CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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S-E-C-R-E-T

COUNTRY	East Germany	**REPORT**	
SUBJECT	Computer Development in East Germany	**DATE DISTR.**	27 May 1955
		NO. OF PAGES	6
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PLACE ACQUIRED		**REFERENCES**	
DATE ACQUIRED			

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THE SOURCE EVALUATIONS IN THIS REPORT ARE DEFINITIVE.
THE APPRAISAL OF CONTENT IS TENTATIVE.
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CORRECTION

An information report with the above heading was issued on 21 March 1955. The heading indicated that there were 13 pages; however, only the eight pages of text were published. Attached are the five pages of diagrams which were omitted from the original report.

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(NOTE: Washington distribution indicated by "X"; Field distribution by "#".)

INFORMATION REPORT

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COUNTRY	East Germany	REPORT	[redacted]
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1. So far as is known, East German development of computing machines above the level of simple mechanical or electrical instruments has been carried out at only three places:

   a. The Academy Institute for Medicine and Biology in Berlin-Buch, where development of a Fourier synthosis analog computer of the Pepinsky type has been carried out[1] under the supervision of Dr. Kaete Dornberger, head of the Crystal Structure Analysis Group of the Institute. The ultimate aim of this development is the construction of a machine for the synthesizing of two-dimensional Fourier series. So far, even the construction of a one-dimensional model has met with many difficulties mainly caused by unsuccessful attempts at developing a suitable sinus generator as the machine element. At present Dr. Dornberger and her group are still working on this development but its successful completion cannot be expected in the foreseeable future.

   b. VEB Carl Zeiss, Jena, where a computer called Oprema, operated by a great number of relays, has been under development under the scientific supervision of Dr. Herbert Kortum[2]. This development is still in its initial stage and has hardly progressed beyond experimental blueprinting and the construction of a provisional rack for the relays.

   c. The Institute for Applied Mathematics at Dresden Technical University, where Prof. N. Joachim Lehmann has worked on the development of a digital computer since 1948, if Lehmann's first projects are counted as the start of this development[3]. From 1950 on, the development has been carried out jointly with technicians of VEB Funkwerk Dresden in a special laboratory of the latter enterprise. The development of the machine was scheduled to be completed by the end of 1954. However, as of January 1955, development of an

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experimental model with 250 electron tubes had not been completed. Completion of the final model is not expected before the end of 1955. Contrary to the Berlin-Buch development, Lehmann's attempts have so far met with success, inasmuch as the most essential circuit elements of the experimental models have worked satisfactorily in trial circuits with 150 and 250 tubes. The final model is to have 620 electron tubes of the RV 12 P 2000 type[4].

2. Since the Berlin-Buch development pertains to an analog computer and since the basic idea and computations for the Oprema development at Zeiss, Jena, were provided by Lehmann, the statement seems justified that East German digital computer development is centered at Dresden Technical University. Lehmann may be considered as the greatest East German authority on digital computer development. In addition to the Dresden computer development, he works as a scientific advisor for the computer developments going on in Jena and Berlin-Buch. While he obtained his first ideas for the Dresden development from Prof. F.A. Willers, a noted authority on numerical calculations and mathematical instruments, he started to conceive projects of his own for the development of a digital computer in 1948 when he first heard about the American ENIAC computer. Lehmann's theoretical work on computers is greatly influenced by computer research carried out in the USA, England, and Switzerland. He has also taken several trips to West Germany in order to study the computers in Goettingen and Hamburg. Essential features of his model are based on the following papers:

a. A. P. Speiser: "Entwurf eines elektronischen Rechengeraets", Mitteilungen des Instituts fuer angewandte Mathematik, Eidgenoessische Technische Hochschule, Zurich 1950, Nr. 1.

b. H. Rutishauser; A. P. Speiser; E. Stiefel: "Programmgesteuerte digitale Rechengeraete": lo 1951, Nr. 2.

c. D. J. Wheeler: "Program Organization and Initial Orders for the EDSAC", Proceedings of the Royal Society 202 (1950), 573-589.

d. H. Billing: "Numerische Rechenmaschinen mit Magnetophonspeicher", Zeitschrift fuer angewandte Mathematik und Mechanik 29 (1949), 1.

