

THE WEEK IN SCIENCE: A NEW CALCULATOR

By WALDEMAR KAEMPFERT.

OUT in the University of California are the Lehmers, father and son, worrying far more about the theory of numbers than about the closing of the banks. Dr. Derrick N. Lehmer is Professor of Mathematics in the university and Research Associate of the Carnegie Institution of Washington; his son, Derrick H., is a National Research Fellow in mathematics.

The theory that gives the Lehmers so much concern is very simple to state and very difficult to fathom mathematically. It deals with prime numbers. When a number is divisible only by itself and 1 it is a prime number. Examples are 1, 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, &c. It is easy to find out whether a number is prime or not when it is small. When it comes to such a serpent as 170,141,183,460,469,231,731,687,303,715,884,105,727, the mathematician knows that he could not live long enough to decompose it. Only a few primes are known beyond ten million and one of them is the thirty-nine figure colossus just quoted.

It was the elder Lehmer who compiled the series of primes for the first 10,000,000 numbers, and gave them to the world in a publication of the Carnegie Institution of Washington. "Beyond this range, vast as a solar system," he says, "lie the inconceivably remote objects of the arithmetician's universe." Like other mathematicians, he has devoted a good part of his life to discovering the laws that express the general properties of prime numbers. Although the original objective has eluded mathematicians, out of their work has come the theory of numbers. The by-products turn out to be of paramount importance. One of these is the method of factorization—discovery of the factors by which a number can be divided.

"Congruence Machine."

With the aid of his son, Professor Lehmer invented a "congruence machine," which automatically broke up numbers into their constituent parts. Crude as the machine was—a thing of bicycle sprocket-wheels, chains and pins running over electrical contacts—it decomposed the number 9,999,000,099,990,001 into two factors, 1,676,321 and 5,964,848,081 in two hours. Thus encouraged, the Lehmers invented a more powerful and also a more delicate machine in which a ray of light slipping through holes in gears displaces pins, plays upon a photo-electric cell and sets calculating mechanism in motion.

A new-born baby is not so sensitive as this extraordinary contrivance. An amplifier must magnify the light-impulse that falls on the cell 729,000,000 times. Not only the light but slight jars, infinitesimal variations in the electric current, even words of exasperation are amplified. The Lehmers had their troubles with the temperamental fits thus caused. Let the elder Dr. Lehmer tell of them:

The machine would run happily and sweetly for a few minutes and then become incoherent. Suddenly it would pull itself together again and behave in an entirely rational manner for another quarter of an hour. And all without any appreciable change in environment. Doctors were called in, but nothing could be inferred from the symptoms. To be sure, it was asking a good deal of a machine to work steadily with a magnification of over 700,000,000 to 1. It was like trying to write a smooth flowing hand with a pen 10,000 miles long, while all the time a mischievous imp was jogging your elbow.

A young doctor called for a stethoscope. With that and a loud-speaker he listened in. The imp proved to be a short-wave radio fan in the neighborhood. So long as he was quiet all was well. When he turned his waves loose the electric eye literally saw red. There was nothing to do but open up diplomatic negotiations.

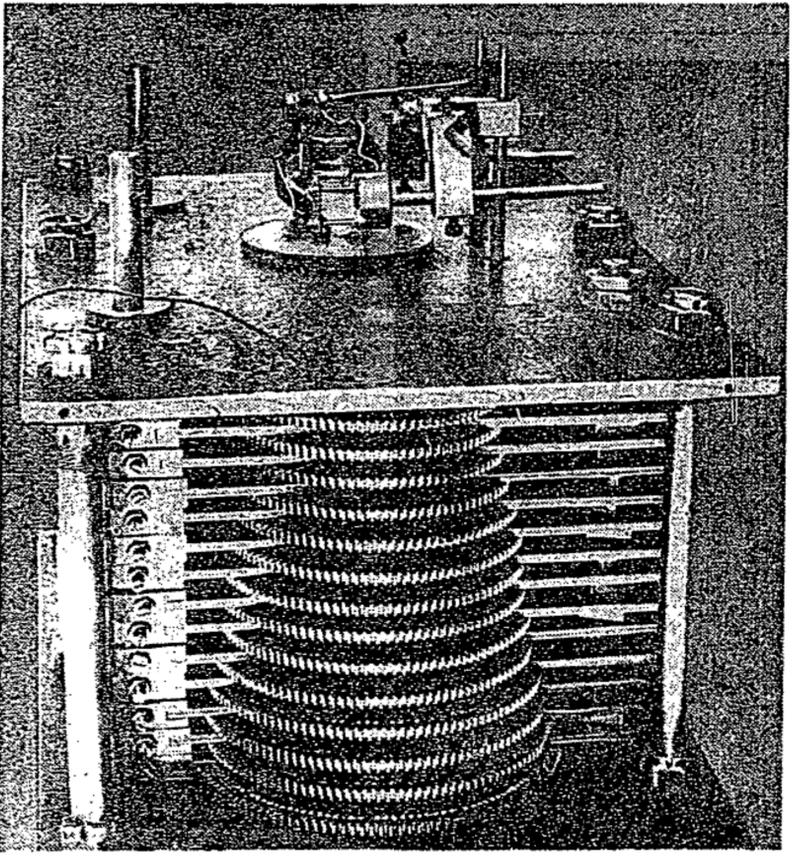
Dissecting a Huge Number.

After the imp was discovered the machine began to do real work. The number 1,537,228,672,093,301,419 was handed out for dissection—a number known by the most effective test to be a composite. In about three seconds the machine came to a stop. Was it the imp on the air again? The machine indicated two prime factors, 529,510,939 and 2,903,110,321. They proved to be right.

Another great test came with the historic giant 39,614,081,257,132,168,798,771,975,169. A few of the factors were known, but some of these, running to nineteen figures, were themselves composites. Lehmer père confesses that he "walked the floor in the deepest anxiety" while the machine was reporting on 10,000,000 numbers. After fifteen minutes the hum of wheels died away. An expert computer, Dr. Wolfe, saw that the dials had found a correct solution for one problem. For twenty-five minutes there was more humming. Then silence. Another solution came out. The Lehmers were in possession of the factors 59,957 and 88,114,244,437. Both proved to be primes. Now the Lehmers are turning the machine loose on time-honored formulas which have baffled students of the theory of numbers for centuries.

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'Congruence Machine' Divides Numbers Quickly—Silver From Waste Films



Courtesy Carnegie Institution.
A View of Some of the Gears of Professor Lehmer's Calculator Which Determines Whether or Not a Number Is Prime.