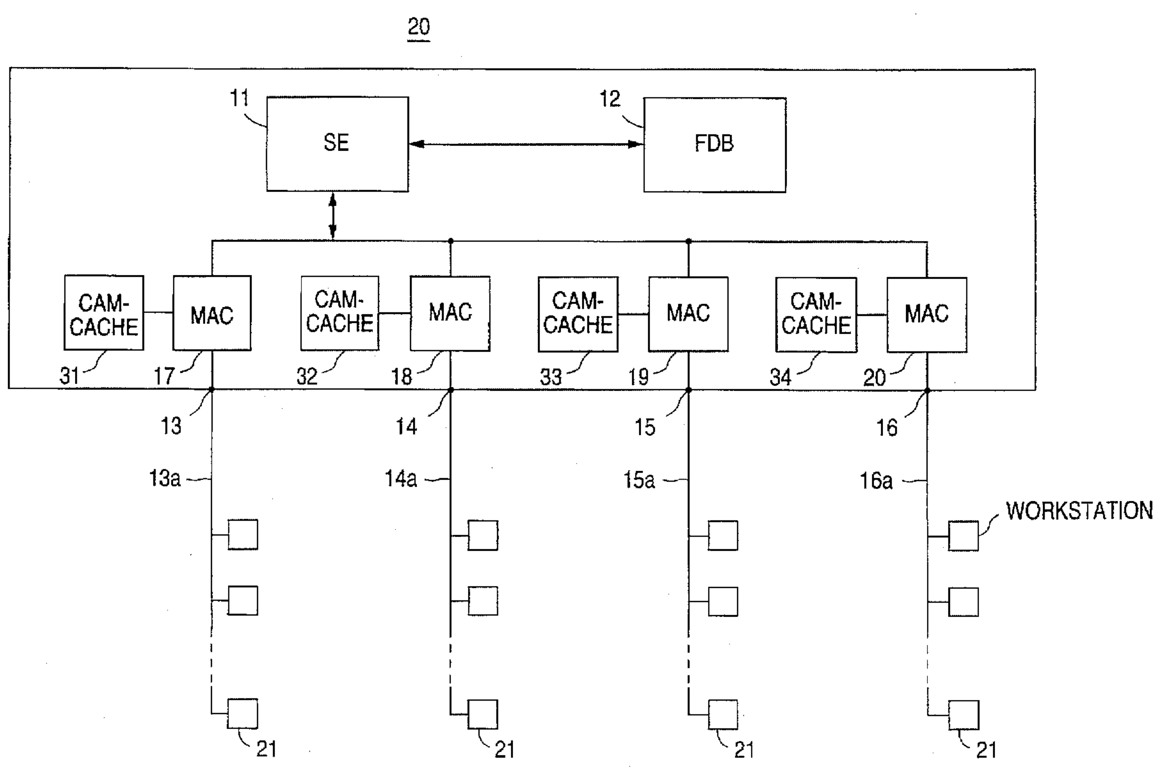
Assistant Examiner—Shick Hom
Attorney, Agent, or Firm—Skjerven, Morrill, MacPherson, Franklin & Friel; Edward C. Kwok

[57] **ABSTRACT**

A LAN network switch includes a RAM forwarding database which contains the address-to-port mappings for all the workstations or other devices connected to the switch's plurality of ports and further includes at least one CAM-cache connected to respective one or more of the switch's ports. The CAM-cache, having an access time much faster than that of the forwarding database, stores selected ones of the address-to-port mappings. When it is desired for the switch to forward a packet, the destination address is extracted and the CAM-cache is accessed and searched. If the correct mapping is contained in the CAM-cache, the packet is immediately forwarded to the destination port without accessing the much larger and slower forwarding database. Only if the CAM-cache does not contain the correct mapping is the forwarding database accessed to retrieve the correct mapping. The packet is then forwarded to the destination port, and the CAM-cache is updated with this mapping so that succeeding packets having the same destination address-to-port mapping may be forwarded to the destination port by accessing only the fast CAM-cache and, by eliminating the need to access the much slower forwarding database, increasing the forwarding speed of the switch.