3. The Dresden computer is a small digital machine, a "Kleinautomat". As characterized by Dr. Lehmann, it is to "allow the easy handling of all routine problems of practical analysis; its computer speed should also allow the occasional handling of simple partial differential equations"[5]. The size and operational scope of the machine were largely determined by the consideration of material and maintenance expenditures. This ruled out entirely any attempt at developing a computer similar to the big machines constructed in the USA and England. According to Dr. Lehmann, the Dresden machine represents the most favorable solution in view of the most favorable relation between performance and expenditures. The magnetophone principle was selected for the numerical memory (Speicher) of the machine as the cheapest, but most efficient, principle available at the present state of technology;

4. Following are the most essential construction elements and functions of the Dresden machine[6]:

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a. The Magnetophontrommelspeicher, a magnetophone drum upon which numbers coded as binary numbers (im Dualsystem verschluesselt), are stored as magnetic dipoles. This Speicher, which holds about 2,000 numbers of 20 decimal digits each, works with about 100 rps and 100 kcs digital train frequency (Ziffernfolgefrequenz).

b. The electronic Rechenwerk carries out the four basic calculation types and the conversion of decimal numbers (tetradisch verschluesselte Dezimalzahlen) into binary numbers and vice versa.

c. The control of the computing operations is of the electronic mono-address-system-control type (elektronische Kontrolle im Einadressen-system). The commands are coded as numbers and pooled in the memory. The required auxiliary installations are combined in a separate computing control mechanism (Steuerrechenwerk).

d. Input of numbers and commands is carried out by the scanning of a punched card (Lochstreifen). It is planned to replace the cards later by magnetophone bands. The input mechanism can also be hand-operated for control purposes.

e. Output of results is done with the aid of Blattschreiber or Streifenlocher. If Blattschreiber are used, intermediary texts can also be written.

5. The following advantages of the Dresden computer were particularly emphasized by Dr. Lehmann:

a. The Magnetophontrommelspeicher, which is the main memory of the device, is being used for computing purposes as well as for control purposes. This twofold purpose is performed by means of a device called Umlaufspeicher (see figure 1 in appendix 1). As shown in figures 2 and 3 of the appendix 2, the memory can also be used for delaying purposes (Verzoegerungszwecke), and for commutable delaying (umschaltbare Verzoegerung).

b. Conversion of decimal numbers into binary ones and vice versa is particularly simple.

c. Lack of certain control possibilities is compensated for by the low material and money expenditure and by the insignificance of error sources.

d. The almost exclusive use of electron tubes in circuits modeled after those developed by A. H. Aiken[7]. It was originally planned to make ample use of relay circuits. This idea was discarded after it was found that use of relays within the interior parts of the machine caused loss of time and disturbances (Stoerstellen). Relays are used in the border parts (Randstellen), i.e. in the input and output installations of the machine, for material-saving reasons.

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6. Organization, function and performance of the Dresden computer:

a. The Rechenwerk

The Rechenwerk is able to carry out--without the use of the memory--expressions of the following form:

$$\left[\left(\left(+a\cdot b\cdot c\cdots+d\cdot f\cdots+\cdots\right)\cdot g\cdot h\cdots+i\cdot j\cdots\right)\cdot k\cdots+l\cdots\right]=m$$

Subtraction and division can be substituted for addition and multiplication in the above formula. This mode of operation, which is the one best adapted to the monoaddress command system, allows the computing in one operation of scalar products and polynomes, according to the Horner scheme. In order to save material, the mechanism works with a fixed comma (decimal point), which is placed after the sixth decimal digit. The essential parts of the Rechenwerk are three registers (Register of Umlaufspeicher), and an accumulator (Akkumulator) in an addition and subtraction circuit. The principle of the Rechenwerk is indicated in figure 4 of appendix 3, where the full lines represent number circuits and the dotted lines control circuits. The small crosses within the lines indicate switch positions (Schaltstellen). The letters in the diagram mean the following:

E: number input
K: number input for parenthesis-multiplication operation
Sp: exit to Speicher
AC: accumulator
Md and Mr: registers (Umlaufspeicher) for multiplications and divisions.
T: register for the adding of products
V: sign computer

