Automatic Digital Computer M-1 of the I.S. Brook Laboratory

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Abstract. This article describes the history of creation of the first digital computer in Russia. It started in the electronic systems laboratory of the Energy Institute of the USSR Academy of Science, led by I.S. Brook. The first developer was N.Y. Matyukhin. The computer M-1 consisted of arithmetic unit, main program sensor (control device), internal memory of two types (fast one – on cathode-ray tubes and the slow one – on magnetic drum), and an input/output device using telegraph alphanumeric equipment. By the end of 1951, for the first time in the world, the M-1 started working in experimental mode with fast-acting storage device made on common LO-737 cathode-ray tubes. The computer successfully passed complex tests and was switched to operational mode. For the first 1.5 years, it had been the only computer in the USSR.

Keywords: I.S. Brook, N.Y. Matyukhin, first computer in Russia, M-1

1 Introduction

In the December of 1951, the electronic systems laboratory of the Energy Institute of the USSR Academy of Science, led by I.S. Brook, issued a scientific and technical report called the "Automatic digital computer M-1". It was the first scientific document about the creation of native electronic computer in the USSR. The machine had successfully passed the required tests and soon, they had switched it to operational mode.

The beginning of I.S. Brook's scientific researches on issue of digital computers dates on 1948. He was the first person in the USSR (together with B.I. Rameev) to develop the design of a digital computer with hard program control. First certificate on invention of "Electronic computer with common bus" appeared in December 1948.

A resolution of the USSR Academy of Science presidium on the start of the development of the M-1 was published 22 April 1950. I.S. Brook was in charge to form a command of developers. The first developer was N.Y. Matyukhin, a young specialist who just graduated with honors in radio engineering from the Faculty of the Moscow Energy Institute. Brook familiarized him with the main concepts of construction of the electronic computer, and soon they together developed a future computer structure, its main characteristics, and specific solutions of many technical situations. Later on, Matyukhin with permanent support of Brook practically carried

out all the functions of the head designer. Below is a fragment from memoirs of Nikolay Yakovlevich:

> "I'll make an effort to revive pictures of our work under I.S. Brook's direction, reproduce the atmosphere of the first working years in the sphere of computer engineering."

2 The M-1 and its Development Team

The formation of group and the commencement of work on the AEC (automatic electronic computer) M-1 began in the summer of 1950. Brook enrolled a command of young specialists from the radio engineering faculty consisted of seven people:

- Two junior research officers – A.B. Zalkind and N.Y. Matyukhin
- Two students engaged on their degree thesis – T.M. Alexandridi and M.A. Kartsev
- Three technicians – Y.V. Rogachev, R.P. Shidlovsky, and L.M. Zhurkin

A first assignment from Isaac Semenovich was to develop a valve for a triple-entry summarizer, as I recall. The second assignment was to produce a standard working table. The third assignment from the group manager was the development of the AEC M-1.

Serious difficulties occurred during the development of the M-1. The project realization was in jeopardy due to a complete lack of component parts. Isaac Semenovich suggested a peculiar way to obtain the necessary material by using the storehouses from the war years. The resulting elements of the project consisted of the following ideas and "trophies":

- combinations of small items made of components from very different origins
- only two types of electronic tubes
- vitriolic rectifiers of electronic measurement equipment
- cathode-ray tubes for the oscillograph
- Trophy teletype from Vermacht's general material

Some of Brook's guiding principles included:

- deep understanding of goals, simplicity and vividness of argumentation;
- no "excoriations" on failures;
- respectful treatment to performers.

The AEC M-1 consisted of arithmetic unit, main program sensor (control device), internal memory of two types (fast one – on cathode-ray tubes and the slow one – on magnetic drum), and an input/output device using telegraph alphanumeric equipment. In the autumn of 1950, the N.Y. Matyukhin "command" reached completion.

Matyukhin and Rogachev were in charge of developing the arithmetic unit and the logical element system. Kartsev and Shidlovsky oversaw the development of the main program sensor system. Matyukhin and Zhurkin were responsible for the storage device on magnetic drum and T.M. Alexandridi was in charge of the storage device on the cathode-ray tube. Zalkind and D.U. Ermochenkov developed the input/output device system. V.V. Belynsky oversaw the power development and A.I. Kokalevsky supervised the construction design. Matyukhin was in charge of the

complex tuning of the computer, its technology, and its regiment of performance testing.

