AUTOMATIC DATA PROCESSING IN MANAGEMENT OPERATIONS OF THE DEPARTMENT OF DEFENSE

29 January 1958

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AUTOMATIC DATA PROCESSING IN MANAGEMENT OPERATIONS OF THE DEPARTMENT OF DEFENSE

29 January 1958

COLONEL LACKAS: Admiral Clark, Gentlemen: This morning we will consider a tool of management. I feel that the tools that become available determine the managerial processes we will employ, for, if you think about it, you will agree that, depending upon the kind of tools that you use, your organization will be developed.

I think that was well demonstrated in General Brown's talk when he illustrated the employment of electronic data-processing machines in the logistic area, particularly in field operations. If you think for a moment, there was nothing much in the literature relating to business prior to 1910 about cost accounting. And today much of our organization and much of the managerial processes which are employed are determined by that particular managerial tool.

The tool we talk about this morning--automatic data processing--is a tool which is becoming more and more important to us. To discuss that tool we have with us Mr. Charles Phillips, who is the Director of the Data Systems Research Staff in the Office of the Assistant Secretary of Defense (Comptroller). We are very fortunate in having Mr. Phillips give this talk on automatic data processing in view of his experience and knowledge of these systems and devices.

After the talk we will have a seminar during which we will consider the utilization of these devices by the various military services.

It gives me great pleasure to introduce to this class Mr. Charles A. Phillips.

MR. PHILLIPS: Admiral Clark and Gentlemen: In describing the scope of what I should cover in today's lecture, Colonel Lackas gave me, in effect, an outline which I will follow with my own variations in order and emphasis.

First, I will describe briefly, and nontechnically, what automatic data-processing systems are, what they can do, and something of their capabilities and limitations. Following this, I will talk about managament considerations in the use of these new tools and the areas in which they may be effectively employed.

You will note that we are using the term "automatic data processing" rather than "electronic data processing," thus broadening the scope of the equipment to include those that might use mechanical, photographic, or other methods, although we will generally be talking about electronic computers and devices. I also like to couple the word "systems" with "automatic data processing" since I believe our principal concern is with the methods by which we solve our management problems rather than the tools we use.

A customary approach to the first part of my talk is to trace the history of computer development from the Chinese abacus through Babbages analytical and differential engine--punched-card equipment--the Mark I Sequence Controlled Calculator--to ENIAC (the first electronic computer) and UNIVAC (the first commercially available computer). I'm going to skip the history, but I do think you will be interested in the fact that modern-day electronic computers were developed to solve military problems in the scientific, engineering, and ballistic fields and are still playing a vital part in present-day work on weapons systems.

Today, in an audience of your varied experience and background, there are sure to be some who are real experts in the field under discussion and others who know very little about the subject. Recognizing this wide variance in knowledge of the art, Colonel Lackas suggested that I avoid too much detail on what automatic data-processing systems are--their capabilities and limitations--to prevent boring the experts; but he did think it advisable to describe the "hardware" generally. He has arranged to furnish you after the lecture with an Army publication on "Concepts and Applications of Electronic Data Processing," which the neophytes in the field can read to fill in the gaps I will leave. Along with the "Concepts and Applications" you will receive a card showing the ABC's of data processing and a little pamphlet which contains facts that will make you a cocktail party expert on office automation.

Before going into the characteristics and capabilities of computers, I should narrow the field a bit. There are two principal types of electronic computers.

There is the analog type, which operates through physical representation of problems and produces answers in physical or analog form, such as the turn of a shaft or changes in electric current, in voltage or resistance; this deals in measurement. This type depends for accuracy on the precision of its manufacture and is used largely in factory automation and for military purposes such as navigation or fire control.

The second type, the digital, with which we are concerned here, works directly with numbers or digits. Its accuracy depends on the smallest unit to be counted and can be as precise as desired. These are used in office automation.

Electronic computers have three principal characteristics which distinguish them from other equipment and which I rank in order of importance so far as management operations are concerned. These are: (1) automatic operation, (2) accuracy, and (3) speed. That is:

a. They are automatic in operation. Based upon detailed instructions or programs, which must be on a step-by-step basis, computers operate with a minimum of human intervention.

b. They are extremely accurate. The inherent accuracy of computers is phenomenal. As an example: A record was kept of errors in the first six weeks of operation of an IBM 705. In this period of 724 hours of operation the machine performed 10,936,296,000 operations with 31 errors; 19 of these were corrected on a second reading, 10 were due to dust, and two were of a mechanical nature.

c. They have fantastically high speeds. Large machines perform operations in microseconds, millionths of a second, while the medium and small machines operate in milliseconds or thousandths of a second. Such speed is usually greater than we can effectively utilize.

Before talking about capabilities of computers, there is another distinction or grouping within the digital type as follows:

a. Special purpose: designed to do a specific job most effectively at lowest cost.

b. General purpose: designed to do a wide variety of jobs as effectively as possible.

Special purpose computers, as the name implies, are designed to do a specific job most effectively at the lowest possible cost. A good example of this type of equipment is the airlines' Reservisor, a computer designed to quickly and accurately handle airline reservations. Another example would be the special equipment designed to account for the telephone toll calls on an automatic basis. The other group, and the one with which we are concerned in most management problems, is the general purpose computer, which is designed to perform a wide variety of problems as

effectively as possible. The UNIVAC is a good example of a general purpose computer. Its flexibility permits its use for most any type of management problem, including problems in the scientific and engineering fields as well.

I could spend considerable time in discussing all of the capabilities of electronic computers, but will limit the discussion this morning to a few that I think are most important from the standpoint of management operations:

a. Ability to "remember" indefinitely; ability to select information; look up or locate related data; perform addition, subtraction, and other operations.

b. Also, follow a long list of instructions; make decisions as to alternative procedures:

(1) Review and check accuracy of results.

(2) Produce answers.

These are not necessarily described in their order of importance, since this might depend to some degree upon the particular operation involved.

First, they have the ability to remember or store information indefinitely, either within the equipment or in some external device or medium, and to accurately and quickly recall this information on command whenever it is required. Next, they have the ability to select particular pieces of information and either act upon it, transfer it from one storage location or another, copy it, or print it out for reference purposes. They can also look up or locate information if furnished one or more pieces of information to which it relates. They can perform addition, subtraction, multiplication, division, square root, or any other arithmetical operation and where necessary, can, through their ability to look up related data, find and use logarithms, compound interest tables, tariff rates, and so forth. They can follow a long list of instructions or commands, generally referred to as programs; and in the course of such programs, they have the ability to make decisions as to alternative procedures or steps based upon intermediate results obtained through the arithmetical processes, table look-ups, or other factors. Also, in the course of their operations, through internal devices such as dual recording or dual operation, they can check the accuracy of the arithmetic or other operations. This accuracy can be further improved by providing in the

machine a program for proof totals, reverse operations, or other standard checking techniques. Finally, computers can produce answers to the problems in a variety of forms, such as a print-out in human language, the preparation of punched cards, magnetic tape, paper tape, or some storage media which can then be used for further later machine processing.

Since this list of computer capabilities covers virtually all clerical functions, let's keep things in balance a bit by looking at the other side of the coin and identify what they can't do. These limitations are:

They cannot think.
They cannot understand speech or read handwritten notes.
They cannot instinctively react.
They cannot exercise advance judgment or discretion.
In essence, they are merely working tools.

First and most important, they are completely incapable of creative thinking. Instead of being referred to as a "giant brain," they would more aptly be called a "giant moron," since they will do only what they are instructed to do. The nearest thing to thinking that they can do is to make decisions based on the equality of or differences in numbers.

They cannot understand human language in the form of speech or handwritten notes, but engineers are working in both these fields and considerable progress has been made in character reading.

When an unusual situation comes up in an operation, a computer cannot instinctively react; nor can it exercise judgment based upon past experience. It must be told in exacting detail <u>every separate operation, including stop</u>. We must continually keep in mind that computers are merely tools and that the responsibility of developing the processes to gain their potential benefits rests with the manager.

Before describing the "hardware," I would like to touch briefly on machine language and the manner in which computers are given instructions for their operations. This is shown in chart 1, page 8.

Electronic equipment can't understand human language, but it can and does communicate and operate through a two-state stable situation: the <u>absence</u> of an electrical pulse or a magnetic charge or the <u>presence</u> of a pulse or magnetic charge. Our decimal numbers can be converted through binary notation to the two required stages--on or off--positive or negative language that the computer recognizes. This chart shows

how our decimal digits would be converted to binary digits and represented on a piece of magnetic tape by magnetized spots. You will note that a decimal digit requires four binary digits and that by adding two additional binary positions, we can convert the alphabet to machine language. As a safeguard, an additional position called a "bit" is added, making a total of seven positions or channels, as they are referred to on tape. This seventh position is called a "check bit" and is added to make the total number of "bits" an even number or omitted if they are already even in number. This is an important internal feature for improving accuracy.

Several references have been made to the machine instructions commonly referred to collectively as a program, which tells the computer what to do. These instructions, which must be in meticulous detail, sometimes cost as much as 50 cents out of every dollar spent on computers, including rentals. The quality of the machine programming is one of the most important factors in the success of any ADP installation. A poorly planned, hit-or-miss program will wreck an installation. You just can't feed a computer with poorly planned paperwork.

Before detailed machine instructions can be written, a schematic general flow chart is usually prepared with full explanation of every step in the operation. This flow chart is then converted to a program block diagram, such as the sample routine shown in chart 2, page 9. This chart indicates by symbols and abbreviated description, the computer steps in a particular series of sequential steps or routine which follow, or which at least end up with the same result as the general flow chart. From this program block diagram the detailed instructions are written. These instructions are in the form of coded groups of numbers or alphabetical characters which direct the performance of a certain operation. The different general types and the typical commands or orders under each type are:

a. Basic Types and Typical Commands:

(1) To move data; write-read-transfer.
(2) Arithmetic commands: add-subtract-multiply-divide-round.
(3) Logical commands: compare and transfer on high, low, equal, or zero condition.
(4) Control: stop-shift-clear-last item-rewind-backspace-start printer.

b. Machine Addresses:

(1) Locations in memory.
(2) Registers or accumulators.
(3) Input and output devices.

Each different make of computer has its own command structure and its own numerical and alphabetic codes for the commands. In addition to the command, each instruction must contain an address which tells the computer where in the "memory" of the machine the information is located--where it should be placed for processing, and where the result should be placed after processing.

The computer, itself, may look like the one shown in chart 3, page 10, a popular medium-priced machine. Whatever shape or appearance it may have, it will probably be composed of the functional components shown in chart 4, page 11, which compares such elements schematically with manual computation processes and devices. By analogy, you can see the functions of the input and output devices, the control unit, the arithmetic unit, and the memory. There are variations between different makes and models of computers in the number or type of these different components, but the general configuration is usually the same.

Chart 5, page 12, shows a number of input and output devices. For input, we have punched cards, punched paper tape, and magnetic tape as the media most generally used. Output is in the same form, with punched cards and magnetic tape being the most usual. As shown in the diagram, input can also be from a keyboard and output from an electric typewriter on the computer's console, but this type of input is generally limited to special instructions, program changes, or inquiries and output to information on program stoppage, answers to inquiries, etc.

The speed and capacity of these input and output devices vary quite widely, and are constantly being improved. As you know, punched cards carry 80 or 90 decimal or alphabetic digits of information. This can be read into the computer at the rate of from 100 to 1,000 cards per minute and punched out at 100 or more cards per minute. Punched paper tape is another fast input and output media, which can be read into the machine at speeds up to 1,000 characters a second and punched out at about 60 characters a second. The highest speed input and output device in use today is magnetic tape with reading and writing speeds of from 10,000 to 15,000 characters a second. Chart 6, page 13, shows a picture of a typical magnetic tape servo unit which reads and writes tape.

