How an Electric Brain Works

Part V—Having learned his arithmetic, Simon is ready to be coordinated by automatic control so that he can learn to follow instructions and find the answer to a problem

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

IN previous articles of this series we have shown how an electric brain made of relays can:

1. Store information in registers;
2. Transfer information from one register to another;
3. Add, subtract, multiply, and divide;
4. Convert from decimal to binary notation, and back again.

These operations are the same as those of an automatic relay calculator. However, we have not yet completed the electric brain, for we have not yet arranged for these operations to be carried out in sequence one after another *under automatic control.* This we shall now set out to do.

When an electric brain operates under automatic control, it carries out instructions one after another in some planned sequence. In one important type of electric brain, the instructions are written out on a long piece of tape, in a language the machine can read. The tape may be made of paper punched in a pattern of holes, or of plastic impregnated with magnetic particles, magnetized in a pattern of spots, or of other recorded material. As each section of the tape comes to the input reading device of the machine, the instructions are read by the machine and carried out.

* Author: Giant Brains

For example, we might desire to give to a machine instructions such as these:

1. Take 24.
2. Take 13.
3. Add them.
4. Store this result (result No. 1).
5. Take 45.
6. Take 31.
7. Subtract the latter from the former, and store the result (result No. 2).
8. Compare these results and record 1 if result No. 1 is greater, and 0 if result No. 1 is not greater.
9. Store this result (result No. 3).

When a machine can carry out a set of instructions such as this under automatic control, it is an electric brain. The capacity to store and refer to information (as these instructions imply) and to carry out a chain of operations is the essential capacity of a brain, mechanical, animal or human.

But how do we get a machine to do this?

Commands

In the first article of this series we noted that a mechanical brain was like a telegraph system with many stations, where information could be telegraphed from one station to another. Accordingly, the key to getting a machine to carry out a sequence of instructions is:

1. Organize each instruction in the form of a command involving two registers or stations (such as Albany and Boston), connect them to the main telegraph line, specify the direction of the message between them (for example, from Albany to Boston), and then transfer the information.
2. Give the computer a long series of successive commands, each of this same standard form.

It is a remarkable fact that almost all numerical and logical handling of information can be reduced to a series of identified commands (i.e., commands that are identified by numbers or labels): "Command No. .....: Transfer information out of register ....., into register ....., and then proceed to Command No. ....." This fact becomes easier to see when we remember that some registers are factories, and manufacture new information out of old, and so put out different information from that which went into them.

Yes, yes, you may say, that may all be very true, but up above you put down a series of instruction for an example: now how do you make a machine carry out that series of instructions—how do you convert them into a series of commands of the kind you speak of?

Here is what we do, supposing that we are to give the machine instructions from a tape (see Fig. 1):

1. Transfer information from INPUT station (where the tape is read, and at this time has 24 at the reading point) into COMPUTER REGISTER NO. 1 (the first register in the computer).
2. Transfer information from INPUT station (the tape has moved along, and now has 13 at the reading point for reading by the machine) into COMPUTER REGISTER NO. 2.
3. Transfer information from INPUT station (the tape has again moved along, and now has at the reading point a signal which means addition) into COMPUTER REGISTER 4 (which, we shall suppose, is a special register enabling us to make the computer add or do some other operation).
4. Transfer information from COMPUTER REGISTER NO. 5 (which we shall suppose is the output register of the computer) into STORAGE REGISTER NO. 1.
5. Transfer information from INPUT station (the tape has moved along, and now holds 45) into COMPUTER REGISTER NO. 1.
6. Transfer information from INPUT station (the tape now has 31 at that point ready to be read) into COMPUTER REGISTER NO. 2.

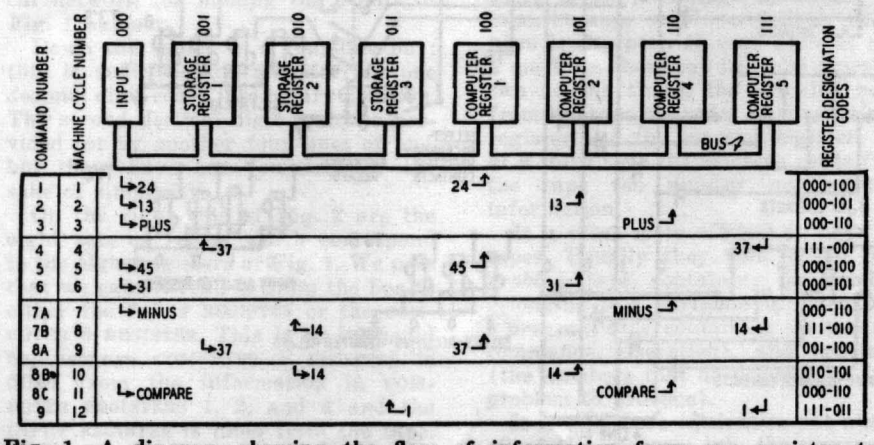

Fig. 1—A diagram showing the flow of information from one register to another in an electric brain in the process of executing a series of commands.