8 Claims, 3 Drawing Sheets



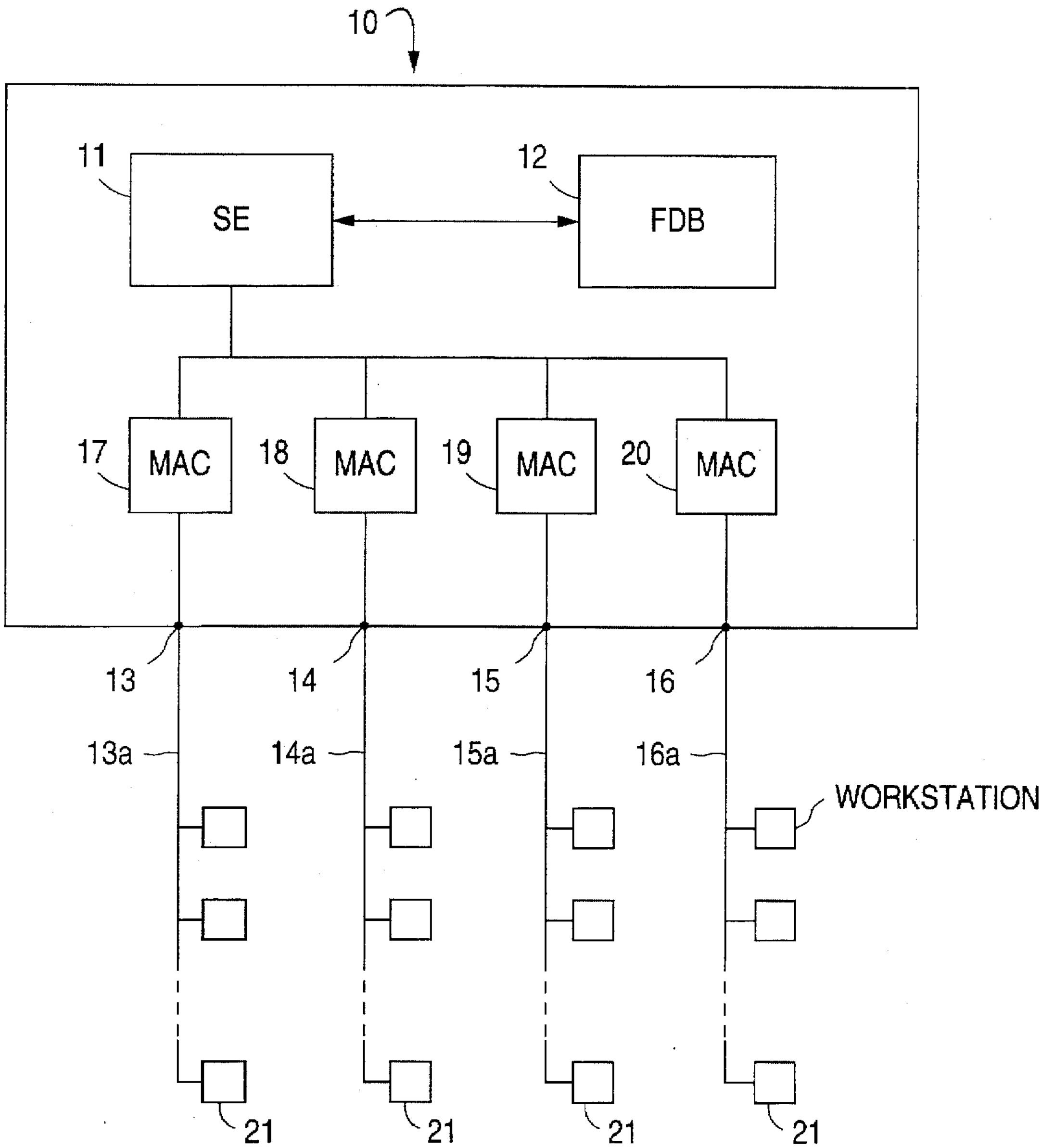


FIG. 1
(PRIOR ART)

