# RECOGNITION EQUIPMENT Incorporated Dallas, Texas



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1500 West Mockingbird Lane, Dallas, Texas

THE ELECTRONIC RETINA COMPUTING READER

## PREFACE



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The Electronic Retina Computing Reader (ERCR) (figure 1) is a general-purpose, program-controlled, optical character recognition system that is used as a basic input device for large-scale data processing systems. Source data automation by optical reading eliminates the expensive, time-consuming data input methods that are now a "bottleneck" at almost all high-speed medium and large scale computer installations.

The ERCR employs a two-dimensional retinal sensing technique to read optically multifont typed or printed information from a variety of forms and documents. Retinal sensing, in comparison to other character reading techniques (single-spot scanning, one-dimensional array scanning, etc.), permits fast, accurate, and relatively inexpensive character reading. The use of an Electronic Retina, simulating the retina of a human eye, results in a system whose reading performance characteristics approach that of the eye.

The ERCR accomplishes character recognition by artificially superimposing a grid over the geometric pattern of the unknown character. The total light energy, reflected from each square or cell in the grid, is translated (transduced) into a proportional amount of electrical potential. The complete array of cells in the grid becomes a mosaic of the unknown character. Since all cells comprising the array are transduced simultaneously, the Electronic Retina performs sensing operations many times faster than single-spot scanners or one-dimensional arrays. An additional advantage of the Electronic Retina over other OCR systems is the elimination of critical timing circuits. The simplicity of the technique completely eliminates the difficult, conscientious maintenance, and calibration schedules associated with other reading methods.

## SYSTEM ORGANIZATION AND COMPONENT FUNCTIONS

A functional block diagram of the complete system is presented in figure 2. The Electronic Retina Computing Reader is organized into four major functional groups. They are the Paper

Handling group, the Character Conditioning group, the Recognition group, and the Control and Output group.

In the Paper Handling group, two paper handling devices are offered by Recognition Equipment. These are the Rapid Index Page Carrier (RIPC) and the Document Carrier (DC). A combination of these devices may be used with the same retina unit, allowing a wide variety of input. For example, the RIPC handles paper sizes from 3 1/4 by 4 7/8 inches to 14 inches square, in weights from 12 to 30 pounds.

The Paper Handling group positions the input so that it is projected onto the Electronic Retina. The Retina is a two-dimensional array that senses characters on a real-time basis. It offers the unique ability to view simultaneously the elements of a complete character. Character viewing eliminates the necessity for controlling a time-versus-position relationship in the electrical transformation of the character. The output of the Retina is analog, so that it registers not only black and white, but also intermediate shades of gray. As a result, the ERCR offers distinct advantages in speed and accuracy over any other system. Additionally, a decision regarding the final destination of a document is made at the read point before it is released. This eliminates the possibility of a document being rejected because of a late decision.

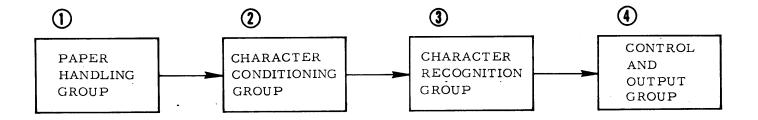
The character is then transmitted to the Recognition Group. There the Character Correlator (containing pattern detection and storage circuits) and the Decision Generator determine identity and decide upon the appropriate electronic portrayal of the character. Because the ERCR is a continuously-looking, parallel system, the final decision in regard to the character is made while it is still on the Retina.

The Control and Output group acts to control the reading and processing in the ERCR. The group includes the Programmed Controller and associated peripheral equipment. As the information is processed, the Programmed Controller codes and routes the information to peripheral output units.

The Programmed Controller, a general purpose digital computer, provides the master control



Figure 1. Electronic Retina Computing Reader.



- 1. The purpose of the Paper Handling Group is to remove a page or document from the input stack, pass it by the viewer for viewing, and stack it in its proper place in the output stacker.
- 2. The Character Conditioning Group views the page or document as it passes, analyzes its vertical position on the retina, selects the proper signals to consider and correlates these signals selected with respect to their amplitude.
- 3. The Character Recognition Group compares the unknown character with its stored, known characters, and makes a decision as to which of these stored characters the input character most closely resembles.
- 4. The Control and Output Group, in addition to coordinating the timing of the various functions of the ERCR, acts as a buffer for the system, provides various output channels, and is the means by which operational control over the system is executed.

Figure 2. Block Diagram - Electronic Retina Computing Reader.

for the Electronic Retina Computing Reader. It functions to buffer and format information for magnetic tapes, and provides editing and control function.

#### OPTIONS

As previously mentioned, two types of input units are available and each system has the capability of accommodating more than one input unit. When full-sized pages and small, unit-sized documents are to be processed intermixed, the optional dual input system is desirable. The two paper-handling units are the Rapid Index Page Carrier and the Document Carrier.

The peripheral devices may be attached to a Programmed Controller as the needs of the installation dictate. Some of the devices that can be attached are Line Printers, Magnetic Tape Units, and Console Typewriters.

In addition to the optional input and output arrangements, the Ink-Jet Printer is an option to the Document Carrier. It selectively encodes and prints flourescent bar codes that represent alphabetic or numeric information generated under program control from documents read in the Document Carrier. The printed bar codes are desirable where rapid multiple sorting and stacking are required (e.g. in the credit card industry).

The Paper Handling group, shown in figure 3, moves the paper or document from the input stack past the viewing lens and into the output stacker. Two different input devices are available. The Rapid Index Page Carrier is used primarily for page-type documents such as, school registration forms. The Document Carrier is used for unit-sized documents such as credit card billing.

### RAPID INDEX PAGE CARRIER

The three functional components of the Rapid Index Page Carrier are (1) the Page Loading Station, (2) the Page Reading Station, and (3) the Page Unloading Station.