3 Designing the M-1

Fundamentally, new technical solutions were proposed and realized during design and development of M-1, especially the double address command system, which we used widely later on in native and foreign computer engineering. Later Matyukhin wrote about this solution as follows.

> "Command system choice was very tricky case – at that time triple address system was generally accepted and thought to be mostly natural. This system required rather high digit rate of register equipment and memory. Our limited possibilities stimulated researches of more efficient solutions. As it sometimes happens in dead end situations, occasion helped. At that time I.S. Brook invited young mathematician Y.A. Shreider. Shreider assimilated the basis of programming, directed our attention on the fact that in many formulas of approximate calculation operation result is the operand for next operation step. That was the start of the first double address system. Our proposals were approved by I.S. Brook, and AEC M-1 became the first double address system".

For the first time in world practice of computer design, we built diode logical elements on semi-conducting elements. Matyukhin estimated the significance of this step in his memoirs:

> "One of the principal solutions, that, on my mind, predetermined the success of our first computer and short creation time, was the line, accepted by Brook on usage of semi-conducting elements. At that time, they appeared in our industry only in compact vitriolic rectifiers, issued for measurement equipment purposes. Brook arranged the issue of special modification of those rectifiers in proportions of common resistor, and we created the set of typical schemes. The creation and assembling of blocks started in laboratory workshop, and less than in one year computer began to "breathe".

Serious problems had arisen during design of electrostatic memory. We all knew that the USA and the USSR had developed special cathode-ray tubes – potential scopes. However, they were inaccessible for us. I.S. Brook determined to use common cathode-ray tubes LO-737, used in oscillographs.

Around that time in September of 1950, a new student engaged doing a degree thesis from the radio engineering faculty appeared in laboratory; her name was Tamara Alexandridi. Brook suggested carrying out the degree thesis in "electrostatic storage devices", intended for AEC. She conducted the first experiments on cathode-ray tubes of the common oscillograph and other additional measurement equipment. These experiments showed that indeed, they could achieve the information memorization effect on cathode-ray tubes. Thus, the design of electrostatic storage device for M-1 started. In the spring of 1951, Alexandridi wrote and defended her thesis called, "Electrostatic storage devices". At the same time, the invention of the electronic memory came into existence. By the end of 1951, for the first time in the

world, the M-1 started working in experimental mode with fast-acting storage device made on common LO-737 cathode-ray tubes.

4 M-1 Characteristics

Work on M-1 tuning ended in the autumn of 1951. By December of that year, the computer successfully passed complex tests and was switched to operational mode.

The M-1 had interesting characteristics. We delineate them here.

- Scale of notation – binary.
- Number of binary classes – 25.
- Command system – double address.
- Internal memory size:
  - On electrostatic tubes – 256 addresses,
  - On magnetic drum – 256 addresses.
- Operational speed:
  - With slow-acting memory – 20 operations/sec,
  - With fast-acting memory:
    - Composition – 50 mksec,
    - Multiplication – 2000 mksec.
- Electronic valves quantity – 730.

5 Conclusion

Academicians A.N. Nesmeyanov, M.A. Lavrientiev, S.L. Sobolev, and A.I. Berg became acquainted with the work of AEC M-1. One of the first people to solve atomic objectives on the computer was Sobolev, who was an assistant on scientific work in Kurchatov's institute.

For three years, the machine had been running in operational mode and for the first 1.5 years, it had been the only computer in the USSR. Only one copy of the M-1 existed. However, its architecture and many of its principal schematic solutions became a foundation for the development of a series of new machines such as the M-3, the "Minsk", and the "RAZDAN".

The M-1 creators became great specialists in computer engineering and noticeably contributed to computer development; they spearheaded many different scientific, educational, and industrial collectives. Their works had been highly recognized by academic degrees, honorary titles, and governmental awards. In the end, N.Y. Matyukhin became a Corresponding Member of USSR Academy of Science. Doctor of Science, Professor M.A. Kartsev became the director of Science and Research Institute of Computing Complexes. They both were the principal designers of large computers in the USSR.