MATHEMATICS

Electric Calculating Machine Devised For Complex Problems

Made of Standard Telephone Switchboard Parts, Robot Receives and Answers Problems Over Long Distance

FOR THE FIRST time in mathematical history, problems can be solved by long distance teletyping.

A new electrical computing robot, synthesized out of standard telephone dial switching equipment, had complex mathematical problems punched into its keyboard in Hanover, N. H., solved the problem in its electrical brain in New York City and teletyped the answers back to appreciative mathematicians at Hanover.

The inventor of the machine, Dr. G. R. Stibitz of the Bell Telephone Laboratories, told the Mathematical Association of America about his electrical mathematical prodigy and asked the members assembled in a Dartmouth College lecture room to write out their own problems on the machine. The answers rattled back in less time than any human being could solve them. And they were free from the inaccuracies that human frailty sometimes commits.

Over a year ago mathematicians of the Bell Telephone Laboratories, charged with designing thousands of intricate circuits and pieces of apparatus through use of complex mathematical methods, felt the need of a new kind of calculating machine to solve their particular needs. Instead of making it mechanically out of gears, cams, etc., they turned to the intricate electrical relays and crossbar switches used to connect subscribers in the most modern dial telephone exchange. These relays became the computing mechanism. For the controlling mechanical-electrical brain, a teletype such as used by the thousands in business and telegraph offices was impressed into service. The keyboard used is the one that the operator of a manual exchange uses to dial a number on a dial exchange.

With the encouragement and cooperation of Dr. Thornton C. Fry, Bell Laboratories mathematics research director, and the expert knowledge of Samuel B. Williams, switching development engineer, Dr. Stibitz had his robot completed and working successfully in about six months. The robot has been a very useful member of the mathematics computing staff for another six months, during which it has been put through its paces and has made good.

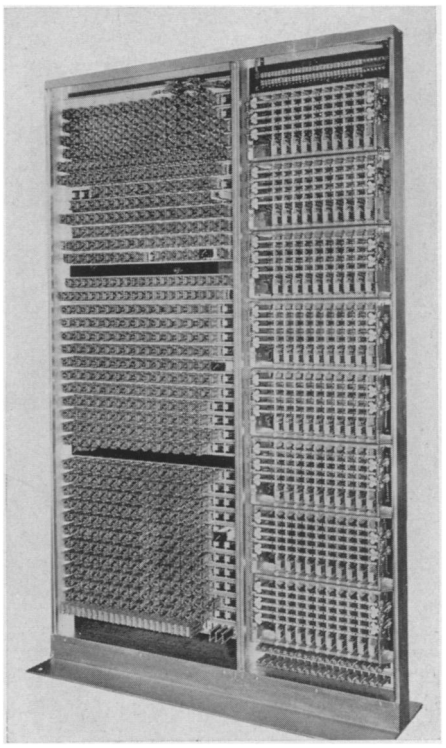
If the mathematical problems needing solving were simple ones, the Bell Telephone Laboratories would not have gone to the trouble of building a new kind of computer, costing somewhere in the thousands of dollars. In designing electrical apparatus, especially the sort that keeps long distance telephony distinct and useful, it is necessary to use the kind of numbers that even mathematicians call "complex."

To a mathematician a complex number is not just one that is long and complicated. It is a number that contains as part of it an "imaginary number." Perhaps you remember from your algebra that no one can ever find the square root of minus 1; for example, minus 1 multiplied by minus 1, under the rules of algebra, gives plus 1, not minus 1. It suits the convenience of some problems to use the square root of minus 1. So the mathematicians invented it, called it an imaginary number and agreed that it would be written "i".

The imaginary numbers or i numbers are very useful in handling alternating current problems, making them mathematically as simple as direct current problems. Filters and equalizers for long distance lines could not be designed without imaginary numbers. Over a dozen physicists and as many mathematicians and computers work on such problems all the time at Bell Telephone Laboratories, where the research for the nation's telephone companies is done.

For the present, at least, you will not be able to dial 211 and ask Long Distance to do your math problems for you. The electrical computer was made for use on the Bell Laboratories' own problems. The one machine constructed so far, when it gets through its demonstrations, will be fully occupied with real computing work already in sight.

Because imaginary numbers are being used in aircraft design and in geophysi-



NOT VERY SPECTACULAR

This is the "brain" of the new electric computing machine. It looks rather like the insides of an ordinary telephone switchboard, but it is so constructed as to perform complex mathematical operations in a fraction of the time that it would take a human brain.