Negative numbers are marked in the memory by a special sign impulse. In the Rechenwerk a counter modulo 2 (called trigger) is coordinated with the Md register. In the T register negative numbers first appear as complements but they are later separated into signs and absolute values. Thus multiplication and division of positive numbers only is required and no complement installations are necessary. Multiplication and division are carried out as repeated additions and subtractions, as described by Speiser in the paper mentioned in paragraph 2. a. above. The Rechenwerk thus is able to carry out a number of command sequences corresponding to the formula cited at the head of paragraph 6. a. The computing times, including search time in the memory, are on the average:

6 milli-seconds for an addition
30 milli-seconds for a multiplication
42 milli-seconds for a division

Considering the average distribution of computing operations (about 32 multiplications and 3 divisions per 65 additions), and some time delays caused by the giving of commands, the above figures signify that about 50 operations can be carried out per second. The multiplication time is relatively long. Dr. Lehmann is now working on its reduction. He is reported to have succeeded in reducing it to about 22 milli-seconds.

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b. The Speicher (storage)

The main memory is an electronic drum about 25 centimeters long with a diameter of about 20 cm. Its surface is covered with a magnetite layer on which numbers are stored as magnetic dipoles with the aid of a number of minute magnetophone heads. The distance between the magnetophone heads and the magnetite layer is 0.05 millimeter. For reasons of correct functioning only two digits are stored per millimeter of the drum circumference. With the drum rotating at the rate of 100 rps, as mentioned above, the mean search time in the memory is 5 milli-seconds. Only 16 numbers are on one drum circumference. Since the drum holds a total of about 2,000 numbers, 128 individual channels are needed on the drum. According to routine methods, 128 magnetophone heads and several hundred tubes would therefore be required. In order to save material, Dr. Lehmann arranged two sets of 8 magnetophone heads each in such a way that each set of 8 can be deplaced along the axis of the drum with the aid of a slide mechanism. This slide mechanism can assume 8 different electro-magnetic positions. In this way the 16 magnetophone heads in the two sets control 128 (namely, 2 times 8 times 8) channels. Operation of the slide mechanism into different positions takes between 30 and 50 milli-seconds. Since 256 storage sections can always be reached at the same time within 5 milli-seconds, the described arrangement increases the total computing time by less than 10%, whereas expenditure of electronic material is decreased by about 80%. The 16 magnetophone heads serve at the same time for "reading" and "writing". They are operated by circuit tubes which in turn are controlled with the aid of small resistor and diode matrices by the flip-flop circuits of the command register. Selection of a number within a channel is provided for in the following way: Each storage section "i" among the 16 of its kind on a drum circumference is coordinated with a premagnetized coil Sp_i. Exactly at the time when the i-th storage section arrives underneath a magnetophone head, a voltage impulse is induced in Sp_i through a mark applied to the drum. The impulse serves for releasing the input or output of the contents of the i-th storage section. The coil Sp_i is controlled by means of a rectifier in the command instrument. This procedure is called "angle selection" (Winkelwahl); the corresponding mechanism is designated by WW in figure 5 of appendix 4.

c. The Steuerrechenwerk

This carries out the commands in the prescribed succession as stored in the main memory in the form of coded numbers. It can also perform minor calculations of auxiliary character, countings, command changes, etc., without the use of the Rechenwerk. A command consists of three parts: one of them indicates the operation to be carried out, another indicates the storage section of the memory which is involved in the operation, and the third is a two-digit number characterizing the command itself (Kennziffer). Carrying out of the commands is done with the aid of a command counter (Befehlszaehler--an Umlaufspeicher with addition circuit), an intermediary command Speicher (Befehlszwischenspeicher), and the command register (all these parts are indicated in figure 5). The described command device was extended to a Steuerrechenwerk mainly through the addition of three auxiliary Umlaufspeicher (Hilfsspeicher S_1, S_2, and S_3 in figure 5). These three auxiliary

Speicher are arranged inabout the same way as the B-tube in the English computer at Manchester. The S_1, S_2, and S_3 Hilfsspeicher make it possible to carry out auxiliary calculations without interrupting the calculating operations in the Rechenwerk.

