ELECTRONICS IN THE OFFICE

Neal J. Dean

The Ramo-Wooldridge Corporation

Presented before the

Office Managers' Association in Long Beach

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Introduction

We might first try to establish why there is the intense interest that exists on the part of high level management in this electronic data processing field -- an interest which is certainly significantly greater than any interest that they may have shown in improved office machines up until this time. Then we can proceed to discuss what electronic data processing really is -- give several examples of the equipment available and typical applications, and, finally, attempt to decide just what it might offer the operations people in today's office from the viewpoint of performance and economy.

First, let us examine in quick order what some of the reasons might be for the tremendous interest in this field on the part of top management. One reason might result from the pressing economic necessity for cutting down the magnitude of our clerical labor force. Some of the statistics here may be familiar to most of you but will help us appreciate the level of the clerical effort in this country today. For example, within the last fifteen years the number of clerical workers has almost doubled, until today one out of every eight in our total labor force is engaged in clerical aspects of data processing. From another viewpoint, it might be legitimately stated that the increased efficiency accomplished in our factories today has been largely offset by the increased expense of our clerical operations. That is, the savings in the factory have been lost in the office. For example, in 1947, one clerical worker handled the necessary paper work for about $47,000 worth of gross end product. Whereas, in 1955, in spite of the increased efficiency, one clerical worker is still needed for each $47,000 of product.

In spite of the increased efficiency of office systems and procedure, developed by methods people, and the improved office machines involved, why is this level of clerical effort still necessary? One of the reasons might be that business is becoming larger and larger with the problems of data processing becoming more and more complex. Business is also becoming more reliant upon accurate accounting data and reports. Fewer decisions are reached personally on the basis of qualitative experience, more and more on detailed information. Also, the government has increased the data processing volume of a great many business organizations by the processing requirements of the many programs of Social Security, withholding for government bonds, the several state and federal withholding taxes, disability insurance, and the many union acquired benefits, such as union dues being withheld from salaries, company sponsored unemployment compensation, retirement benefits, overtime and incentive payment plans and the many other deductions with which I am sure you are all familiar in our present payroll accounting.

Also, in other areas such as production control, there is an increased load of data processing. Management is becoming increasingly interested in more refined and sophisticated methods of controlling production lines, resulting in greatly improved operation, but requiring more rapid computation based upon this data. The potential savings in this field alone are staggering.

Perhaps one of the most significant reasons for this great interest on the part of top management in the field of electronic data processing is the development of a dramatic new tool which has been associated with electronic data processing, although it is really quite different. This is the field of Operations Research. I don't think you can get two people in our country today to decide upon a specific definition of Operations Research, but basically, it is the application of scientific techniques and methods to the solution of problems which occur in the management of business organizations. In addition to Operations Research, a closely allied field of systems engineering has developed which in many cases promises even greater savings and improvements than Operations Research. The systems engineering field is characterized by a broad but analytical approach to the over-all business systems problem. It involves an analysis of the requirements without being prejudiced by present operating procedures, and culminates in a design or syntheses of an "optimum" system.

Although both Operations Research and systems engineering are not per se electronic data processing, they are closely allied to electronic data processing systems. Specifically, an electronic computer sometimes proves very useful in the analysis stage, and very often electronic data processing equipment is essential to the efficient implementation of the proposed optimum system.

Some of the other reasons that might be advanced for the intense interest on the part of top management in electronic data processing, which I have been assured are very real in spite of the fact that they may seem trivial, are the prestige factors associated with one or more actual electronic data processing installations in a company and the fascination and appeal of flashing lights on the control panel of the high speed computers that executives can show off to their colleagues and exploit via press releases and demonstrations, and consequently improve the company's competitive position.

Whether these are the reasons or not, there is certainly a great deal of interest on the part of high level management and management on all levels. It might be well at this point to determine just what constitutes an electronic data processing system.

Discussion of Electronic Data Processing Systems

Electronic data processing is actually an accomplishment of the data processing functions by means of electronic equipment. Sometimes the distinction between electronic equipment and electromechanical equipment becomes somewhat nebulous. I think you will find that most people agree that it can be properly referred to as electronic if the speed is not limited by speed of moving parts, whereas electromechanical, in general, is so limited. If this distinction were to be followed one hundred per cent it would lead to several contradictions, so I don't wish to propose it as a foolproof definition.

I think we can probably proceed to the understanding of electronic data processing systems best by considering its main components, and for this purpose, we can be aided by Figure 1. First we have the input. The input consists of the source documents, representing the transactions, and other raw data which is subsequently processed to maintain the files and produce the output reports required for running a business. We will later examine the inputs in further detail. Let us now see how these various components fit together and we can discuss each one of them later in more detail.

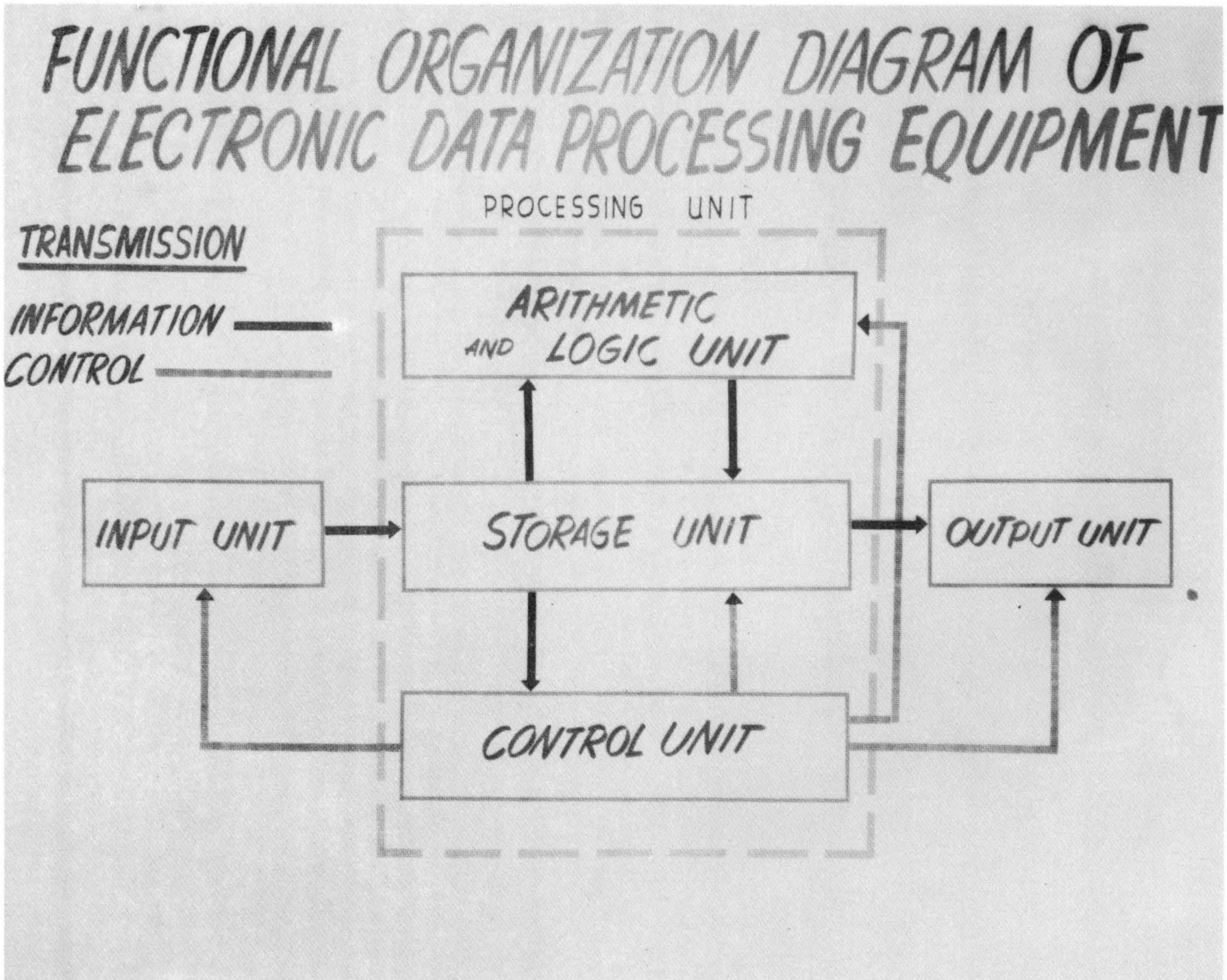

Figure 1 **FUNCTIONAL ORGANIZATION DIAGRAM OF ELECTRONIC DATA PROCESSING EQUIPMENT**

The input is transmitted to a storage unit where it is maintained for reference during the processing part of the application. Note that the storage unit communicates with the arithmetic unit. Both the arithmetic unit and the storage unit, as well as the input, are under the control of the control unit. To start the operation, the control unit would send a signal to the input telling it to send data to the storage unit. It would then notify the storage unit to transmit this data to the arithmetic unit, having previously told the arithmetic unit what to do with this data when it receives it. The results of the arithmetic unit (which is really an arithmetical and logical unit) are then returned to the storage unit and finally are produced as output. Output may be on a one-to-one basis, that is, an output being produced for each input, or the output may be a summary, a consolidation, or an analysis of the input.

Now I think we will want to consider the input, the storage unit, and the output in more detail. To really examine the control unit or the arithmetic unit would lead us into quite technical considerations which I am sure would not be appropriate for us tonight.

Figure 1A displays the basic block diagram again, but indicates some of the typical equipment which might be involved in each of the components of this basic system.