CHART 1

MACHINE LANGUAGE

DECIMAL DIGITS		BINARY DIGITS 8421
1		0001
2		0010
3		0011
4		0100
5		0101
6		0110
7		0111
8		1000
9		0110
ALPHA		
A	11	0001
B	11	0010
J	10	0001
K	10	0010
S	01	0001
T	01	0010

AS REPRESENTED ON MAGNETIC TAPE

(By presence and absence of magnetized areas)

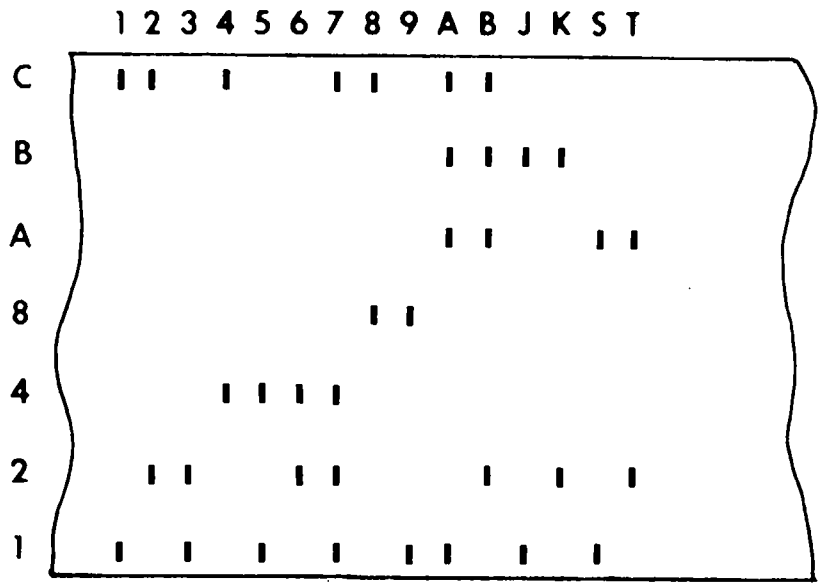


CHART 2

PROGRAM BLOCK DIAGRAM

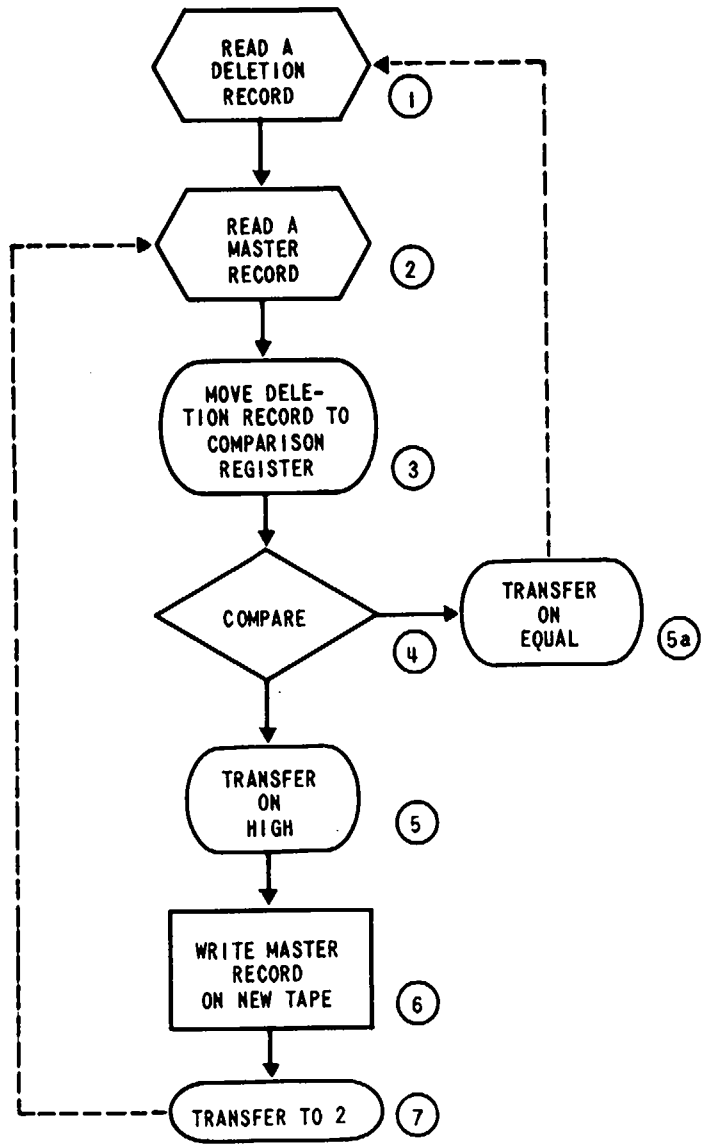


CHART 3

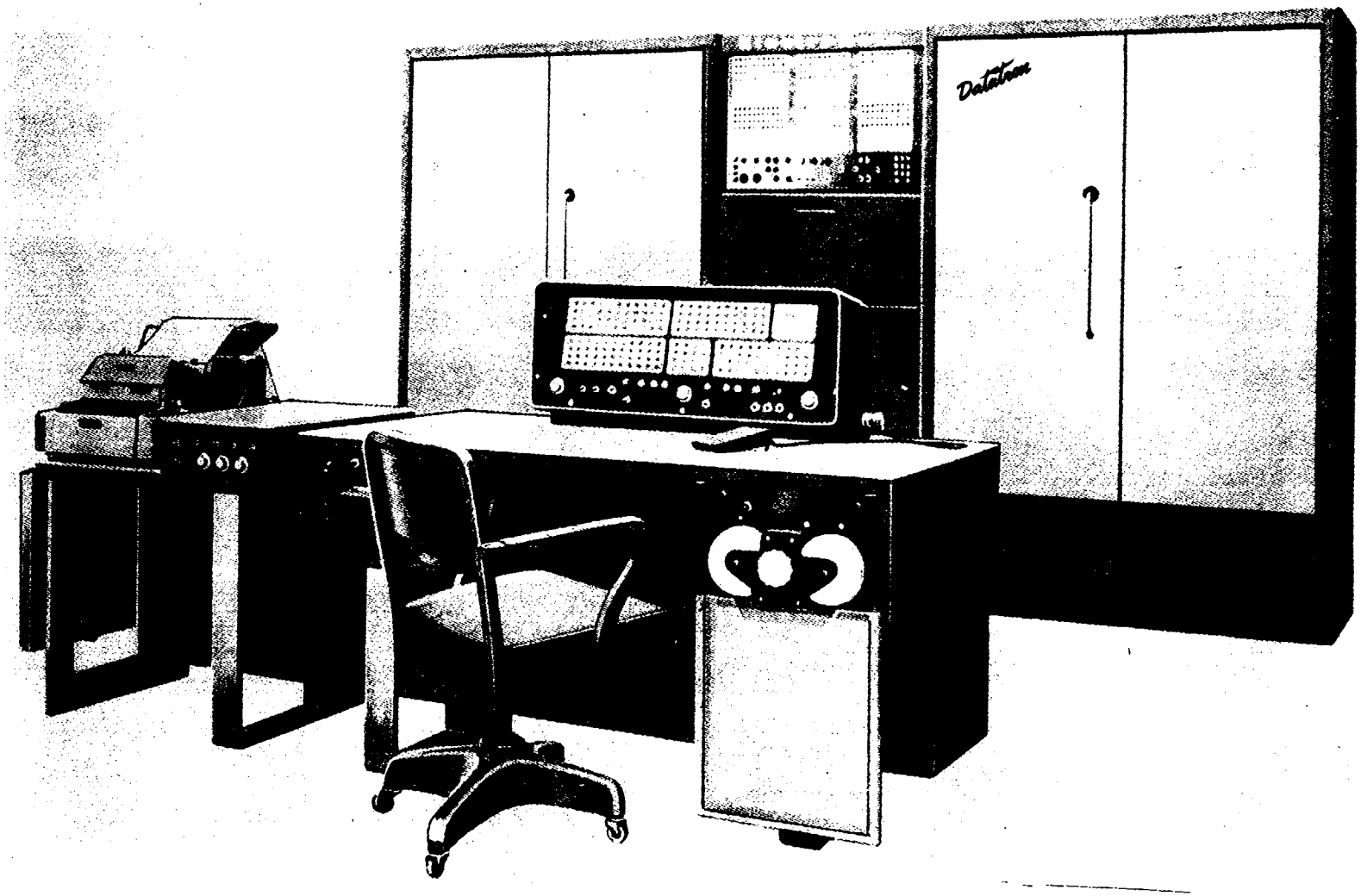


CHART 4

BASIC FUNCTIONAL COMPONENTS

OF AN ELECTRONIC COMPUTER RELATED TO MANUAL OPERATIONS

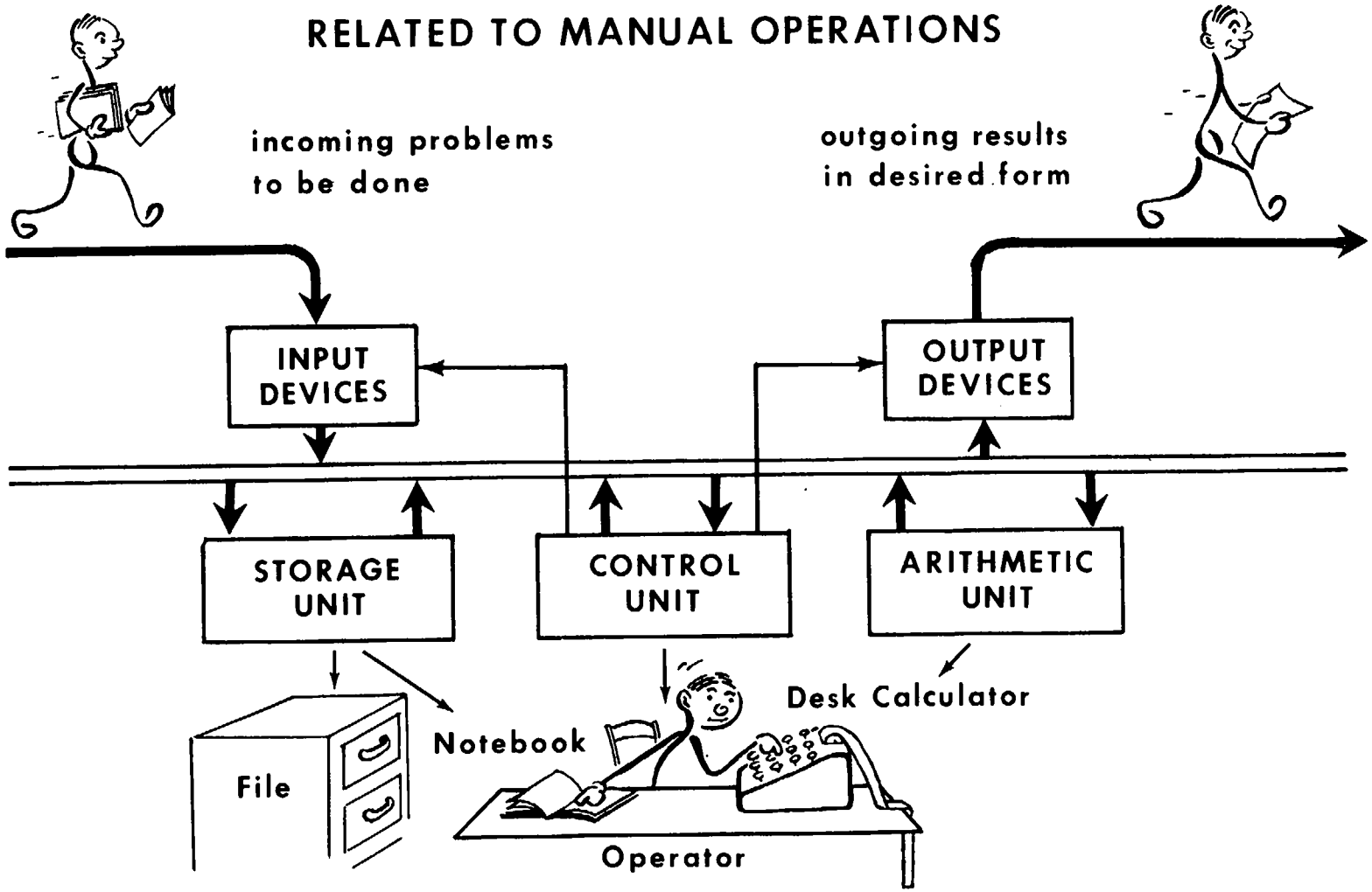


CHART 5

basic functional components

INPUT AND OUTPUT UNITS

some more common methods of getting information into and out of a computer-

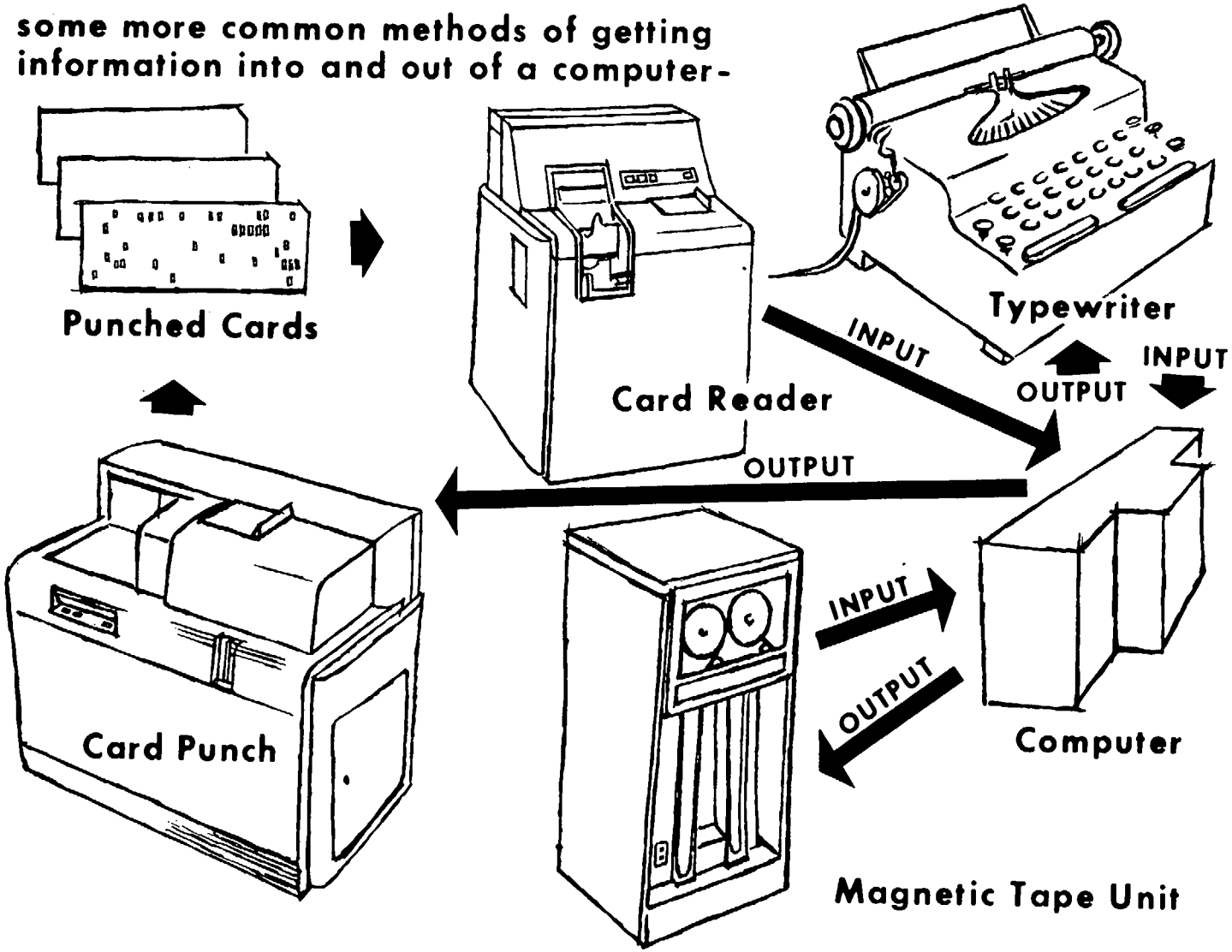
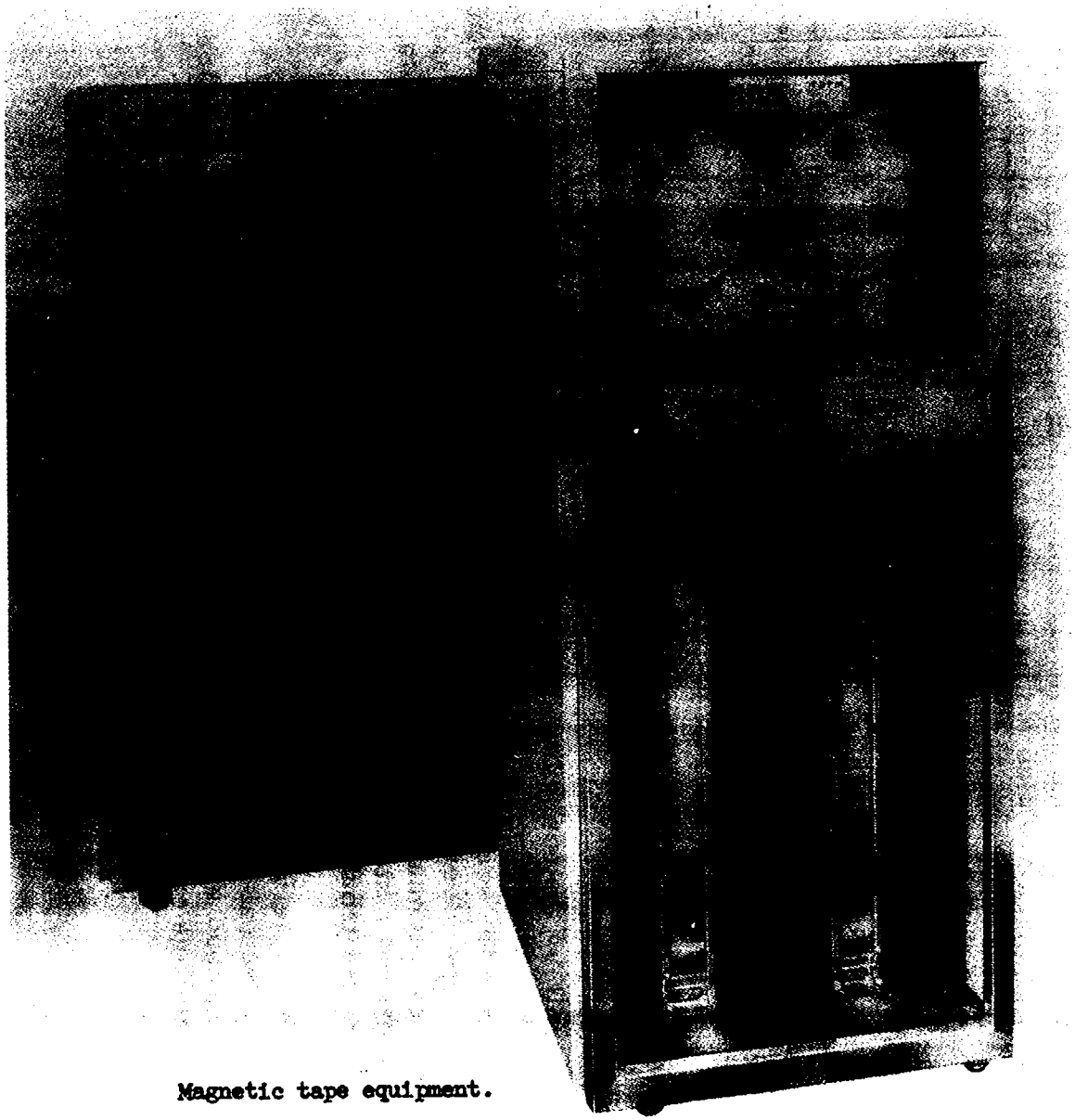


CHART 6



Magnetic tape equipment.

In data processing operations, the printing of reports, forms, or the results of other problems is usually done on electronic printers such as the one shown in chart 7, page 15. This is a high-speed printer which operates at from 600 to 1,000 lines of 80 to 120 characters per line each minute. Such a device may be connected directly to the computer or, as shown here, it may be able to operate "off-line" from a tape servo unit and not tie up the rest of the computer components. Such printers are also fed by punched cards for "off-line" output.