d. The Eingabewerk and the Ausgabewerk

Input of numbers and commands is carried out with the aid of a Lochstreifen mechanism. Results can either be printed or punched. Punching of the results becomes necessary if the total capacity of the memory within the device (interior memory capacity) is not sufficient for storing all intermediary results; the Lochstreifen is then used as "exterior memory". The numbers, and in a similar way the commands, are represented on the Lochstreifen in the form of

$$z = \pm a \cdot 10^{k}$$

with the absolute value of z smaller than 10^7 and k assuming the values 0, -3, -6, -9, and -14. If 20 Lochreihen (decimal numbers) are scanned per second the filling of the entire memory of the device takes between 10 and 20 minutes. In order to save time in the handling of extensive amounts of numbers (for instance whenever the Lochstreifen must be used as auxiliary memory), and also in order to save time during the punching and printing of many intermediary results, a special Pufferspeicher (Umlaufspeicher with double number length) is built into both the Eingabewerk and the Ausgabewerk (ZP in figure 5.) These Pufferspeicher at most times function independently of the other parts of the machine. Only when a number is transferred from them to the Rechenwerk or when a number is taken from there, connection with the Rechenwerk is established for about 30 milli-seconds. During the same time the conversion of decimal into binary numbers and vice versa, is carried out. According to Horner's scheme, the binary equivalent of the decimal number a, b, c, ... is

$$((a \cdot LOLO + b) LOLO + c) LOLO + \cdots$$

whereby a and b and c, etc., are dual "verschluesselte Ziffern". Multiplication with LOLO is carried out in a circuit as indicated in figure 6 (appendix 5) with the aid of the "Addiator" and the register of the Rechenwerk. The same mechanism carries out reconversion of binary into decimal numbers. A regular electric typewriter is used for the printing of results. The keys of the typewriter are operated by relays. The typewriter speed is about 15 strokes per second. The punching mechanism mentioned above operates with a relatively low speed of 5 punch series (Lochreihen) per second.

7. Figure 5 (appendix 4) represents the total circuit scheme of the Dresden machine. Following is the meaning of the letter designations used there (in German nomenclature):

Sp-Tr	Speichertrommel
U-Sp	Teil der Trommel fuer Umlaufspeicher
WW	Winkelwaehler mit Spulen Sp_1
MK	Magnetophonkoepfe
SV	Schlittenverschiebung
H	Hauptkanal fuer Zahlen und Befehle
S	Synchronisierwerk
RW	Rechenwerk
Md, Mr, T	Zahlenregister
AC	Akkumulator
L	Leitwerk mit Zaehlspeicher
ZE	Zahleneingang
ZA	Zahlenausgang
EP	Eingabe-Pufferspeicher
LA	Lochstreifenabtaster
BR	Befehleregister
A	Adressenteil
Op	Operationsteil
K	Befehlskennziffer
U	Hilfseinrichtung zur Umwandlung des Befehls in Parallel-darstellung
St-RW	Steuerrechenwerk
BZ	Befehlszaehler
BZw	Befehlszwischenspeicher
ZP	Zahlenpufferspeicher
S_1, S_2, S_3	Hilfsspeicher
D.	Diskriminator
BL	Leitwerk fuer BZ und BZw
V	Verteiler
AP	Ausgabe-Pufferspeicher
Soh	Blattschreiber und Locher

8. In an assessment of the machine made by Dr. Lehmann for ZAFT, he stated that the computer is capable of carrying out 50 operations per second, and after reduction of the multiplication time, 70 operations per second; that it has a storage capacity of 2,048 decimal numbers of 20 digits each or of three times that much of commands; and that it has many advantages facilitating its "program operation". Comparing this with the relatively small number of only 620 electron tubes needed, the relation between performance and expenditure was judged by Dr. Lehmann as being extremely favorable[8].

1. [redacted] 25X1

2.

3.

4. [redacted] Comment. The plans and blueprints for the Dresden computer were changed several times during the development. In the present report, Lehmann's ideas regarding the final model of the machine are reported. Earlier reports on the machine should be judged as referring to plans which underwent repeated changes. 25X1