Input

The form of the input, however, is extremely important. You are all familiar, I am sure, with various forms of what might be considered input to a data processing system. Such things as invoices, receiving tickets, sales tickets and orders, in an inventory control application; job tickets and time cards in a payroll; checks, deposit slips, and withdrawl slips in a bank, would all be considered as input source documents.

Normally this input is not in a form which the computer can utilize directly, although it is to be hoped that as the techniques in electronic data processing systems become more sophisticated and more universally utilized, more and more source documents can be directly in a form which the computer can utilize. The philosophy should be that once the information required for input is recorded, it should be recorded in a form in which all subsequent processing can be done by an automatic reading of the information. There are many of the so-called common language devices which tend to implement this philosophy. For example, the Flexowriters in which, as a by-product of typing a document, a punched paper tape is produced. This punched paper tape can be subsequently read as input to a computer either directly or by means of converters which convert either to magnetic tape or other input media. Such punched paper tape attachments have been utilized with accounting machines, adding machines, bookkeeping machines of various types, cash registers, and what has been referred to as "Point-of-Sale Recorders". With the latter devices, it is possible to record on paper tape at the time a sale is made in a department store all of the pertinent information such as the customer's charge account number, the inventory number of the article purchased, the clerk's number, the amount, and any discount and taxes involved, so that with the reading of the paper tape it is possible to do all the data processing required.

There are numerous other devices which have been developed for use in this common language field, frequently referred to as integrated data

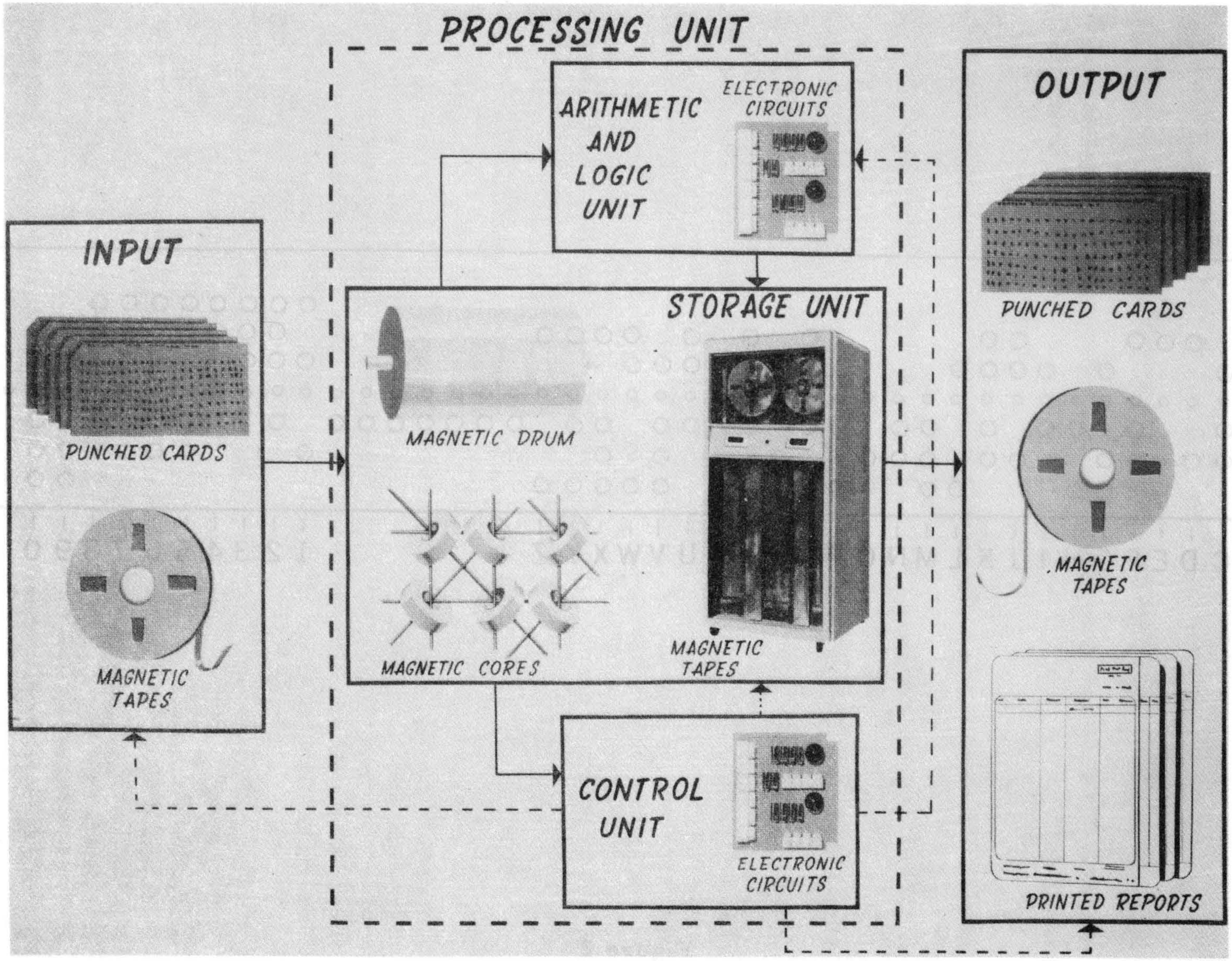

Figure 1A COMPONENTS OF ELECTRONIC DATA PROCESSING EQUIPMENT

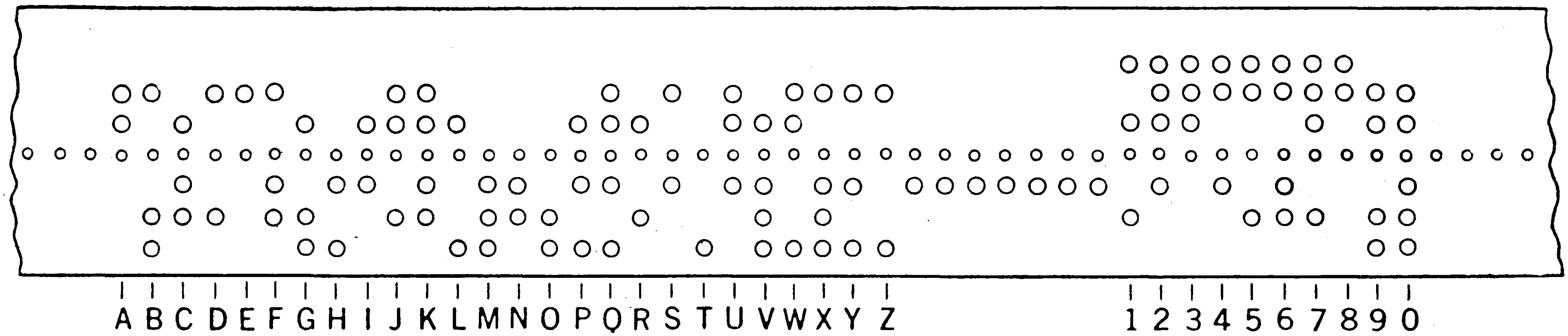

Figure 2

processing (although I don't feel that this particular term is very appropriate). In spite of attempts to avoid it, the input frequently requires transcription to a form which is acceptable by the computer, but it is desirable that at the very first opportunity the input data be recorded in a mechanically readable form so that no further manual or human intervention is required.

The typical input media are the punched paper tape, punched cards, and magnetic tape which has the advantage over the punched cards and punched paper tape of being much more rapidly read. Typical rates, incidentally, are about 200 or 400 characters-per-second from punched paper tape, and about 200 or 250 cards-per-minute, or about 330 characters per second, from cards; whereas, magnetic tape can be read at the speed of 15,000 characters-per-second and at even higher rates. The information on these input media are recorded in what is referred to as codes. We will not go into this method of recording information and handling it in the computer, except to remind you that there are several different codes utilized by the many equipments in the field today. In this respect not too much progress has been made among the various computer manufacturers in standardizing upon a code or a common language. However, many code converters have been built which facilitate the translations from one language to another, and it really is not essential for a common language to be established by all manufacturers as long as any one system is integrated properly.

It might help you to visualize some of these devices if we take a look at some of the input media. Figure 2 shows a picture of a punched paper tape. Now there are several varieties of punched paper tape available, 5, 6, 7 or 8-channel being used in several applications. This particular one is 6-channel. There are sprocket holes in the middle for positioning of the tape. These channels are read either by electrical contact through the holes or sometimes photoelectrically. The particular array of holes across one of these lines determines the value of the character. It is, then, a code for that particular character.

A magnetic tape unit is shown in Figure 3. These are actually UNIVAC magnetic tape units referred to as Uniservos. The information on the tape is arranged in quite similar fashion to the way it is on the punched paper tape; except that it is magnetic recording and, therefore, much more densely recorded than it is on the paper tape. It is also possible to move the magnetic tape much more rapidly, thus resulting in higher reading rates. The density on paper tape is usually ten characters-per-inch, whereas on magnetic tape it may be a hundred or two hundred, or even more, characters-per-inch. Now the information may be recorded on the magnetic tape either by various converters from punched cards referred to as card-to-tape converters, or directly from a keyboard on a device developed by Remington-Rand, referred to as a Unityper.

Figure 4 shows this Unityper. This is the Unityper I. Actually, there is a new device referred to as Unityper II which is much simpler. Unityper I utilizes a Uniservo and a typewriter as shown, where the Unityper II has the tape mechanism in a section of the typewriter case.

Figure 5 shows an IBM 705 Magnetic Tape Unit. Here we see the information recorded along the tape in records or unit items that have all the information on a given unit. It can be made to read or write records of variable lengths, whereas the records on the UNIVAC Tape Unit, the Uniservo, have to be a fixed length.

