VIDEOFILE -- A MICRO RECORDS TOOL

AMPEX

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I. INTRODUCTION

Videofile is a trade name generated by the Ampex Corporation to describe its new functional product system employing state-of-the-art television technology to aid in the automation of document storage and retrieval techniques. This family of products includes document cameras, Videotape recorders, video buffers, automatic tape changing equipment, address and command electronics, monitors and printers integrated into a system to serve all commercial and government requirements to store, update and retrieve documents. The objective of this document is to familiarize the potential user with the concepts that have evolved into the present hardware. The remainder of this introduction is an excerpt from a paper given at the Visual Communications Congress by Mr. R. A. Miner of Ampex and describes generally how we think of filing problems as we approach a prospective system analysis.

If you stop and think about it for a moment, a file cabinet is a rather arbitrary "critter" to communicate with. You, or your secretary, must go to it in order to communicate; the file cabinet will not come to you.

In any large file, its location is usually separated from those needing to communicate with it. It takes your time, or someone else's time, to seek out the particular file folder containing the information you need. All too frequently the first file folder does not contain all the information you wanted and more time is required to select another.

Furthermore, this file cabinet is extremely selective in who it communicates with on a particular subject. It can only communicate with one person at a time on any one subject. Expressing it another way, the file folders in your possession are "out of file" and not available to anyone else during the time that you are working with them.

Finally, this file cabinet is a fairly bulky storehouse for our records. We can do something about this bulk -- that's our business. But, generally, reducing bulk is accomplished at some sacrifice in flexibility -- our ability to update information in the file, or our ability to add new information into the same file folder containing old information, or else our ability to re-order the file, keeping its organization current with our changing need for information.

Visual communications -- visual access to records -- would certainly provide much better answers for management if the file cabinet could be made less arbitrary to communicate with, less selective in communicating on a specific subject, and less bulky without sacrificing flexibility. In fact, these words would probably describe the objectives of most micro-storage systems.

II. VIDEOFILE CONCEPT

Our purpose here is to present a new system concept for micro-storage which is aimed at easing these problems in communicating with a file cabinet. This system concept has a name -- it is called Videofile. Videofile employs television to bring information from the file to you; you don't have to go to the file. The electronic capabilities of television are such that two or more people can be working with information contained in the same file folder at the same time. Television is also the technique employed for picture storage in the file. The micro-storage media on which these television images are stored is magnetic tape - magnetic tape that allows one or any number of stored images to be erased and new ones put in their place; tape which can be reused after it has been erased; a media to which new images can be progressively added; and one that can be re-ordered as file organization needs change. Videofile, in other words, is a system concept which employs television pictures and television picture storage on magnetic tape to provide a document storage and retrieval system.

III. VIDEOFILE SYSTEM DESCRIPTION

To illustrate this concept, let's apply it to a hypothetical case -- a policy file in an insurance company for example. We will assume that the stack of documents shown at A in Figure I represent material to be filed. As is often the case, this particular file is indexed according to policy number. Documents to be filed are prepared by key-punching the policy number onto the document itself, B, Figure I, so that it can be read like punched paper tape. These prepared documents are then televised -- a television picture is taken, C, Figure I. This television picture is recorded on magnetic tape by means of a Videotape recorder. As this television picture is being recorded, the punched address is simultaneously read from the document and recorded on magnetic tape along with the document image.

In this manner we obtain a recorded reel of tape with document images -- each image having its identification recorded along with it. In our hypothetical insurance company example, the day's input to the file would likely be recorded all at one time on part of a reel of tape; we will call this a "daily reel." Once this "daily reel" is prepared, our documents are ready to be transferred automatically into the file.

The choices of file order and arrangement are as varied for a Videofile system as they can be in a filing cabinet. No matter which method is employed, however, the technique of transferring document images into the file will be a matter of electronically copying the image and its address from our recorded reel containing the day's file input, onto the file reel, by means of two or more Videotape recorders, D, Figure I. Once all of these images are copied, the filing process for that day is complete. Manual labor in our insurance company example has consisted of key-punching perhaps 7 to 9 digits into the original document, plus feeding them into the camera unit. It has taken no manual labor to actually file our documents.