The fundamental theme of parallel operation has been extended to the mechanical design, as well as to the electronic design of character sensing and recognition equipment; i.e., there are three identical, but independent pagecarrying drums in the machine. The three drums are mounted on a Ferris wheel type device which causes the drums to index sequentially to each of the three functional stations in the machine -- Page Loading, Page Reading, and Page Unloading, Ioading, reading, and unloading occur simultaneously; that is when one page is being loaded onto a drum, the previous page is being read on another drum and the page before that is being unloaded from the third drum. This parallel approach has two advantages. It has eliminated the idle time experienced by other scanning devices in page insertion, extraction, and release by providing sufficient time to load and align a page on a drum and to unload and stack a page from a drum without jeopardizing the effective page reading rate of the machine. Secondly, the machine will process pages that vary in size from 3 1/4 inches by 4 7/8 inches to 14 inches by 14 inches, and in weight from 12 pound paper to 30 pound paper at a rate which varies from 10-24 pages per minute depending upon total information to be read from any page. Different-sized pages within the above range can be intermixed as long as there is no more than a 3-2 ratio difference in length among the papers in the batch.

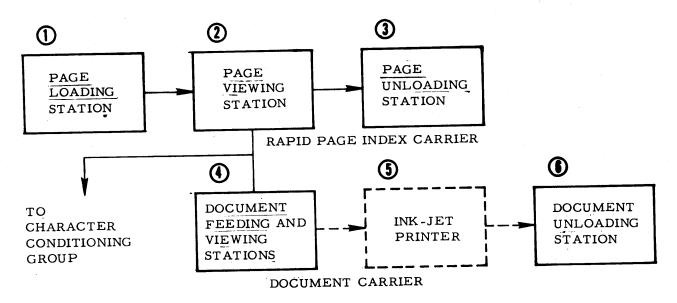
## Page Loading Station

The Page Loading Station (figure 4) provides an automatic elevating device (1) to keep the top of the input paper at a constant height. The top page is removed from the stack by an oscillating vacuum nozzle (2) which draws the pages toward the introductory rollers (3). As the document is gripped by the introductory rollers, stationary air nozzles (4), blowing in and down on the page held by the vacuum nozzle, strip off any extra pages not held on the pile by gravity. A multi-item detector (5) detects two or more sheets of paper from being loaded onto the RIPC load station drum. Any change in pressure, caused by two sheets of paper passing between the detector blocks, is converted to an electric pulse that interlocks the RIPC until the documents have been removed from the load station. The rollers (6) move each page into registration against the aligning slot (7) on the drum in the Page Loading Station (8), without regard to most tears, dog-ears, and staples.

## Page Viewing Station

The Page Viewing Station is shown in figure 5. When the Ferris wheel drum arrangement is indexed 120 degrees clockwise, the drum that was formerly in the loading station rotates into the Page Reading Station. The drum (1) traverses horizontally down its axle causing the point at which the viewing lens (2) is focused to move down the page as the rotational motion of the drum passes each line by the viewing lens. The horizontal speed along the axle accommodates either single, or double line spacing without reducing the processing rate of the machine. Wider line spacing is accommodated at slightly reduced machine rates. The incremental distance the drum moves along its axle is automatically modified to accommodate random differences in line pitch sensed by the line finder.

The Ferris wheel mechanism is actuated and the drum assembly indexed 120 degrees clockwise, when any one of three conditions occurs. One condition is that the viewing lens reaches a point, selected by program control, below which no active reading is desired. A second condition is the internal indication of maximum



- 1. The Page Loading Station removes a page from the input stack and readies it for viewing.
- 2. The Page Viewing Station, consisting of a lens and mirrors, views the page in selected horizontal bands.
- 3. The Page Unloading Station stacks the viewed page in the same order as it was originally sorted.
- 4. The Document Feeding and Viewing Stations handle unit-sized documents. The Document Feeding Station removes a document from the top of the document stack and passes it in front of the line in the Document Viewing Station.
- 5. The Ink-Jet Printer, optional to the ERCR, prints encoded information in the form of bars on the document as it passes.
- 6. The Document Unloading Station places the document in the selected output stacker.

Figure 3. Paper Handling Group.

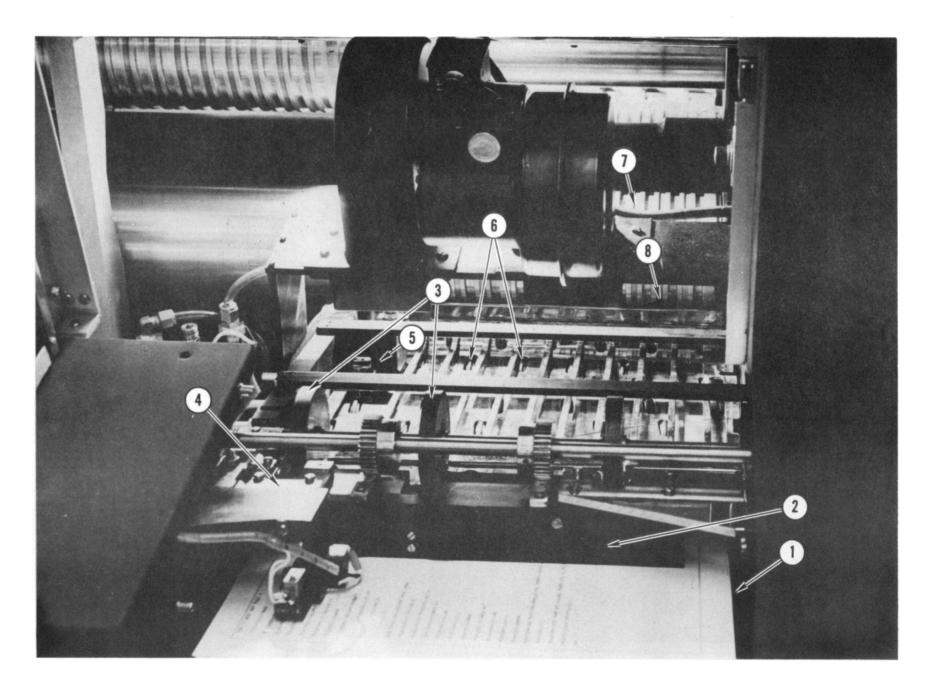


Figure 4. Page Loading Station.