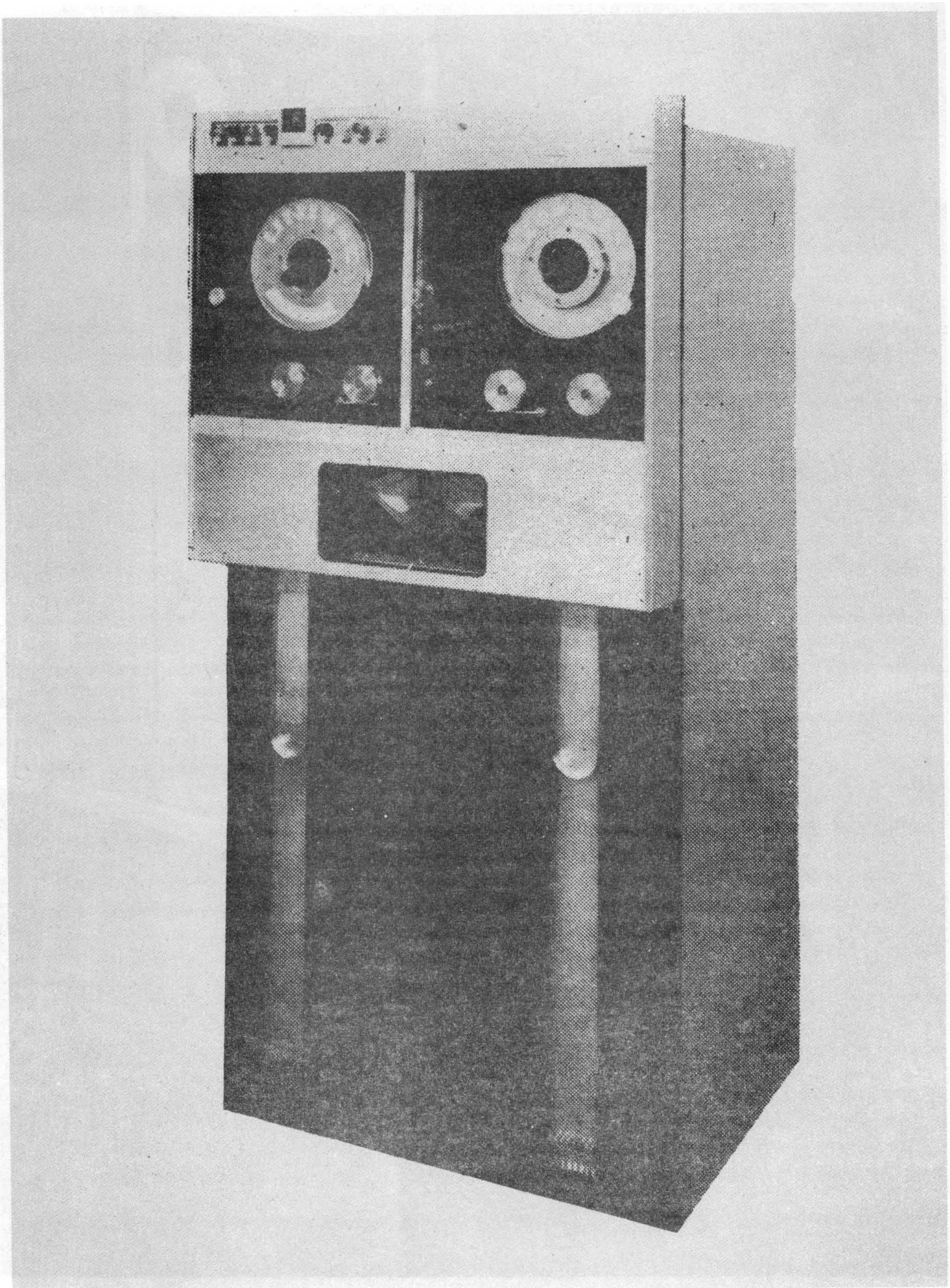

Figure 3

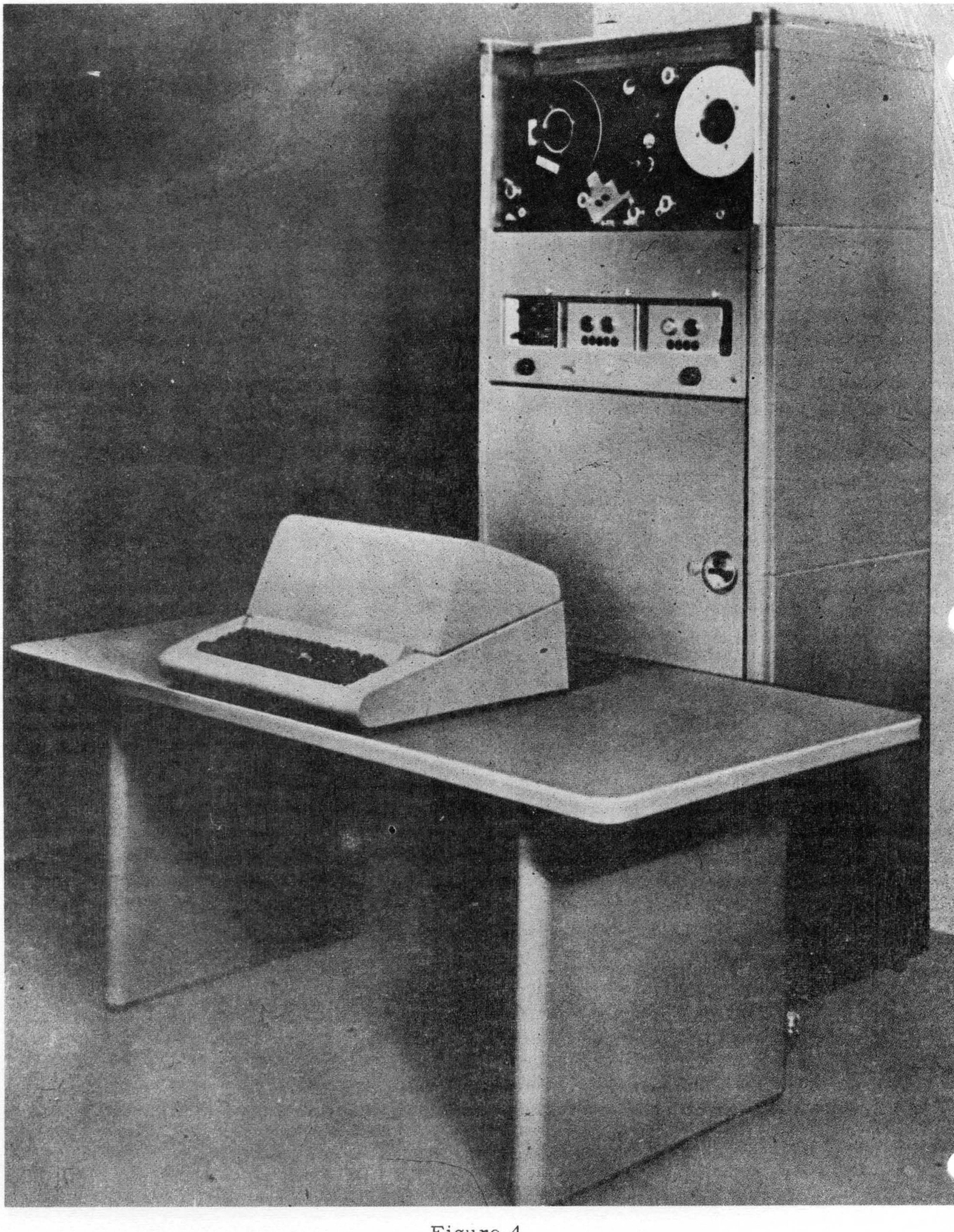

Figure 4

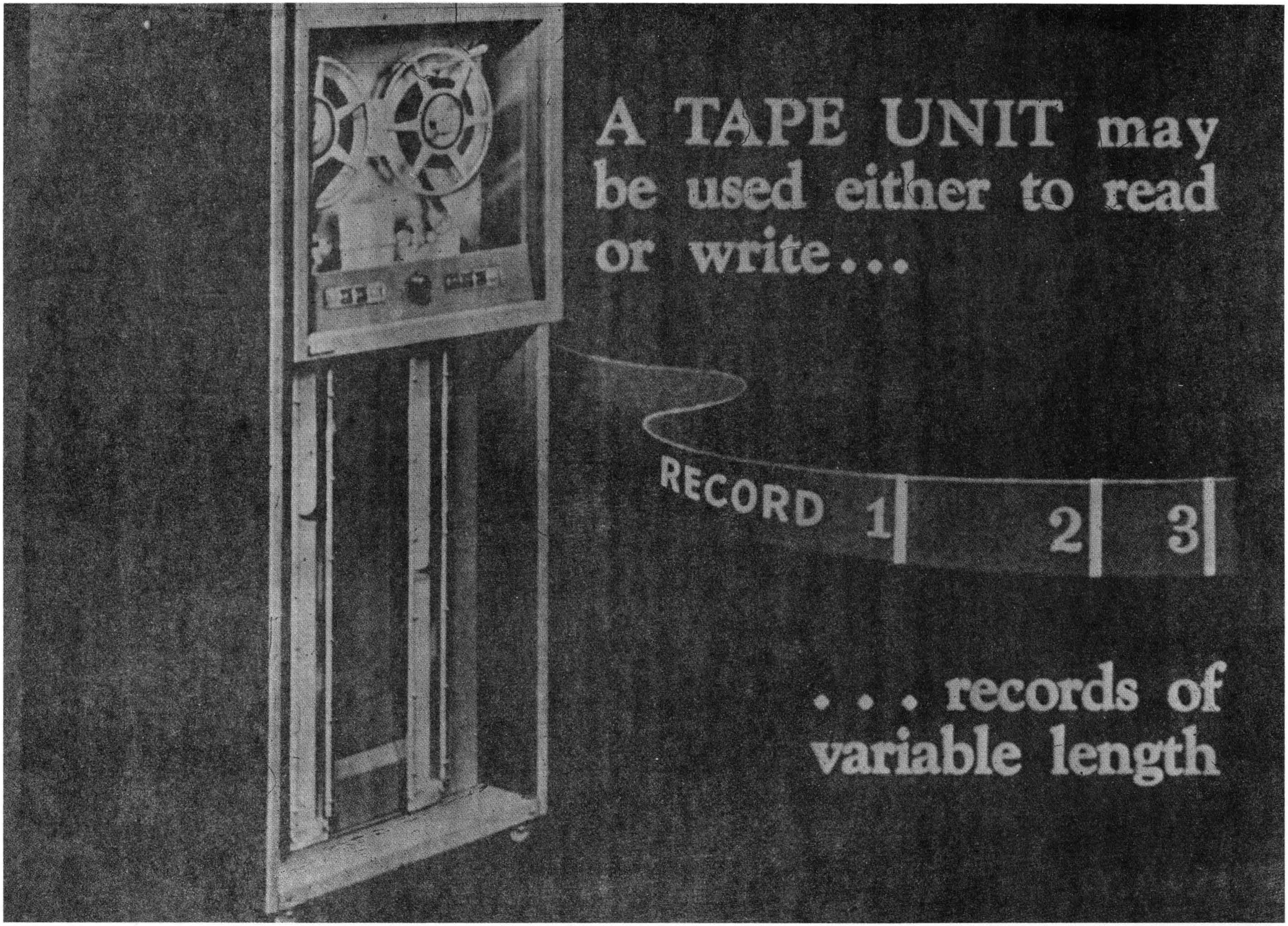
A TAPE UNIT may be used either to read or write...
RECORD 1
2
3
... records of variable length