Now let's turn our attention to the recall of filed documents. Continuing with our same insurance company example, let's assume that a claims adjuster wants to look at a particular policy file. His desk unit, F, Figure I, consists of a television monitor and control unit. He dials the policy number he desires into the system. The Videotape recorder searches through the appropriate reel of tape, E, Figure I, and locates the desired policy file. All of the document images contained in the policy file, for this number, are copied electronically into a temporary storage unit - or buffer.

The documents in the buffer are now at the disposal of the claims adjuster for examining one-by-one on his television monitor, for as long as he wishes. When he is through, the stored images in the buffer are erased and the unit is ready for someone else's use. It should be noted also that an appropriate electrostatic printer can be tied to this buffer to provide hard copy when needed.

Nothing has been removed from this television file on magnetic tape, and, therefore, no manual labor has been used to pull files and then refile them when the requestor was through. Also, no file is ever "out of file" -- it is always there, even when someone is referring to it.

This, then, is the Videofile concept. I am sure - at this point - you can readily envision its application to engineering drawing files, or a whole host of similar subject business files.

IV. RESOLUTION

In making this general description of the Videofile system concept, there were several specific details which were glossed over in the interest of painting a systems picture. Now let's go back and look at some of these details more closely. Perhaps one of our first considerations should be the television image itself and the matter of resolution.

In photography, different grades of film are capable of providing various grades of resolution depending, for example, on grain size of the film. As you know, this resolving capability is usually expressed in resolution lines per millimeter. One hundred lines per millimeter might be required for many microfilm applications. A single frame of film, then, can provide a given number of resolution lines depending upon the resolution quality of the film itself, in lines per millimeter, times the size of the film.

Expressing this another way, a single frame of 8 millimeter film of 100-line per millimeter resolution quality can provide a total of 800 resolution lines in one frame for any image to be photographed. Similarly, 16 millimeter film could provide 1,600 lines in one frame, 35 millimeter - 3,500 lines, etc. This total number of lines, in a frame, is vitally important in any microfilm storage concept because it determines the maximum size document that can be photographed with a given film size. For example, the 800 resolution lines in an 8 millimeter frame might be adequate for photographing the information on a 3" x 5" file card, but would certainly be inadequate for a large engineering drawing, etc.

The number of resolution lines, in a television frame, is equally important for exactly the same reasons outlined for photography. The variables in television however -- equivalents to film sizes and grades -- are all electronic. By varying electronic design parameters, a television frame might have anywhere from 400 to 10,000 resolution lines -- 10,000 being approximately equivalent to 55 millimeter photographic film with 100 lines per millimeter resolution.

Commercial television, familiar to all of you, operates on a standard of 525 lines per frame. There are various conversion factors that apply here, but this resolution is approximately equal to 50% of an 8 millimeter frame's resolution. In practice, commercial television equipment is quite likely to have adequate resolution for 3" x 5" file cards or slightly larger sized documents, but 8½" x 11" documents would require changing the television to special parameters providing more lines per frame.

How many lines are needed? Perhaps some examples will help. Figure II is a photograph made from a television monitor displaying ordinary typewritten material at 100 lines per inch resolution. (The line distortion is due to the fact that the surface of the picture tube is rounded. Such distortion would not exist if you were actually looking at the tube.) It would seem reasonable to conclude that such resolution is very readable and quite acceptable for reference file use. One hundred lines per inch resolution should be adequate then for typewritten material. Standard commercially available television equipment would allow us to obtain this resolution for document sizes up to approximately 4½" x 6". Television systems to handle larger sized documents would require equipment designed to provide more lines in each frame, i.e., 1,100 lines for an 8½" x 11" document.

Figure III is 8-point type displayed on a television monitor with a resolution of 100 lines per inch. Its readability is marginal, and something approaching 150 lines per inch, Figure IV, would be required to make it as easily read as the typewriter print. If we are likely to encounter 6 or 8-point type in material to be placed in our television file, we can then conclude that we need a television system providing 150 lines per inch. Presently available television equipment could adequately handle 6 or 8-point type information on documents up to a size of 3" x 5". Larger documents would again require specially designed television systems to provide more lines per frame -- in this case, 1,750 lines per frame for an 8½" x 11" document.