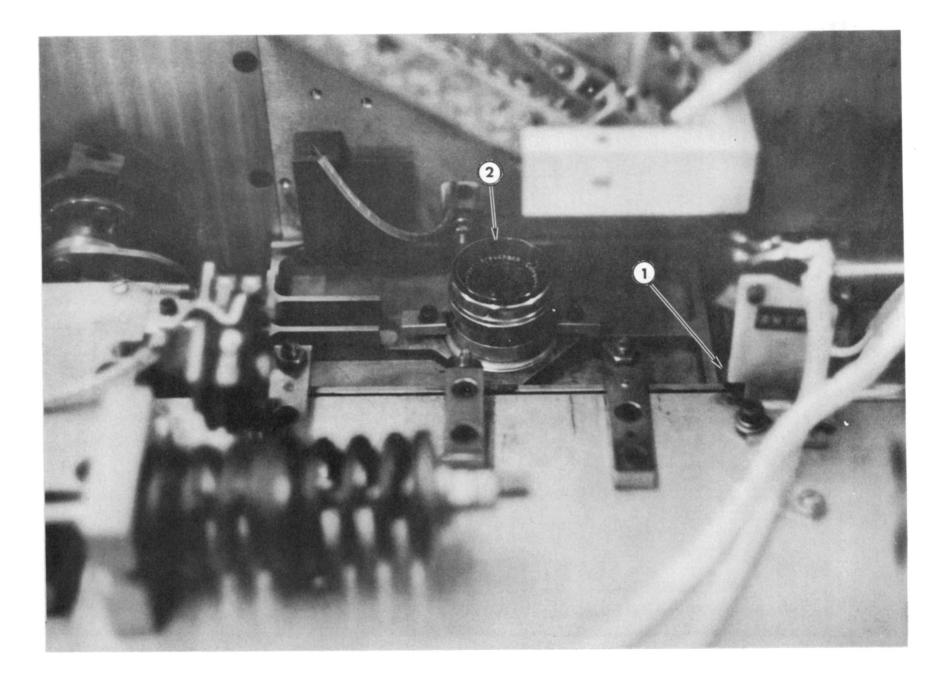


Figure 5. Page Viewing Station.

drum travel. The third condition is the machine sensing improper motion of the drum along the axle. Any of the specified conditions moves the drum from the Page Reading Station to the Page Releasing Station.

Under program control, the machine can skip over selected horizontal bands across a page and selected vertical bands down a page.
Under program control, an optional line marking device marks each line as desired.
typical page, with three lines marked indicating invalid characters, is illustrated by figure 6.

The unique ability of the Electronic Retina to combine exceptionally high resolution with a two-dimensional view of the character provides sufficient information for recognition without rescan. This ability is a distinct advantage over other optical character reading methods, e.g., the single spot scanner. If desired, the ERCR can be programmed to reread automatically any line in which one or more rejected characters occur. The reread capability can be used to permit temporary storage of the characters read from each line of the page in a buffer between the recognition unit and the output unit. While this feature reduces the effective operating rate of the system, the exceptionally high reading speed makes this method of verification feasible in applications where unusually high accuracy is essential.

## Page Unloading Station

Figure 7 shows the Page Unloading Station. This view is of the opposite side of the machine from that in figure 4.

After the drum is indexed to the unloading area, its rotational speed is decelerated and its motion reversed. The drum (1) is returned along its axle to its front-most position. The page is stripped from the drum by finger (2) which fit into the grooves in the drum. As the page unwinds from the drum, it is inserted into the belt transport (3) which moves the page to the top of the output stack (4). Pages are stacked face down in the same sequence in which they were loaded into the machine. Pages can be sorted by program into two output stacks. When sorting is used, the two output stacks will contain the pages in the same sequence that they were loaded, but the stacks must be merged

if the initial order is to be maintained.

Each output stacker can contain more than 2,000 pages and may be emptied while the machine is running.

### DOCUMENT CARRIER

The Document Carrier contains two functional blocks -- (1) the Document Feeding and Viewing Stations and (2) the Document Unloading Station.

Document Feeding and Viewing Stations

Figure 8 illustrates the Document Feeding and Viewing Stations. The techniques used for document handling in the Document Carrier are similiar to those used in the Rapid Index Page Carrier. An oscillating member, within which a vacuum is valved on and off, is used to pick one document from the front of the feeder tray and insert its leading edge into a moving, double-belt transport system. Since the valving action is caused by the lateral motion of the oscillating member, its timing does not vary with respect to member lateral position. A stationary opposing vacuum, lower in force than the oscillating vacuum, is used to separate or hold back any document picked up in addition to the front one. The Document Feeding Station is shown in figure 9.

At the midpoint of its stroke, the oscillating member is moving at the rate of 200 inches per second. At this time, the leading edge of the document reaches the transport belt system, which is also moving at 200 inches per second. The document is grasped between the moving belts and pulled away from the oscillating member as the vacuum is turned off.

At the Viewing Station (figure 10), a lens system looks at a band across the document. The height of the band can be as much as three times as high as the tallest character to be read from the document. The vertical position of the band with respect to the bottom of the document can be adjusted to predetermined settings by the machine operator.

FORM 341a (Rev. July 1963) U.S. Treasury Department Internal Revenue Service

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063 94 3580

## CONTINUATION SHEET FOR SCHEDULE A OF FORMS 941, 941-M, 941SS, OR 943

REPORT OF WAGES TAXABLE UNDER THE FEDERAL INSURANCE CONTRIBUTIONS ACT Page Number 12-0345678 2 6-30-68 If this form is used as a continuation sheet for Form 943, Employer's An-nual Tax Return for Agricultural Em-ployees, please check here. XYZ EQUIPMENT CORPORATION 3174 Main Street Garland, Texas READ INSTRUCTIONS CAREFULLY Attach only original continuation sheets to your tax return. Do not send a carbon copy to the U.S. District Type or print in this space employer's identification number, name, and address exactly as shown on the return. Director of Internal Revenue. STATE OR
POSSESSION
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ACCOUNT NUMBER
(If number is unknown, see Circular A, E, or SS): NAME OF EMPLOYEE (Please type or print) ABBIE LEE BURNETT 880.32 **TEXAS** 029 13 8877 1,334.54 334 45 4452 JAMES WILLIAM BIGGS 988.09 BENTLEY BROWN 034 65 7658 897.43 WILLIE BEN COOPER 543 78 2378 1,009.04 DAVID DENNIS 224 17 1789 845.33 LEONARD DICKSON 567 23 0987 732.40 998 20 4117 OSKAR EDWARDS 934.17 HAROLD EUGENE GIBBS 645 34 2526 1,204.89 413.02.2957 SAMUEL HANSON 645.23 706 63 7036 BETTY LEE JOHNSON 554.73 SARAH JANE KRUEGER 823 11 8114 1,489.26 WILLIAM CHARLES PARKS 556 56 9863 984.22 KENNETH RAY PARSONS 294 38 3647

Figure 6. Typical Marked Page.

