has been worked out and translated into machine language, it can be stored on paper tape or magnetic wire, and given back to the machine whenever needed.

Even this labor can be reduced. For example, the Harvard Computation Laboratory has worked out a "coding machine" which will enable one to punch on a keyboard ordinary mathematical symbols, and let the machine prepare the detailed instructions for the automatic computer in machine language.

Problems worked on

What are the problems that SEAC has worked on? Up to the end of 1950, SEAC has put in 525 hours on problems for the Office of the Air Comptroller, solving large systems of linear algebraic equations in connection with planning of programs for the Air Force. It spent 72 hours in the study of the starting transient of a class C oscillator. It spent 68 hours determining sample sizes corresponding to the minimum variance in a census, using sampling methods. It spent 48 hours calculating the solution of a 27th-order system of ordinary differential equations relating to the neutron capture theory of the formation of the chemical elements in the universe. This problem was posed by the Applied Physics Laboratory of Johns Hopkins University.

Most of the problems are of course quite beyond the intelligent understanding of everyone but those few who have made a special study of the field in which they occur. We, the authors of this article, confess that we have to recite the above problems like parrots, repeating them from literature put out by the Bureau of Standards, with only a dim notion of what they mean!

But one problem we can understand is the following: SEAC calculated that the number 9,999,999,977 is a prime number, that is, has no factor except itself and 1. It did so by actually trying 80,000 trial divisors (the right trial divisors which would prove it) in 80,000 long divisions and finding that there was a reminder every time. It took SEAC 30 minutes to do that. A man with a desk calculator, working eight hours a day, would take about two months to do the same problem!

Operating experience

The operating experience on SEAC has been reported for October, November, and December, 1950. In those three months, the Bureau of Standards planned to operate the machine 24 hours a day, 7 days a week. Of each week's 168 hours, "preventive maintenance" was scheduled for 16 hours. Of the remaining time, half was devoted to the solution of problems, and the balance to computing machinery development and testing.

Now, in those three months, with regard to the part of the time allocated to problem solution, the average of "good" time was 76%. In fact, in the last week, the average was 96%. By

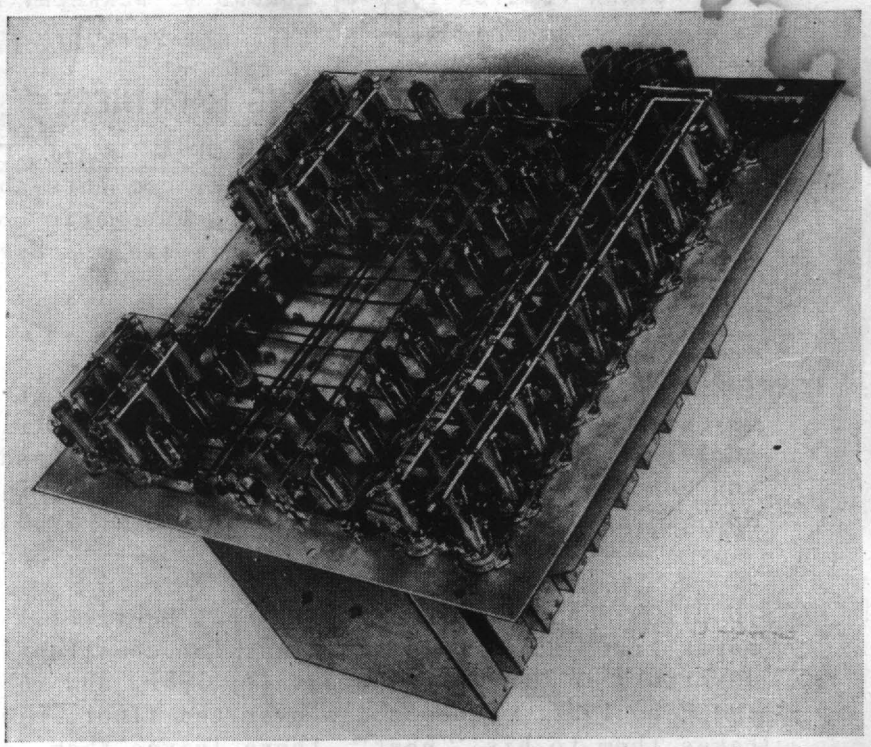

Fig. 4—Program registers were described previously. This is the SEAC unit.

CHART I

Operation	Abbreviation	Time*
1. Addition	(A)	0.9
2. Subtraction	(S)	0.9
3. Multiplication		
a. Major or left-hand part, unrounded	(M)	3.0
b. Major part, rounded	(R)	3.0
c. Minor or right-hand part	(N)	3.0
4. Division	(D)	3.0
5. Comparison (This is a conditional transfer of the control of the machine based on the value of the arithmetical result in the arithmetic unit)		
a. Value taking into account the sign plus or minus	(C)	0.7
b. Value disregarding the sign plus or minus	(K)	0.7
6. Logical Transfer (This is an arbitrary partial word transfer, for the purpose of forming composite words)	(L)	
7. Input-Out Control		
a. Read-In	(T)	50.0
b. Print-Out	(P)	50.0
c. Reverse Motion (This time is based on using input-output with a single channel magnetic wire, and handling words in blocks of 8 words)	(7)	50.0

*In milliseconds for complete operation including average access time.

"good" time is meant time when either problem solutions or coding checks were produced correctly, or when the machine was in good operating condition but idle—as may happen when the machine is being changed from one problem to another.

Thus we can see that if a machine doing 1,000 operations a second is operating at 75% efficiency, it is still worth a good deal more than a machine that does 2 or 3 operations a second with 100% efficiency.

Achievements such as SEAC's are the pay-off, the end result of the long, fascinating road of computer design and construction and testing and operation, so that more of the mental drudgery in the world can be lifted off the minds of human beings. And we hope that many of the readers of RADIO-ELECTRONICS will take a good look into the field of electronic handling of information, and attack some of the big problems of today, such as lower cost,

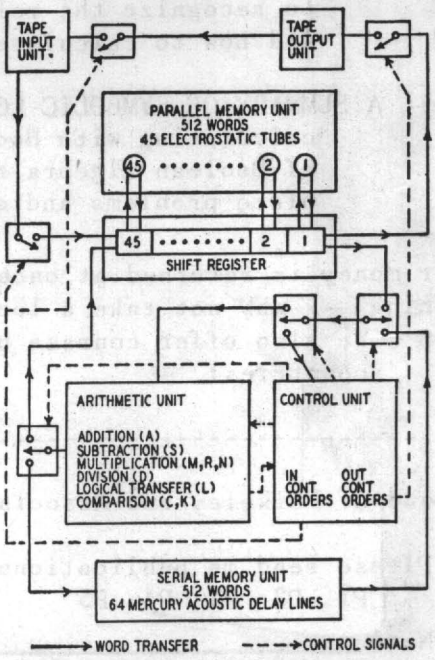

Fig. 5—How signals travel in SEAC.

more and cheaper memory, cleverer ways of programming machines, and the other great and interesting unsolved problems in this new field.

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