Figure 5

Figure 6 shows a newer and very novel input device which utilizes a reader of actual printed information. It optically determines the value of printed characters by scanning them. It was developed by Intelligent Machines Research Corporation and is incorporated in a system referred to as Scandex, marketed by the Farrington Company. The Farrington Company makes a great many metal "charge-a-plates". The particular application described here is used by a large oil company for its charge card customers. The customer presents the charge-a-plate and, by a very inexpensive device in the gas station, the image on the card is transferred to a punched card. Later when these cards are delivered to the accounting department of the oil company, it is desired to punch the account number into the card without actually manually key punching. This is done by the IMR scanner unit optically reading the account number recorded on the card and this account number then being automatically punched into the card. The amount has to be key punched in, but it is much faster than punching in both the account number and the amount. The subsequent processing can be done by utilizing punched card machinery.

Storage Devices

Now, when the information has been read in the input unit of the computer, it is transmitted to the storage unit. The storage unit is used not only for recording the data which is used in the computation, but also for the recording of instructions. The instructions are coded information which are used to tell a computer what to do. The computer succeeds in performing the specified operations on the data under the control of the stored instructions. Such devices are referred to as stored program machines. Most of the commercially available computers are of the stored program variety and are referred to as general purpose computers. Such a general purpose computer was diagrammed in our first slide. We saw the instructions from the storage unit being transferred to the control units where they were interpreted so that the control unit can emit the proper control signals.

Let us now consider some of the devices which might be used for the storage unit. In some of the early computers, much of the storage was actually in vacuum tube circuits. This is quite bulky, however, and requires a great deal of power to heat the filaments. In UNIVAC I, the storage unit consisted of an acoustic delay line whereby the information was re-circulated in a delay channel and it could be read on a cyclical basis. More recent computers have been utilizing magnetic core storage.

In Figure 7, there is shown a picture of magnetic core storage as used in the IBM 705 Computer. This core memory efficiently stores 20,000 characters, grouped in variable size fields. The example shown here is for the class, part number, and cost in an inventory application. Now all of these storage devices mentioned have what might be referred to as "quick access". That is, information in them can be obtained rapidly. In addition to this fast access storage utilized in computers, there is usually a "back-up" storage of a relatively slower access time. A magnetic drum has become very popular in this regard. This is a metal cylinder which has been coated with a magnetic material. The magnetic material has been magnetized in accordance with the digital information and as the drum rotates, magnetic heads read the information stored on the drum. The heads can also be used to change the information; that is, to write new information on the drums.