Before leaving the input and output area, I would like to mention the equipment used to link the output of one computer to the input of another one, miles away. Chart 8, page 16, shows schematically a data transmission system which is widely used in the Department of Defense to send information in machine language between our installations or to and from our contractors. The card transceiver system sends 80 column cards over leased lines or over radio circuits at from 6 to 11 or 12 cards a minute, with a very high degree of accuracy.

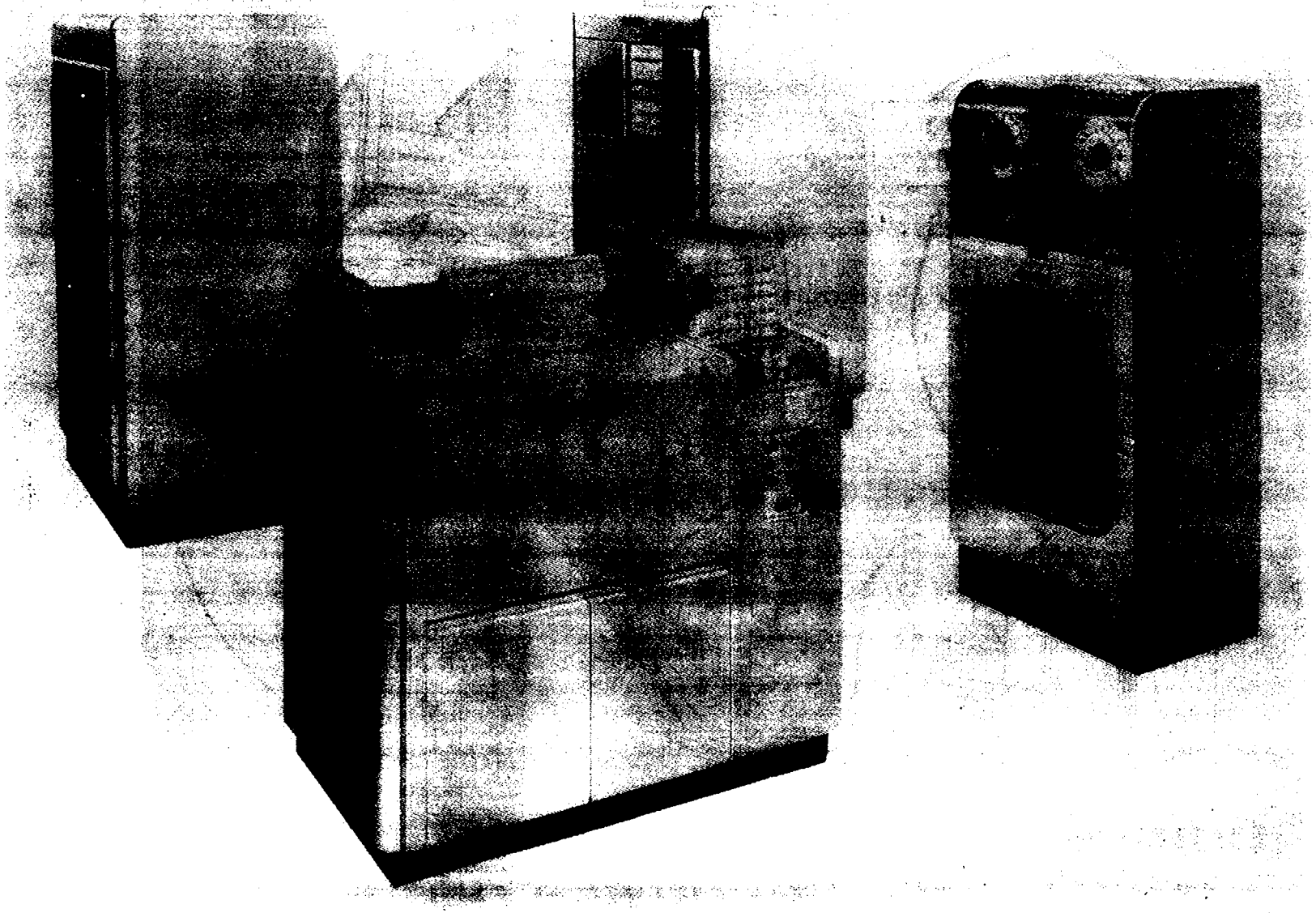
Chart 9, page 17, shows the control unit, which is the heart of the computer and controls its every move. In a sense, there are both internal and external controls, the latter being exercised through the console by the computer operator. The internal automatic controls interpret machine instructions and activate the proper circuitry which controls the sequence of operations. The external controls are performed at the operator's console, which is connected with the Control Unit and is shown in chart 10, page 18. Through buttons, switches, and lights, the operator starts and stops the machine, enters information and diagnoses trouble.

Next, let's consider the memory or storage devices and media. The principal types, which are generally classified as external or internal and which have a wide range in speed of access to information and storage capacity are as follows:

Computer "Memory" or Storage

External	Internal
Punch Cards	Electrostatic Tubes
Punched Paper Tape	Mercury Delay Lines
Magnetic Tape Reels	Magnetic Drums
Magnetic Discs	Magnetic Cores
Magnetic Tape Bins	

CHART 7



High speed printer.

