Memorandum M-1320

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Digital Computer Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

SUBJECT: Third Meeting on Air Defense Computer, Nov. 7, 1951

To: Jay W. Forrester

From: B. E. Morriss

Date: November 7, 1951

Those present were:

Forrester, Jay W.
Adams, C. W.
Brown, D. R.
Everett, R. R.
Israel, D. R.
Morriss, B. E.
Papian, W. N.
Taylor, N. H.
Walquist, R. L.

The meeting began with a discussion on transfers of information between magnetic cores. Referring to Figure 1, flux in a clockwise direction is assumed to indicate a zero and in a counterclockwise direction a one.

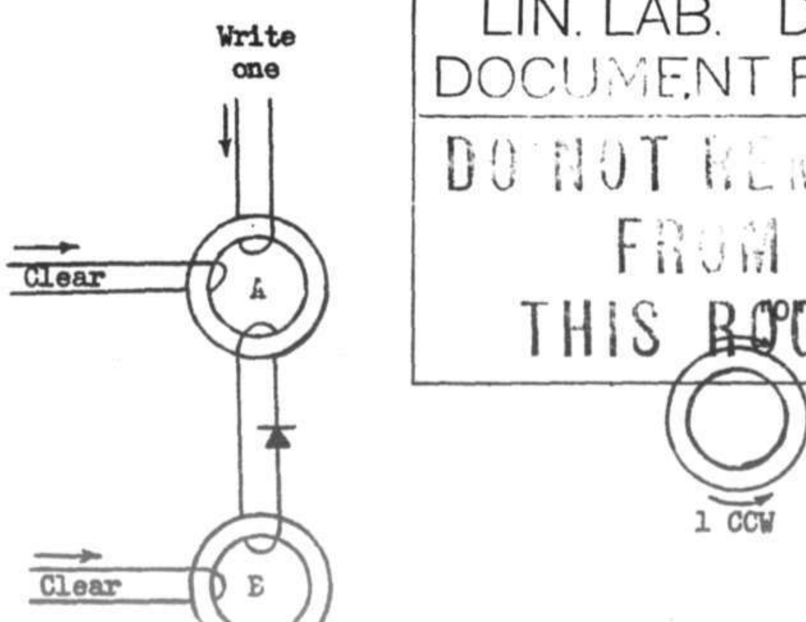

Figure 1.

If both cores are in the zero condition, 0,0, and a one is written in core A, then B will remain in the zero state, and 1,0 will be their new states. Now a pulse on the clear line of A will reverse both cores and 0,1 exists. Finally, if the clear line of B is pulsed core B will be cleared and the one transferred back into core A, giving 1,0. Thus with core B cleared and A containing a 0 or a 1, a reading out of core A by pulsing the clear line followed by a clearing of core B should leave both cores in their original states and could be a useful method of getting around the destructive read-out which seems to be inherent to the magnetic cores. Unfortunately a one-to-one turns ratio had to be assumed between cores A and B; this will not be sufficient, however, due to losses in the transfer. A two or three-to-one ratio is usually used between the driver and driven cores in a stepping register. With repeated transfers the fluxes will become weaker and weaker, and after one or several such transfers probably will be too weak to switch cores. It was suggested that the addition of a small amount of MMF directly into the core into which information may be transferred might be sufficient to make up for the losses in transfer. This additional MMF would be small enough so that it would not change the state of the core if no transfer takes place. An alternative to trying to use two cores as explained above was the use of three cores in a manner similar to present stepping register techniques. If the cores are connected as shown in figure 2 and core A is read-out (cleared), it may be restored to its original state by first clearing core B and then core C.

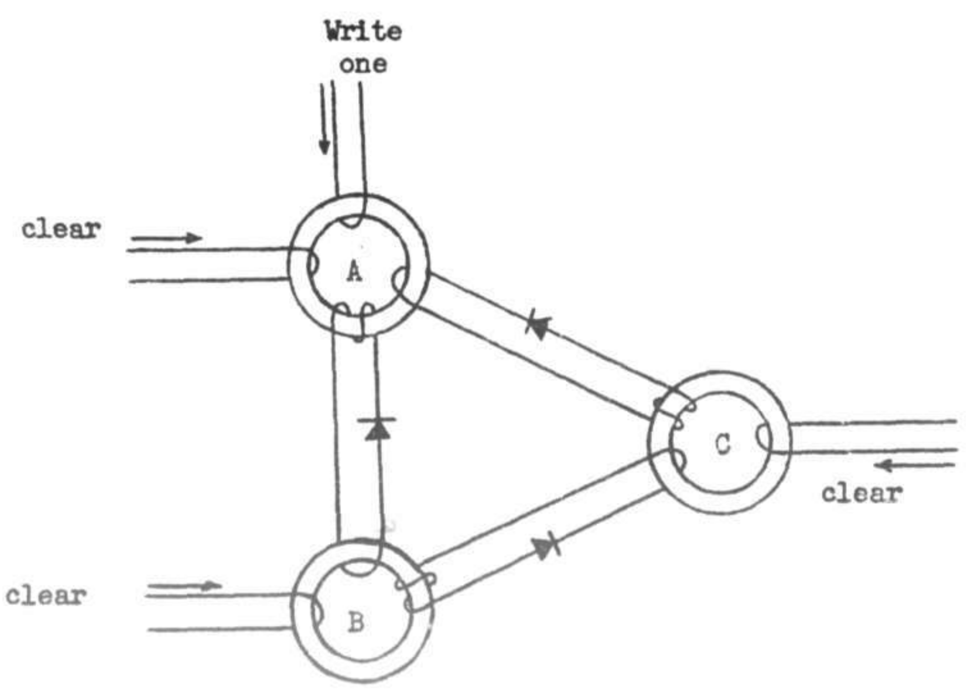

Figure 2.