Perhaps we can summarize this matter of resolution by saying that in television, just as in photography, there is a direct relationship between the size of the document versus the resolution that can be provided by storing it in a particular frame size. The variables to cope with different resolutions and document sizes, in television, are electronic instead of grain size and film size as they are in photography. Standard television equipment can provide readable resolution for small documents; special designs are used for larger documents.

V. TELEVISION STORAGE ON MAGNETIC TAPE

Perhaps the next point to cover, in more detail, is the manner in which this television frame is recorded, or stored on magnetic tape. Figure V shows the magnetic pattern of our image as stored on tape. The tape itself is 2" wide -- the heavy transverse lines across the tape indicate each television frame and the dashed lines in between denote the recording pattern of the television image. We can store the image of an 8½" x 11" document with 100 lines per inch resolution in 5/8ths linear inch of this tape. The standard commercial television frame, with 525 resolution lines, would occupy 1/4th linear inch of tape. The top ¼" of this tape would normally be used for the sound track in television recording, but is employed for address information in document recording. There is sufficient track space for 25 to 30 address characters with an 8½" x 11" document, 8 to 10 characters for a standard television frame. The cost of the magnetic tape itself, to store one 8½" x 11" document, is approximately ¼¢; the cost to store one standard television frame is about 1/12¢. An 8½" x 11" system can read out or read in documents at the rate of approximately 12 per second, and can search for an address at a high speed equivalent to over 500 documents per second. The system employing standard television frames can read in or read out documents at the rate of 30 per second and can search at the equivalent speed of more than 1,200 documents per second.

Tape is available in various reel sizes up to a maximum of 7,200 feet on a reel 14" in diameter. This size reel would hold over 135,000 $8\frac{1}{2}$" x 11" document images with a resolution of 100 lines per inch; or, it could hold 350,000 standard television frames.

One million $8\frac{1}{2}$" x 11" documents or two and one-half million standard television frames can be stored on seven reels of tape.

Like any magnetic tape recording, our document images are stored in a form which facilitates erasing and reuse, as shown in Figure VI. Our recording process is instantaneous, available for use immediately after recording. We should also note that television is a process that can be conducted in daylight conditions.

VI. FILING TECHNIQUES

Since our storage media can be erased and reused, we have a variety of filing techniques that can be employed in Videofile. Perhaps the simplest way to put information into the file is to add new recordings at the end of old, as illustrated in Figure VII. Such a random filing technique, however, does not work for many applications, including our hypothetical insurance company policy file we discussed earlier.

In these cases, we need some sort of an ordered file. We can, for example, set up our tape file much like we would set up file folders in a file cabinet; we can leave blocks of blank tape - equivalent to the file folder - for each unit of our index. As shown in Figure VIII, we would in this case simply record television images on the appropriate tape block when it was presented for filing, similar to our action of placing documents in the file folder in a file cabinet. When a block becomes full, we would have to re-record or re-order our file just as we would have to provide room for expansion in a file cabinet when a particular folder occupied all of the space we had allocated for it.

If we cannot forecast, with some degree of accuracy, the size blocks which are practical for our file, we could employ merge techniques similar to computer tape files. In this case, we would order our information as shown in Figure VIII, but would not provide the blank spaces for expansion. Instead, as new information was added into a reel, we would re-record that entire reel, placing the new information in its proper position among old recordings. From this it should be apparent that there are many techniques that can be employed depending upon the requirements of a particular filing system.

VII. CURRENT STATUS

So far we have referred to Videofile as a concept. What is the status of hardware today to implement this concept and what are the next steps? Obviously, the most readily available elements are those that can be borrowed from commercial television. All of the elements of the system shown in Figure I are commercially available today to handle standard television frames. Engineering feasibility studies, aimed at determining how these elements can perform in an integrated system, have been completed, and a demonstration system is under construction planned for completion in early October. This system will use only $5\frac{1}{2}$" x $8\frac{1}{2}$" documents and is intended only to show basic operation procedure and features.