RANDALL REED

BILLIE BOB SMITH

WILLARD WILKINS

TOTALS FOR THIS PAGE—Taxable wages and number of employees . . . . | \$ 15,302.70

884.57

894.32

Number of 16

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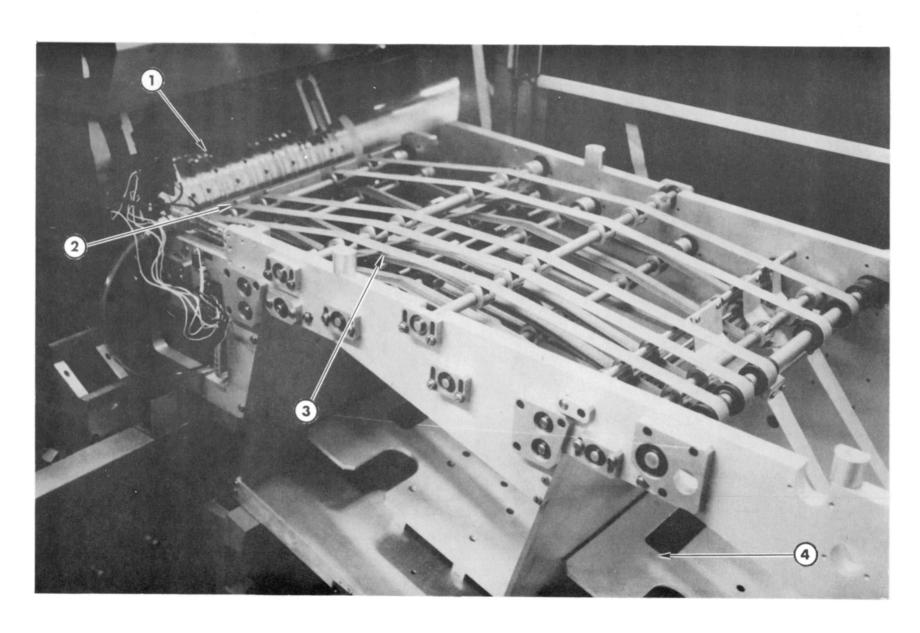


Figure 7. Page Unloading Station.



Figure 8. Document Feeding and Viewing Stations.

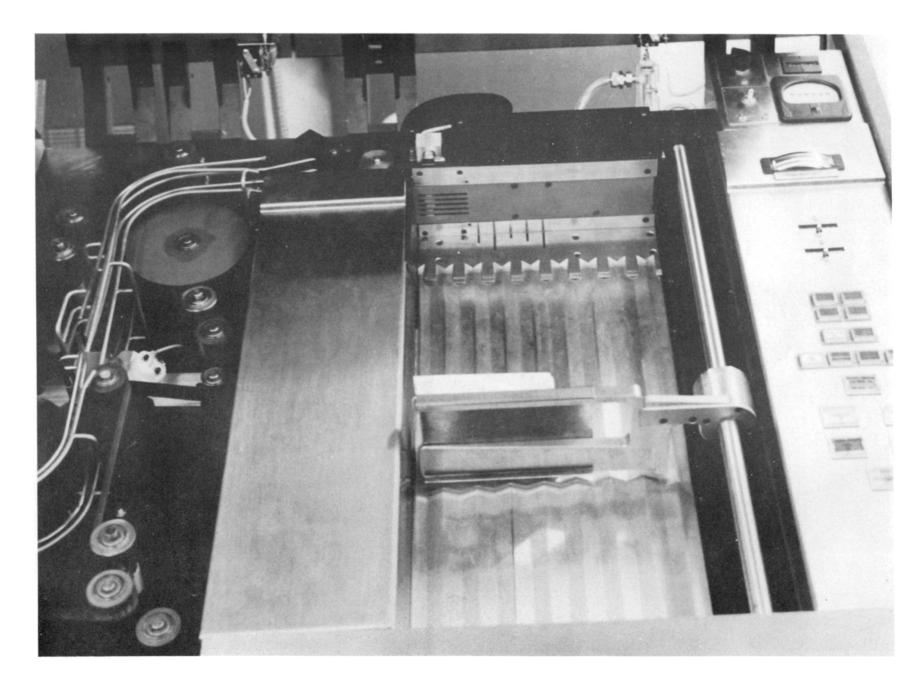


Figure 9. Document Feeding Station.



Figure 10. Document Viewing Station.

The document feeder can be refilled by the operator, without stopping the system, by inserting additional documents immediately behind those already in the feeder tray.

As an option, a second viewing station can be installed nine inches along the belt system from the first viewing station. The station can be used to read a second line on a document or to reread the first line.

## Document Unloading Station

Figure 11 illustrates the unloading and stacking areas of the Document Carrier. One document output module contains three output pockets, or stackers, with associated gates and belts. The standard Document Carrier has one module (three pockets). Additional output modules (to a maximum of four) are available. One example of an optional unloading arrangement is the use of the fourmodule (12-pocket) machine as a decimal sorter.

As documents pass along the transport belt system away from the feeding area, they pass individual gates sequentially, one gate for each output pocket. After the system logic has determined the pocket to which a given document is to be directed and immediately before the document reaches the gate associated with its pocket, the destination gate is caused to open and guide the document out of the main belting system into a decelerating disk associated with that pocket. The disk reduces the velocity of the document to facilitate stackinging. The gate remains open until the last selected document enters the pocket. The automatic follower in the stacking tray aids

the unloading of the deceleration disk and assures that documents are stacked neatly in the pocket.

## Ink-Jet Printer

The Ink-Jet Printer (figure 12) is optional to the Document Carrier and is comprised of the Print Modulator (Gun), the pressurized ink-flow system, and the printer electronic control circuits. Pressurized fluorescent ink flows steadily through a precision-ground glass nozzle; as the ink jet stream leaves the nozzle, it forms into 48,000 drops every second. A crystal vibrator ensures that the drops form in the ink stream with uniform spacing.