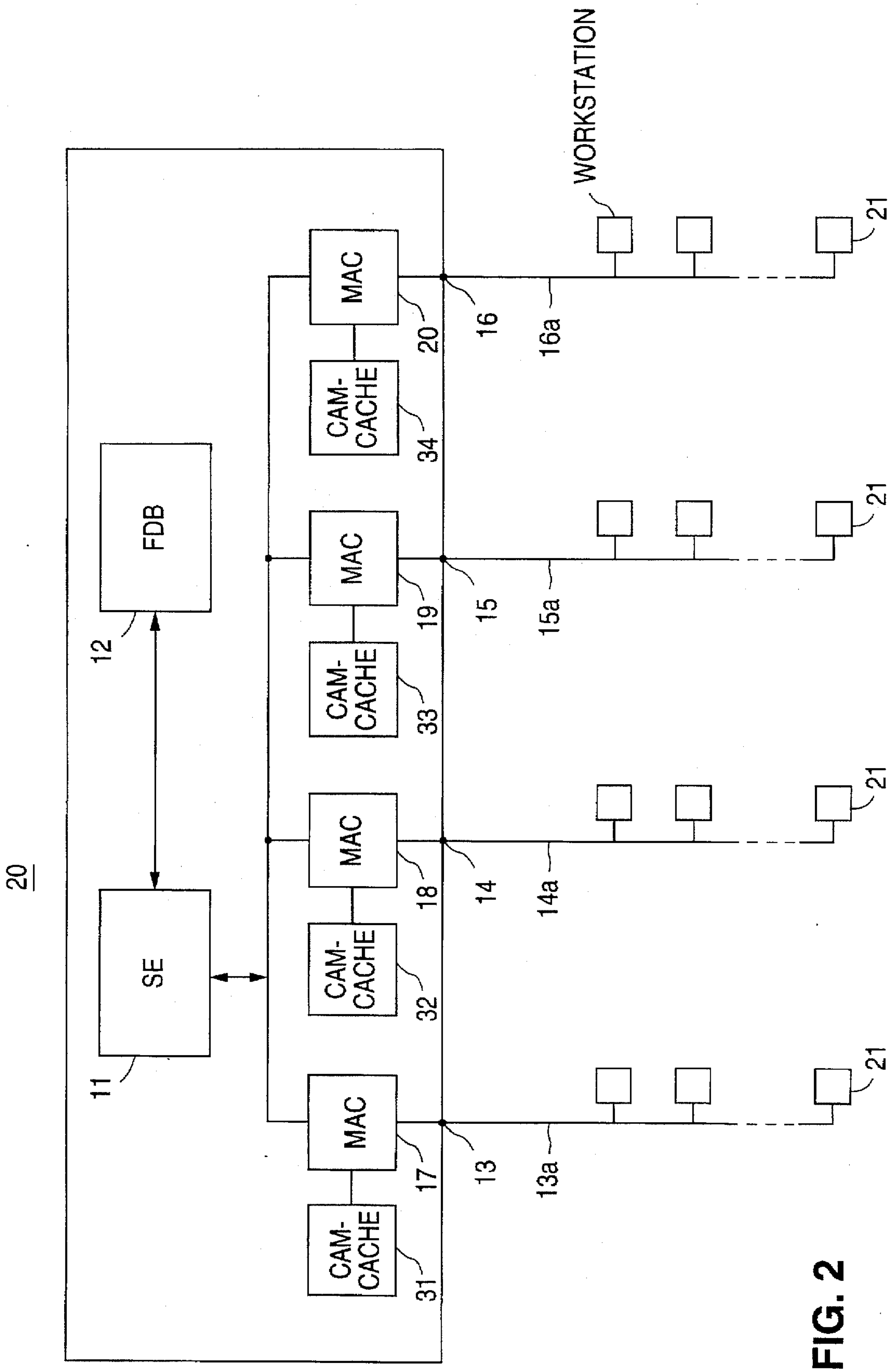

20
WORKSTATION
FDB
12
SE
11
MAC
MAC
MAC
MAC
CAM-
CACHE
CAM-
CACHE
CAM-
CACHE
CAM-
CACHE
31
32
33
34
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FIG. 2