Elements for an 8½" x 11" document system are available today. Camera units complete with paper handling transports are available for this size document; electrostatic web printers operating from a television type of input are also available for 8½" x 11" pages, and existing Videotape recorders can be modified to handle this size image. The cameras and printers, however, operate at speeds of approximately 60 pages per minute; the Videotape recorder operates at 720 pages per minute. To solve this incompatibility, a buffer unit is used which also incorporates address electronics for entry and replacement work, etc. The buffer is currently not considered to be completely standardized and will be, for some time, custom-built. This is due, in large part, to the varying conditions and requirements from system to system, which results in size increase and decrease of the buffer element.

What about cost? It is hard to generalize system costs when the specific pieces of hardware, and therefore the cost of a system, can vary so widely from one application or installation to another. A very general rule of thumb, however, for initial guidance would be to the effect that a file center which requires the equivalent of twenty clerks on one shift -- this might be ten clerks on two shifts, etc. -- will spend more for file maintenance than would be spent in capital and operating costs for a Videofile system, over a period of five years.

VIII. CONCLUSION

Even though system elements to handle every application are still some distance in the future, the door to this new form of micro-storage is already open today. System elements exist to satisfy many applications. We believe that Videofile holds the promise for automating reference filing as computers have automated data processing. In this role, Videofile will indeed become a powerful economic tool.

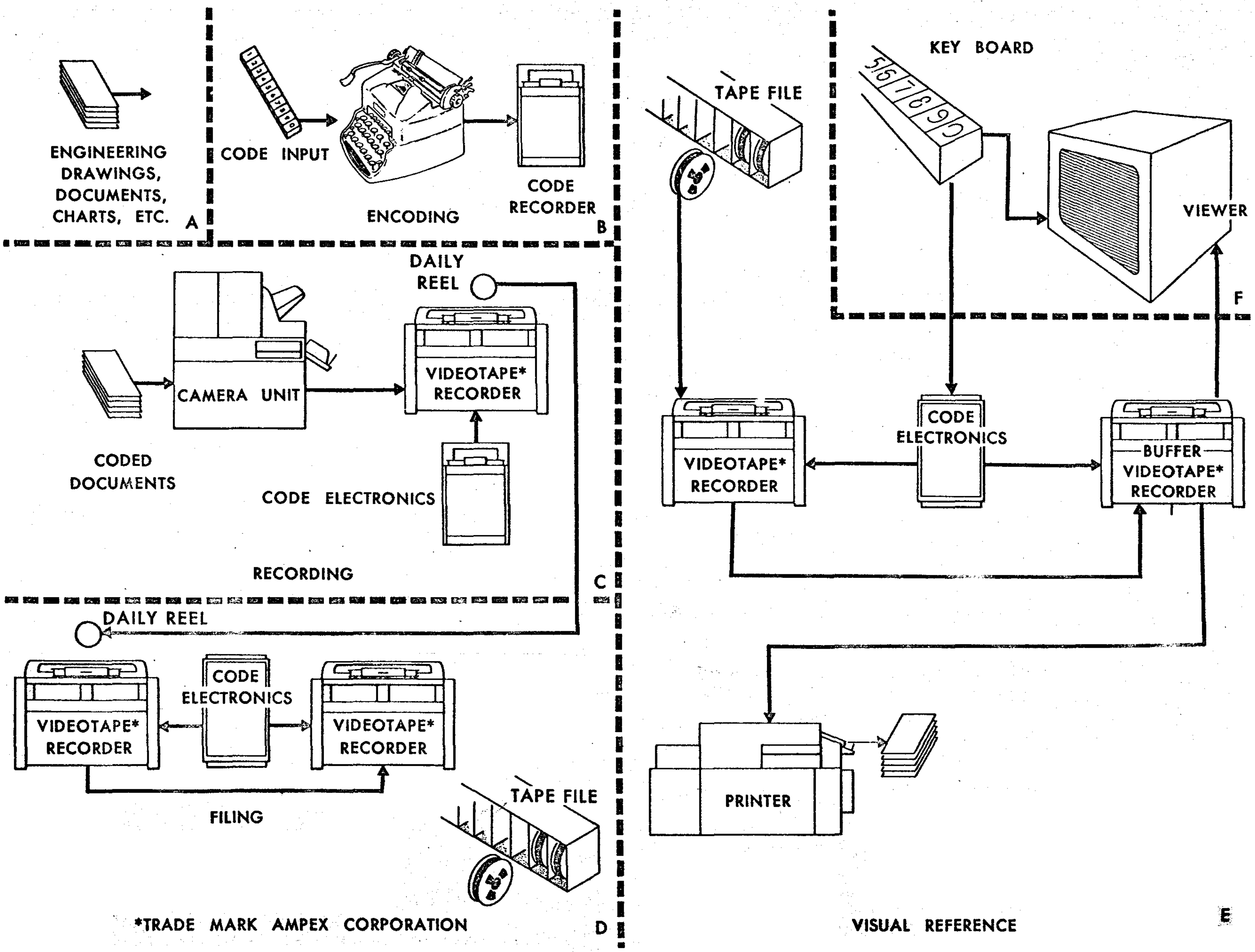
ENGINEERING DRAWINGS, DOCUMENTS, CHARTS, ETC.
A
CODE INPUT
ENCODING
CODE RECORDER
B
DAILY REEL
CAMERA UNIT
VIDEOTAPE* RECORDER
CODED DOCUMENTS
CODE ELECTRONICS
RECORDING
C
DAILY REEL
VIDEOTAPE* RECORDER
CODE ELECTRONICS
VIDEOTAPE* RECORDER
FILING
TAPE FILE
*TRADE MARK AMPEX CORPORATION
D
TAPE FILE
KEY BOARD
VIEWER
F
VIDEOTAPE* RECORDER
CODE ELECTRONICS
BUFFER VIDEOTAPE* RECORDER
PRINTER
VISUAL REFERENCE
E