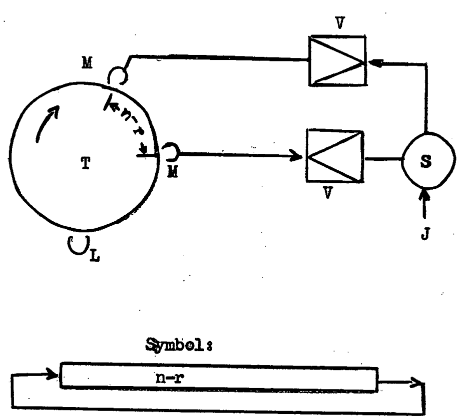
5. [redacted] Comment. The quotation above, as well as the drawings attached to this report and most of the following data, are taken from a paper "Report on the Project for a Small Computing Automat at Dresden Technical University" written at an unspecified time by Lehmann, originally for publication. However, he was forbidden by the East German government to publish this paper. It is now kept in the archives of the Institute for Applied Mathematics at Dresden Technical University. Copies of it went to the East German Academy of Sciences and to the Central Office for Research and Technology (ZAFT) of the East German State Planning Commission. 25X1

6. [redacted] Comment. German nomenclature is used wherever practical.

7. [redacted] Comment. Mentioned in the paper cited in paragraph 2.b. above. 25X1

8. [redacted] Comment. [redacted], a rack with 250 electron tubes had been completed by October 1954. The memory device [redacted] 25X1
[redacted], which differs from the memory device described in this report, is a preliminary one. According to Lehmann's plans the final model will have the memory described in this report. It is now under construction. 25X1

