How an Electric Brain Works

PART II

Simon, the little moron described last month, now learns how to add

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

IN the last article we observed how an electrical brain could store information in a register and transfer information from one register to another.

What do we mean by a "register" and "information"? A register is any physical equipment that can store information, and information is an arrangement of equipment that has meaning. For example, the registers we spoke of were relays, and the information stored in them was a pattern of 1's (relays energized) and 0's (relays not energized).

Relays vs. tubes

Why use relays instead of tubes? After all, tubes can represent a pattern of 1's (conducting) or 0's (not conducting). And in changing its state from one condition to the other, a tube is very much faster than a relay.

We shall discuss tubes later in these articles. In the meanwhile, there are several reasons for concerning ourselves with relays. In the development of electrical brains, relays were used before electronic tubes; and it is some help in explaining electrical brains to follow the course of their development. In the second place, a circuit involving relays can be understood simply by seeing whether current will flow or not. But understanding a tube circuit involves many more factors, such as plate voltages, nature and strength of signal, the tube characteristics, values of the resistances, etc. In the third place, one relay may take the place of a number of tubes. For example, a six-pole, double-throw relay has 20 terminals including those of the pickup coil; a considerable number of tubes is required to do as much as that one relay. And finally, after the logical relations of circuit elements have been expressed once in any one form such as relays, it is easier to translate them into other circuit elements such as tubes.

We have seen how we can store information in a register and transfer it from one register to another, and now we wish to manipulate that information according to mathematical and logical processes. That is calculating. And the first of the calculating processes is addition. How can we add and calculate with electrical circuits?

Calculation is possible only with a good system for representing information. For example, the decimal notation using Arabic numerals, considered one of the great human inventions, is a remarkably fine system for representing numerical data. As a counterexample, the ancient Greeks used letters of the alphabet in a rather unsystematic way for numbers, and never got far with arithmetic. To calculate with electrical circuits we first must understand systems for representing information.

Representing information

Suppose we write down a piece of information such as 1,011. We are referring to a number which is equal to one 1,000, zero 100, one 10, and one 1. The positions of the digits report *powers* of 10—1; 10; 100; 1,000; 10,000; etc. Numbers written in this style are said to be in *decimal notation.* This notation is convenient for a calculating machine that contains dials that may take one of ten positions, like the speedometer of an automobile.

But this notation, convenient as it may be for human beings and some machines, may actually be inconvenient for most digital electrical brains containing two-position circuit elements.

Numbers may be written in other more useful notations. Two of them

* *Author: Giant Brains*

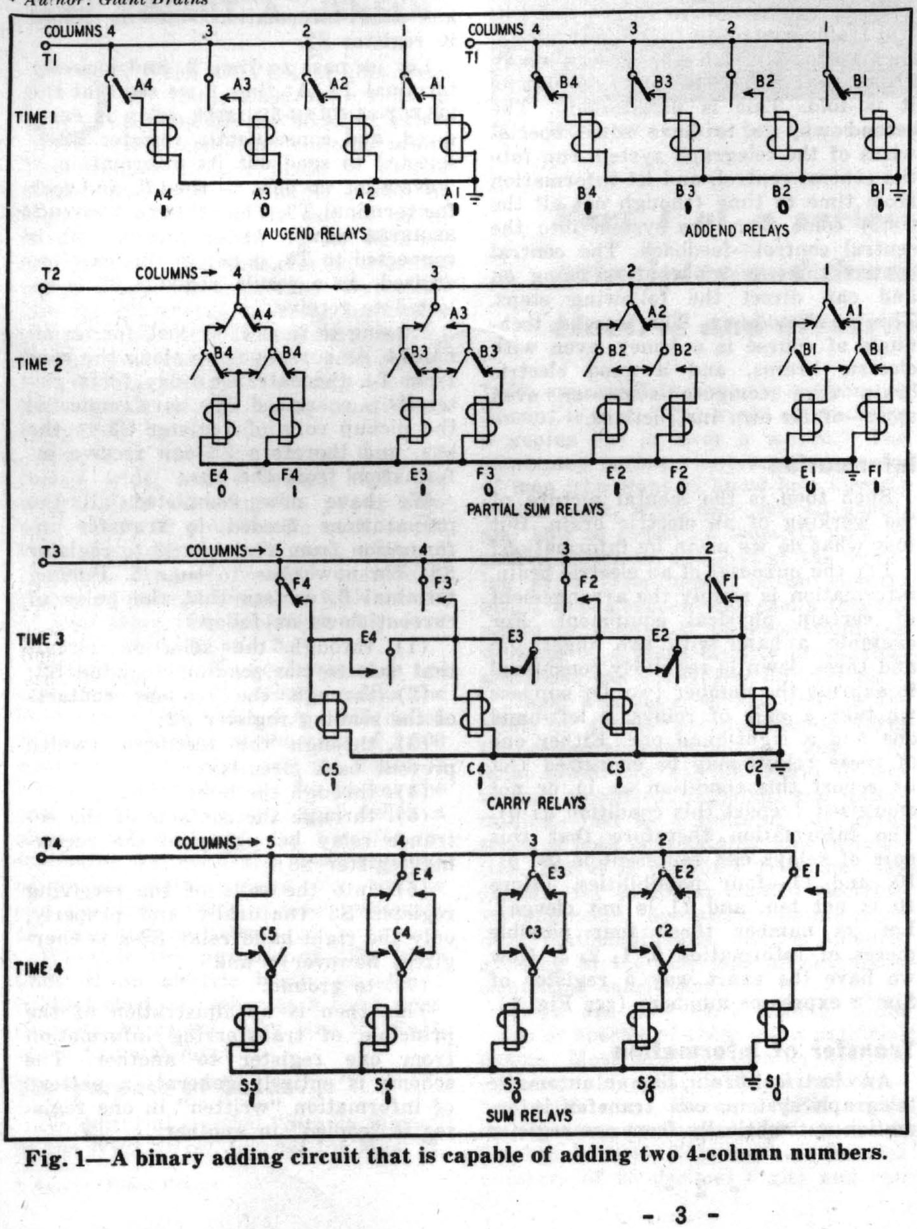

Fig. 1—A binary adding circuit that is capable of adding two 4-column numbers.