CHART 8

DATA TRANSMISSION

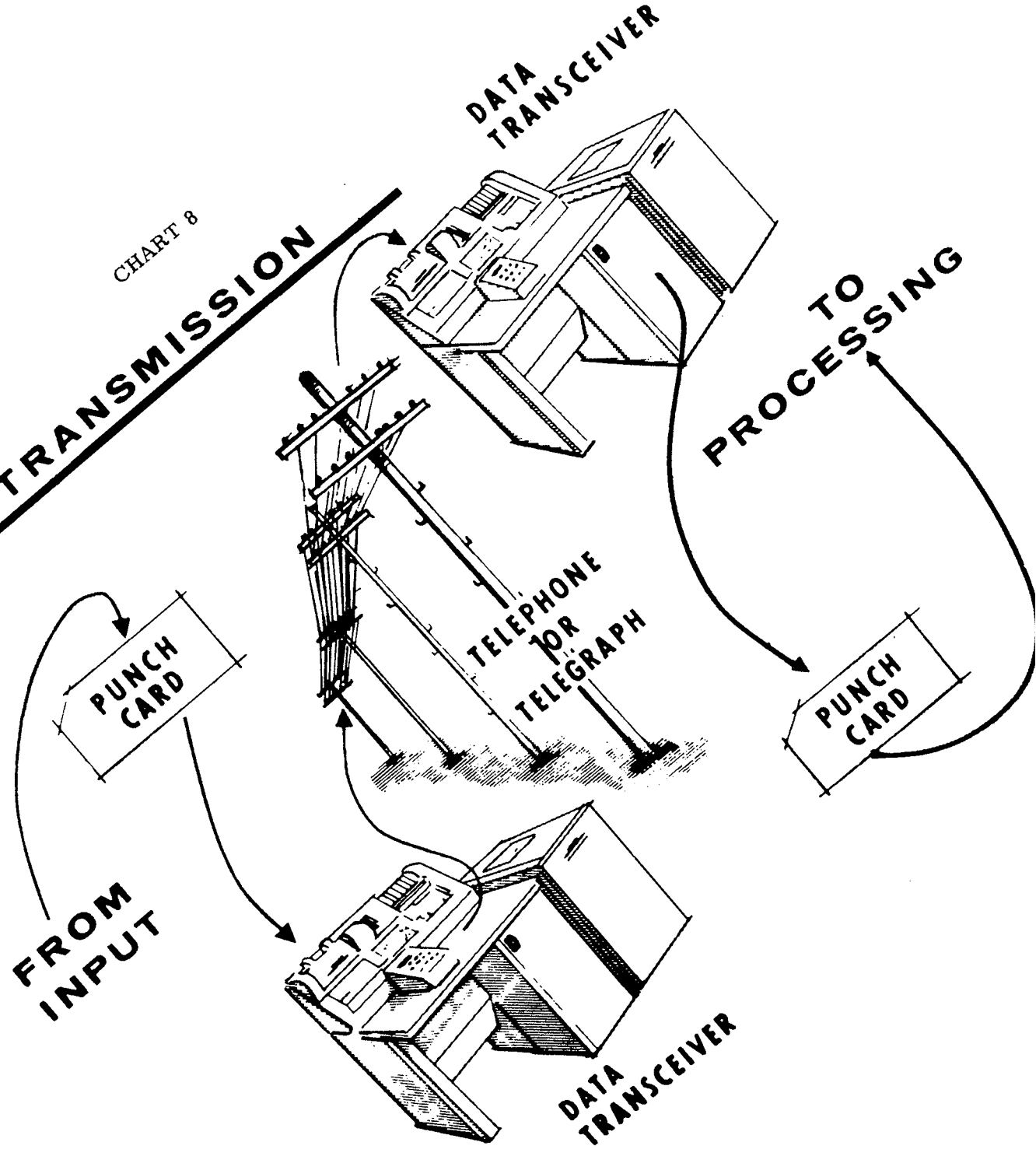


CHART 9

basic functional components

CONTROL UNIT
just as the OPERATOR controls the steps in manual computation-in the COMPUTER

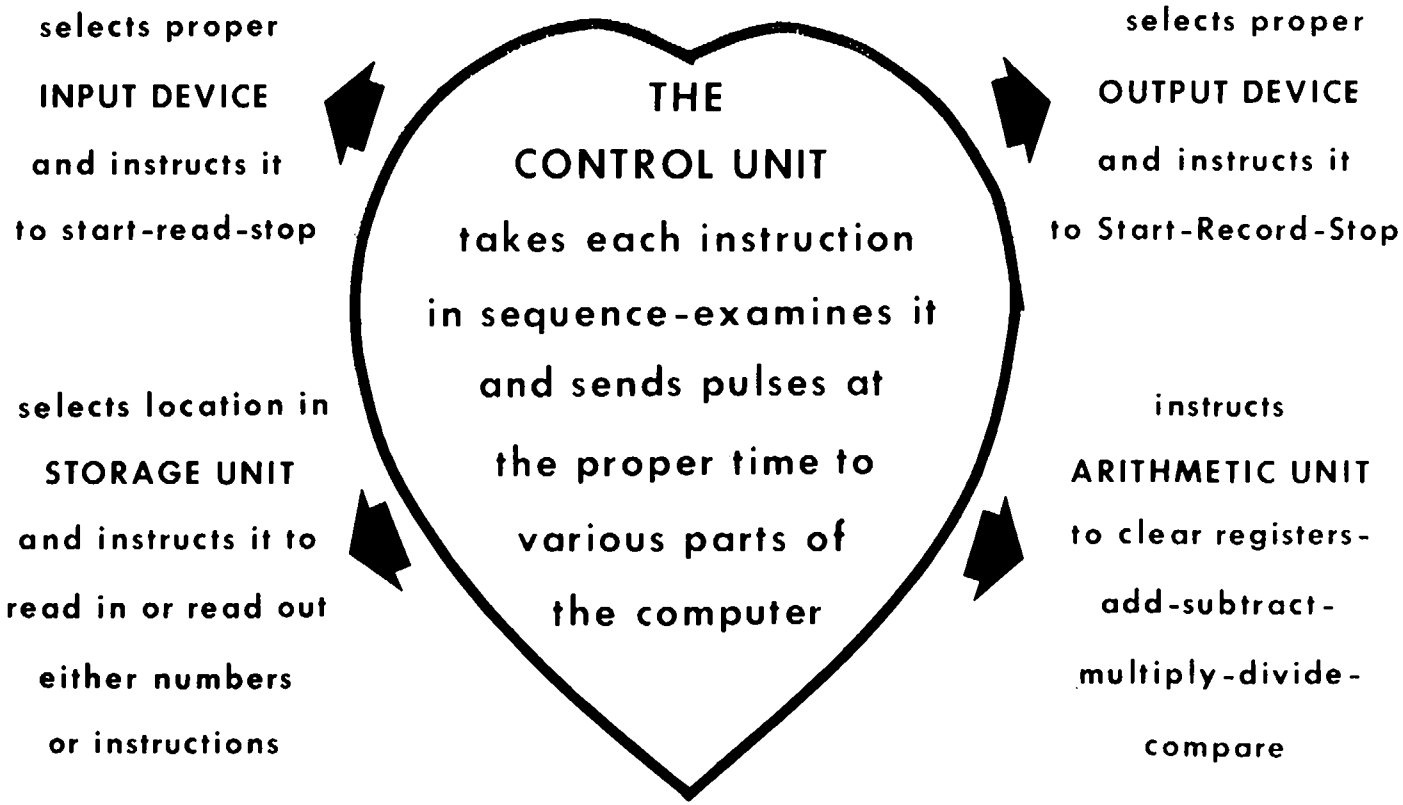
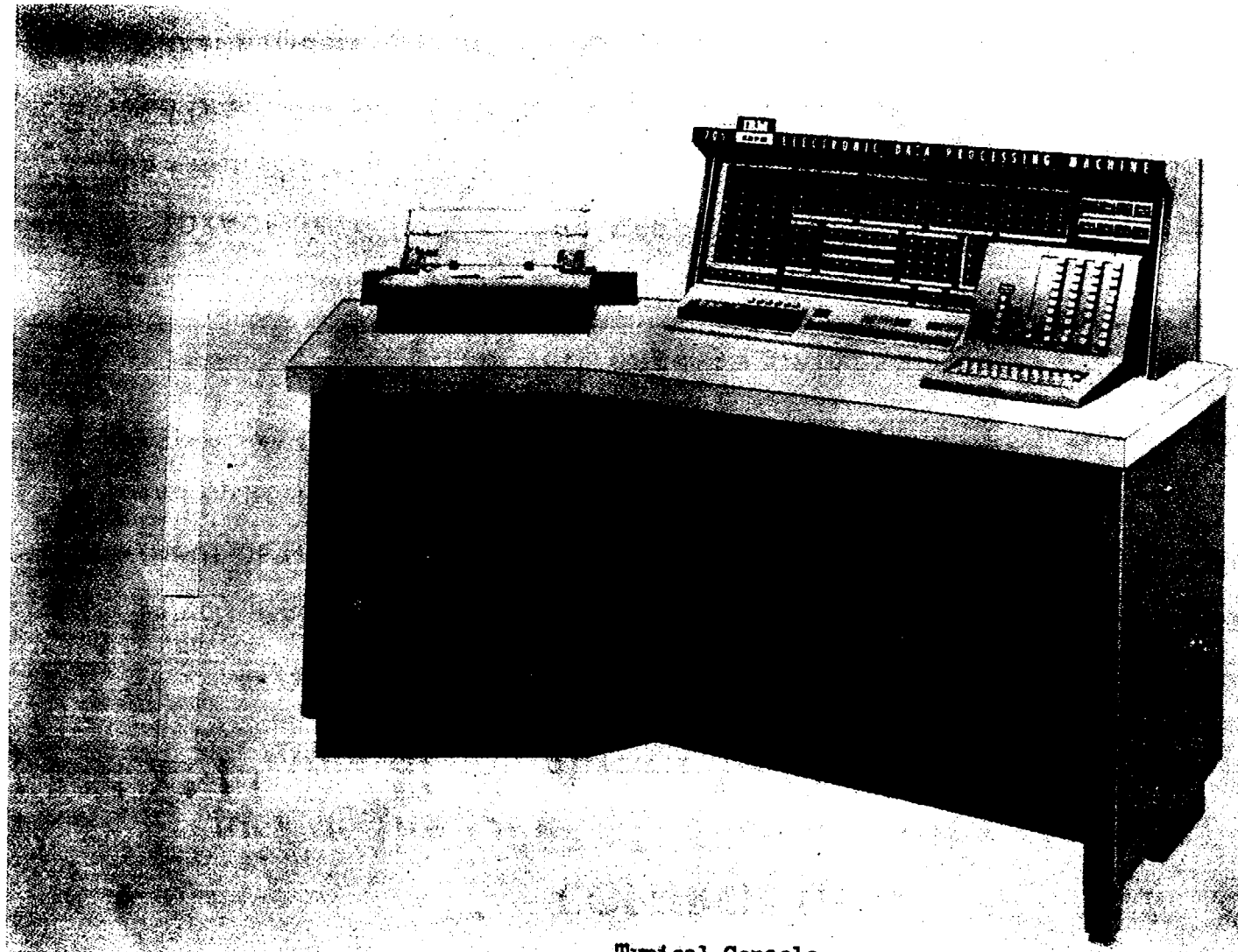


CHART 10



Typical Console

Of the external media, the punched card is still by all odds the most widely used. As a unit record of 80 or 90 digits of numeric or alphabetic data, it offers many advantages, such as the ability to mechanically sequence or sort data before feeding it into the machine. It is relatively slow of access, however, and requires substantial filing space and cabinets. Paper tape is another storage medium that is increasing in popularity. It offers unlimited record length as compared to the 80-90 digits on punched cards and somewhat higher input speeds, but it cannot be sequenced, merged, or sorted outside of the machine. It also presents problems of filing and storage.

Next to punched cards, and coming up fast, is magnetic tape. A typical magnetic tape is from one-half to one inch wide and records data in magnetic dots on its surface at a density of from 100 to 200 characters to the inch. One reel of tape can store the information from 20,000 or more punched cards. Magnetic tape can be erased and used repeatedly, or the record will remain and can be read many times over a number of years without any apparent deterioration.

Using a tape servo unit such as was shown a few minutes ago, tape is usually searched sequentially for desired information. Searching for data on tape is comparatively slow, requiring an average time of 3 to 5 minutes to find an item in a tape reel. Information on tape reels must be sorted and merged on the computer. As a storage medium, it is probably the cheapest available today per unit of information stored.

Magnetic tape bins are a variation on the tape reels and consists of perhaps 50 separate lengths of magnetic tape, 250 feet to each length, suspended over two bars, with a read-write head positioned above the bars on a sliding mechanism. Such a bin is capable of sorting 400,000 characters and has the advantage of much faster access to any given item, since only 250 feet of tape must be searched. Such tape bins have an access time of less than a minute.

Before leaving this chart to show you an external storage device, I would like to point out that this list is not a comprehensive one and that improvements are constantly being made. The first two of the internal storage devices shown--electrostatic tubes and mercury delay lines--are in use on many of our present-day computers, but will not be found in advanced equipment or in new designs. Although these two devices are fast, they lose their memory if there is an interruption of electric current; and the equipment designers are, therefore, turning to magnetic drums and magnetic cores, which, like external magnetic media, will retain data indefinitely without electric current.

