OUTLINE OF PLANS FOR DEVELOPMENT OF ELECTRONIC COMPUTORS

The first objective of the proposed company will be to design and develop a multi-purpose rapid computing machine of moderate cost.

Two or three years will be required for this development. This estimate, and the estimate of engineering staff and operating funds needed for this period, are based on the experience gained (by those who will form this company) during the development and construction of the ENIAC, the first electronic multi-purpose computing machine ever to be built.

It is hoped that, during the developmental period, contracts may be secured which will help to defray the development costs. Since at the present time such contracts have not yet been assured, and since some of the development contracts which are in view might require larger or somewhat different types of machines, it appears that a conservative procedure is to secure enough capital in advance so that the entire development program can be carried out even though no such assisting contracts can be made.

In the event that additional funds can be secured through such development contracts, the scale of costs - both as to the number of engineers employed and other costs - can be increased by about 50% per year (estimate B). In this case, the overall time of development might be shortened, since this increase in the size of the organization remains compatible with efficient engineering and research supervision and management.

The machines to be developed, whether for business and accounting purposes, or scientific and engineering work, will represent a great advance over the present ENIAC, being more easily and automatically controlled, and involving considerably less equipment. An essential improvement lies in increasing the speed of the associated mechanical equipment by replacing present punched card equipment by radically different devices. Not only will such new machines be much smaller and more easily operated, but the reliability of their operation can be substantially improved.

As a consequence of these improvements, both the initial cost and the maintenance of such machines will be made much lower.

The market for high-speed multi-purpose computing machines of moderate cost can be indicated by the following brief list of possible users:

- 1. Scientific laboratories, universities and research foundations.
- 2. Industrial research and engineering laboratories.
- 3. The U. S. Census Bureau.
- 4. The U. S. Weather Bureau.
- 5. Other government agencies such as the U. S. Bureau of Standards.
- 6. Astronomical observatories.

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- 7, Accounting and bookkeeping departments of large business firms.
- 8. Inventory, stock control and planning of departments of large business firms.
- Agencies having voluminous files and records, libraries, social security offices, etc.
- 10. Insurance companies, both for records and actuarial work.

It is believed that the equipment to be developed will constitute a sufficiently great improvement over existing business machines, and will be cheap enough, so that its use will be extended to many places which now cannot even consider the introduction of automatice machine methods. The electronic devices will not only have superior speed and flexibility, but will carry out a longer and more complicated routine without human supervision during the course of the work. Thus business firms will find that the same work, such as large payroll or inventory jobs, can be carried out with a smaller operating personnel than with any equipment now in use for such work.

Agencies now using punched cards frequently find the storage of these cards a difficult problem. This storage problem will all but vanish with the new equipment which it is proposed to develop. The same information which now requires 50,000 punched cards (occupying an entire filing cabinet) can be stored on a spool of magnetic tape or wire which can easily be carried in one's pocket (which is less than 1/1000 the size by volume). It is obvious that this compactness of storage is important in another way, since it means that when an operator has placed such a spool in the electronic apparatus, she has in that simple act performed the equivalent of carrying 50,000 punched cards from the storage file to one of the present day business machines. To carry that many cards, and see that they are properly fed into the card machine, is a laborious and time-consuming job in itself.

Taking into account the more automatic way in which large quantities of information can be fed into the electronic equipment, it is estimated that when the operation to be carried out is one of sorting or arranging the data, the electronic device will function at a rate perhaps ten times that of present card machines. For operations which require computations, the advantage will be even more marked. As an example, a card machine may require several seconds to perform a single multiplication. The electronic computor will perform about 1000 multiplications in one second.

The physical size or bulk of such an electronic device might be slightly larger than one of the present card machines. It should be borne in mind, however, that this single machine will do everything that is required, while from four to six different card machines may be required to perform the various operations needed for ordinary business and accounting work. (In addition to the electronic computor itself, there will be a small auxiliary device, like a typewriter, for the preparation of magnetic tape and the printing of results. This corresponds to the key punch devices for cards, and the card tabulators).

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The cost of such electronic computor, of course, can only be estimated very roughly at this time, but present judgment is that the development work will make it possible to market such a machine for less than \$30,000. and possibly as low as \$5,000. That such a cost is not unreasonable is indicated by the fact that many business firms spend more than \$30,000. per year for the rental of card machines which are not able to do what this equipment is expected to do. Furthermore, such firms spend about an equal amount per year for personnel to operate these card machines. As already stated, it is believed that a smaller staff will be able to operate the electronic machine in those cases where the operations are recurrent routine business and accounting jobs.