FIGURE I

K. from the head channel assembly.

RATING HOURS indicator which operates when the equipment or reproduce modes, and indicates the total accumulated hour n.

'ROJECTION control which adjusts the position of the female

OMATIC COMPENSATION push-pull type switch. This switc rightly when the position of the female guide is being automat it is illuminated (but dim) when the position of the guide is at l from automatic to manual due to signal loss or deterioration ated when the system is switched to manual.

WER indicating light of the push-to-test type which is illumina eam to the video head drum motor is operating normally.

CKING control which centers the video heads on the recorded

FigureII 100 line/in text

Btu per hour	Horsepower-hours	[illegible]	3.969
Bushels	Cubic feet	3.929×10^{-4}	2545
		1.2445	0.8036
Centigrade (Celsius)	Fahrenheit	$C° \times 9/5 = F°-32$	
Chains (surveyor's)	Feet	$(C° + 40) \times 9/5 = (F° + 40)$	
Circular mils	Square centimeters	66	1.515×10^{-2}
Circular mils	Square mils	5.067×10^{-6}	1.973×10^{5}
Cubic feet	Cords	0.7854	1.273
Cubic feet	Gallons (liq US)	7.8125×10^{-3}	128
Cubic feet	Liters	7.481	0.1337
Cubic inches	Cubic centimeters	28.32	3.531×10^{-2}
Cubic inches	Cubic feet	16.39	6.102×10^{-2}
Cubic inches	Cubic meters	5.787×10^{-4}	1728
Cubic inches	Gallons (liq US)	1.639×10^{-5}	6.102×10^{4}
Cubic meters	Cubic feet	4.329×10^{-3}	231
Cubic meters	Cubic yards	35.31	2.832×10^{-2}
Degrees (angle)	Radians	1.308	0.7646
Dynes	Pounds	1.745×10^{-2}	57.30
Ergs	Foot-pounds	2.248×10^{-6}	4.448×10^{5}
Fathoms	Feet	7.376×10^{-8}	1.356×10^{7}
Feet	Centimeters	6	0.16667
Feet	Varas	30.48	3.281×10^{-2}
Feet of water @ 4° C	Inches of mercury @ 0° C	0.3594	2.782
Feet of water @ 4° C	Kg per sq meter	0.8826	1.133
Feet of water @ 4° C	Pounds per sq foot	304.8	3.281×10^{-3}
Foot-pounds	Horsepower-hours	62.43	1.602×10^{-2}
Foot-pounds	Kilogram-meters	5.050×10^{-7}	1.98×10^{6}
Foot-pounds		0.1383	7.233