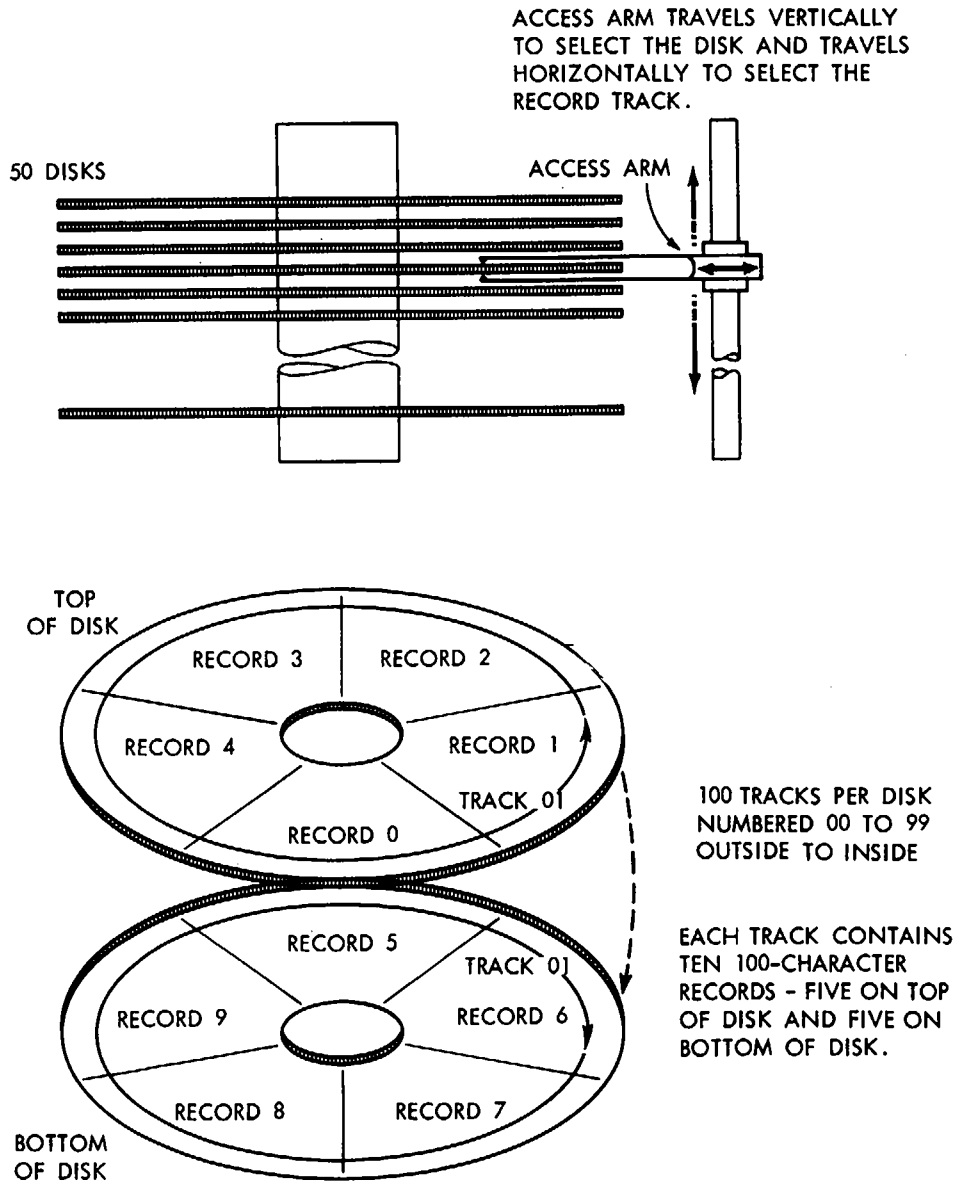
Chart 11, page 21, is a schematic diagram of a magnetic disc file. The stock of 50 discs revolving on a spindle looks something like a juke box. Each disc is coated with a substance which will record data on tracks and within fixed sectors as shown. Both sides of the discs are used and a total of over 5 million characters can be stored on the 50 discs. Its principal advantage is the ability to go directly to the record without searching sequentially. This random access ability permits the location of an item in less than one second. Chart 12, page 22, shows how the device actually looks.

As compared to external storage devices with access times of minutes or fractions of seconds, internal storage devices are in the millisecond and microsecond range. Chart 13, page 23, shows how a magnetic drum would be used as a storage device. The coated drum surface is magnetized with the proper pattern of binary bits, which can then be read out when needed. Drums are normally used to store program instructions or data that are in process, and has an access time in the millisecond range, with a capacity of 100 to 10,000 10- or 12-digit words.

The internal memory device currently used by many computers for very high-speed access is the magnetic core. The core material is ferrite. It is shaped like a tiny doughnut and strung on a grid of wires, as shown on chart 14, page 24. Each of these cores can be separately magnetized since, as you can see, each core has a specific and individual address formed by the horizontal and vertical wire. A third wire is passed through each core diagonally to sense the magnetic condition, although this is not shown on the illustration.

By arranging several core planes as shown in chart 15, page 25, the pattern of on-off conditions required to form a number or character in binary notation can be formed. This type of memory is relatively expensive and its use is therefore limited to purposes requiring very high-speed access, such as the temporary storage of data that are in process. The capacity of magnetic core memories varies with the size of the computer, and some large-scale machines have units that will store 20,000 or 40,000 characters. The access time is in the microsecond range. Chart 16, page 26, shows a large-scale magnetic core unit.

CHART 11


ACCESS ARM TRAVELS VERTICALLY TO SELECT THE DISK AND TRAVELS HORIZONTALLY TO SELECT THE RECORD TRACK.
50 DISKS
ACCESS ARM
TOP OF DISK
RECORD 3
RECORD 2
RECORD 4
RECORD 1
TRACK 01
RECORD 0
RECORD 5
TRACK 01
RECORD 9
RECORD 6
RECORD 8
RECORD 7
BOTTOM OF DISK
100 TRACKS PER DISK NUMBERED 00 TO 99 OUTSIDE TO INSIDE
EACH TRACK CONTAINS TEN 100-CHARACTER RECORDS - FIVE ON TOP OF DISK AND FIVE ON BOTTOM OF DISK.

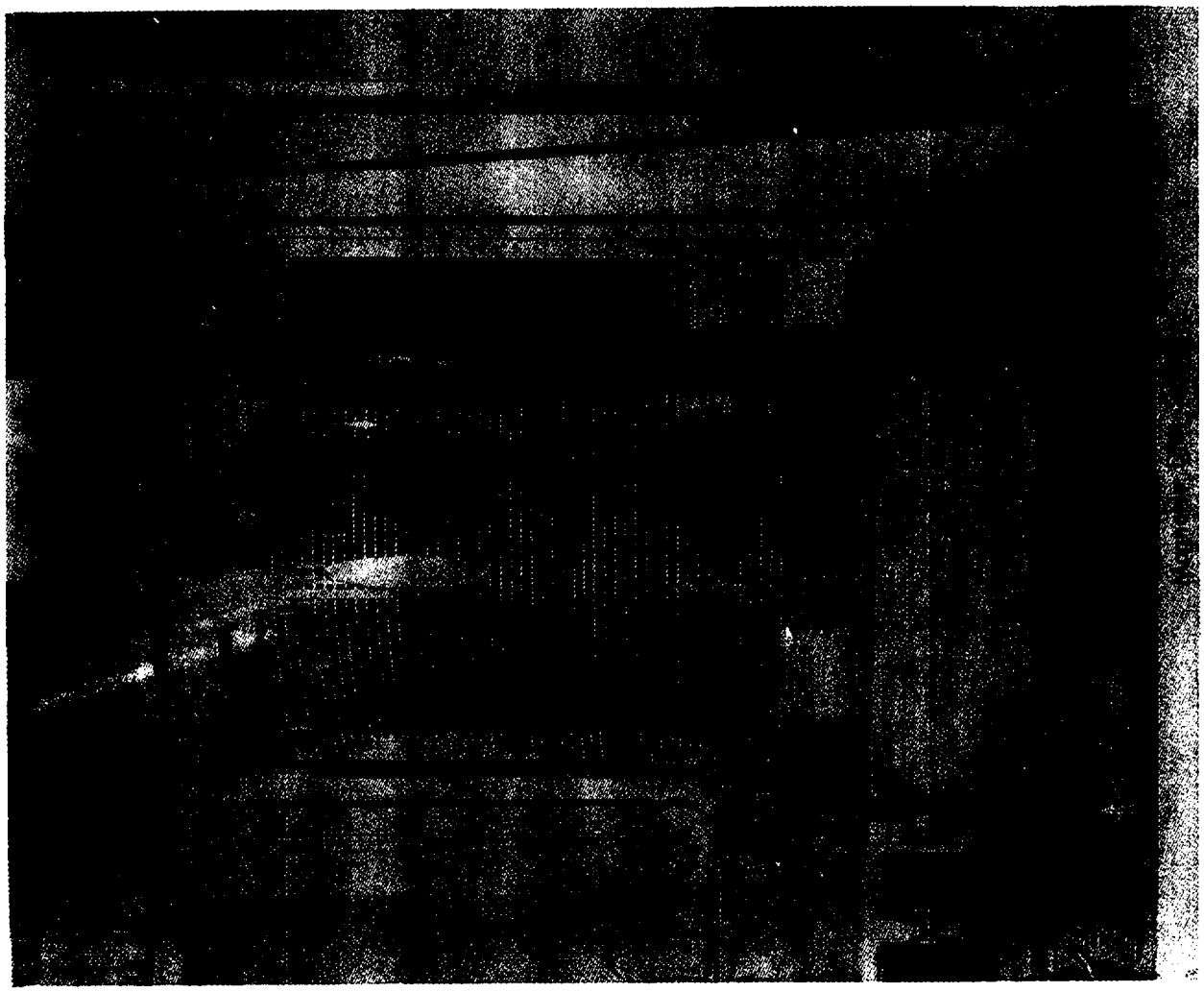
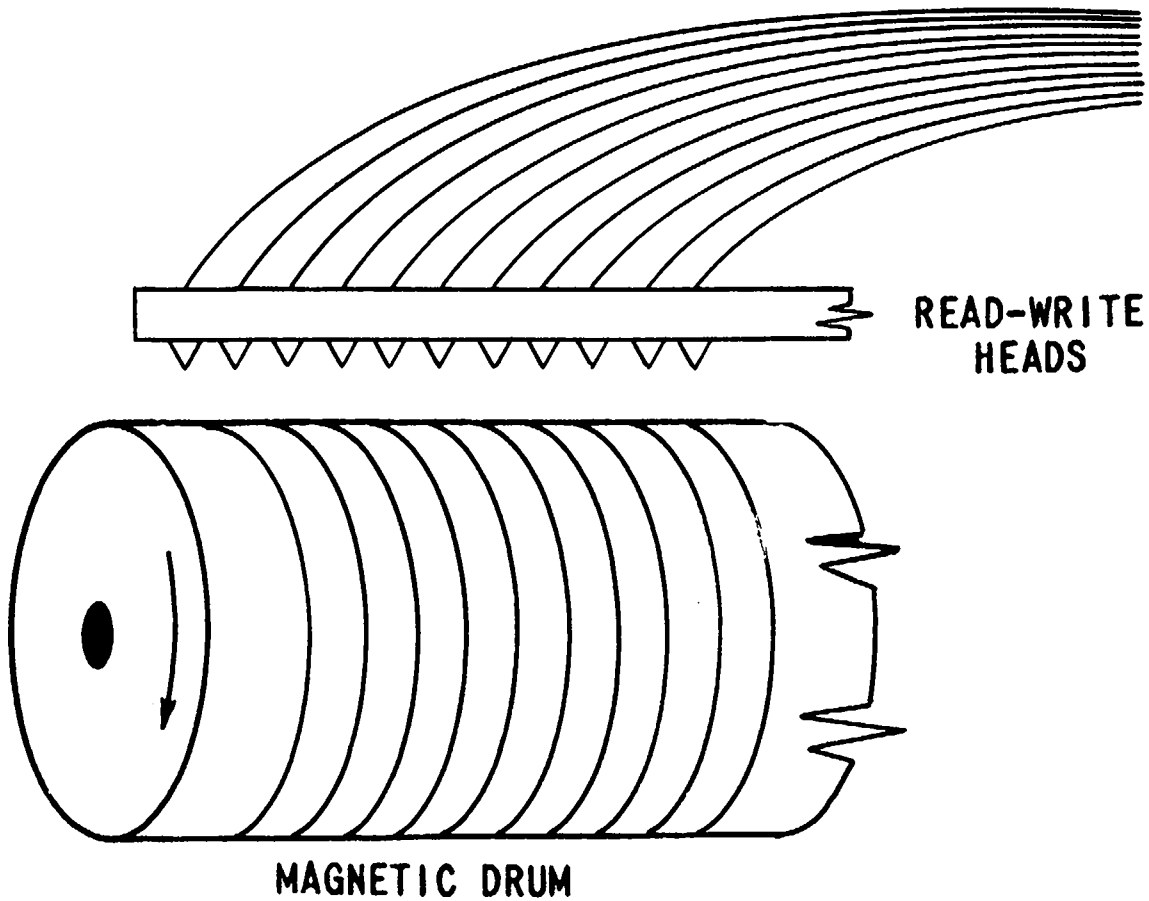