When the printer receives a command from the Programmed Controller to print a bar, a precisely-controlled, variable electrical charge is applied to each drop of ink. As the drops pass through a constant electrical field, they are deflected upward in proportion to the charge applied to them. The deflection enables the drops to form a vertical line when they strike the document.

The ink-flow system consists of a flourescentink supply and a solvent supply that is filtered
and applied under a constant pressure through
the fluid network to the print modulator. The
plumbing network is composed of flexible tubing and cam-operated valves. The valves
control the flow of ink and/or solvent to the
selected print modulator and regulate the turn
on and turn off timing cycle. Pressure for
the system is supplied from a tank of nitrogen
mounted beneath the module base plate.

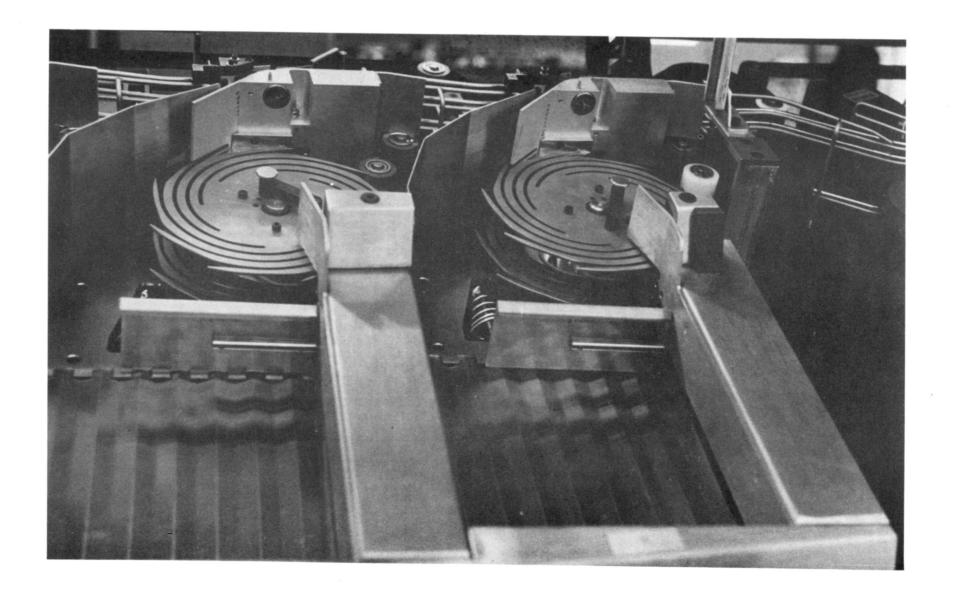
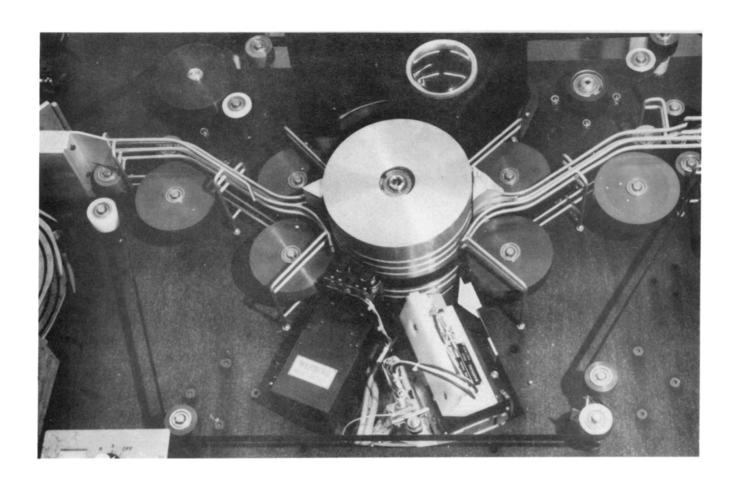


Figure 11. Document Unloading Station.



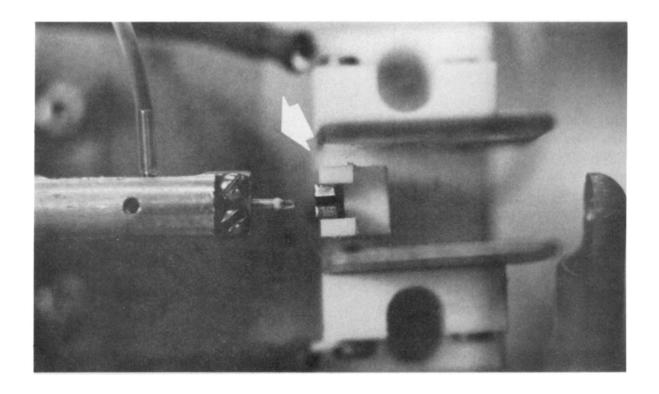


Figure 12. Ink-Jet Printer.

The Character Conditioning group illustrated in figure 13, views the character, selects its vertical, position on the Electronic Retina, and translates the light energy into electrical energy for later use in making a decision as to character identity. The functional components of the Character Conditioning group are the Optical Character Viewer, the Electronic Retina, the Character Analyzer, the Video Switching circuits, and the Amplitude Correlator.

#### OPTICAL CHARACTER VIEWER

Figure 14 portrays the Optical Character Viewer. The viewer consists of a magnifying lens and mirror system. The image of the character on the page is magnified in order to project an enlarged view of the character upon the silicon sensing cells that make up the Electronic Retina.

As character viewing begins in the RIPC, the lens and the mirror move parallel to the horizontal travel of the drum. The image viewed by the lens is reflected through a series of three mirrors to the Retina. The character is enlarged with each mirror reflection. The drive mechanism returns the lens and mirror to the starting position, after the last image line is projected on the retina. The viewing system on the DC performs the same function as on the RIPC, but is stationary.

## ELECTRONIC RETINA

Figure 15 shows the Electronic Retina.

The Electronic Retina is a two-dimensional array of photosensitive devices. The array forms a grid of cells upon which the character is focused. Each cell is a solid state device, has no moving parts, generates essentially no heat, and has a very long operating life.

The Retina is rectangular in order to accommodate vertical character misregistration of as much as one character height above or below the nominal character position.