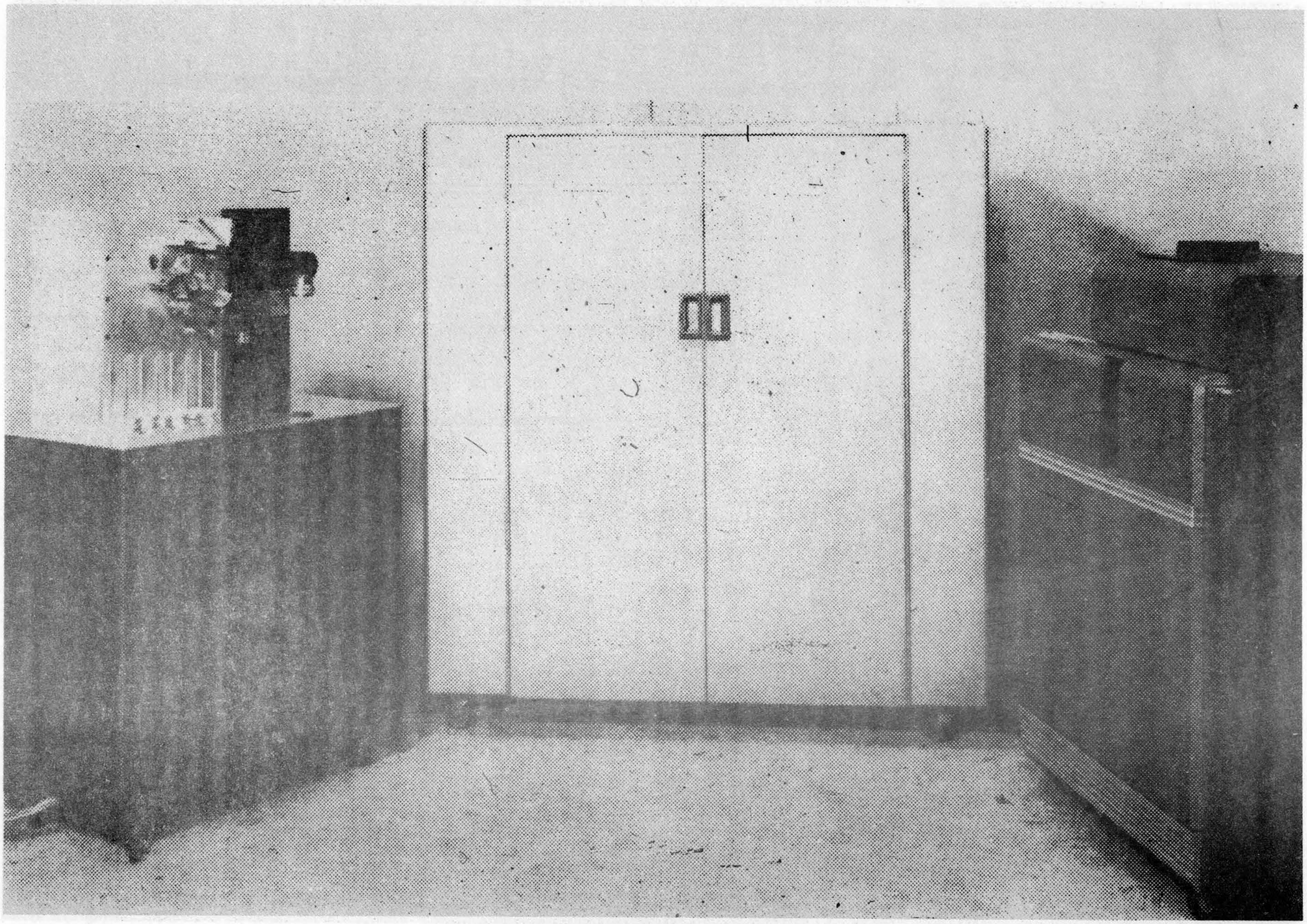

Figure 6

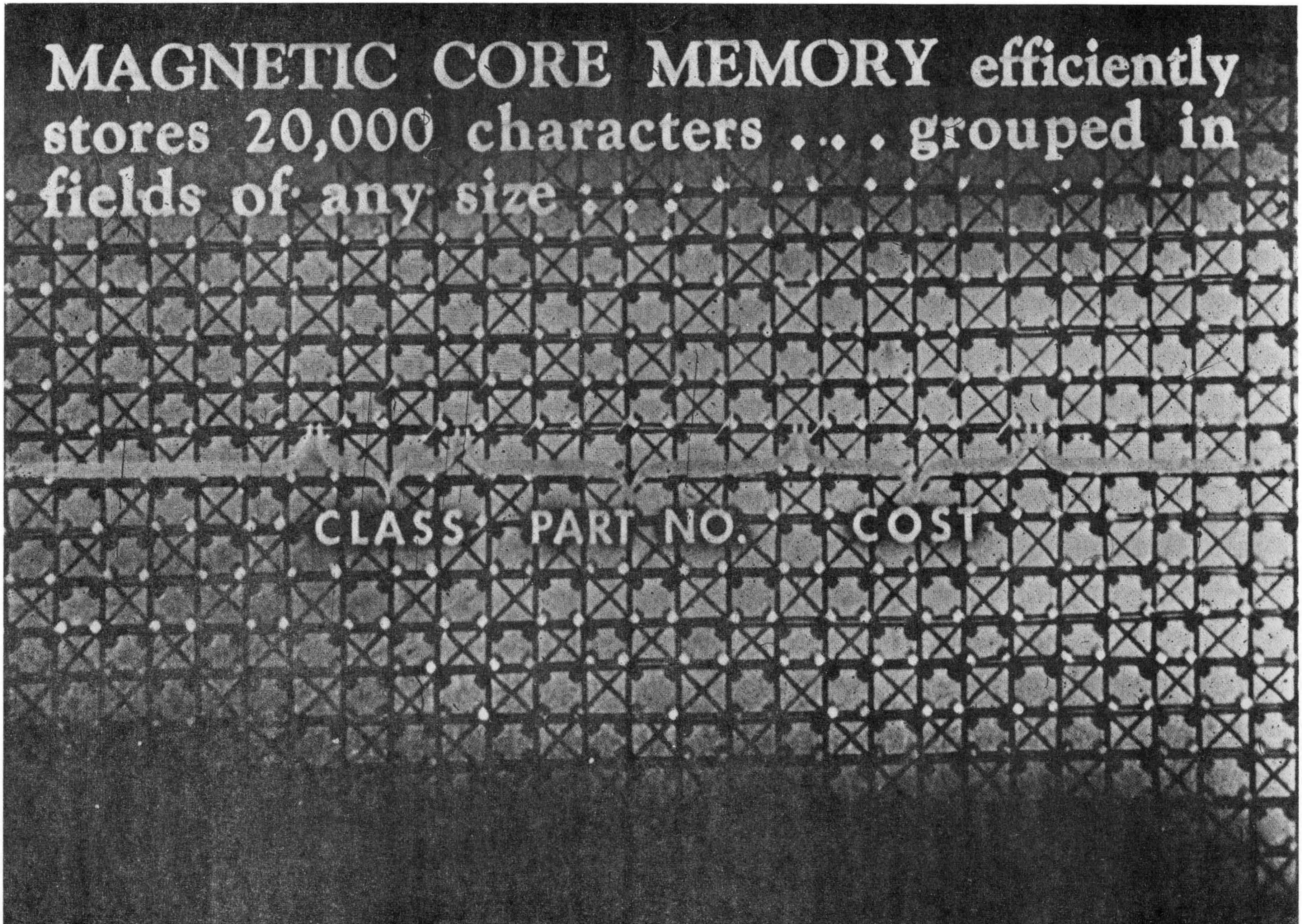
MAGNETIC CORE MEMORY efficiently stores 20,000 characters .... grouped in fields of any size ....
CLASS
PART NO.
COST

Figure 7

Even the back-up storage afforded by magnetic drums has been at times inadequate and magnetic tape units, in addition to being used as input devices, have been used to store additional data and to store some of the instructions in very long programs which might be required in some applications. One always attempts to get all the instructions in the internal storage if possible, since it has immediate access. However, it is sometimes necessary to develop rather lengthy routines of instructions for exception cases which are only used rarely and these might be conveniently stored on tape units since the access time is not serious as these routines are only rarely involved.

Speeds

Perhaps it would help now to get an idea of the comparative speeds of some of these devices we have been discussing.

Figure 8 shows the comparison of several types of computers. In 1943, the decimal desk computer operated at a speed of one addition per ten seconds; that is, ten thousand milliseconds. (Incidentally, a millisecond is a thousandth part of a second. In other words, there are one thousand milliseconds in a second.) And if we rate this at a relative speed of one, we can see the factors of speed increase as we progress. In 1944, we had the Harvard Mark I which was a mechanical computer utilizing relay circuits with mechanically moving parts. It was a decimal computer and operated at a speed of one addition per three hundred milliseconds. This was a factor of increase of 33 over the desk computer. In 1951, UNIVAC I appeared. This was an alphanumeric machine in which it was possible to code alphabetic data as well as special symbols and decimal digits. It performed an addition in .525 milliseconds. That is almost two thousand a second. This was a factor of increase of 20,000 to 1 over the desk computer. In 1955, the IBM 705 was available and this again was an alphanumeric machine and performed an addition in 0.2 millisecond, the factor of speed increase being 50,000. In 1958, we are scheduled to see a LARC installation; LARC referring to the Livermore Atomic Research Computer now under construction by Sperry Rand. This will have the phenomenal speed of an addition in .006 millisecond. (Incidentally, a millionth part of a second is frequently referred to by technicians as a microsecond and this would be six microseconds.) The LARC, then, represents a factor of speed increase over the desk computer of 1943 of 1,300,000.

Also, it might help us visualize the development and the evolution of electronic data processing and computers if we compare the storage capacities as shown in Figure 9.

In 1943 again, the desk calculator had a capacity of 40 decimal digits. The Harvard Mark I, a mechanical computer, had a capacity of 1,728 decimal digits. UNIVAC I in 1951, had a storage capacity of 12,000 characters. This was its internal storage capacity. On the external storage (that is, the tapes) it was possible to store 11,000,000 characters. And in 1955, with the IBM 705 again, we have an internal storage capacity of 20,000 characters. This is the magnetic core unit of which you saw a picture earlier. Also, 1,800,000 characters of drum storage on thirty drums, and one-half billion characters on the magnetic tape storage if you had the full total capacity of one hundred tape units.

In Figure 10, we see a layout of a large scale electronic data processing system. This particular one is the IBM 705. We see here in the

Date	Type	Addition Speed (milliseconds)	Factor of Speed Increase
1943	Desk Computer (Decimal)	10,000 (10 sec)	1
1944	Harvard Mark I Mechanical Computer (Decimal)	300	33
1951	Univac I (Alphanumeric)	.525	20,000
1955	IBM 705 (Alphanumeric)	.200	50,000
1958	LARC*	.006	1,300,000

*Livermore Atomic Research Computer, under construction by Sperry-Rand.

Figure 8

Storage Capacity

1943	Desk Calculator	40 decimal digits
1944	Harvard Mark I	1728 decimal digits
1951	Univac I	12,000 characters 11,000,000 characters (10 tapes)
1955	IBM 705	20,000 characters (cores) 1,800,000 characters (30 drums) 5 billion characters (100 tapes)

Figure 9

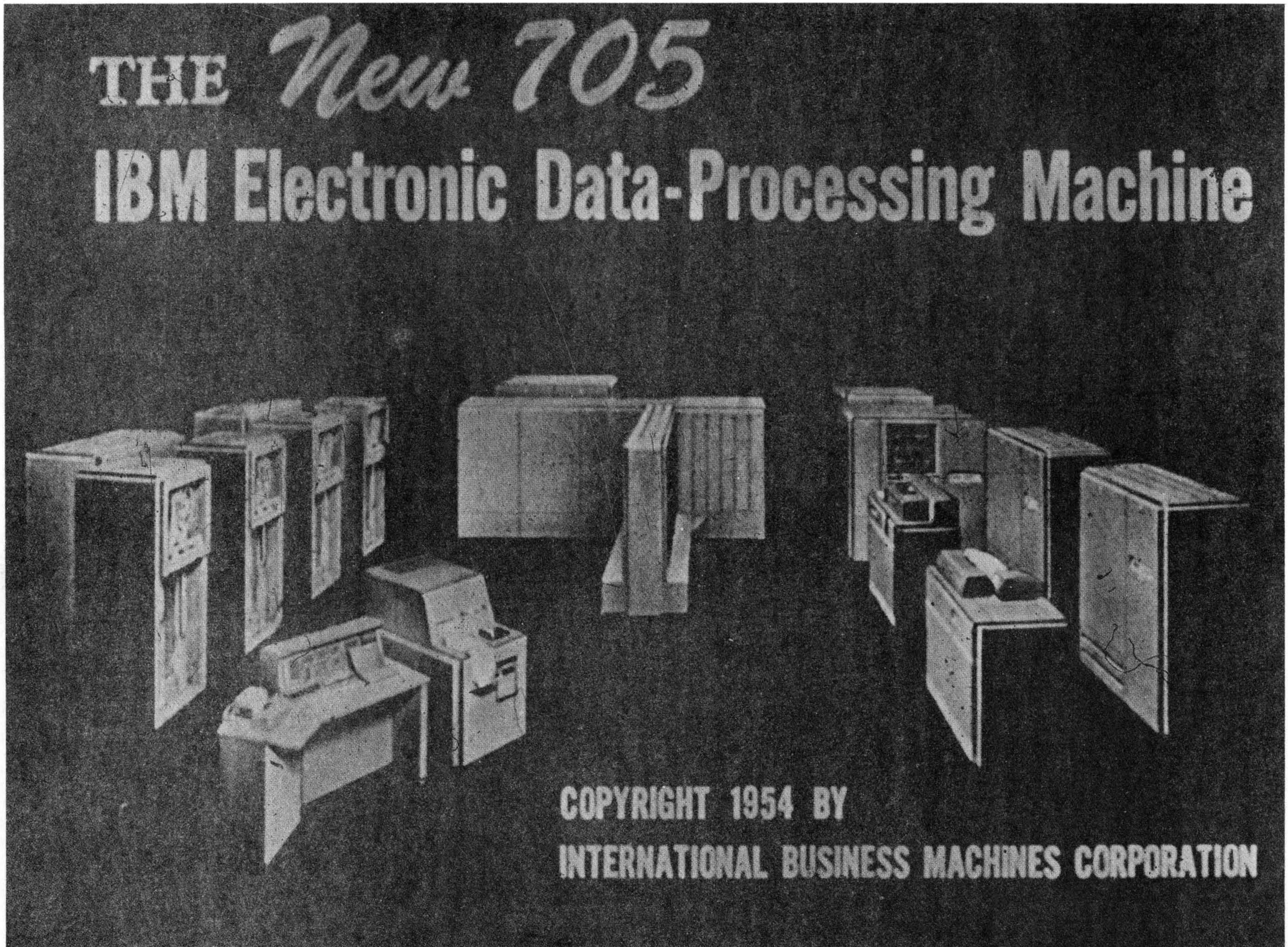
THE New 705
IBM Electronic Data-Processing Machine
COPYRIGHT 1954 BY
INTERNATIONAL BUSINESS MACHINES CORPORATION