CHART 13



MAGNETIC DRUM

CHART 14

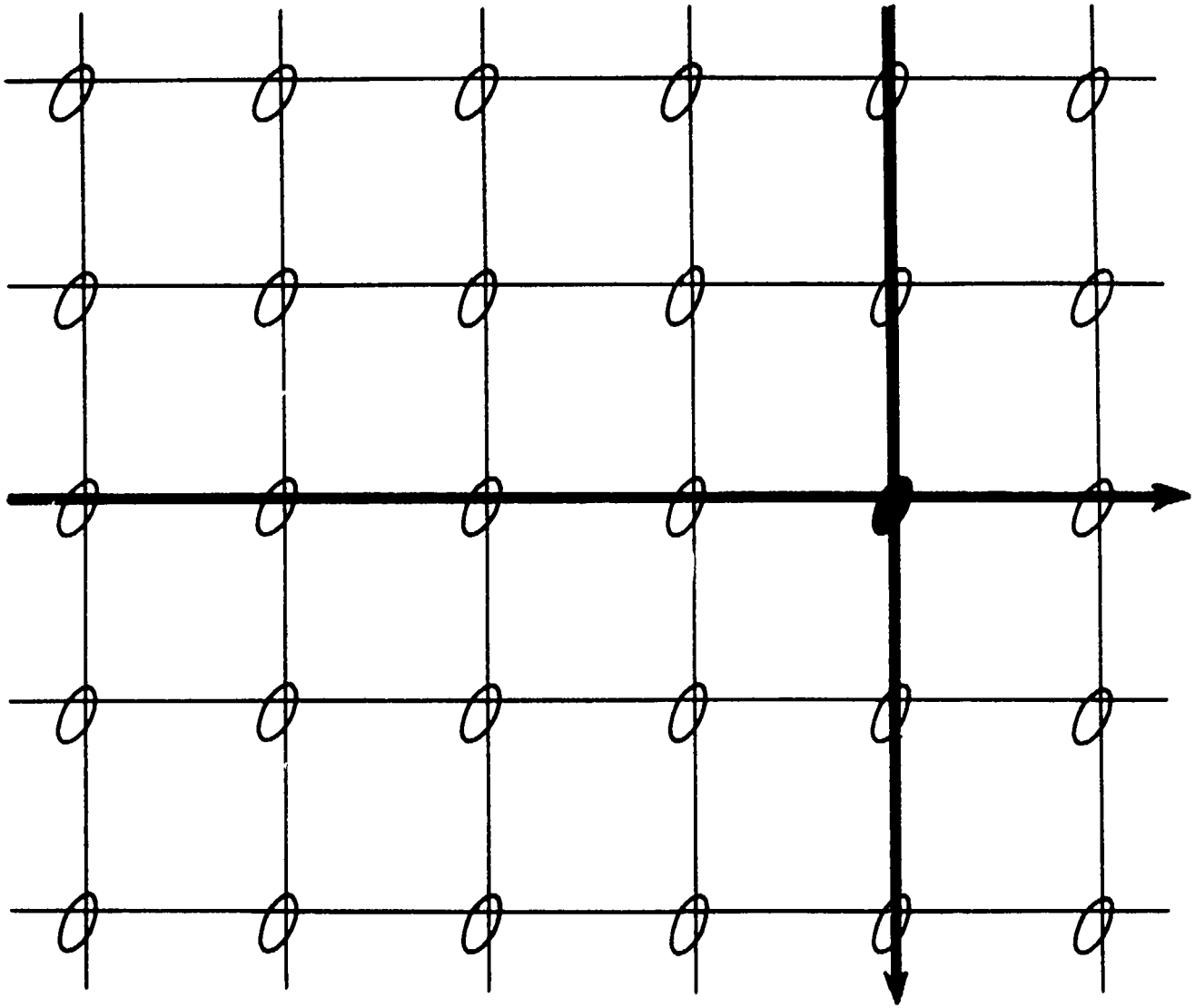
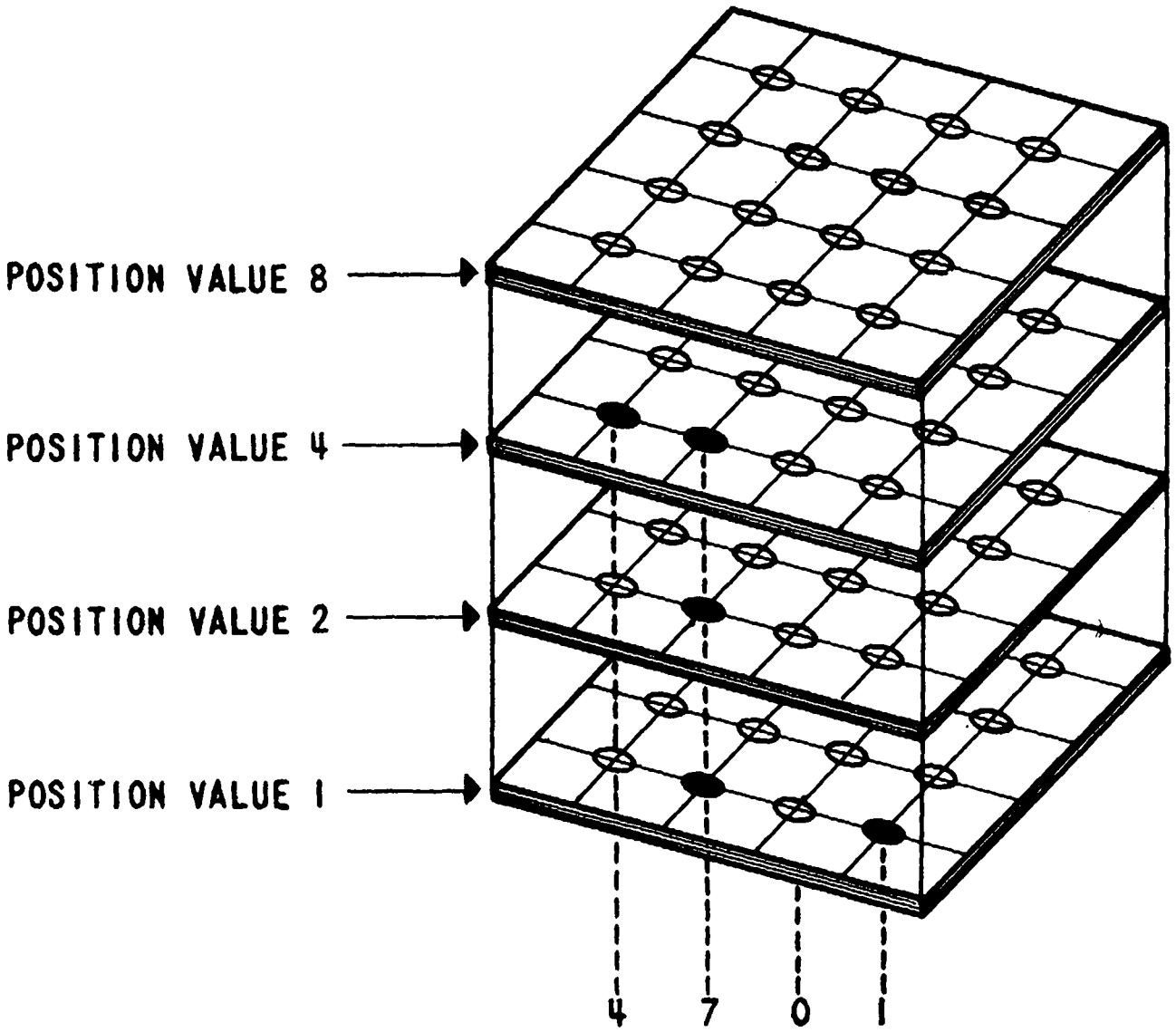
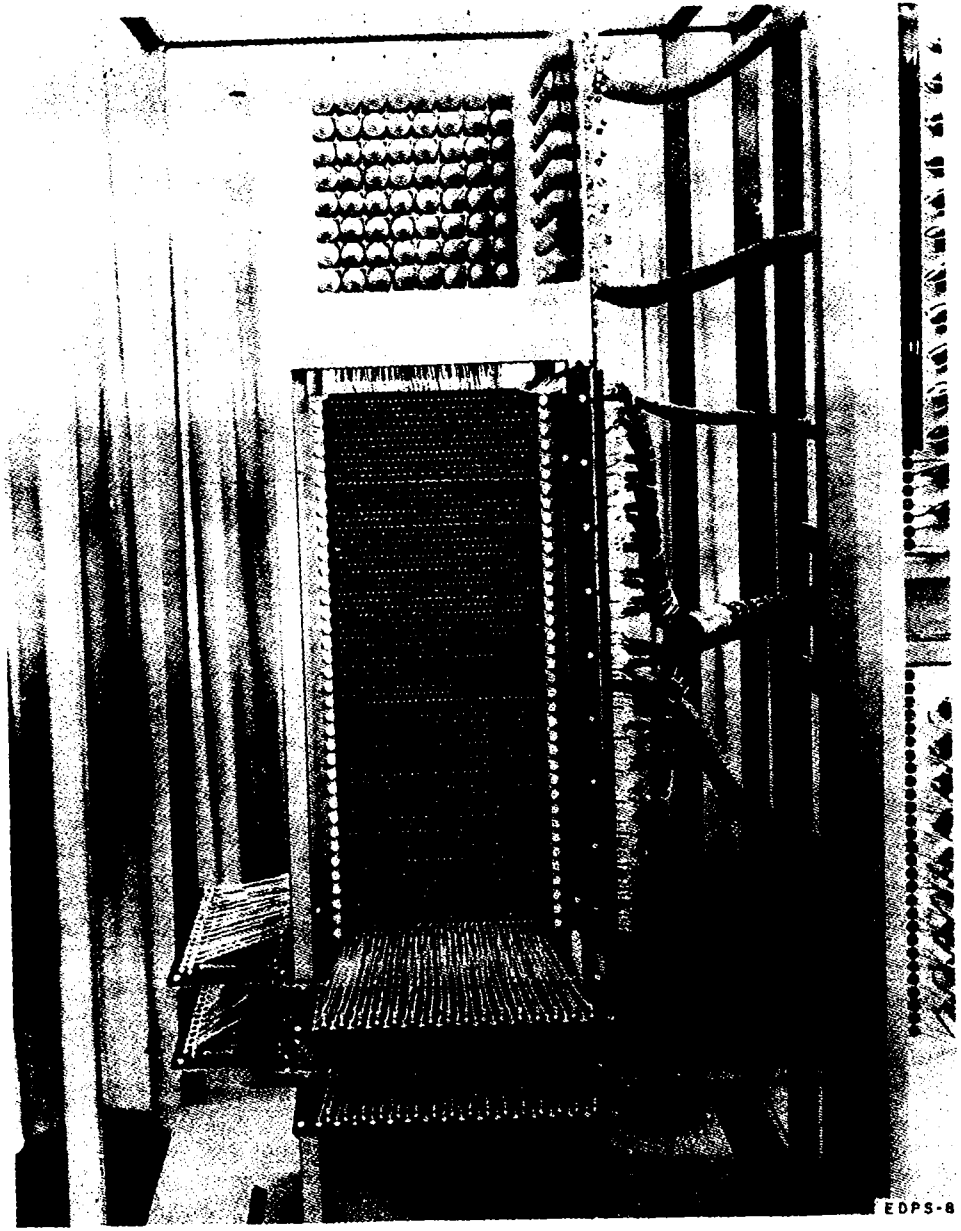


CHART 15



Storing the number 4701 in magnetic core memory.

CHART 16



The last of the basic computer elements is the arithmetical unit, sometimes referred to as the processor. Chart 17, (page 28) shows a schematic diagram which compares this unit with a desk calculator. This is the unit that does all the processing, arithmetic operations, and logical operations. The computation circuits in this unit are known by such names as adders, counters, registers, and accumulators. Some equipments have dual circuitry and perform each operation twice to assure accuracy. Processing speeds are measured in microseconds. This means that on some machines you can add two 11-digit numbers in 200 microseconds or 1/5000 of a second.

You will all appreciate that all of the basic elements that have been mentioned are in themselves rather complex mechanisms and deserve more than the passing reference I have given them. There are over 20 companies making about 35 models and we couldn't cover them all in a week. I hope, however, that this rather superficial discussion of their characteristics, capabilities, and capacities will give you a little better understanding of what they can do for our management operations.

The proper use of a tool does not require that management have a comprehensive knowledge of the scientific technology involved, but rather that management have an appreciation and respect for it. On the other hand, it is vital that management have a thorough and quite detailed knowledge of the systems technique involved in the use of such tool.