[redacted] 25X1



T: Magnetic drum

M: Magnetophone heads

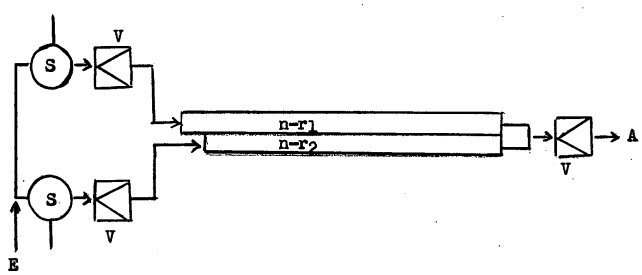
L: Cancellation head

V: Amplifiers

S: Circuit tube for impulses and synchronizing

J: Synchron impulses

Figure 1: Umlaufspeicher



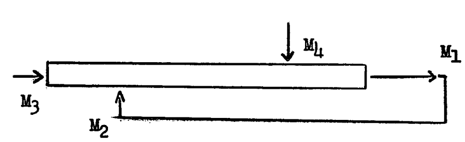


Figure 2: Umschaltbare Verzoegerung

E: Input

A: Output

S: Circuit tubes

V: Amplifiers

Figure 3: Example of a delaying circuit

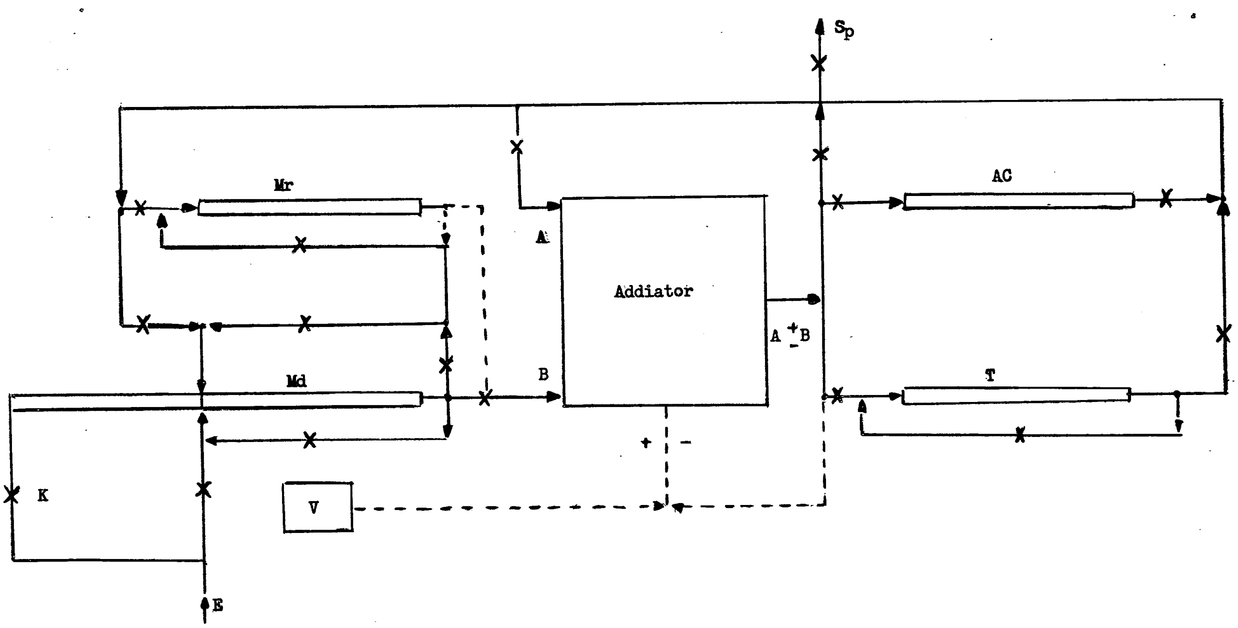


Figure 4: Rechenwerk
(The letters are explained in the text.)

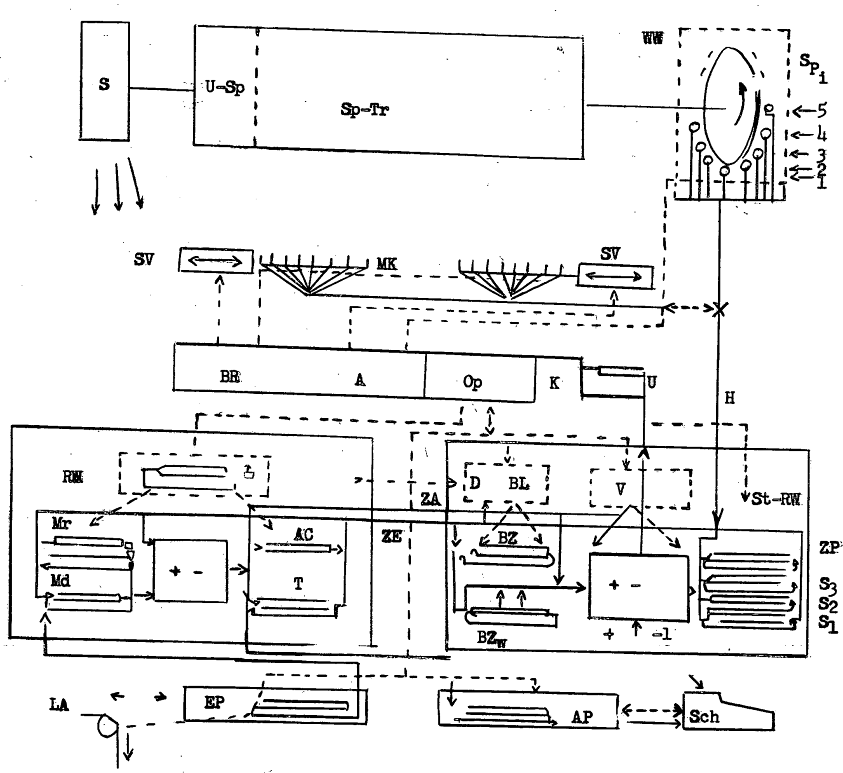


Figure 5: Total scheme of the computer

(The solid lines represent number circuits, the dotted lines control circuits. Letters are explained in the text.)

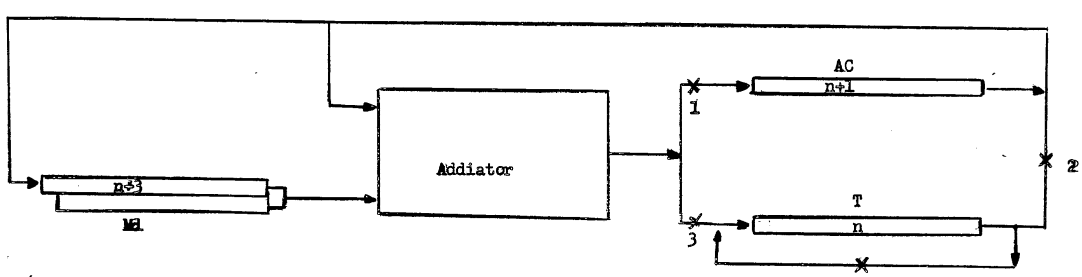


Figure 6: LOLO Multiplication Circuit
((T) x LOLO)