Figure 10

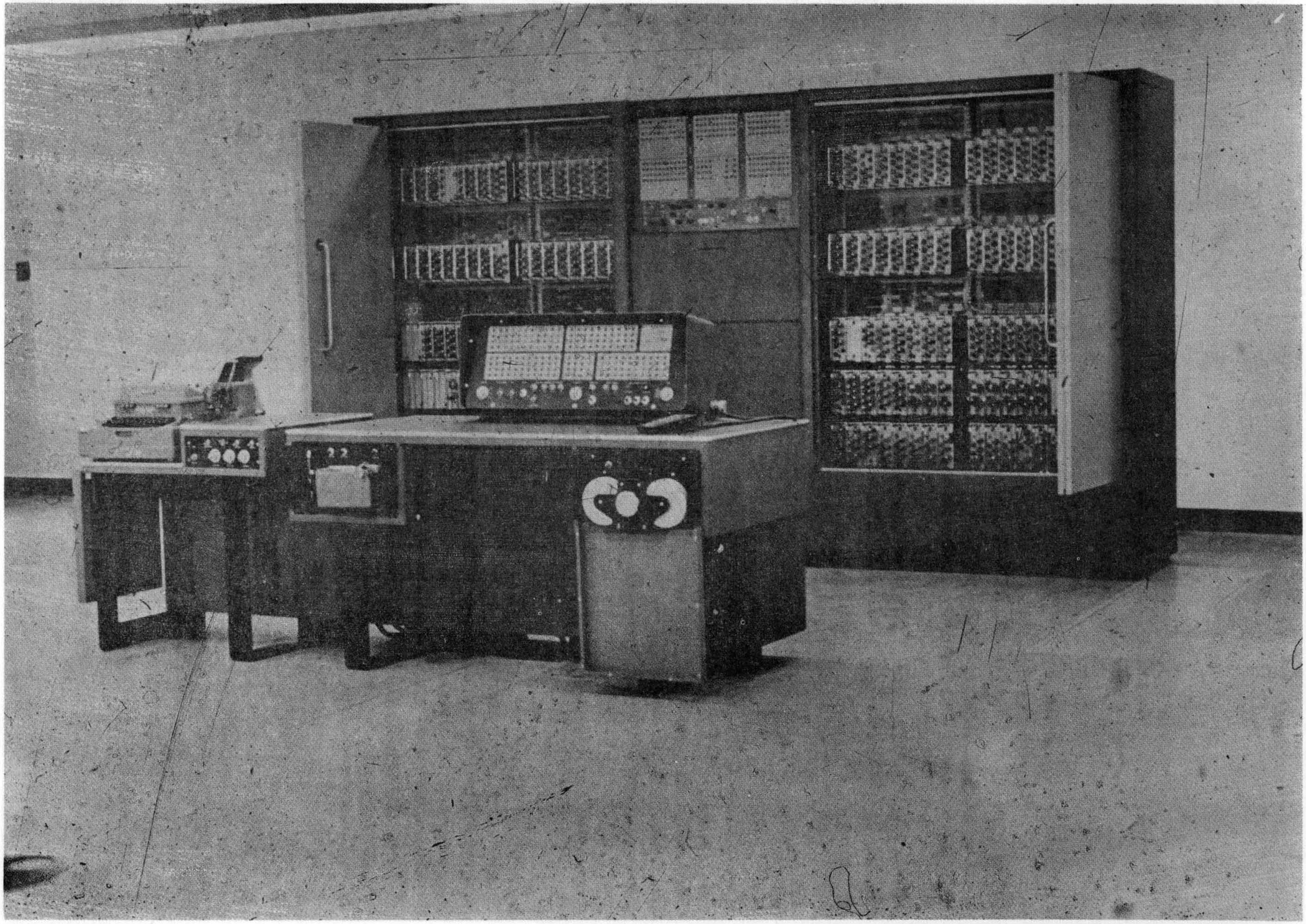

Figure 11

forefront the operator's console, on which we have the indicator lights displaying the conditions of the various units and some of the information stored in particularly important storage locations. The tape units are over here on the left. In the rear, we see the central unit which controls the arithmetic and logical units and the control unit, and, over on the right, some of the output printers and punch units.

In Figure 11, we see a medium scale system. This particular one is the Datatron, a digital computer system manufactured by the Electrodata Corporation out here in Pasadena (recently purchased, incidentally, by the Burroughs Corporation). Here we see the computer circuits themselves, the arithmetic and logical unit; the drum is stored in these units over here. Here we see the input console with a punched paper tape reader and punched paper tape punch for the input-output unit. The Electrodata system now has been designed to handle magnetic tape input and output, as well as punched cards.

Applications

Now perhaps it might be well to look at how some of this equipment can be used in typical applications.

In Figure 12, we see a layout on tape of an inventory record. Here we see seven inches of magnetic tape on which a fourteen-hundred character record has been recorded. (There are two hundred characters-per-inch.)

In Figure 13, we see how an ordinary life insurance application might be performed on punched cards; and, on Figure 14 how this same ordinary life insurance might be performed on a magnetic tape computer.

Incidentally, to compare the equipment that might be involved in performing this insurance application on punched card equipment as opposed to electronic data processing equipment, I would like to quote a few figures from a study made by the Bureau of Labor Statistics entitled "Automatic Technology Number 2", as shown in Figure 15. Here we see for 850,000 policies that the input and the storage requirements for the file on punched card equipment would be 3,500,000 cards per month; whereas, with electronic data processing, although the input would be used on cards originally, it would be converted to magnetic tape before inputting to the computer and the basic files would be stored on tape. The total tape file would be 71 magnetic reels. In the punched card equipment, a total equipment complement of 125 machines would be required; whereas, in the electronic data processing systems, 27 machines, plus one large computer would be required. The estimated yearly rental for the punched card equipment would be $235,000; whereas, under the electronic data processing equipment it would be $410,000 including $50,000 for punched card equipment. The number of operating personnel under the punched card system would be 198 and, under the electronic data processing system, 85. The average salary of the operating personnel, $3,700 under the punched card equipment, and $4,200 under the electronic data processing system. In this operation there was a fifty per cent saving to the budget of the section and some 15,000 square feet of floor space was saved. The initial amortization period was planned as five years, but operational savings indicate that it will be possible to recover the investment within a much shorter period.

A rather novel and interesting recent application of electronic data processing equipment was made on an experimental basis to the stock market analysis. In the past, the typical brokerage firm analyzed three hundred out of two thousand stocks following certain

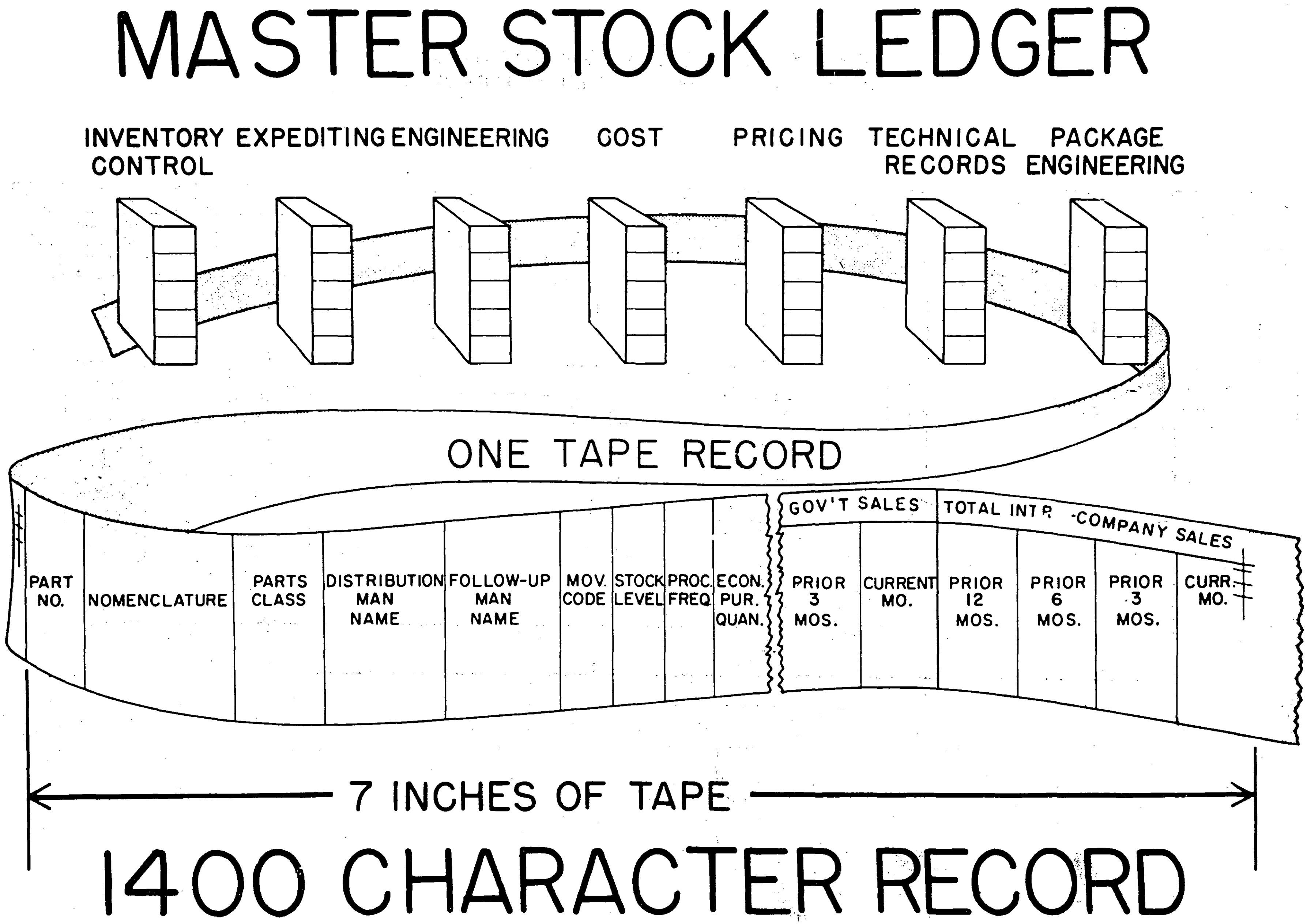
MASTER STOCK LEDGER
INVENTORY CONTROL
EXPEDITING
ENGINEERING
COST
PRICING
TECHNICAL RECORDS
PACKAGE ENGINEERING
ONE TAPE RECORD
PART NO.
NOMENCLATURE
PARTS CLASS
DISTRIBUTION MAN NAME
FOLLOW-UP MAN NAME
MOV. CODE
STOCK LEVEL
PROC. FREQ.
ECON. PUR. QUAN.
GOV'T SALES
PRIOR 3 MOS.
CURRENT MO.
TOTAL INTR -COMPANY SALES
PRIOR 12 MOS.
PRIOR 6 MOS.
PRIOR 3 MOS.
CURR. MO.
7 INCHES OF TAPE
1400 CHARACTER RECORD