Figure III 100 line/in table

Joules	1054.8	9.480×10^{-4}
Kilogram-calories	0.2520	3.969
Horsepower-hours	3.929×10^{-4}	2545
Cubic feet	1.2445	0.8036
Fahrenheit	$C° \times 9/5 = F°-32$	
	$(C° + 40) \times 9/5 = (F° + 40)$	
Feet	66	1.515×10^{-2}
Square centimeters	5.067×10^{-6}	1.973×10^{5}
Square mils	0.7854	1.273
Cords	7.8125×10^{-3}	128
Gallons (liq US)	7.481	0.1337
Liters	28.32	3.531×10^{-2}
Cubic centimeters	16.39	6.102×10^{-2}
Cubic feet	5.787×10^{-4}	1728
Cubic meters	1.639×10^{-5}	6.102×10^{4}
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Cubic feet	35.31	2.832×10^{-2}
Cubic yards	1.308	0.7646
Radians	1.745×10^{-2}	57.30
Pounds	2.248×10^{-6}	4.448×10^{5}
Foot-pounds	7.376×10^{-8}	1.356×10^{7}
Feet	6	0.16667
Centimeters	30.48	3.281×10^{-2}
Varas	0.3594	2.782
Inches of mercury @ 0° C	0.8826	1.133