Each cell in the Electronic Retina translates the quantity of light striking it into electrical signals that are exactly proportional in amplitude to that quantity of light. Intermediate shades of gray are maintained in their proportional forms for consideration by the Recognition Unit.

The Retina is "open" all the time. Recognition occurs whenever a character comes into proper registration on the Retina. There is no danger of recognizing part of one character as another, different character. This openreference feature permits test patterns placed in front of the viewing head to be used as trouble-shooting and check-out tools.

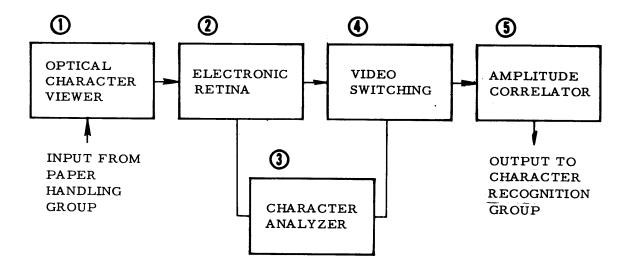
The Electronic Retina approaches the 20/20 resolution of the human eye when reading normal printed material. From the Retina, the character is transmitted to the character analyzer and the video switching circuits.

#### CHARACTER ANALYZER

The Character Analyzer is illustrated in figure 16. It consists of a single column of the same type photosensing devices used to construct the Retina. This vertical column is located along the leading edge of the Retina in such a manner that viewed characters pass under it before they are focused on the Retina.

The Character Analyzer senses the vertical position and height of each character just before it comes into lateral registration on the Retina. The vertical-position information is used to define that horizontal band of cells which will be the active sensing area for the character coming into lateral registration on the Retina.

The Character Analyzer, which descends below the bottom of the Retina, is also used to sense the location of the next line of characters on the page which will be read by the machine. This information is generated for the drum in the Page Viewing Station and for the mirror in the Optical Character Viewer to accommodate random variation in vertical spacing between lines and variations in "line skew". The line-finding function of the Analyzer is not pertinent to a Document Carrier. However,



- 1. The Optical Character viewer, consisting of a lens and mirror system, views each character as it passes and projects the character onto the Electronic Retina.
- 2. The character striking the retina is changed from high energy to electrical energy by means of photo-cells placed in a rectangular pattern.
- 3. The information that contains the unknown character passes the Character Analyzer which aides the Switching Circuits in selecting the correct band of information to present to the Amplitude Correlator.
- 4. The Video Switches select the band of information to be presented to the Amplitude Correlator.
- 5. The Amplitude Correlator receives the electronic representation, and through a process of measurements and averaging, strengthens character definition.

Figure 13. Character Conditioning Group.

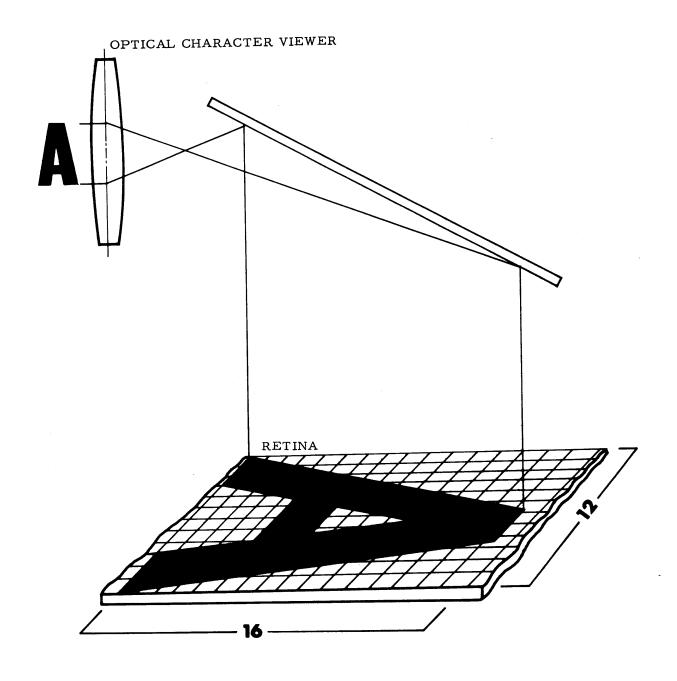


Figure 14. Optical Character Viewer.

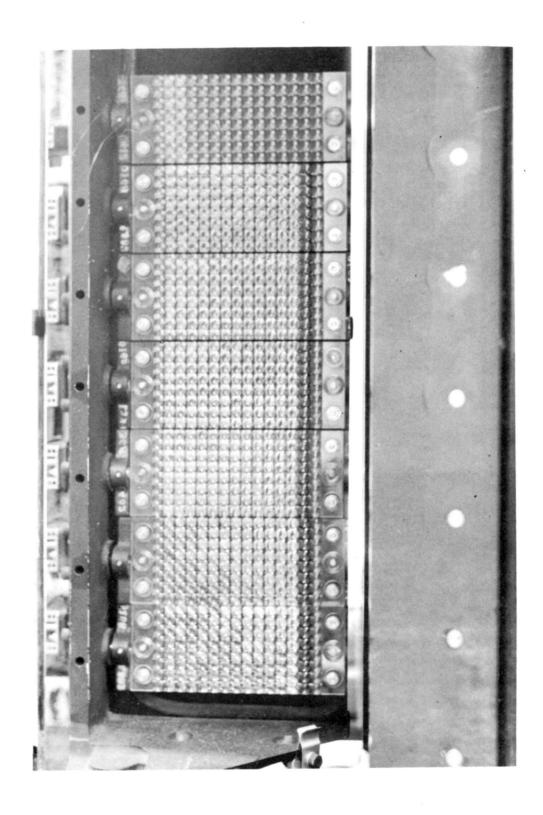


Figure 15. Electronic Retina

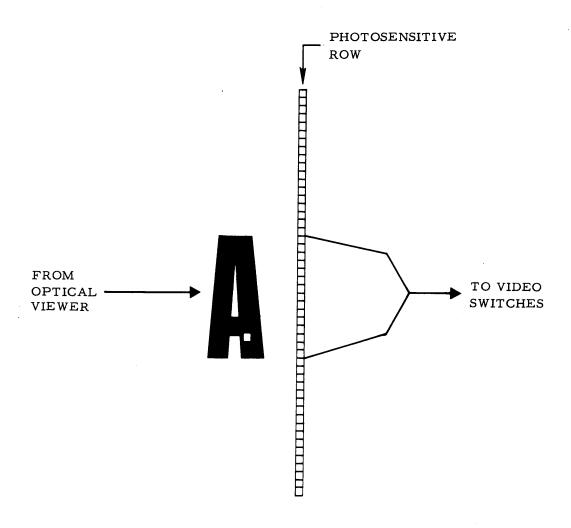


Figure 16. Character Analyzer.

the cells extending below the Retina are used by both the Document Carrier and Page Carrier to register the position of bar codes.