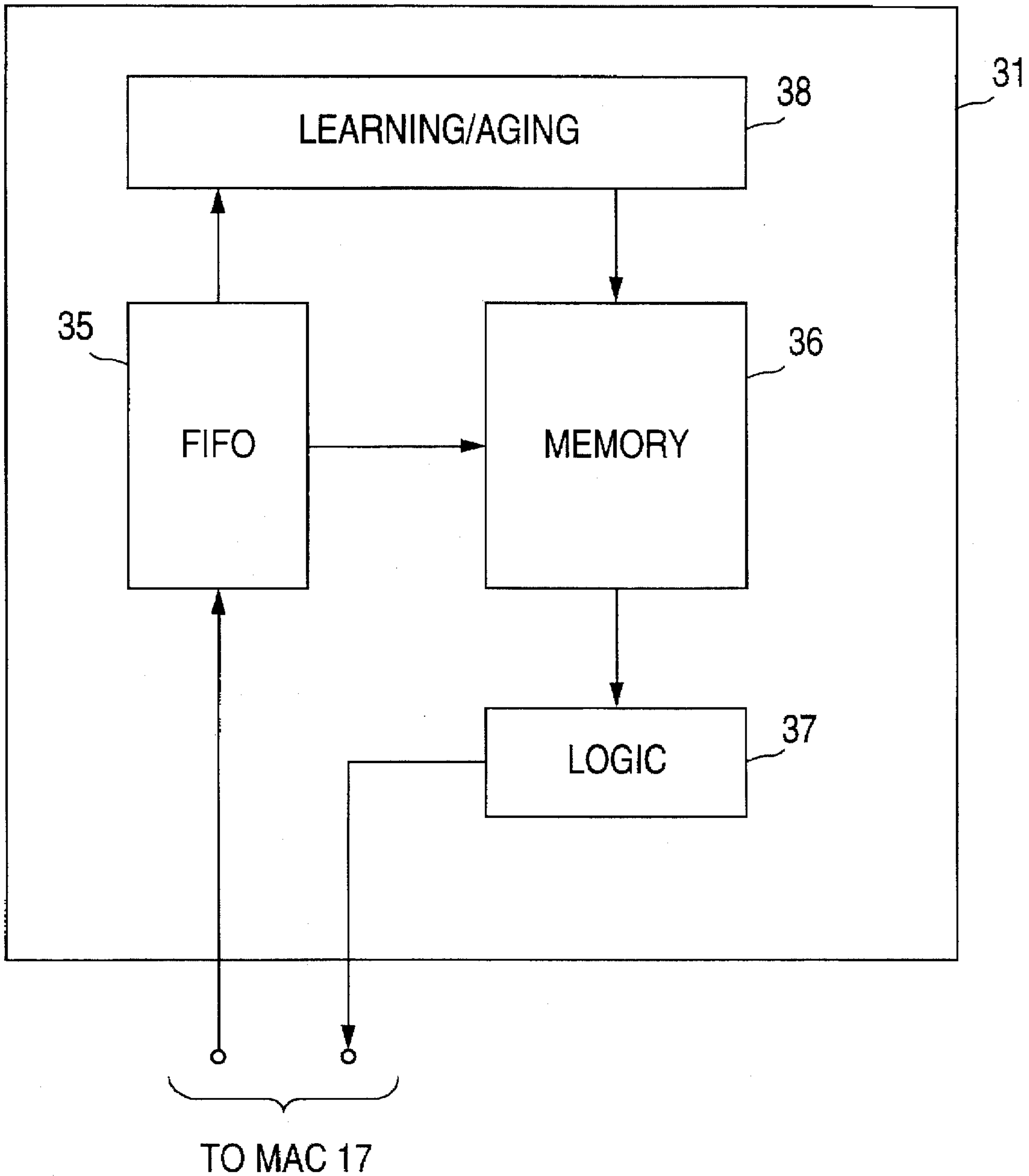

FIG. 3

FORWARDING DATABASE CACHE FOR INTEGRATED SWITCH CONTROLLER

FIELD OF THE INVENTION

This invention relates to a communications switch and in particular to an Ethernet switch controller.

BACKGROUND

Local area networks (LANs) have become increasing popular in business and industrial applications, in part because of their flexibility in allowing multiple users to communicate with one another and with one or more commonly accessible servers. A typical LAN system may include hundreds or even thousands of individual workstations or user interface devices such as PCs. Communication between workstations and any attached server(s) is controlled in accordance with ethernet protocol, IEEE 802.3.

