How an Electronic Brain Works

Part XIII—SEAC, the 800-tube Thinking Machine

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IN the last five articles, we discussed the organization of an automatic electronic digital computer (for short, an electronic brain). In the seven before those, we described the organization of a similar machine made out of relays. Now in this article—the last one of the series—we shall take a good look at one of the big automatic electronic digital computers. This one is the National Bureau of Standards Eastern Automatic Computer, SEAC. It began to operate in May, 1950.

Fig. 1 is a picture of SEAC in one of the buildings on the grounds of the National Bureau of Standards in Washington, D. C. But, like any photograph of a machine that handles information, this photo does not tell very much.

SEAC came to be built as a result of three factors. The first of these was the demonstration that giant electronic computers could be built and made to work. ENIAC, now at the Ballistic Research Laboratory in Aberdeen, Md., proved that. ENIAC started working in 1946 and has been working ever since.

The second factor was the decision of the office of the Air Comptroller, Department of the Air Force, in early 1948, that it needed a big automatic computer for the study of supply programs for the Air Force. The question is: what sort of materials and personnel should be supplied and trained at what times, so that the United States should have the best possible Air Force? This is a prodigious planning problem, and it must be planned. The Air Force set up Project SCOOP (Scientific Computation of Optimum Programs) for this purpose.

The third factor was private industry's continuing delay in constructing giant automatic electronic digital computers. Two firms received government contracts for big electronic computers in 1946-47. One finished its first machine in 1951, the other company has not yet finished its first big computer.

So the Air Force and the Bureau of Standards got together in early 1948; and by the end of 1949, the machine system, the circuits, and the construction techniques had been settled on, and construction begun. The machine SEAC was completely assembled in March 1950. After some preliminary computing, it ran its first significant practical problem in May, 1950. This short period of 20 months was a fine accomplishment. The main reason was the decision to stick to well-established techniques.

The appearance of SEAC

When you walk into the room where SEAC is, and see the front of the machine, it looks like Fig. 1. It is about 15 feet long, 5 feet deep, and 8 feet high. The nine racks are: 1, 2, 3, the control unit; 4 and lower 5, the arithmetical (or computing) unit; upper half of 5 and all of 6, the time pulse generator; rack 7, upper half, the clock pulse generator; rack 7 lower half, spare; racks 8 and 9, controls and power supplies, and also the circuits for the input-output systems using punched tape (this is the first of the planned input-output systems). But there is more to SEAC.

If you walk around the machine to the right, and go behind, you find another large bulky cabinet about 5 feet wide, 3 feet deep, and 7 feet high. This contains the machine's "memory," or rather the first installment of the memory of the machine, the "serial memory." This cabinet consists of 64 units like the one shown in Fig. 2—a long glass tube filled with mercury, mounted in an aluminum holder, and connected to recirculation amplifiers; these units are "mercury delay lines" (see Article VIII). Each of these tubes stores eight units of information called "words." The words are usually numbers, but may be sets of logical indications, or instructions to the machine.

If you take a good look at a certain part of the machine, you will see an assembly like that shown in Fig. 3. This is an inside view of a section of the main part of SEAC. It shows, first, long fiber tubes containing short lengths of electrical delay lines—"rapid memory"; and, second, clusters of germanium diodes mounted in the tube bases—used as high-speed electronic switches.

The register which stores instructions (which we called the "program register" in our last article) is shown in Fig. 4. Fiber turrets support the resistors in the gating circuits; these turrets make the resistors accessible, and allow them to cool. In aluminum shields on the rear of the chassis, there is a coiled electrical delay line which can delay for 48 microseconds. When the computer is working, this delay line stores an instruction word (consisting of 48 binary digits) in continuous circulation.

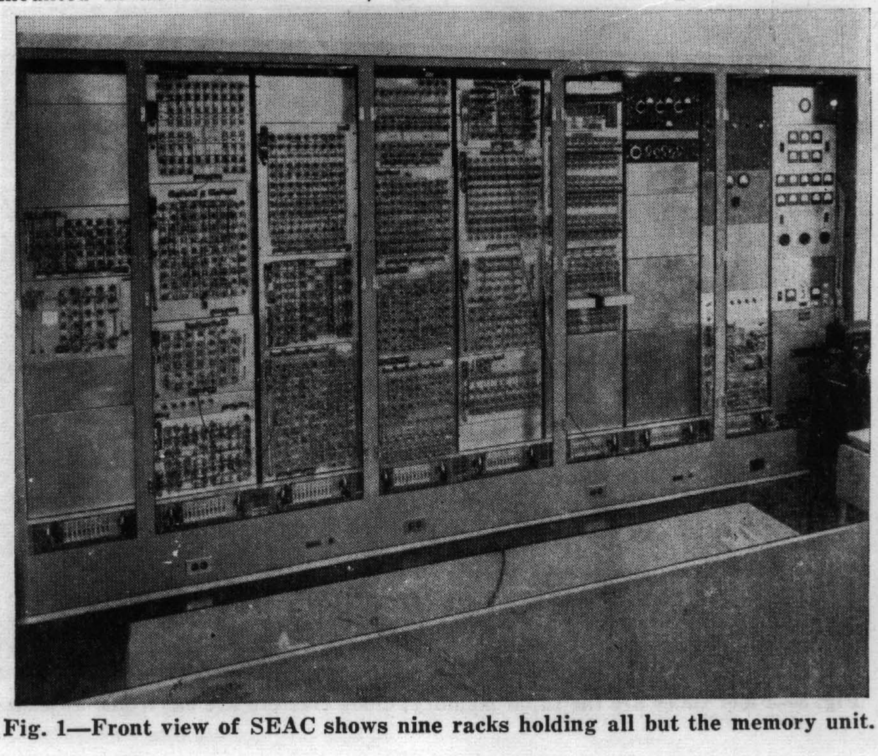

Fig. 1—Front view of SEAC shows nine racks holding all but the memory unit.