#### VIDEO SWITCHING

The Video Switching circuitry, illustrated by figure 17, functions to select only the band of signals which contains the unknown character. Proportionally amplifier signals from each photo-cell in the Electronic Retina are delivered to the Video Switches. Only those signals representing a character will be switched to the recognition circuitry.

## AMPLITUDE CORRELATOR

The Amplitude Correlator is shown in figure

18. Although the Amplitude Correlator is portrayed as a separate functional block on the over-all block diagram; it is, in fact, an integral portion of the circuitry associated with the Electronic Retina. The output from each cell of the Retina is electronically compared against the average output from 20 surrounding cells. The relative magnitude of the actual output of the cell with respect to the 20-cell average is used to offset the degradation in character definition caused by voids within the character and extraneous ink around the character. The parallel operation implicit in the Electronic Retina approach to scanning permits this averaging or "clean-up" technique to be effective in both dimensions rather than one. This approach is more reliable than other methods of sampling.

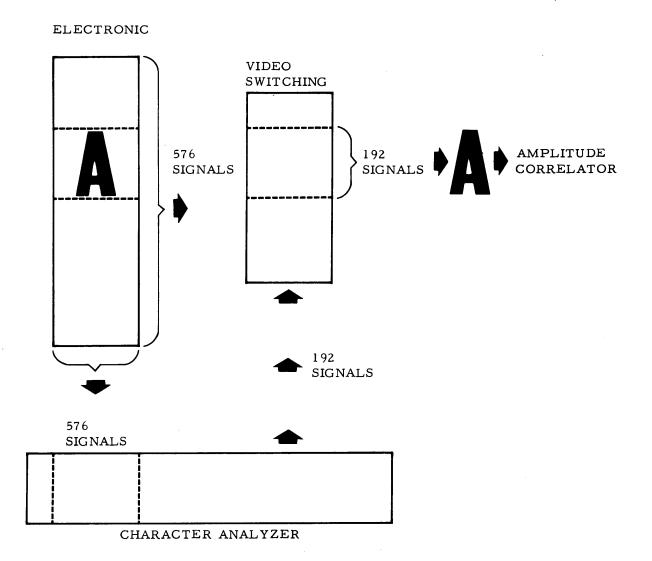


Figure 17. Video Switching.

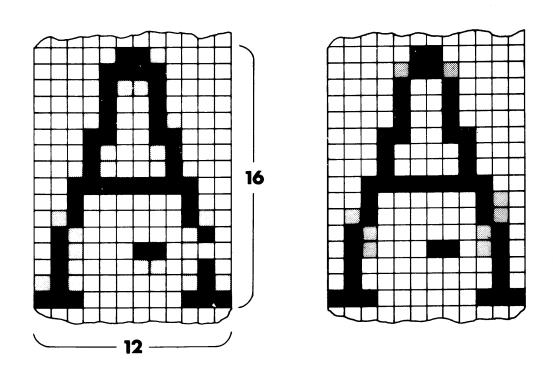


Figure 18. Amplitude Correlator.

## CHAPTER IV. THE CHARACTER RECOGNITION GROUP

## INTRODUCTION

The Character Recognition group is illustrated in figure 19. When the video information has been transduced into electronic information and amplitude correlated, the recognition group determines the identity of the character. The Character Recognition group is composed of the Character Correlator and the Decision Generator.

## CHARACTER CORRELATOR

The Character Correlator is composed of the Pattern Detection and Storage circuits. These circuits contain masks, or character templates, to define character relationships. Significant parts of a character are weighted to aid in identification. For example, the presence of the tail on the "Q" can be demanded more emphatically be attaching more weight to those cells associated with the tail. This is an important feature when trying to recognize one character from a large group of possible characters. The more characters that are added to a vocabulary, the smaller the differences are which must be identified for discrete recognition of an unknown character.

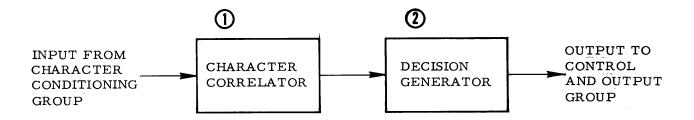
The Character Correlator compares the analog signal from the Amplitude Correlator with all characters recognized by the system and stores the results in the Decision Generator.

### DECISION GENERATOR

The Decision Generator is portrayed in figure 20. The Decision Generator simultaneously compares the outputs from all the character templates to which it has access in an effort to determine that character mask which provides the best match with the unknown character on the Electronic Retina. In this continuously-looking parallel system, the decision is actually made while the character is on the Retina. There is little time delay between presentation of the character at the viewing head and identification of the character by the Decision Generator.

The Decision Generator operates under some important ground rules in its effort to find the best match. That is, the best match must be at least X per cent better than the next best match. There may be a variation in X of between five and fifty per cent depending upon the particular application in which the machine is being used. This is a simple adjustment which essentially determines the relationship between reject rate and error rate. A high X means a lower error rate and a higher reject rate, and vice versa. It is this ground rule in the decision-making process of the machine that permits the machine to be tolerant of wide variations in density of printing. Since the best match is relative, the absolute values of the best match and next best match are not important in the decision-making process. This basic ground rule can be incorporated into a digital system; however, it becomes a much more powerful tool in an analog system since all or portions of a lightly printed character in a digital system will, in fact, be called white and will contribute nothing.

The second ground rule requires that the best match be at least Y per cent of a perfect match. This assures that noise, interference, or characters which are not part of the machine's vocabulary do not generate errors (substitutions). There can be a variation in Y of from fifty to ninety per cent depending upon the requirements of the user in a specific problem.