It should be pointed out that the development here proposed is based on prior development work done for Army Ordnance, using government funds. Some of the devices which are to be used are at present still under security classification. No patents are as yet issued, but the work of filing patents is now in progress. The inventors, who will head the proposed company, are required to give the government a royalty-free license (non-exclusive) and have agreed to license educational institutions to build and use such devices for non commercial purposes. The inventors now hold the commercial rights under all patents which will issue.

NAME OF THE COMPANY:

The company to be formed will be engaged in the development of, and possibly the manufacture and sale of, electronic calculating devices and a large variety of other devices which may be associated with such devices or utilized components of such devices. An important category of such devices lies in the field of control of industrial processes. With this in mind, the following names are suggested. They are listed in order of preference:

Electronic Calculator Company.

Electronic Control Company.

Electronic Manufacturing Company.

Automatic Electronic Control Co.

Automatic Electronic Company.

STATEMENT OF PURPOSE of the Proposed Company:

- a. To conduct, or to have conducted for it, research on electronic devices and associated equipment (examples itemized later).
- b. To perform services for others in connection with design, development, installation and use of such items.
- c. To manufacture, or to have manufactured for it, all such items.
- d. To sell such items, manufactured by it or for it.
- To engage in consulting work (possibly covered by b.).
- f. To publish books, manuels, technical catalogs, etc.
- g. To acquire patent rights from others, either by licensing or assignment, and to license or assign patents which it controls to others.
- h. To rent or lease equipment which it owns or controls to others for specific uses.
- i. To conduct experimental or development work for others either on its own premises or on the premises of others.

Perhaps the purposes set forth in the corporation charters of companies like IBM and RCA should be examined for further suggestions.

Some indication of the extent of the interpretation to be given to "electronic devices and associated equipment" can be given by listing some of the items now foreseen as coming within the range of possible development. For this list, see the following:

The following list is intended to indicate the extent and variety of devices and equipment which are now foreseen as subjects of possible development or improvement by the engineering and research work of the proposed company. Even at the present time,

this list cannot be complete or exhaustive, and the future developments in connection with electronic calculators and control equipment will necessarily bring to light new fields of application.

- Automatic high-speed computing machines for scientific and engineering use. Examples: design of ship turbines, and weather forecasting.
- 2. Automatic high-speed "business machines" for accounting, inventory, industrial phanning, marketing research, etc.
- 3. Automatic machines for instantly registering, at some central point, transactions made at numerous remote points, and striking a current balance, computing running averages, etc. Application to banks, department stores, stock exchanges, pullman reservations, race tracks, etc.
- 4. Automatic high-speed machines for all sorts of statistical purposes. Example: organizing U. S. Census results, and providing, when required, answers to all questions by drawing from voluminous Census Bureau data.
- 5. Automatic navagation equipment. In combination with Loran or other equipment, high-speed calculations made automatically can provide all data for navigation and automatic control of surface or air ships.
- 6. Communication secrecy: High-speed electronic computing is most closely associated with devices for coding, ciphering and maintaining secrecy of communication. Adaptation of computing devices are also used in breaking down enemy secrecy systems.
- 7. Television: Certain electronic circuits and components developed for computing machines can be used for improved television systems.
- 8. Typewriters and printing devices, linotypes, etc.: Highspeed typing and printing are important adjuncts of any highspeed computor. Developments for computing purposes may be
 applied to allied devices, improvement of electric typewriters,
 linotype machines, etc.
- 9. Control of high-speed knitting machines: Knitting or weaving machines for making intricate designs in woven or knitted fabrics must be controlled in accordance with a desired pattern. Electronic methods may be applied to facilitate control, change of pattern, and to simplify the process of "transferring" the pattern from artists' designs to the machine set-up.
- 10. Industrial process control: Although many industrial processes do not require split-second timing (as do applications 8 and 9 just above), nevertheless the speed of electronics is needed in many cases to perform intricate computations which are essential to proper control. As an example, certain chemical processes depend upon almost continuous adjustment of certain flow rates so that reaction temperatures are kept within definite limits. Complex relationships may exist between the indications of various measuring instruments and the proper settings of flow valves which will best maintain the desired conditions. Electronic computing devices can be arranged to accept

information in electrical form from the measuring instruments and to automatically set the necessary control valves in accordance with whatever formula is appropriate to the system and the process. Moreover, the same electronic control equipment can be quickly and easily modified or "set" for a new and entirely different process control.