More recent LANs employ a network switch to interface between groups of attached workstations, as shown in FIG. 1. A network switch **10** typically includes a switch engine (SE) **11**, a forwarding database (FDB) **12**, and one or more dozens of ports **13–16**, each having an associated network segment **13*a*–16*a***, respectively, attached thereto. Each of segments **13–16*a*** may, in turn, have one or more workstations **21** "hanging" therefrom. Note that switch **10** is shown to have only **4** ports **13–16** for simplicity. Media access controllers (MAC) **17–20** are provided at associated ones of ports **13–16.**

Switch **10**, operating in accordance with IEEE 802.3 protocol, directs data transmission between segments **13–16** of the LAN. Data is typically transmitted as a series of data packets, each containing a source address and a destination address. Upon receiving a packet of data from a source workstation **21** hanging on for instance port **13**, MAC **17** alerts SE **11** of the incoming packet and of its destination address. SE **11** allocates memory (not shown) to temporarily store the packet and directs MAC **17** to forward the packet to memory. SE **11** uses the destination address to retrieve from FDB **12** the correct destination address-to-port mapping (destination mapping), and then alerts the MAC associated with the destination port where in memory to retrieve the temporarily stored packet. The MAC then forwards the packet onto the associated port's attached segment where it can be retrieved by the MAC associated with the destination port. This "destination" MAC then forwards the packet to the destination workstation **21.**

SE **11** must be able to retrieve the destination mappings from FDB **12** fast enough to keep pace with incoming packets. If FDB **12** is too slow, incoming packets will undesirably be queued in SE **11**. Unless SE contains a fairly large memory, queuing packets in such a manner not only reduces the speed by which switch **10** forwards data but also may result in the loss of queued packets.

FDB **12** is typically implemented either as a hardware content addressable memory (CAM) or as a RAM. A hardware CAM is very fast and can typically retrieve mappings in less than 100 ns. A RAM, on the other hand, requires a searching algorithm and typically requires several microseconds to locate the correct mapping and, thus, is typically too slow to keep up with SE **11.**

Although much faster, however, a hardware CAM database large enough to service a LAN having as few as a hundred or so attached workstations can be prohibitively expensive. A RAM-based database, on the other hand, can be implemented at a fraction of the cost of such hardware CAM.

Choosing an appropriate network switch thus requires a balancing between cost and performance. As the speed and size requirements of an associated LAN change, however, the initial choosing between a CAM and a RAM database may become invalid. For example, the performance limitations of a RAM database may be insignificant in a LAN system having only a few attached workstations and be far outweighed by the cost savings afforded by such a RAM database. Where, however, it is desired to increase the number of attached workstations is dramatically increased, the RAM database may not be fast enough to keep pace with the now more congested communication between network segments, thereby resulting in, as mentioned above, slower forwarding speeds and lost information.

Thus, there is need for a network switch which is not confined by the rigid balancing between the superior performance of a CAM database and the cost savings of a RAM database.

SUMMARY

A network switch is herein disclosed which overcomes problems in the art discussed above. In accordance with the present invention, a network switch for use in a LAN system includes a RAM forwarding database containing the address-to-port mappings for each workstation or other device connected to the switch's plurality of ports, and also includes a CAM-cache connected to each of the switch's ports. The CAM-cache has an access time much faster than that of the forwarding database.

Upon receiving an incoming data packet, the MAC associated with the source port will, after extracting the destination address from the packet, access its associated CAM-cache to find the correct address-to-port mapping. If the correct mapping is contained in the CAM-cache, the packet may be immediately forwarded to the destination port without having to access the much larger and slower forwarding database.

Where the CAM-cache does not contain the correct mapping, the MAC then causes the correct mapping to be retrieved from the forwarding database. The packet may then be forwarded to the correct destination port. The CAM-cache is then updated with this mapping so that succeeding packets having the same destination address-to-port mapping may be quickly forwarded to the destination port by accessing only the fast CAM-cache, thereby eliminating the need to access the much slower forwarding database. The size of the CAM-cache is kept to a minimum in order to achieve savings in implementation costs. In this manner, present embodiments may achieve faster forwarding speeds without substantial increases in cost.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a LAN system employing a conventional network switch;

FIG. **2** is a block diagram of a LAN system employing a network switch in accordance with one embodiment of the present invention; and

FIG. **3** is a block diagram of a LAN system employing a network switch in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION

Embodiments in accordance with the present invention are described below in the context of a distributed DMA architecture for simplicity. However, it is to be understood

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