- 1. The Character Correlator compares the electronic image of the unknown character with stored information. Special emphasis is given to significant parts of the character.
- 2. The Decision Generator simultaneously compares the unknown character with all stored characters and decides which comprises the best match.

Figure 19. Character Recognition Group.

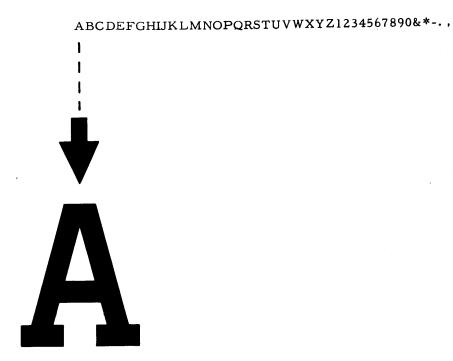


Figure 20. Decision Generator.

The Control and Output Group, figure 21, is composed of the Programmed Controller (PC) and the peripheral equipment which the user requires for compatability with his data processing installation. The Control and Output group provides communication between the elements of the system, input and output communication, and operational control of the system. Data storage can be provided by a Magnetic Tape Unit.

## PROGRAMMED CONTROLLER

The PC is a general-purpose digital computer used to provide master control for the ERCR. The inclusion of the digital computer as an integral part of the ERCR automatically enhances the system flexibility. Two Programmed Controllers are available from Recognition Equipment. The PC-I (figure 22) is available when only the Rapid Index Page Carrier is desired. It has an 8000 word basic core memory which is expandable in 4096 word increments to 16,384 words. All words are directly addressable. The PC-I has an eight microsecond cycle time. When other options, such as the Ink-Jet Printer, are desired, the PC-II (figure 23) is available. The PC-II has a core memory of up to 32,678 words. Cycle time for the PC-II is 1.7 microseconds.

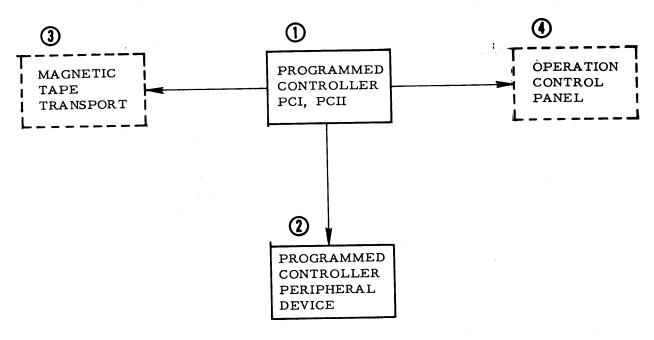
The PC functions primarily as a translator and "traffic director" between the Recognition Unit and the output devices. It coordinates the functions of the individual units of the system and is the means through which an operator controls the overall system. Some of its functions include:

- 1. Calculate, insert, and verify parity.
- Insert end-of-field and end-of-line marks on tape.
- 3. Accomplish read-after-write verify (if applicable).
- 4. Control tape record size and gap size.
- 5. Control bad-spot detection.

In addition to the functions associated with buffering and formating of magnetic tape, the Programmed Controller can be used to accomplish a wide variety of editing and control functions at the same time.

The PC may define the following:

- A field is all numeric, all alphabetic, or both alphabetic and numeric.
- 2. A field is not a fixed-length field or it is a fixed-length field containing X number of characters.
- A check digit associated with a field, to be verified before accepting the field.
- 4. The location of a field in which marks rather than characters are to be identified; e.g., variable information may be manually marked on a document to indicate confirmation, quantity received, etc.
- 5. The manner in which the system reacts to rejects; i.e., mark a rejected line, and/or place it in a separate pocket, and/or inhibit magnetic tape writing, etc.
- A limited capability for intermixed processing of more than one data format.
- 7. The criteria for directing documents to additional output pockets when they are available.
- 8. The number of blank lines to be used as a criterion for determing end of page on those pages which do not have a fixed format.
- 9. The character space used as the criterion for decimal sorting when the Retina and Recognition Unit is used in conjunction with a Document Carrier.
- 10. Left justification or right justification of fields to be recorded on magnetic tape. It is desirable to suppress spaces to conserve magnetic tape.
- 11. Those fields to be accumulated and balanced against a control total.



- 1. The Programmed Controller provides operational control of the system, buffering of the system and communication between elements of the system.
- 2. The Operational Control Panel provides a means for operator control of the system.
- 3. Magnetic Tape Transport, optional to the system, provides a method of storage for data read by the ERCR.
- 4. Programmed Controller Peripheral Device, such as the Console Typewriter, provides optional input/output communication with the Programmed Controller.

Figure 21. Control and Output Group.



Figure 22. Model I Programmed Controller.



Figure 23. Model II Programmed Controller.

The information above can be used to increase the ability of the machine to find and correct its own mistakes and, even more important, the mistakes of those people who prepared the documents being read. That is, when the machine knows how long a field is supposed to be and what type of characters are to be in it, it can reject a document which does not conform to these characteristics. It is a basic rule in preparing input to an data processing system that the closer to a source document any exceptions can be identified, the easier it is to correct these exceptions by reference to the source document.

The degree of sophistication of the editing accomplished at the time that magnetic tape is prepared from the source document is a function of the programmer who writes the program for the Programmed Controller. The speed and storage available with the Programmed Controller make it an extremely effective tool for this type of work.

The PC has the same functions when used in conjunction with a DC as it has when used with a RIPC. In addition, when used with a Document Carrier, the stored program is used to define sorting and collating logic.

## PROGRAMMED CONTROLLER PERIPHERAL EQUIPMENT

Figure 24 depicts some of the peripheral equipment available.

Some of the peripheral devices that can be attached to a Programmed Controller include:

Magnetic Tape Unit

Console Typewriter

High-speed Line Printer

For more additional information on peripherals refer to appropriate system manual (e.g. O&P Reference Manual for the ERCR, etc.)







Figure 24. Programmed Controller Peripheral Apparatus.

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# RECOGNITION EQUIPMENT

Incorporated

United States Headquarters, Dallas, Texas
Offices in Frankfurt, Japan, London, Rome, Paris and Stockholm