- 11. Fire control: The control of guns from radar or other ranging and direction-finding equipment invalves the use of a computor which can mathematically predict how a gun is to be aimed in order to hit a moving target. The calculations are not simple, and they must be done rapidly to be useful. The trend toward higher and higher target speeds has made practically all of the existing fire-control mechanisms obsolete. More accurate and more rapid computing devices are needed, and electronic computing methods seem indicated. Also, the devices for automatically training the gun in accordance with the computor results need to be faster. The improvement of mechanical motive devices electrically controlled is a part of the development work to be carried out in connection with computors, since these are needed by printers, typewriters and industrial control applications.
- 12. Hydraulic and hydrodynamic motive elements: When the mechanical system to be controlled requires a great deal of power for its proper control, hydraulic and hydrodynamic devices (such as "fluid drives" in automobiles) have certain advantages over electric motors. The development of systems of this sort, responsive to electrical control, is contemplated as a natural extension of the development of control devices in general.
- 13. Industrial research apparatus and laboratory equipment: Many physical and physical-chemical measuring instruments have been developed and put into use in industrial research laboratories. Many of these still require painstaking labor by highly trained scientific workers to achieve results. Whenever counting or computing is involved, electronic computing devices directly connected to the measuring instrument can be developed to deliver, without loss of time, whatever results are desired in the form in which they will be most useful. For example, mass spectrographs are now used by petroleum, rubber, and other organic-chemical laboratories to perform analyses which formerly were made by chemists. The old method sometimes required several days. The mass spectrograph now gives its results in a few minutes, but in a form which necessitates several hours work by a skilled human computor before the proportions of various constituents can be stated. An electronic computing device could reduce this computing time to less than a minute, commensurate with the time taken by the mass spectrograph itself.
- 14. Musical instruments: Although seemingly unrelated to the field of mathematically computing, electric organs can be developed using components and techniques which are used in electronic computing machines.
- 15. Miscellaneous: From the above it is seen that the devices and equipment which may be associated with electronic computing and control apparatus are numerous and varied. In the course of development and research, the company might develop new radio tubes, new ways of recording magnetically on wire or tape, new alloys for magnetic material, new typewriters or other printing devices, new methods of reproduction of printed material, new kinds of electric motors, new kinds of hydraulic or other motive devices, new physical instruments for laboratory work, new systems for television of

TENTATIVE

BASIS FOR ESTIMATE OF FUNDS REQUIRED

Estimates have been prepared for two cases --

- A. On the unfavorable assumption that three years of development work will be necessary to produce a satisfactory model for a small machine suitable for manufacture and sale to firms now using card machines for business and accounting work, and further assuming that during this period no income is available from government or other development contracts.

 Estimate A. is a minimum requirement for this situation.
- B. On the assumption that more funds are available, either from the original source of funds or from government or other contracts obtains by the company. Such contracts, while providing income for the company, whuld also (almost certainly) call for the development of machines for scientific and engineering calculations. In this case the size of the organization has been estimated as that which can be efficiently directed and utilized so as to carry forward the scientific and the business machine developments as rapidly as possible.

	EST. A.		EST. B.	
Yearly Expenses:	Persons	Total	Persons	Total
Engineering Staff Galaries Inc. Dr. Mauchley & Eckert	10	\$55,000.	. 18	\$100,000.
Office Manager	1	5,500.	1	5,500.
Secretaries, bookkeeper	3	7,000.	4	9,000.
Draftmen	1	2,200.	2	4,400.
Machine shop foreman	1	4,300.	1	4,300.
Shop assistants	1	2,800.	2	5,600.
Wiremen, electrical assembl	у 6	16,800.	10	28,000.
nnual Salaries for Personnel		\$93,600.		\$156,800.
nnual charges for office and laboratory space, inc. rent, lower, janitorial services, e	heat,	7,400.		10,200.
Parts, materials, office suppand outside contracts for fabor special parts, etc.	lies, rication	25,000.		40,000.
OTAL ANNUAL EXPENSES, SALARI	Es,	126,000.		\$207,000.
nitial expenditures				
Electronic equipment		15,000.		\$ 25,000.
Office equipment	A STATE OF	3,000.		6,000.
Stock of radio and shop p	arts	7,000.		9,000.
Shop machinery		10,000.	<u> </u>	10,000.
OTAL INITIAL EXPENDITURES		35,000.		\$ 50,000.
COTAL SALARIES, ETC. FOR 3 YE	ARS	378,000.		621,000.
CALLE DESCRIPTIONS AND CONTRACTOR AND				

These figures do not include incorporation costs and taxes.

These salary estimates allow for raises which may be given during the three year period.

or message transmission, new measuring instruments for industrial control purposes, new methods for automatic navigation, etc. All of these are related in that they utilize one or more of the elements or components of an automatic electronic computor.