A BINARY MULTIPLIER-TRANSLATOR

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For my science project I have selected the design and construction of electronic brains. The first model I built used a design which appeared in the March, 1953, issue of *The Scientific American.* This machine was used to represent and solve the classic puzzle of a farmer crossing a river with a fox, a goose, and some corn. However, shortly after completing the project, I discovered that the design was incorrect. I then did some work on circuits and discoverd a correct design. This work gave me much valuable experience in circuit design which enabled me to design two others; these were a nim-playing machine and a binary translator. The construction of this latter machine gave me much experience in adapting the binary system to electrical circuits; this latter work was the inspiration for my multiplier.

Now let us examine this multiplier. Since it is based on the binary system, let us first take a look at this system. Just as our decimal system contains 10 digits and is based on powers of 10, the binary system contains 2 digits, 1 and 0, and is based on powers of 2. In the decimal system the power of 10 which a digit is the co-efficient of, is determined by the position of that digit in relation to the digit on the farthest right: that is, in the number 123, the 3 is the coefficient of 10°, the 2 of 10^1, and the 1 of 10^2. Thus the number 123 is equal to $1 \times 10^2 + 2 \times 10^1 + 3 \times 10^0$. The same things is true in the binary system. Therefore, 10011 in the binary system is equal to $1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$ or 19.

Since the binary system has only two digits, a 1 and a 0, the laws of multiplication are very simple. They may be summarized in the following table:

	0	1
0	0	0
1	0	1

After a brief look at this table it is evident that it also represents the law of series circuits, a 1 representing a flow of electricity, a 0 the absence of it. This property of binary numbers makes my multiplier possible.

Keeping these facts in mind, let us look at a binary multiplication:

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    101  (5)
    110  (6)
    000
   101
  101
  11110  (30)
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For purpose of illustration, I have chosen two 3-digit numbers. Note that there are three partial products, each containing 3 digits. Each of these 9 digits is the result of the multiplication of two of the digits in the two numbers to be multiplied. Now, since the law governing these multiplications is the same as that of a series circuit, a method of designing a multiplier becomes evident. If three single pole-single throw switches are used to represent a 3-digit multiplicand and three triple pole-single throw switches are used to represent a 3-digit multiplier, then the nine digits of the partial products can be represented by connecting in series each of the top three switches with one of the poles of the bottom three switches.

Now we come to the translating part. Each one of these 9 flows of current controls a certain number of impulses according to its position in the partial product. Since the final product is the sum total of these partial products, each digit is determined by the digit below it in the complete product. For example, in the sample multiplication, the coefficients of the three digits in the middle column are the same as that of the middle digit of the complete product, which is 2^2. Therefore, each of the 9 digits has a certain decimal value which is the product of its aparent value and the coefficient determined by its position. The complete product in the decimal system can be found by adding up all of these 9 values. Thus the machine can be constructed so that the number of impulses controlled by the flows are correct as to the position of the digit they represent. Now the product is represented by the total number of impulses sent out by the 9 flows.

Now that we have our product in terms of flows of electricity, it is easy to convert it to a decimal number. These impulses are each led to one contact of a large rotating scanner switch. As this switch rotates slowly, the impulses one by one are led to a counter. This counter tabulates the total number of impulses present. Of course if there is no flow of electricity, the counter does not record anything and switch continues rotating.

My machine contains the previously described switches, the rotating switch, and a Veeder Root counter. The switch is powered by pulsating direct current produced by a Christmas tree light flasher and a selenium rectifier unit. Since there are more impulses than could be contained on one deck of the rotating switch, I have installed a deck changer relay which allows power to pass from only one deck at a time. Other innovations are an indicator light which flashes when power is being received, a relay which cuts off the rotating switch when all points have been scanned, and a starter light which lights when the machine is ready to be operated. To operate the machine, merely turn on the main power switch, check and see if the starter light is on, and throw the switch which powers the scanner switch. Merely let it rotate until it automatically turns itself off and read the correct product from the counter.

I enjoyed designing and building this machine, and I believe that I have gained invaluable experience from it. In the future I plan to improve this machine and design and build others. This experience will be of great value to me, as I intend to go into this field in my future life at least as a hobbyist.

FORCED FEEDING OF IRRADIATED RATS

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INTRODUCTION

During the summer of 1955, I had the opportunity to learn something about scientific research while doing volunteer work in the Biochemistry Laboratories at Vanderbilt Hospital. While there, I became interested in a problem that arose and was allowed to do experiments on it. Before the experimentation began, I was carefully taught all techniques and checked on them. However, once I began my project, I did all the work myself. Before beginning the tests, I skimmed through the *Nuclear Science Abstracts*, *Chemical Abstracts*, and *Biological Abstracts* for what had previously been done on my problem. I then chose the titles of relevant articles and read the reports.

I would like to express my appreciation to Dr. Granville W. Hudson, who did all irradiation for me, to Dr. H. C. Meng, who supplied the fat emulsion which I used, and to Dr. John Coniglio, whose interest and confidence in me enabled me to stay cheerful when the work seemed hard or discouraging.

Technical terms used in this report are as follows:

r = the amount of radiation that will ionize a fixed volume of air at standard conditions.

Leucocyte counts = white cell counts.

Hematocrits = the percentage of red cells in the blood.

LD/50/30 days = lethal dose that will kill 50% of the animals in 30 days.

FORCED FEEDING OF IRRADIATED RATS

Immediately following a large dose of total body irradiation, rats eat little or nothing at all. The question has thus been raised: could the animals use food advantageously enough to decrease the mortality rate or at least to increase survival time? If so, we though that the answer to the problem of weight loss and early death might lie in forced feeding by stomach tube. Smith, Tyree, Patt and Bink (1) reported that forced feeding of a semi-fluid diet (composition not stated) to rats pretreated with cysteine and x-irradiated with 800 r, reduced post-irradiation