Figure IV 150 line/in table

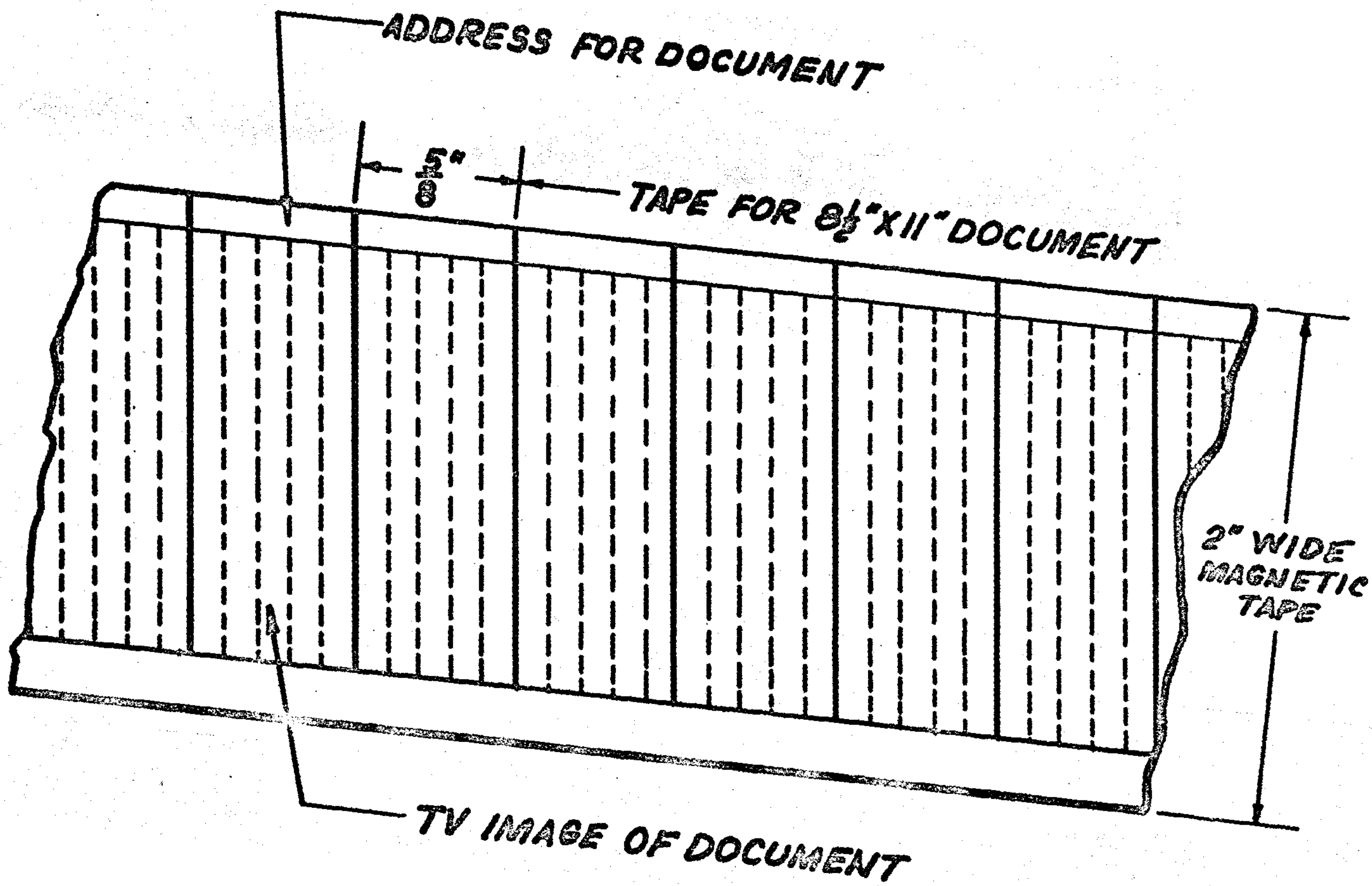

ADDRESS FOR DOCUMENT
5"/8
TAPE FOR 8½"X11" DOCUMENT
