July 10, 1940

Dr. Irgin Stewart, Director
Committee on Scientific Aids to Learning
41 East 42nd Street
New York City, N.Y.

Dear Dr. Stewart:

In the treatment of many mathematical problems one requires the solution of systems of linear simultaneous algebraic equations. The occurrence of such systems is especially frequent in the applied fields of statistics, physics and technology. The following list indicates the range of problems in which the solution of a system of linear algebraic equations constitutes an essential part of the mathematical difficulty:

1) Multiple correlation
2) Curve fitting
3) Method of least squares
4) Vibration problems including the vibrational Raman effect
5) Electrical circuit analysis
6) Analysis of elastic structures
7) Approximate solution of many problems of elasticity
8) Approximate solution of problems of quantum mechanics
9) Perturbations theories of mechanics astronomy and the quantum theory

This list could be expanded considerably; linear algebraic systems are found in all applications of mathematics which possess a linear aspect. The theory and method of solution of such systems is well known and, if the number of unknowns is small (the number of equations is generally but not always equal to the number of unknowns), this solution presents no difficulty. However the satisfactory treatment of many problems, certain cases of each of the above list for instance, requires the use of ten or more unknowns. Since the work of solution goes up roughly as the cube of the number of unknowns the solution of the larger systems becomes extremely arduous.

About seven years ago I began to investigate the possibility of mechanizing this solution. After I had succeeded in forming a rough outline of the process necessary I attempted to realize this process

by using the computational capacity of the commercial punched card tabulating equipment. I finally abandoned this attempt largely because the computational capacity of even these machines is not large enough. The construction of a machine of adequate capacity to perform the necessary functions seemed very involved in terms of the conventional computing mechanisms.

However beginning about three years ago I had a succession of ideas which have enabled me to design a computing machanism along entirely new lines which is at the same time much simpler and much faster than any other mechanism of which I am informed. It is almost entirely electrical in nature; mechanical motions are only used to snychronize the cycles of the machine and there are no mechanical motions at the higher calculating frequencies. It seemed evident to me that I was in a position to attempt the construction of an entire machine with sufficient computing capacity to solve large systems of linear algebraic equations.

Accordingly I requested and received a grant of $650 from the Iowa State College Research Council to explore the field. In September 1939 we began the construction of a computing element based on the new principles and with surprisingly little trouble had it in actual operation by the end of the year. We knew than that the fundamental principle was workable, simple and surprizingly cheap. With this encouraging result we started work on the design and later the actual construction of various units of a complete machine having a computing capacity of 30 fifteen place numbers. i.e. of such a size that it will solve a system of 29 equations in 29 unknowns with a high degree of accuracy. (The extra computing element is of course used to carry the constant terms in the system of equations.) We have worked on this machine continuously since the first of the year and our progress has been entirely satisfactory. Our design has been continually guided and checked by experimental work and is complete except for a few details of a purely technical nature. The actual construction is well started and we have completed several assemblies for the entire machine.

This machine will have a numerical capacity nearly six times that of the largest punched card tabulator which is, as far as I am aware, the largest computing machine ever built. At the same time its computing speed will be much greater so that what might be called the computing capacity will multiply that of the large tabulator by a factor of ten or twenty for the work for which it is designed. Its speed in the solution of systems of linear algebraic equations will be very great and here it should multiply the efforts of an expert computer with a calculator (which is the usual way of solving such systems at present) by a factor of more than one hundred.

This machine is designed to solve systems of equations by actual calculation and should not be confused with other devices which work upon the principle of a mechanical or electrical analogy of which there are a

number already in existence. The electrical set-up boards used to calculate distributions systems for electrical power may be regarded as devices of this second type. I believe that a machine of the type that we are constructing will be much more accurate, cheaper and probably faster.

I have received a grant of $700 from our Research Council for the fiscal year beginning July 1. While I consider this grant very generous in view of the limited funds allocated for such purposes at our institution it will of course not enable me to make the progress I desire in the construction of this machine. I should like very much to obtain a grant of $5000 for completing this machine and putting it into successful operation during the next two years. In view of the very considerable value that the successful completion of this machine would have in scientific and technical applications would your organization be interested in advancing this grant?

I have discussed these plans in some detail with Dr. Warren Weaver of the Rockefeller Foundation and I have reason to believe that he will be glad to discuss them with you. I have also had a brief conversation about these plans with Dr. Vannevar Bush who is, I believe, a member of your committee.

Very truly yours,

John V. Atanasoff
Associate Professor of
Mathematics and Physics

JVA:lt

01625