LIFETIME ACHIEVEMENT AWARD - 2015

Robert "Bob" Norman is the recipient of the 2015 FMS Lifetime Achievement Award. He was the key system architect of "System-Flash," the hardware and firmware that has made both NAND and NOR flash a practical medium for data storage throughout the computer industry.

System-Flash uses a processor and firmware to manage the flash cells using techniques including wear leveling, error correction, low-stress write/erase and the Flash Translation Layer. By implementing these in a device having a standard storage interface, flash-based devices became plug-compatible replacements for disk drives. System-Flash remains the foundation for the flash industry by enabling mobile computing and ubiquitous access to personal data.

Eli Harari, co-founder of SanDisk said "In 1988, I recruited Bob Norman as our first engineer beyond the founders because he was one of the best disk drive controller architects in the industry. Bob taught current CEO Sanjay Mehrotra and me about disk drives, and we taught Bob about Flash Memory. Bob captured our combined efforts into a document that was the blueprint for a flash SSD. Today's award is a long overdue and well-deserved recognition of Bob Norman's enormous contribution to our industry."

Bob Norman also pioneered other important advances in disk drive controllers, error correction and servo control while working at SanDisk, Micron, StorageTek, Texas Instruments and AMD. With over 200 issued patents and others pending, Bob remained a prolific inventor until his passing in early 2021.

SunDisk Team 1991

This 1991 SunDisk (now SanDisk) photo shows **Bob Norman (the blond-haired engineer with glasses in the middle of the photograph)**. This group photo was taken when Sundisk was delivering their 20MB 2.5 inch ATA SSD to GRiD for use in their GRiDPad pen computer. This was the world's first Flash Memory SSD. Jeff Hawkins (at the far right) was GRiD's VP of Research at the time, and he went on to found Palm Computing and Handspring. Shortly after their contract with GRiD, SunDisk landed a contract with IBM to deliver 10,000 SSDs.

Dan Auclair: SVP of Engineering (Bob Norman's boss)

Eli Harari: CEO and Co-Founder
Bob Norman: Dir. of System Engineering
James McNamara: GRiD Sr. Hardware Engineer
Jeff Hawkins, GRiD VP of Research
(crouching in front) John Mangan: Firmware Engineer

The First Flash-Based SSD

📄 1991 SunDisk Press Release about a PCMCIA SSD (completed a few months after the ATA SSD), and it includes the signatures of Bob Norman, Eli Harari and others.

📄 US Patent No. 5,297,148
> Bob Norman is an inventor on this patent (as are Eli Harari and Sanjay Mehrotra)
> Fig. 1A from the patent illustrates the System Flash for which Mr. Norman received the Lifetime Achievement Award. It shows a Controller managing Flash Memory (within dashed lines at upper right) in a computer system (the remainder of the image)
> The first sentence of the patent's Abstract states that the invention describes how flash memory can be used to emulate a disk drive
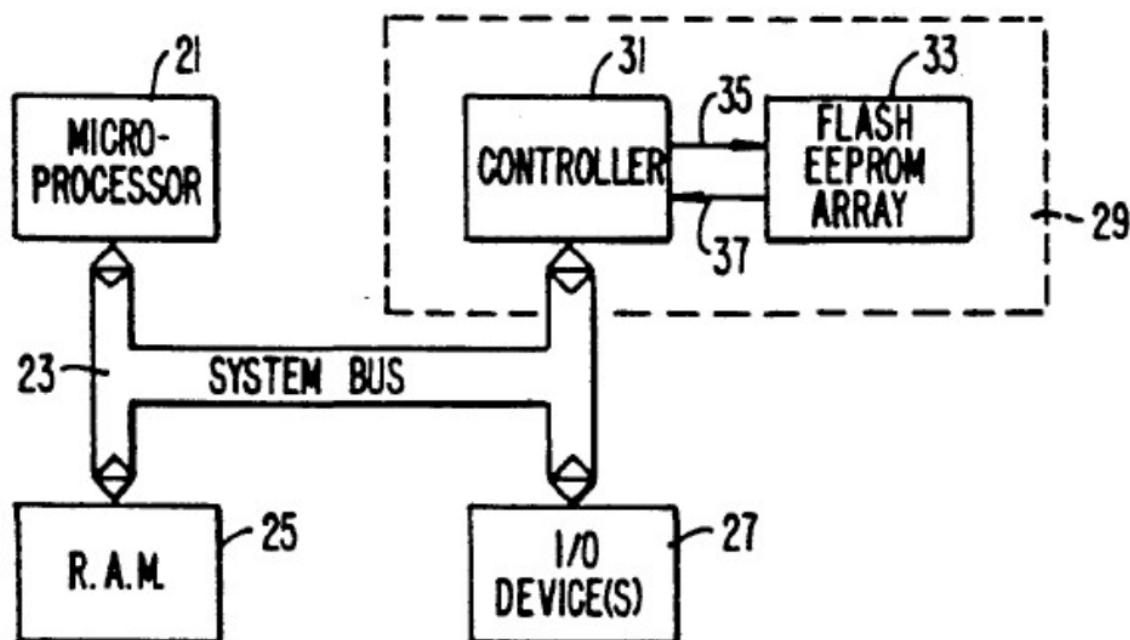> The priority date of this patent is April 13, 1989

FIG._IA.

[57] **ABSTRACT**

A system of Flash EEprom memory chips with controlling circuits serves as non-volatile memory such as that provided by magnetic disk drives. Improvements include selective multiple sector erase, in which any combinations of Flash sectors may be erased together. Selective sectors among the selected combination may also be de-selected during the erase operation. Another improvement is the ability to remap and replace defective cells with substitute cells. The remapping is performed automatically as soon as a defective cell is detected. When the number of defects in a Flash sector becomes large, the whole sector is remapped. Yet another improvement is the use of a write cache to reduce the number of writes to the Flash EEprom memory, thereby minimizing the stress to the device from undergoing too many write/erase cycling.