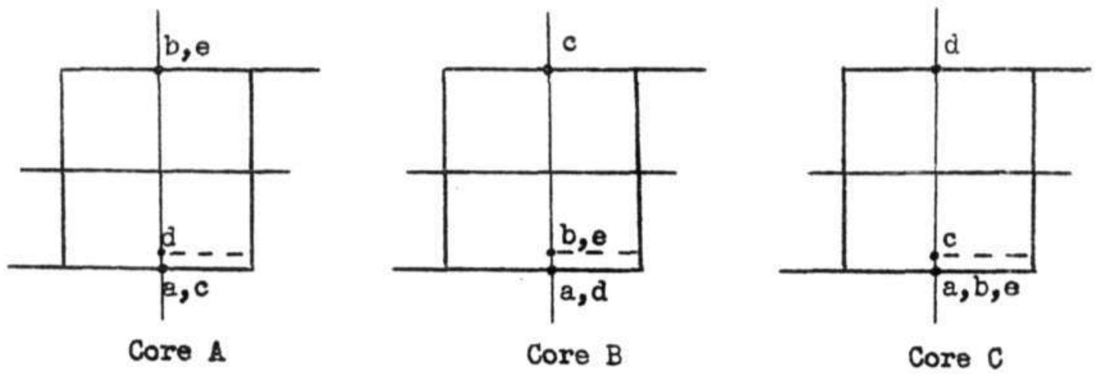

Figure 3

Figure 3 indicates the state of each of the cores at different stages:

a — all clear
b — write one in A
c — clear A (read out)
d — clear B
e — clear C

Thus if all of the cores start in the cleared (zero) state, core A may be changed to one without appreciably changing cores B and C. Since cores B and C are in the zero state, core A may be cleared (read-out) and returned to its previous state by then clearing first B and then C. To return all three cores to the cleared condition after writing a one in A requires pulsing all three of the clear coils simultaneously.

The shunt crystals and series resistors or inductances used at Harvard or by Haynes at the University of Illinois were reported by W. N. Papian to be unnecessary because of the turns ratios of the coils. It is possible to read-out of the three cores in a cyclic fashion eliminating the need of cycling the information back to core A after every read-out if there is a convenient method of remembering and gating this process.

Mr. Papian said he would have the question of transfers between cores further investigated. This included transfers between two cores and between a power core, gate core, and information core. Will a gate core have a sufficient output to drive another core? Another fundamental question was how much energy could be passed through a single core from the input winding to the output winding? These were also to be investigated.

Mr. Brown mentioned an interesting piece of news about transistors. Transistors which previously have been operated with 6 to 10 milliamperes have now been used with 120 to 160 milliamperes to operate relays. The transistors seemed to operate well. The question of whether transistors had been slighted in the discussion was asked by R. L. Walquist. This was answered in several ways. Transistors do not seem nearly as useful as cores for storage elements because no easy way has been found to select and read them out of a storage array. Many other people are working on transistors, but very few with cores. At this time it is much more important to discuss ways to eliminate registers rather than how they may be built.

The necessary size of the computer was discussed briefly. This was defined in terms of the problem which was given to be approximately one thousand aircraft in a square three hundred miles on a side. The figure of a three hundred mile square was reached as a compromise between the desires of having to transmit information over as short a distance as possible to the computer, having to transmit small amounts of information between computers to give the overall picture, the number of computers which would be necessary for the job, and a reasonable size for each computer.

Mr. Adams, Mr. Israel, and Mr. Walquist were asked to think about the functions of a buffer storage. What should be its size, speed, and modes of operation? Consider a 2-3μs storage shared by input-output and by the computer. How important is it to have large quantities of random access internal storage available to input-output as compared to having a magnetic drum? What are the fundamental reasons for times between making use of information? Mr. Israel expressed the view that there was more information obtainable when several successive returns on the same target by the same or different radars are considered together than when they are considered one at a time as they come in. This brought up the question of how can the past history be adequately preserved without attempting to save a large number of returns. Another point which had a bearing on this was that it may take 30 seconds before it is possible for an aircraft to make a change of position which can be detected as compared to a 10 to 15 second scan rate.

Mr. Forrester presented some ideas on how a simplified control might be obtained. A set of flip-flops could be used as the time pulse distributor and control switch controlling magnetic gates. These magnetic gates might be of the type commonly referred to as Olsen's magnetic gate. When a steady output rather than a pulse is desired an RF carrier could be used. Mr. Brown and Mr. Taylor will discuss this in more detail with Mr. Olsen.

Tomorrow Mr. Israel will discuss his investigation of multiple address coding and the conclusions reached. Mr. Walquist will discuss the sharing of functions and interrelationship of various parts of the overall system. Examples of this might be conversion from range and azimuth to x and y coordinates, shuffling of data, clutter rejection, and correlation of data outside of the computer proper.

Signed B. E. Morriss
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Approved JWF
Jay W. Forrester

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