Figure 12.

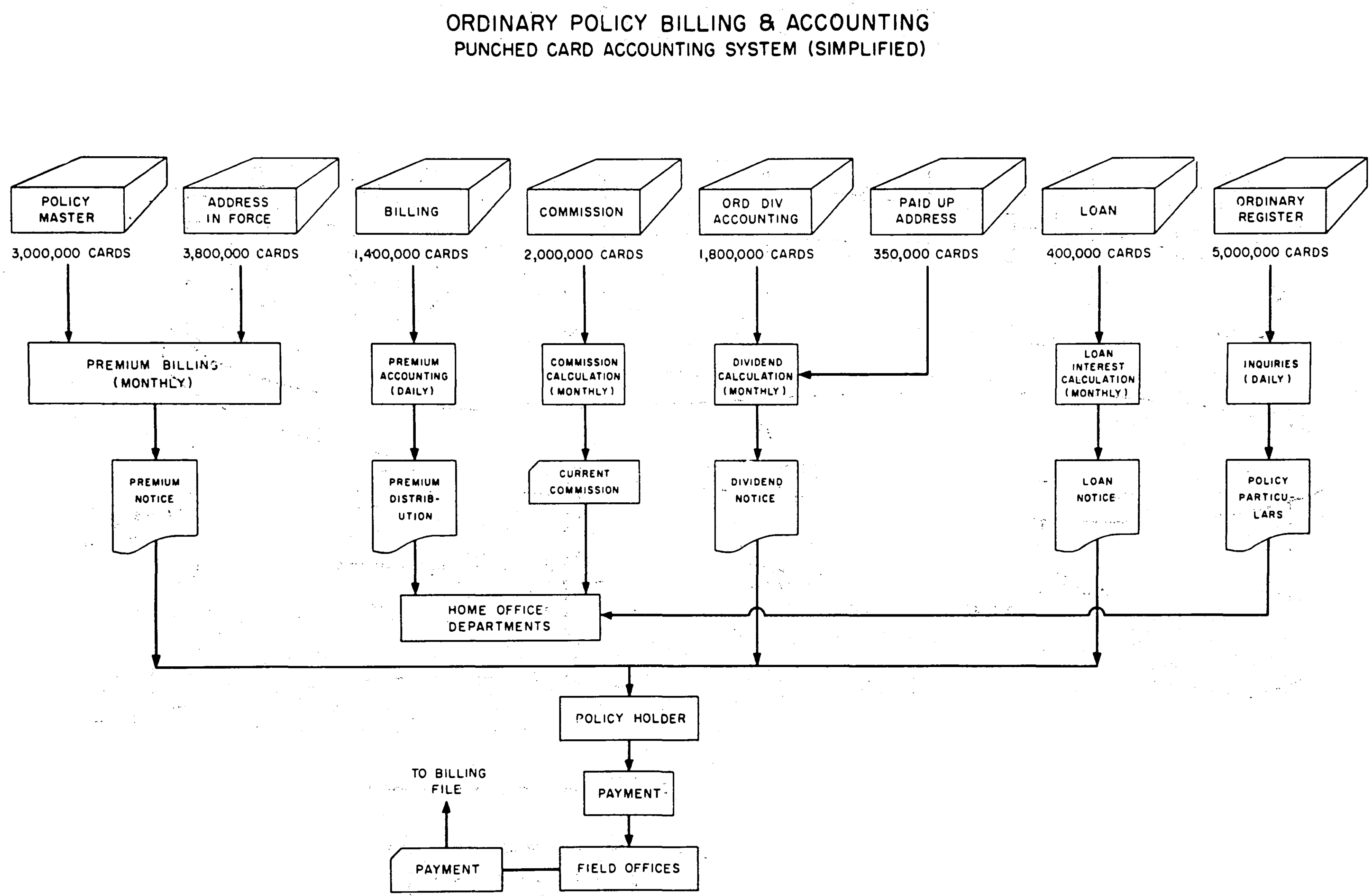
ORDINARY POLICY BILLING & ACCOUNTING
PUNCHED CARD ACCOUNTING SYSTEM (SIMPLIFIED)
POLICY MASTER
3,000,000 CARDS
ADDRESS IN FORCE
3,800,000 CARDS
BILLING
1,400,000 CARDS
COMMISSION
2,000,000 CARDS
ORD DIV ACCOUNTING
1,800,000 CARDS
PAID UP ADDRESS
350,000 CARDS
LOAN
400,000 CARDS
ORDINARY REGISTER
5,000,000 CARDS
PREMIUM BILLING (MONTHLY)
PREMIUM ACCOUNTING (DAILY)
COMMISSION CALCULATION (MONTHLY)
DIVIDEND CALCULATION (MONTHLY)
LOAN INTEREST CALCULATION (MONTHLY)
INQUIRIES (DAILY)
PREMIUM NOTICE
PREMIUM DISTRIB-UTION
CURRENT COMMISSION
DIVIDEND NOTICE
LOAN NOTICE
POLICY PARTICU-LARS
HOME OFFICE DEPARTMENTS
POLICY HOLDER
PAYMENT
TO BILLING FILE
PAYMENT
FIELD OFFICES