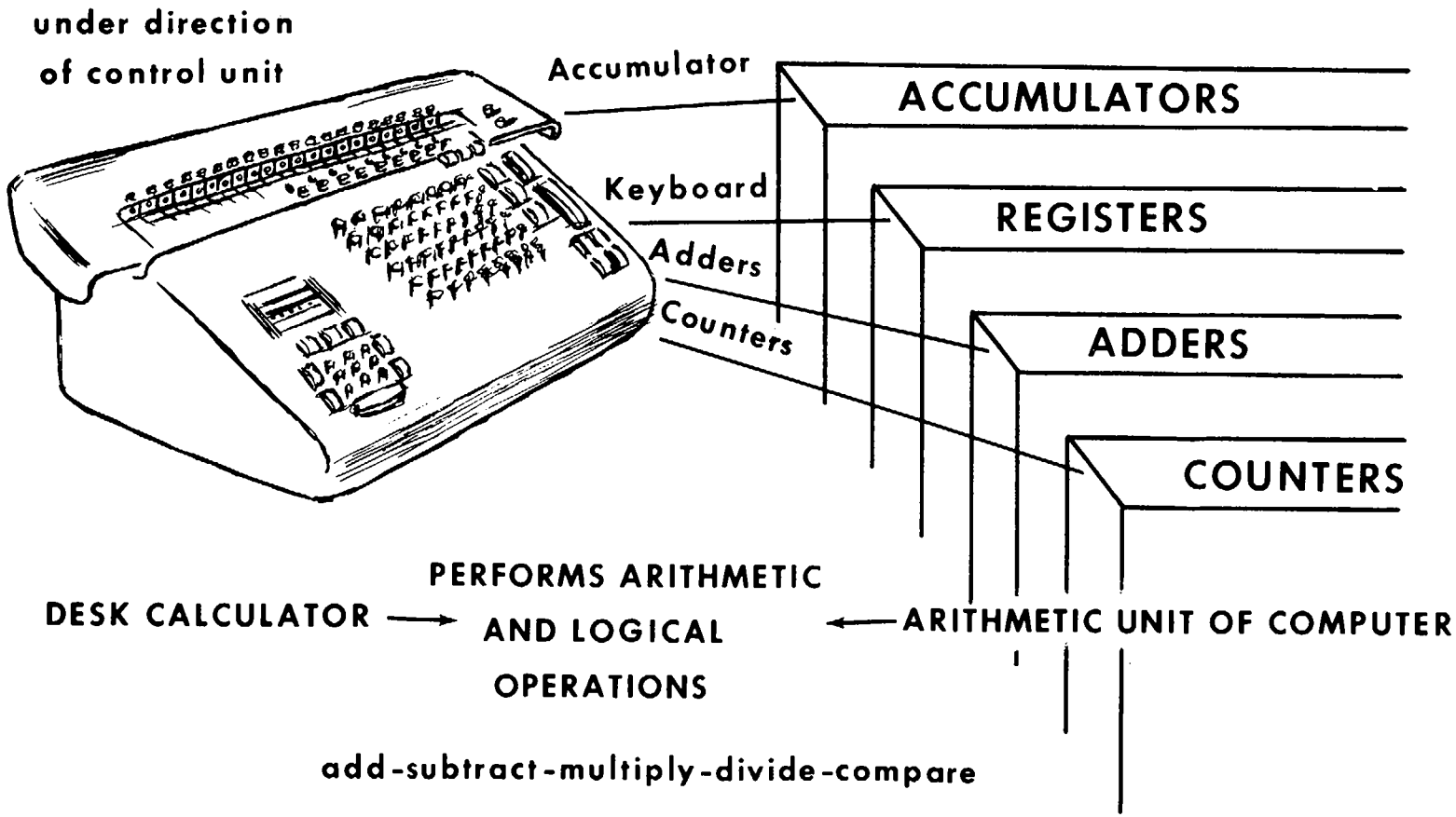
Today we are in a period of change which in the light of history may appear as the third phase of a technological evolution in American industry. The first phase was the shift from hand methods to machine methods in the last part of the 19th century. The second phase was the adoption of mass production or line production methods, sometimes called the "Ford Revolution," which reached its climax in the 1920's and involved extensive use of conveyors, automatic machines, and the simplification and specialization of processes and products. The latest or third phase is popularly called "automation." Electrical and electronic devices with feed-back controls link together the conveyors and automatic machines under standardized techniques, which go through cycles of operations without human intervention.

CHART 17

basic functional components

ARITHMETIC UNIT

compared with a desk calculator



Automatic data processing is the automation of office operations, and we have passed through the same three phases of technological evolution. By "office" I mean the paperwork mill--whether it be in payroll, inventory, or maintenance control. In the late 1800's typewriters, adding machines, bookkeeping machines, and other mechanical devices began to be used; and punched-card equipment was introduced. Sometime in the 1920's the second phase began, with development of more automatic and high-speed equipment, including some with automatic features and electronic devices such as the punched-card electronic calculator. During this second phase, we began to give some much-needed attention to paperwork simplification, standardization and specialization of processes, and systems analysis. The third phase, or office automation, finds us linking together these high-speed equipments, refining our systems, and utilizing new tools which permit long cycles of complex data processing operations without human intervention.

It should be noted that electronic computers are also providing the connecting link between factory automation and office automation. The new high-speed automatic factory techniques require quick management decisions involving complex factors. Computers process the data needed for these decisions, and in some cases are connected directly to factory equipment, thus providing automatic feed-back controls.

This group will respect the judgment and wisdom of Ralph J. Cordiner, president of General Electric and chairman of the "Cordiner committee," which recommended the overhaul of our present military pay structure. Mr. Cordiner appeared before a congressional committee investigating automation back in 1955 and had this to say:

> "When the history of our age is written, I think it will record three profoundly important technological developments: (1) Nuclear energy, which tremendously increases the amount of energy available to do the world's work; (2) automation, which greatly increases man's ability to use tools; (3) and computers, which multiply man's ability to do mental work. Some of our engineers believe that of these three, the computer will bring the greatest benefit to man."

While our new technology may displace workers at the machines, it seems to require more and more office work and, therefore, more office workers. Back in 1900 there was one office worker for every 30 factory workers, while by 1950 this ratio had changed to one office worker for every two and one-half factory workers. Articles appearing in Nation's

Business in December 1955 and in The Management Review in March 1956 predicted a chronic shortage of office workers through the period ending about 1960. These articles contended that the supply of office workers is not growing as fast as the total economy and went on to say that we could not hope to operate our offices of the future without more automation.

A recent well-planned Government installation of a large-scale computer in a high-volume operation succeeded in eliminating over 485 positions. Most of the positions were in low-skilled, routine, and monotonous jobs; but it did mean a fairly sizable lessening of the clerical labor requirement. While few installations offer a quick reduction of this size, the fact that it did actually occur gives us a good reason to believe that office automation may be the answer to at least part of our clerical worker shortage by substituting machine minutes for man hours.

With few exceptions, our Defense ADPS installations show a reduction, or projected reduction, of personnel required to do the job selected for ADPS. This seldom means an overall reduction of total personnel spaces, but rather a shifting or reassignment to jobs for which personnel were not available before.

Before talking about specific management uses of ADPS, let me generalize a little more and propose a syllogism for your consideration:

Major premise:	The quality of management decisions in planning and policymaking is directly proportional to the quality of available information.
Major premise:	The quality of information is primarily dependent upon its completeness, appropriateness, timeliness, and accuracy.
Conclusion:	ADPS can (if properly used) produce complete, appropriate, timely, and accurate data; therefore, it is an effective management tool.

I wouldn't want you to think that I don't recognize that many of our most important management decisions are based upon those nebulous hunches we usually refer to as intuition.

This business of managing has many definitions, but I'd like to give you one that I like. Simply speaking, it is, of course, "seeing to it that

the right things are done quickly and well and that improper things aren't done." In the business-type operations of Defense, we have layers and layers of managers from the operating unit up, many of whom are continually busy managing managers and seeing to it that wrong things aren't being done. At times, anything new gets labelled as wrong. At other times, the so-called "right" things are merely the desire of an individual who is in a position to give it effect, regardless of its merit. We must recognize, of course, that rank has its privileges. After all, we may have that rank some day ourselves. These facts of business life have a direct bearing on the uses to which we can put ADPS.

Getting back to the quality of information: We are accustomed to think that quality is incompatible with quantity and that you somehow improve the product if you cut down on the volume. This isn't always true. The more pertinent facts you can bring to bear on a problem, the more complete will be your analysis and the better will be your decision. While this is good theory, in practice we become overwhelmed with the multitude of factors that should be considered, so we lop off a few that we consider as generally less important, but which we realize could be vital in a given situation. We rationalize this action (at least to ourselves) on the premise that we have improved the quality by reducing the quantity.

In a talk that he made before an ADPS conference here, my boss, Mr. McNeil, Assistant Secretary of Defense (Comptroller), made a statement which I like to quote and which is appropriate here:

> "Before leaving the subject of management information, I would like to mention what I shall call 'data reduction,' a term usually associated with scientific and engineering calculations, but with a connotation that I think should be applied to business data processing. These new data processing systems give us the ability to drown management with information--an ability we must not use. Too much information can be almost as bad as not enough. Fortunately, this equipment also makes it possible to summarize and select the significant and sensitive information that management can use and needs for informed decision making. Through this 'data reduction' capacity of the equipment, we can turn the flood of data which management can't use to a flow of selected, integrated, significant facts on which sound decisions can be quickly made."

This leads us logically to the management philosophy of "management by exception," which has almost fallen into disrepute because it's something like the weather--everybody talks about it, but no one does anything about it. There are many reasons for not putting into practice this generally accepted philosophy. Either our facts are so voluminous that it's beyond the capacity of our present paper mill to sort out the exceptions, or the exceptions themselves are too voluminous. Here is where ADPS can come to our rescue if properly applied. With its tremendous speed and storage capacities, together with the ability to make routine decisions--which previously required human judgment, no matter how simple--ADPS can present to management only those problems requiring judgment of a higher order. No matter how large and complex the operation, ADPS can make management by exception a reality instead of a nice theory.

In this same general area, there is another potential in computer operations that we should make every effort to capture. This is the ability to reduce paper volume. I have no idea of the quantity of paper that goes into our Pentagon paper mill, but I do know that we destroy 28 bales of it every day. Not only can a computer compress and store information very efficiently and cheaply; it can if properly used avoid the preparation of many intermediate records. Most clerical operations generate some kind of paper output, but this can be minimized in a computer which follows long sequences of such operations without human intervention. If intermediate results are needed for audit or record purposes, they can be condensed and compressed on magnetic tape, with print-out for reference purposes only when required.

Another generalization, and then I'll get down to the specific uses and applications of ADPS. The speed, capacity, and versatility of these new machines create a compelling requirement that management take a look at its philosophy and practices to see if it is fully utilizing these new tools. ADPS demands that management think in terms of the whole enterprise and not of a single functional area or location. Through ADPS we have the opportunity to take a bigger bite of our management data at one time. Therefore, efficient use of ADP generally means the integration of data systems. I hasten to assure you that I am not for one minute advocating changes in management philosophy or organizational structure that are not in themselves sound and desirable just to take advantage of or justify a computer. Such a situation would be analogous to the tail getting so big it wags the dog.

When I refer to integrated data processing, I am talking about an approach to the arrangement and sequence of operations and tasks in

such a way that duplication of effort is minimized or eliminated. Once a bit of information is introduced into the system--that is, recorded, written, or copied--it can be rearranged, summerized, printed, or otherwise manipulated with a minimum of human intervention. By making our original entry of information into the system in some form which can be recognized and acted upon by the equipment, we can obtain many advantages, not the least of which is a reduction in human error.

The concept of integrated data processing extends to hardware other than computers. Indeed, United States Steel used this approach to prepare for the use of electronic computers. Typewriters, adding machines, bookkeeping machines, and other devices can be tied together in machine language and through the machine language media different geographic locations can be linked together. Thus, integration can be horizontal--that is, at the local level only--or vertical, in that it will tie together several geographic areas or centralize a function at a single location. We have examples of both types in our military ADPS which will probably be described to you later this morning.

There is an increased recognition of the interdependence of specialized functions, such as inventory control, requirements determination, transportation and communications, accounting and budgeting, personnel planning and utilization, and mobilization planning. Our previous general failure to integrate these functions or to develop integrated systems was probably due to (1) our failure to recognize these relationships and provide for their integration, or (2) the limitations imposed by our equipment or systems as to volume, speed, or compatibility. Today, ADPS has largely eliminated the first of these reasons and we are no longer equipment limited. The second reason is still with us--our inability to to recognize the relationships and to take the sometimes tough actions required for their integration and coordination. Let me repeat my previous warning. Let's not let the tail wag the dog and integrate just for the sake of integration.

As to the specific uses of ADPS, my colleagues on the second half of this morning's program will tell you about actual installations in the Army, Navy, and Air Force; so I will limit myself to identifying the areas. Incidentally, the booklet you will receive as a handout has some very good descriptions of ADPS installations.