ELECTRICAL MATHEMATICS

Computations by the new Bell Telephone Laboratories electrical computer are neat and accurate. Complex numbers, consisting of a real and an imaginary number, were multiplied and then the result was divided by one of the numbers to obtain the other. Note that the divisor was written before the dividend. This is done to allow the brain of the computer to get to work immediately after half of the second number is written, instead of having to wait until the whole number is completed. The last line proves that the machine knows simple arithmetic also. The way the machine was set up forced it to solve the problem as .2 x .2, which is .04.

+.56785432 +12564532 X +.45632450 +45367899 = +0.31612847^{+}+0.20028853
+.45632450 +45367899 \ +.31612848 +20028853 = +0.56785431 -0.12564532
+.20000000 +00000000 X +.20000000 +00000000 = +0.04000000 +0.00000000

cal prospecting for oil, this kind of machine may find use in other industries.

Its application to the Bell Laboratories work will be facilitated by the installation of special teletypes in all the computing rooms. Mathematicians will be able to walk across the room, type their problems and get the answer promptly.

The machine does the average problem in a third of the time taken by present methods using conventional computing machines. It multiplies twice as fast but divides about four times as fast. Computing work on a long-distance lines problem, for instance, usually requiring six months will be done in six weeks.

Mathematicians will be interested in knowing that part of the design of the machine was worked out by means of Boolean algebra, a newer kind which has also proved useful in symbolic logic.

The machine has not received a nickname as yet. Since it deals with imaginary numbers, it may answer to the name of "Yehudi."

Science News Letter, September 14, 1940

PUBLIC HEALTH

Mosquitoes Kept Suppressed On South's Eight New Lakes

EIGHT new lakes, formed by the eight great dams of the Tennessee Valley system, have become health and pleasure resorts as well as sources of wealth and power for the nation because the malaria-carrying mosquitoes are not permitted to breed in the shallow waters along their shores. Workers in shallow-draft boats, in low-flying airplanes, trudging along on foot, patrol every spot where the malevolent insects might lay their eggs, and prevent their coming with clouds of poison dust.

When the new lakes are all filled to normal height they lap shorelines totaling some 5,000 miles, or 25 times the shoreline length of the Panama Canal. Not a mile can be neglected, either, for the lakes lie in seven states that have in past times been known as the heart of the malaria belt.

Control of mosquitoes (and hence of malaria) in the Valley is the fruit of painstaking preliminary research, participated in by the U. S. Public Health Service, the Bureau of Entomology and Plant Quarantine of the Department of Agriculture, and the Rockefeller Foundation. Several steps in control were found necessary, and all have been most thoroughly carried out.

First came a complete clearing away of all bushes and other growths along the zone over which the water level fluctuates, as the dams are first closed for filling, then opened to maintain navigation heights in the streams and to develop power. Malaria mosquitoes love to lurk and breed in such sheltered places, and that part of the shoreline had to be shaved clean. It cost money at first, but saved heavily on poison dust expenditures later.

A second element in the new technique was a radical departure in the schedule of pool level fluctuation. The purposes of flood control, power and navigation would not always permit fluctuation of the pools at the times when the variation was most needed for mosquito control. Early in the construction program the Health and Safety Department succeeded in obtaining the addition of one foot (called the "malaria control surcharge") to the heights of the dams.

Starting at the beginning of the mosquito-breeding season, the pool level is varied once every week or ten days—first to the maximum and then down to the minimum, each succeeding time falling slightly short of the preceding maximum. In this way the pool level is kept always a little ahead of the encroaching vegetation.

Finally comes dusting of mosquito-breeding waters with Paris green, diluted with soapstone, so that only half a pound of the poisonous green powder is spread per acre of water treated. Airplanes are much used: in 1939, pilots flew more than 300 hours to spread more than 100 tons of dust over 82,000 acres of lake shore. Boats with oil sprays are also in use, and men on foot to get at the less accessible places. Lately, copper arsenite has been found quite as effective as Paris green, and only about half as expensive.

Public health officers keep close track of the incidence of malaria in the Valley. Every year they make approximately 20,000 blood examinations, from samplings of the population. In the area as a whole the number of malaria cases has already been reduced.

Science News Letter, September 14, 1940

INVENTIONS

Small Centrifugal Pump Efficient in Operation

A SMALL centrifugal pump for light liquids, that handles surprisingly large quantities despite its size, weighs only six pounds. (Eastern Engineering Company.) It is made of monel metal, stainless steel and chromium-plated bronze construction, and will be especially useful where weight and space for the pump must be kept at a minimum.

Science News Letter, September 14, 1940

Seals are good divers, and can stay under water for 12 to 15 minutes.

THIS IS WAR

But war of a kind that everybody applauds, for the man in the boat is "blitzing" the breeding places of malaria mosquitoes along the shallow lake shore with a cloud of poison dust. More than 5,000 miles of shoreline, along the Tennessee Valley's new lakes, are thus protected for the health and comfort of resorters as well as permanent residents.