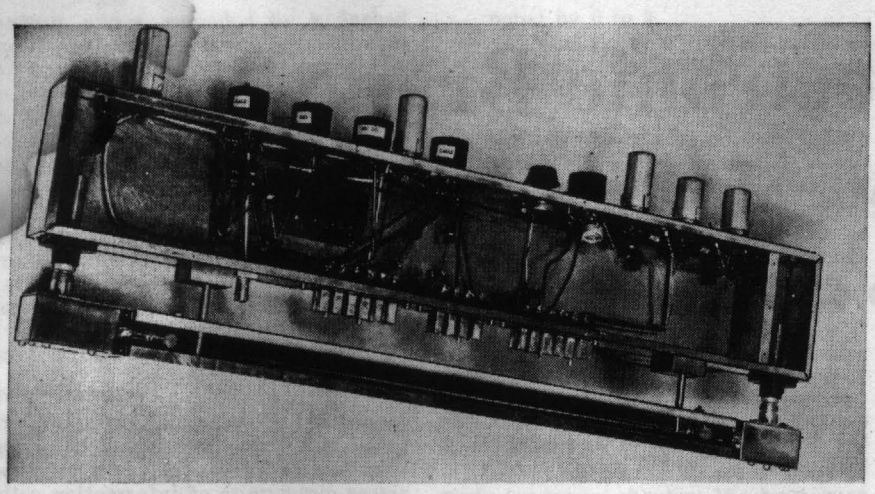

Fig. 2—One of 64 mercury delay lines in the serial memory section of SEAC.

How SEAC is organized

The over-all block diagram of SEAC is shown in Fig. 5, as drawn by the Bureau of Standards. The switch symbols indicate electronic operations performed automatically under the direction of the control unit of the machine. The time for switching is about 1 microsecond.

The usual five parts of the block diagram of an automatic computer are all here in the six blocks drawn. Input and output are shown at the top of the diagram in Fig. 5. In the machine, input consists of: (1) manual keyboard; (2) 5-hole paper-tape reader; (3) magnetic-wire reader, reading one channel of magnetized spots on wire. Output consists of: (1) a teletype printer; (2) paper-tape punch; (3) magnetic wire recording.

The next lower block in the block diagram is the "parallel memory unit." This unit was not in the machine when it started working in 1950, but at present writing is under test, about to be completed. It consists of 45 "electrostatic storage tubes" (see Article VIII of this series), each able to store 512 spots. This added faster memory will speed up the machine considerably.

The next two blocks are the arithmetical (or computing) unit, and the control unit of the machine. The last block is the second part of the memory, "the serial memory unit," consisting of the cabinet of the mercury delay lines.

The flexibility of the machine is indicated in the diagram by the solid-line arrow going into the control unit. This means that information from its various parts can affect the control of the machine.

The basic pulse rate of the machine is a million cycles per second. It contains 800 vacuum tubes, 500 pulse transformers, 11,000 germanium diodes, and 100,000 soldered connections. When the parallel memory is added, another 300 vacuum tubes and 4,500 germanium diodes will be added to the figures above.

All the information-manipulating as such in this machine is done by circuits using germanium diodes—rectifier circuits such as those described in Article XII. So far as information-manipulating goes, vacuum tubes are used only to change positive pulses to negative ones or vice versa.

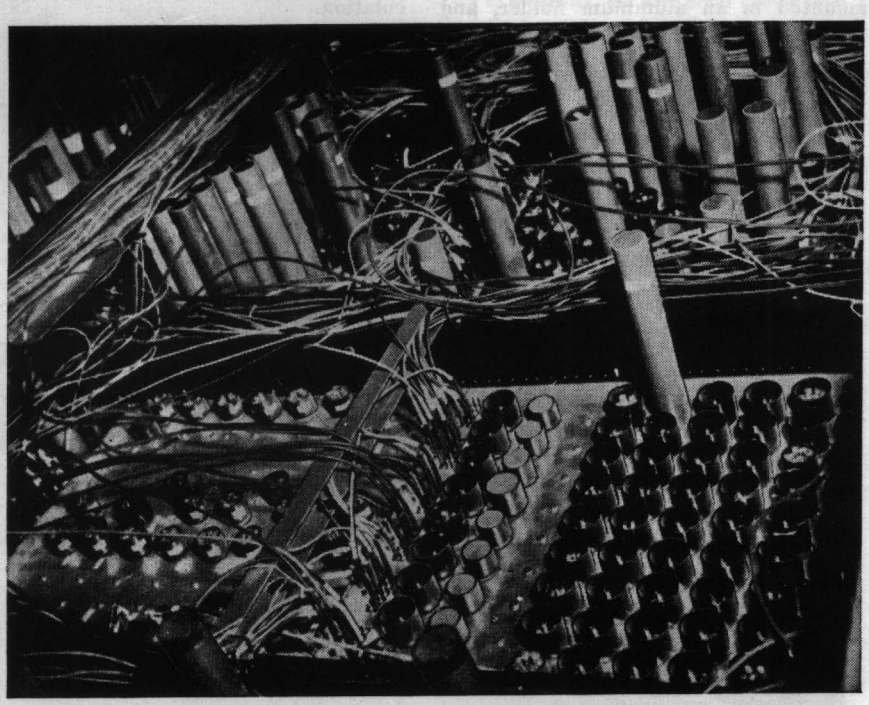

Fig. 3—Fiber tubes are the rapid memory; diode clusters are electronic switches.

How information is handled

The regular piece of information in SEAC consists of 45 binary digits, ones or zeroes, and is called a word. A word may be a number of 44 binary digits, together with one more binary digits designating the sign (plus or minus). Or the word may be an instruction, or group of instructions. A 44-binary-digit number is equivalent to an ordinary number of about 13 decimal digits.

Two instruction systems may be used with SEAC. One is called a "four-address system." The machine is told the *address* (or register number, or memory location) of the first *operand* (number to be operated with); the address of the second operand; the address where the result of the operation is to go; and the address where the next order number is to be found. The other is a three-address system; and the address where the next order is to be found is normally the next consecutively numbered memory location (see the discussion of programming in Article XII of this series). Each instruction also includes four binary digits used to specify the operation that the arithmetical unit is to perform on the cycle when it is obeying such instruction (the letters of operations shown in Chart 1 are translated into machine language).

The operations, and the time in thousandths of a second they require, are shown in the chart. For example, take multiplication. Most of the time, if we multiply two 13-decimal digit numbers together, like 1.789789922981 and 2.566566783422, we want the answer to only 13 decimal digits. We shall be content to throw away the right-hand part, and we will use order R. Only when we are interested in 26 decimal digits of accuracy will we want the right-hand part. Only in that event will we use the M and N orders.

The time shown for addition is 0.9 milliseconds and for multiplication is 3.0 milliseconds. Hence SEAC will on the average perform about 1,100 additons per second or 330 multiplications per second.

SEAC handles numbers only in pure binary form. Hence if any decimal number is to be used, it must be converted into pure binary. But SEAC is clever. It will take in the decimal number, convert it to pure binary, calculate with it, and when the results come along, will turn them back into decimal number form.

This conversion and all other mathematical work is accomplished by programming the machine. Once a program or routine for a type of computation