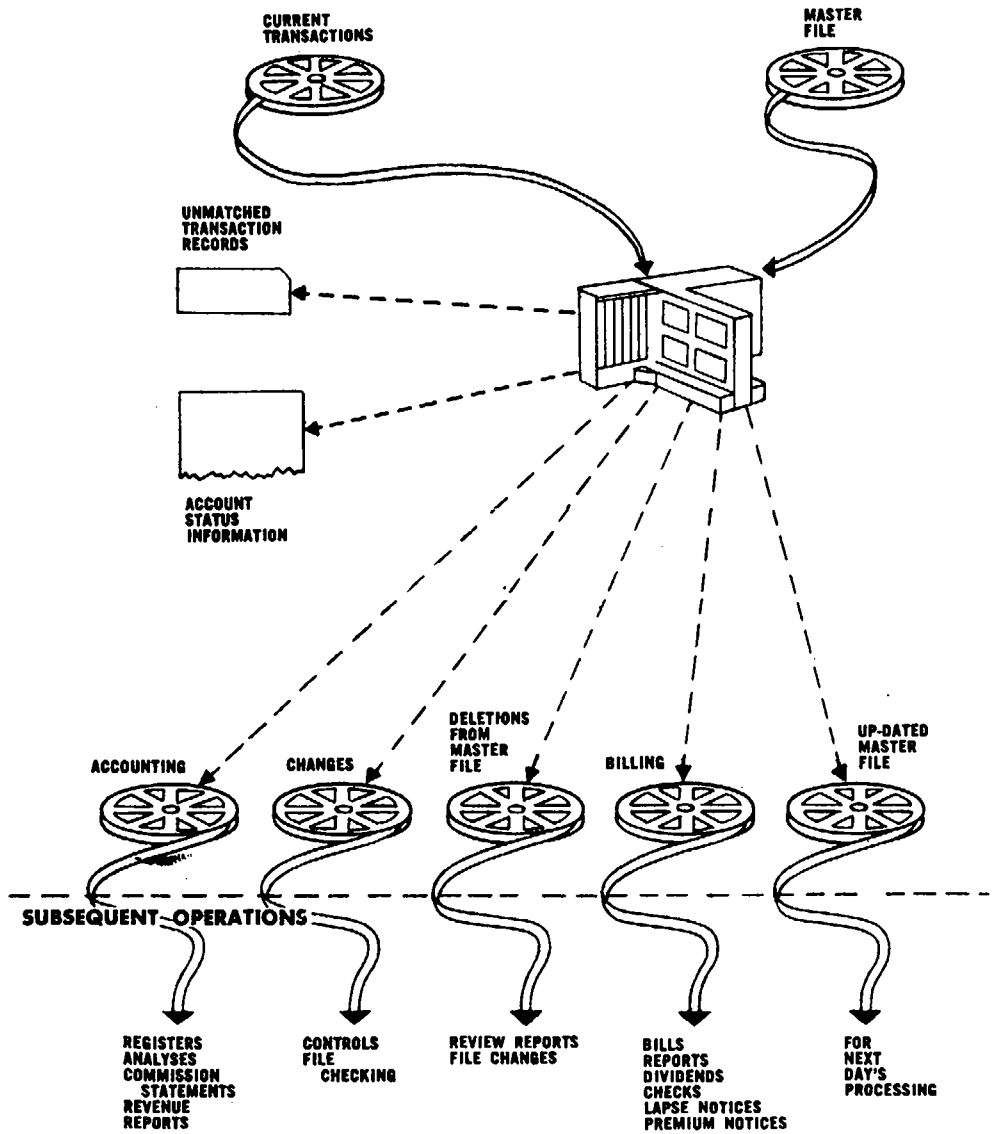
Outside of Government, the payroll application is probably the one most generally used as the "pay-out" or "bread-and-butter" application

to justify the installation of automatic data processing. In Defense I don't know of a single case in which payroll has been the principal application. The reason for this difference is a simple one: The payroll operation in private business is much more complex and expensive than it is in Government. Even our most complicated payrolls, such as those in our industrial establishments, don't compare in difficulty with the payroll of a railroad, for example. In private industry it has become a rule of thumb that if the business is not large enough to support a payroll application, it usually couldn't justify a computer. In Defense, our payroll applications are usually secondary, but we still have a substantial number in this area. A major advantage of using ADPS for payroll is that it gives basic data needed for labor and cost distribution purposes and, so far as private business is concerned, simplifies reporting to the Government on social security and taxes. Magnetic tapes are now being accepted for reporting purposes by Social Security, and I understand that Internal Revenue is planning to use the same technique.

We don't have anything in Defense that would compare too directly with the billing operations that are probably the second largest application in private business. Chart 18, page 35, shows a typical billing operation on ADPS. Utility companies throughout the country are turning to ADPS as an answer to their mounting problems in this area. Most of the large insurance companies are also using electronic computers for their premium billing, along with actuarial work and the preparation of statements and payments to agents.

Our largest application in Defense is in the supply area, but I think this would probably rank third in private industry. As you will hear later, we have some quite sophisticated applications to stock control, supply control requirements determination, cataloging, and the other areas of the supply and logistics field. Since I don't think my colleagues will cover it specifically, I would like to mention briefly a pet project of mine in this field--the exchange of data with our defense contractors in machine language.

CHART 18


CURRENT TRANSACTIONS
MASTER FILE
UNMATCHED TRANSACTION RECORDS
ACCOUNT STATUS INFORMATION
ACCOUNTING
CHANGES
DELETIONS FROM MASTER FILE
BILLING
UP-DATED MASTER FILE
SUBSEQUENT OPERATIONS
REGISTERS ANALYSES COMMISSION STATEMENTS REVENUE REPORTS
CONTROLS FILE CHECKING
REVIEW REPORTS FILE CHANGES
BILLS REPORTS DIVIDENDS CHECKS LAPSE NOTICES PREMIUM NOTICES
FOR NEXT DAY'S PROCESSING

We have found by experience that we can save money and improve our operations by transferring data between our installations in machine language. It makes sense to extend this same technique to our defense contractors, since savings and improved operations here should be reflected in reduced contract costs and ultimately in reduced taxes. Anyway, we are trying it in a few areas, and today 13 contractors and 8 defense agencies talk to each other in machine language. To be more specific, the agencies and contractors exchange information in connection with the provisioning operation in the form of punched cards, punched paper tape, or magnetic tape. Chart 19, page 37, shows some typical examples of such information exchange. We also exchange technical data with contractors as shown on chart 20, page 38, and although I don't have a chart to show it, we have several cases where we transfer data in machine language on such things as contracts shipments and deliveries, contract status, and projected delivery requirements. In a few cases we are even using wire transmission facilities, and I predict that this area will grow in importance as its potentials are more fully recognized.

The second largest category of defense applications is in the field of personnel information, and there is nothing in private industry with which this can be compared. In my opinion, this is the area in which we should exploit the potentials of ADPS to the maximum, for there is no other area in which we have a greater need for complete, appropriate, timely, and accurate data. When they are fully operational, our personnel information systems on ADPS will give us much more complete information than we have ever had before on the skills of our officers and enlisted personnel, their present status and distribution, projected gains and losses, and all the other data we need to be on top of our manpower problems.

There is another area that is usually considered as being in the scientific or mathematical field, but I would be inclined to classify it as advanced management. I'm referring to the development and expression of a balanced schedule of actions necessary to reach and maintain desirable military positions at specific points in time, including statements of resources available and required, and projected capabilities. We call this a Military Program, but the term just doesn't seem to connote the importance that it has to our national security. Here is where we should use the full power of our new management tool. As shown in chart 21, page 39, the cost of war's hardware continues to go up. What it will be in the "space age" is hard to predict.

CHART 19

TYPICAL EXAMPLES OF PROVISIONING DOCUMENTATION INTERCHANGE

CONTRACTOR	DEFENSE AGENCY	CONTRACT
ALLISON	NAVAL AVIATION SUPPLY OFFICE	J 71 ENGINES
CONVAIR DOUGLAS GENERAL ELECTRIC MARTIN	BALLISTICS MISSILES OFFICE	BALLISTIC MISSILES PROGRAM
BOEING	OKLAHOMA CITY AIR MATERIEL AREA	B-52 / KC-135

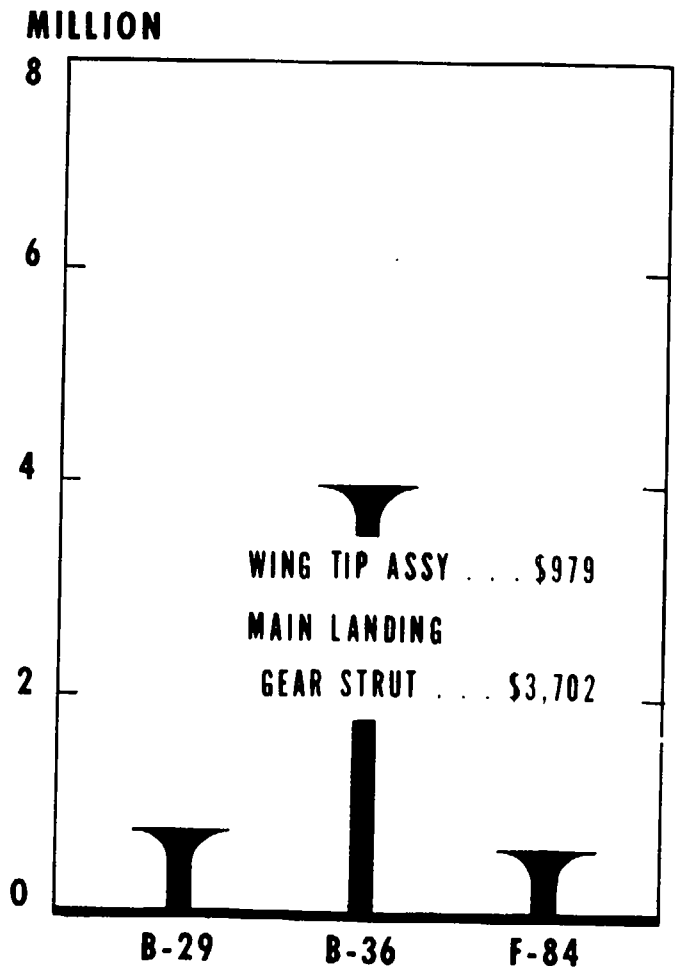
CHART 20

TYPICAL EXAMPLES OF TECHNICAL DATA INTERCHANGE

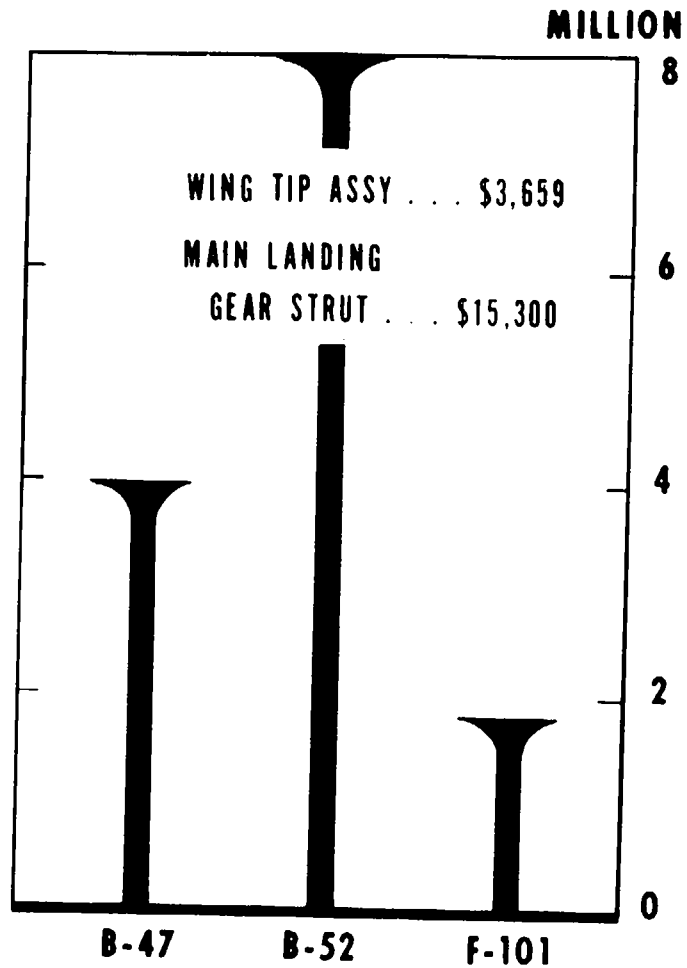
CONTRACTOR	DEFENSE AGENCY	CONTRACT
PRATT-WHITNEY	NAVAL AVIATION SUPPLY OFFICE	ENGINES
LOCKHEED	SACRAMENTO AIR MATERIEL AREA	F-104
BELL	ARMY TRANSPORTATION SUPPLY AND MAINTENANCE COMMAND	H-13 HELICOPTER

CHART 21

COST OF WAR'S HARDWARE GOES UP



10 TO 15 YRS. AGO



TODAY

In closing this part of my talk, I'm going to borrow from something that General Rawlings said in a New York speech to the American Management Association. He referred to Dr. Frankenstein's experience with his monster and reminded his audience that because Frankenstein devoted his entire thought to developing the capabilities of his mechanical marvel and none to the parallel development of his own abilities to direct and control it, the monster turned upon him and destroyed him. Management should take a lesson from Dr. Frankenstein and develop the ability to control and effectively use this mechanical marvel as a true and obedient servant.

COLONEL LACKAS: Thank you, Mr. Phillips, for describing the various automatic data processing devices, how they operate, and how they may be utilized by management.

(31 July 1958--4,100)B/rc:mjs:ekh