Figure 13

ORDINARY POLICY BILLING & ACCOUNTING
ELECTRONIC DATA PROCESSING SYSTEM

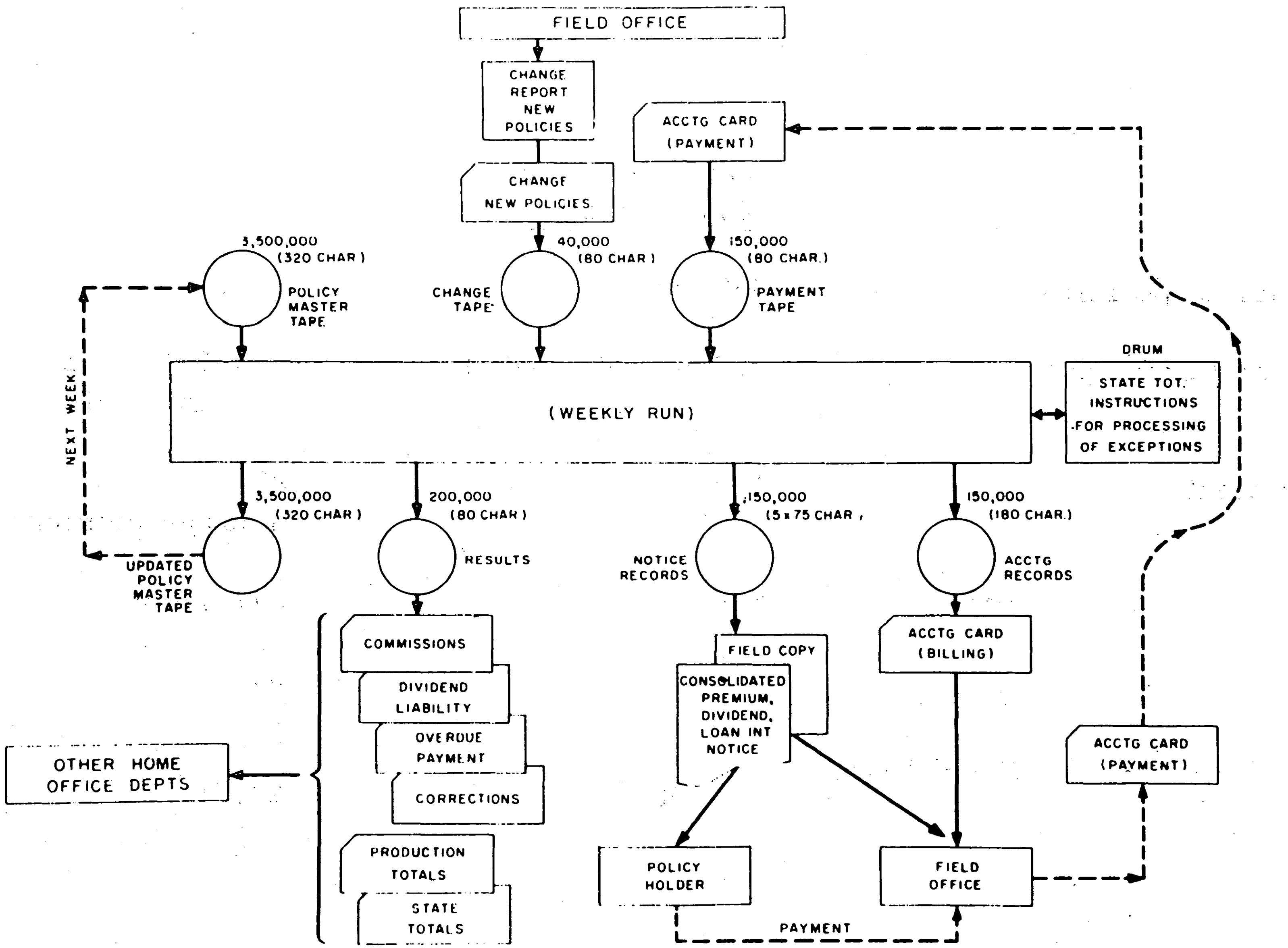

Figure 14

	Card Punching Equipment	Electronic Data Processing
Number of policies	850,000	850,000
Input and storage	3,500,000 card/mo.	1,000,000 cards/mo. 71 tape reels
Equipment	125 machines	27 machines 1 large computer
Estimated yearly rental	$235,000	$410,000
Operating personnel	198	85
Average salary of operating personnel	$3,700	$4,200

Figure 15

rules for prediction of future activity. Recently a magnetic drum computer was utilized for the technical analysis of securities, and one stock can be analyzed on this computer in somewhat less than twenty seconds. Hence, within about 11 hours after the close of the stock market, a complete analysis of all two thousand stocks could be completed so that the information would be available before the stock market opens on the following day. More recently it has been planned to take the information on a stock's price immediately from the ticker tape information and perform the analysis in what might be referred to as an on-line operation; that is, as the market is operating.

In the production control area, data processing has been applied by many companies. At General Electric's Appliance Park plant in Louisville, Kentucky, a 20-week production schedule, involving thirty models, 1,000 purchased parts and 350 raw material items, can be exploded in approximately two hours. The schedule gives the lead time and loss factor for each part and reports the quantity of each part and raw material that must be scheduled to meet the requirements.

Actual Installations

We have briefly reviewed some of the salient reasons why there may be so much interest on the part of management in electronic data processing systems; we have attempted to describe very briefly what an electronic data processing system is; and we have seen several examples of the equipment and cited some typical applications. It might be well now to examine to just what extent electronic data processing systems have been utilized in business applications. At the present time there are approximately 450 modern electronic computers being used in data processing applications for business type problems in the United States. Over fifty of these are of the large scale variety, that is, UNIVACS, IBM 702's and 705's. (The 702, incidentally, was the predecessor of the 705). The remaining four hundred are of the medium scale or small scale variety and are of the type referred to as magnetic drum computers.

Incidentally, the potential market for electronic computers has been predicted in a recent study performed for a brokerage firm by a management consulting company in the following terms: It is stated that there are firm orders for well over 1,000 internally programmed computers, and that the value of the backlog is estimated to be in excess of $4000,000,000. The total demand for general purpose digital computers was estimated in this study as $2.4 billion and the breakdown was approximately as follows: About $1,250,000 for the large scale computers and about $1,150,000 for the medium scale computers.

So you see, it's about an equal division here. About a billion and a half would be for business applications, $500 million for science and engineering, and $350 million for government. So here we see a ratio of three to one for business applications over science and engineering. The early history of the computer was almost the opposite of this. That is, the preponderance of the applications were in the scientific and engineering fields.

Benefits to Office Operations

I promised at the beginning that we might indicate what the possible benefits to the operations people in today's offices might be from the utilization of electronic data processing systems. The primary advantages seem to be the following:

1. Reduced costs, as we have seen in the insurance application. This is largely the result of reduced personnel.
2. Increased speed. That is, the information can be made available to management in reports much more rapidly than it could have in the old manual and semi-automatic electromechanical data processing systems.
3. Increased accuracy. The accuracy results from self-checking features, which can be built into the computer, and the ability to perform multiple program checks on its operation, i.e., the inherent accuracy of electronic computers as compared with manual or semi-automatic methods.
4. Improved reporting. It is possible for the first time to obtain new reports consolidated with respect to more sophistacated or complex criteria or including only items which are of an exceptional nature, the so-called management by exception routines.
5. The consolidation of files. This has been particularly apparent in the insurance data processing applications in which many files have been heretofore maintained in the punched card systems simply because it was not feasible to run through the enormous file that would be necessary on punched cards if all of the information were to be maintained in a single file. However, with the increased speed of running through the information on the magnetic tape this has proven feasible and has resulted in increased accuracy and more efficient operations.

6. <u>The automatic processing exceptions</u>. In manual systems, exceptions were usually handled without too much difficulty by human operators who made decisions based upon policy and information available. However, in punched cards systems it represented quite a bit of additional processing and actually the operations were sufficiently obnoxious in some cases as to be handled or processed by hand. Electronic data processors can handle such exceptions efficiently and machine decisions are consistent with the policies established, whereas sometimes human interpretations of company policies or procedures can vary.

Future Data Processing Equipment Trends

Perhaps it would also be appropriate to have a few remarks about some of the future equipment trends. Some of the major problems remaining in electronic data processing equipment are the following:

1) Sorting is not particularly efficient with magnetic tape computers. It is a time consuming operation and indeed some of the applications which I have examined have resulted in a ratio of the time required for sorting to that required for processing to be ten to one or even greater. To meet this requirement, several companies are presently developing, and actually some of them have available on the market, special purpose sorters which are off-line devices; that is, they don't require the main computer for the sorting but do it with a separate auxiliary device independent of the computer itself.

2) Another deficiency (in the present magnetic tape systems at least) is the lack of sufficiently rapid random access for answering interrogations. To run through a magnetic tape file from one end to

another requires three minutes or more and this is frequently a prohibitive amount of time to wait in answering an inquiry; indeed, if the volume of inquiries is sufficient, it may not be physically feasible to keep up with the interrogation rate by running through the files of magnetic tape. In addition, there may not be a magnetic tape unit for each reel so it may be necessary actually to go and get the reel from the storage bin and then rotate the tape to the proper record in order to get the required information.

To satisfy these requirements for interrogations in those applications where necessary, a number of companies have been developing random access memories in which it is possible to obtain the information from a record in a <u>random</u> fashion; whereas, the magnetic tape units are sequential in nature running from one record to the next in sequence. One of these devices was recently announced by IBM, called RAM for Random Access Memory, and consists of a number of magnetic discs on which the information is recorded. It looks very much like a juke box of the Wurlitzer variety in which a head moves up and down the stack and goes in and out between the magnetic discs in accordance with the location of the information requested.

A great deal of development is also going into the output area where higher and higher speed printers are being developed. In the punched card equipment you will recall the 407 tabulators ran at one-hundred-fifty lines a minute. Some of the electromechanical printers recently developed operate at nine hundred lines a minute. A newer type printer, utilizing wire matrices for printing the information, operates at a speed of about a thousand lines a minute. An even higher speed printer which would operate at a page at a time, has been developed using a television type tube whereby the information is displayed in visually readable characters which can be optically recorded on thirty-five millimeter film and later reproduced on hard copy by means of any one of a number of processes, such as Xerography.

Company Program for EDPS

A few concluding remarks might be appropriate as to how a company might reasonably start upon a program of investigation of electronic data processing systems; i.e., application possibilities in their particular company. One way to do this is to conduct a feasibility study of those areas which seem to be the most attractive. To determine those which are most attractive accurately really requires a detailed study; however, some of the characteristics can be easily recognized. Those which have a large volume of repetitive operations quite possibly will prove fruitful for electronic data processing.

Such a feasibility study might be performed by one's own employees but frequently it proves very useful to bring in an outside consulting firm, which can do an impartial and efficient job of such a feasibility study. Several of us in the management consulting field have been performing this activity lately. It requires the combination of three talents: 1) the business system analyst; 2) the data processing specialist or engineer; and 3) Operations Research talent represented typically by the applied mathematician or scientist. We feel this combination in a team organization represents an optimum approach to an efficient systems study.

Regardless of what method you utilize to conduct your feasibility study, it is recommended that it have a high level backing. An electronics committee should be set up to review its results and to become familiar with the potentialities of electronics by means of an education program.

It seems to me that we are now in the third, and perhaps the final stage of the evolution of electronic data processing systems and applications. The first of these three stages was the stage of romance in which there was a tremendous interest in this new and powerful -- if you will, romantic tool -- with its great possibilities as an electronic brain. It was going to solve all problems, create a Utopia. This stage, of course, was characterized by a gross over-statement of the capabilities of this tool; it included a great elation in its potential, only to be followed by a second stage of disillusionment, in which these wonderful promises for electronics were not actually realized.

However, I think today that we are in the third stage. The pendulum has swung back almost to the middle as a reaction to the disillusionment. We are finding today a number of very practical, workable installations of electronic data processing systems. Management is beginning to realize that computers do have a place, perhaps not the exaggerated one that was claimed in the romantic stage, but a very practical place in today's business world. This current stage might be referred to as one of realism.

I feel if we all remember that we do not have the panacea here for all the problems of increasing paper work, and if we thus approach a realistic feasibility study, we should find that electronic data processing systems will prove very beneficial indeed to the mechanization of many of our routine office operations.

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