Differential Analyzer, Used For War Projects, Will Solve Industrial Problems

100-Ton Machine Exhibited Recently For First Time

A new type of differential analyzer, a 100-ton calculating machine which marks a significant advance in the field of mechanized mathematics, was given its first public demonstration before a distinguished group of scientists, engineers, and officers of the United States Navy and Army in the Center of Analysis at the Institute recently.

Designed for the solution of scientific and industrial engineering problems, this new electro-mechanical giant was assembled three years ago to various important war projects, the most formidable of which was the urgent task of computing range tables for the guns of the United States Navy. Built to accommodate as many as three complex problems at once, the machine's power could be directed to solve the other problems such as those of fire control and radar antenna design without interrupting its main program.

The new analyzer is the latest development in a distinguished sequence of mathematical aids in Technology's Center of Analysis, which was established in 1939 for the purpose of encouraging and assisting technological progress in all fields and making available to scientific institutions, government agencies, and industry the means of carrying out intricate mathematical processes economically. No small part of the importance of this division of the Institute's Department of Electrical Engineering lies in its contributions to teaching and research.

Its war service over, the Institute's new instrument of mechanized mathematics will turn to its original objective, the solution of peace-time problems in a field of usefulness which includes every branch of science and engineering.

The new differential analyzer is, in effect, a mathematical automaton, designed not merely to relieve human brains of the time-consuming drudgery of difficult calculation and analysis, but to attack and solve mathematical problems which are economically beyond the reach of ordinary methods of solution. As a tireless ally of science it achieves economy of time and labor and liberates man's thinking for creative effort.

Scientific announcement of the differential analyzer has just been made in the Journal of the Franklin Institute in a joint paper by Dr. Vannevar Bush, formerly Vice-president of the Institute, and now President of the Carnegie Institution of Washington and Director of the Office of Scientific Research and Development, and Dr. Samuel H. Caldwell, Director of the Institute's Center of Analysis.

The new differential analyzer contains approximately 2,000 electronic tubes, several thousand relays, about 150 motors, and nearly 600 miles of wire. It occupies a laboratory specially constructed to support its great weight and has a special ventilating system to dissipate heat generated in the processes of operation.

The original differential analyzer, designed by Dr. Bush and his associates and built in 1931, was entirely a mechanical machine, and the solution of problems required manual setting of gears and other connections. In the new machine these settings and connections are automatically accomplished by electrical "couplings," an instantaneous process controlled by punched paper tapes. For ordinary operations the huge machine requires only one operator. The symbols of the mathematician representing the problem for which a solution is desired are translated into a "language" which the machine understands. This "language," a code punched on a paper tape, is transmitted to the machine which automatically selects the various units required for the process of computation.

The differential analyzer has proved extremely valuable for such widely diversified problems as the analysis of information on earthquakes, sound waves, geophysical exploration, the rates of change in chemical processes, atomic wave functions, analysis of complex vibration problems, studies of the behavior of electrical machinery, and power transmission problems, investigations associated with the design and performance of aircraft, analysis of radar wave patterns, and the study of cosmic phenomena.

Unlike conventional types of calculating machines which operate on numbers, the new differential analyzer deals with problems involving rates of change among variables quantities. The solution of a differential equation is not a number; it is a numerical list of the concurrent instantaneous values of two or more variables. These solutions may be printed either graphically or numerically and in both forms. A graphic solution consists of a curve drawn systematically by the machine, indicating the relation between any variables appearing in the differential equation. A numerical solution consists of a printed table of corresponding values of the variables at any convenient intervals.

In the differential analysis, variables of a problem are represented on the shafts of a number of mathematical units. The role (Continued on Page 15)