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BACKGROUND ON FORRESTER COMPUTER MEMORY

The invention of magnetic core computer storage dates back to the late 1940s at the M.I.T. Digital Computer Laboratory.

The Laboratory was established in 1946 under the direction of Dr. Jay W. Forrester, then a research engineer and now Professor of Industrial Management. The Laboratory drew initial support from the Office of Naval Research to which was later added support by the U.S. Air Force.

The Laboratory developed the Whirlwind computer, one of the first high-speed electronic digital computers, for application to science, engineering and experiments for the processing of air defense information.

By 1949, it became clear that the bottleneck in computer design was the internal memory, in which commands for the complex computer operations are stored. Relays and electronic tubes had been found too slow or too bulky and lacked the necessary speed or reliability to satisfy the rigorous requirements of the applications on which Dr. Forrester and his associates were working.

In the middle of 1949, the idea came to Forrester of making a memory system with magnetic cores capable of bistable operation through the use of materials having nearly square hysteresis loops, and electrically exciting them by coincident currents. The cores were to be toroidal (doughnut shaped) in form, and each was to have a magnetic flux which

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could be set to one direction or the other around the core. The "state" of the core was determined by the direction of the flux in the core, that is whether clockwise or counterclockwise.

Each core was to have a number of wires through it, and the direction of flux could be changed only by passing pulses of current through two of the wires at the same time. A pulse through only one wire at a time would not cause any change. Each core could then store a single "bit" or binary digit of information.

The cores were to be arranged in columns and rows to form planes, and the planes were to be arranged in a three-dimensional stack, so that a large number of cores could be arranged in a small space.

The use of cores for computer memories had been suggested earlier but they did not utilize the features of coincident-current excitation which solved the problem of selecting the desired core.

Memory systems using the cores were built at the M.I.T. Digital Computer Laboratory and were incorporated into successful computers. In the early 1950s, the Laboratory was joined with several other groups to become the M.I.T. Lincoln Laboratory. It was at Lincoln that the first core system -- developed earlier at the Digital Computer Laboratory -- was incorporated and successfully operated in the Whirlwind computer.

Further development was done by Dr. Forrester's laboratory in cooperation with others, and a great deal of development work was done by other experimenters. One of the developments was in ceramic cores, which had the advantages of small size and fast operating speed. Improvements in cores have been made continually until some cores are now less than one-fiftieth of an inch in diameter. A single core is barely visible to the naked eye but it has its hole in the middle, through which four wires are passed to form the rows and columns of the memory plane.

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The core memory, as it is called, was so successful that almost every large computer now uses it. In the opinion of competent authorities, it was the core memory that broke the bottleneck to make the modern computer possible. So fast has been the expansion of the computer industry that the demand for cores has exceeded all estimates, and the numbers of cores now being made run into billions per year.

Forrester filed a patent application on the core memory system and assigned it to Research Corporation, a non-profit organization devoted to handling inventions made at universities. The assignment was in accordance with a long-standing agreement with Research Corporation for handling of inventions made by M.I.T. faculty and staff. Under policies established by M.I.T. as early as 1932 and continued through the present day, M.I.T. recognized that an inventor should participate in the proceeds of any income from his invention. Under the agreement with Research Corporation, therefore, a part of the proceeds from the invention were to be paid to Dr. Forrester and a part to M.I.T.

In keeping with the standard policy of the Department of Defense, a royalty-free license was granted to the United States Government, whereby the Government could make or purchase memory systems without payment of any royalty. This form of license insures that the Government will have free access to inventions developed with Government funds, while the inventor and the university have the right to participate in income from commercial uses of the invention.

Forrester's patent was obtained in 1956, but his inventorship was contested in the Patent Office by Dr. Jan A. Rajchman, a researcher in the employ of Radio Corporation of America, who had filed in the Patent Office a patent application describing a form of magnetic memory system. The contest was carried through the Patent Office and then through the

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United States District Court in New York City in a suit between Research Corporation and R. C. A. Research also brought suit against International Business Machines Corporation, charging infringement of the Forrester patent.

The agreement between Research and M. I. T. was terminated in 1963, and M. I. T. then became a party to both the R. C. A. and the I. B. M. suits.

Last week, more than eight years after the Forrester patent was granted, these complicated cases were ended. In a series of settlements entered by Judge E. J. Dimock of the United States Court in New York, the long litigation against R. C. A. was terminated by a consent judgment in which Forrester's position as inventor of the coincident-current core memory was established. And the suit against I. B. M. was terminated by a license granted by M. I. T. to I. B. M. In that license, I. B. M. elected to pay M. I. T. lump sums based on its estimated future core production as related to past production and a figure of \$13, 000, 000 was negotiated. Under the agreement between R. C. A. and M. I. T., R. C. A. will use the invention under a combination of royalty-free and royalty-bearing licenses, depending on the use. Proceeds from the patent will be used by M. I. T. for enrichment and expansion of its educational program.

Professor Jay W. Forrester has been a member of the Faculty of M. I. T.'s Alfred P. Sloan School of Industrial Management since 1956. He is applying his earlier work in digital computers and servomechanisms to developing the field of "industrial dynamics," a new approach to the design of corporate policy based on the feedback system character of the industrial enterprise.

Professor Forrester's book, "Industrial Dynamics," (M. I. T. Press, 1961), was chosen by the McKinsey Foundation in 1961-62 as one of the five books most important to managers.

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