2" WIDE MAGNETIC TAPE
TV IMAGE OF DOCUMENT

FIGURE V

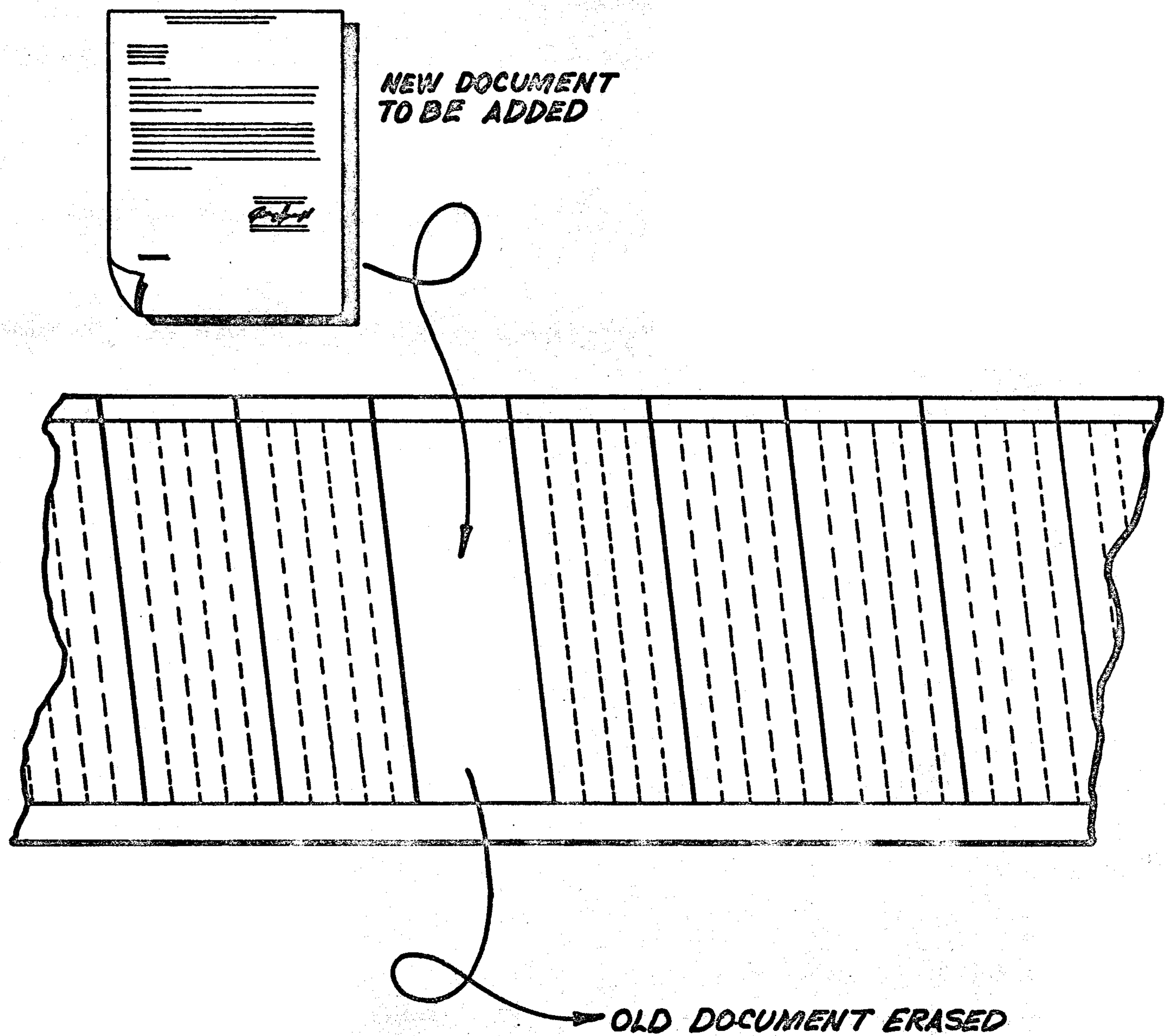
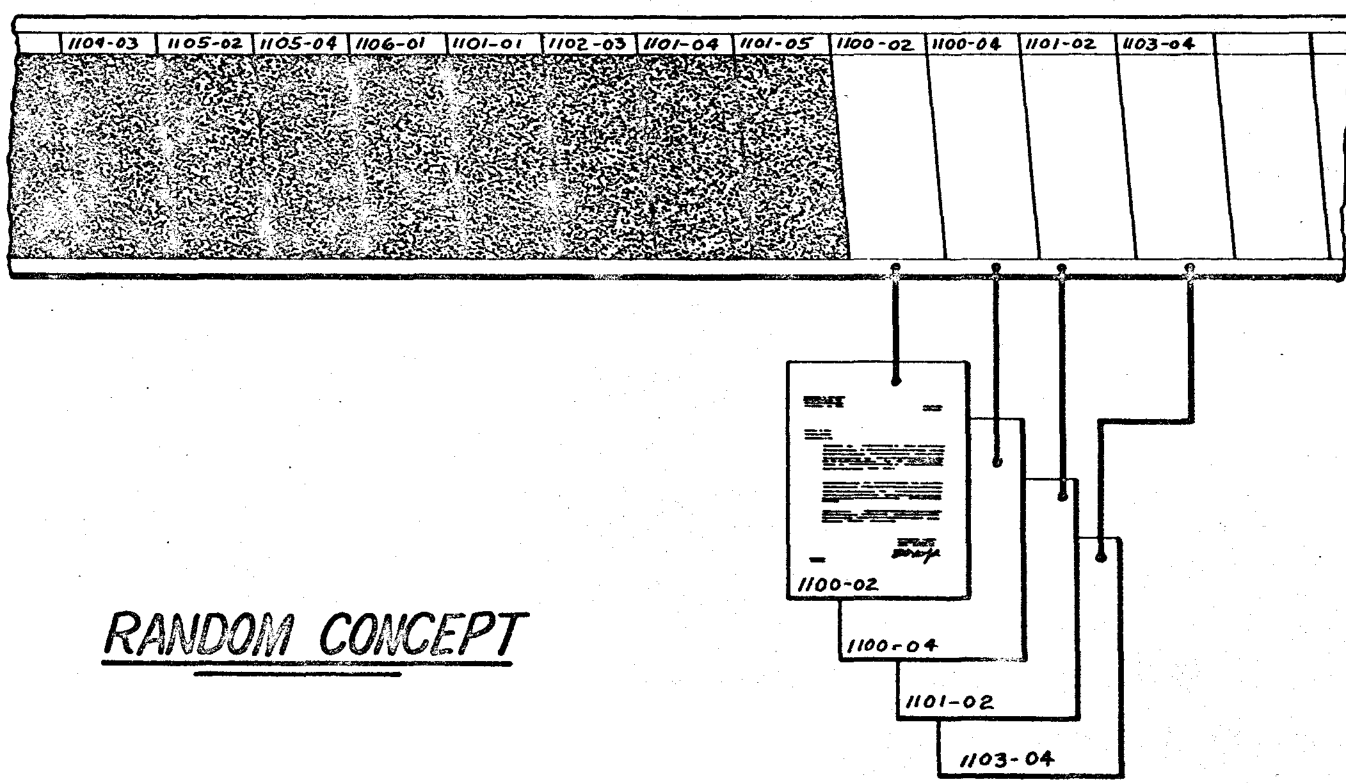


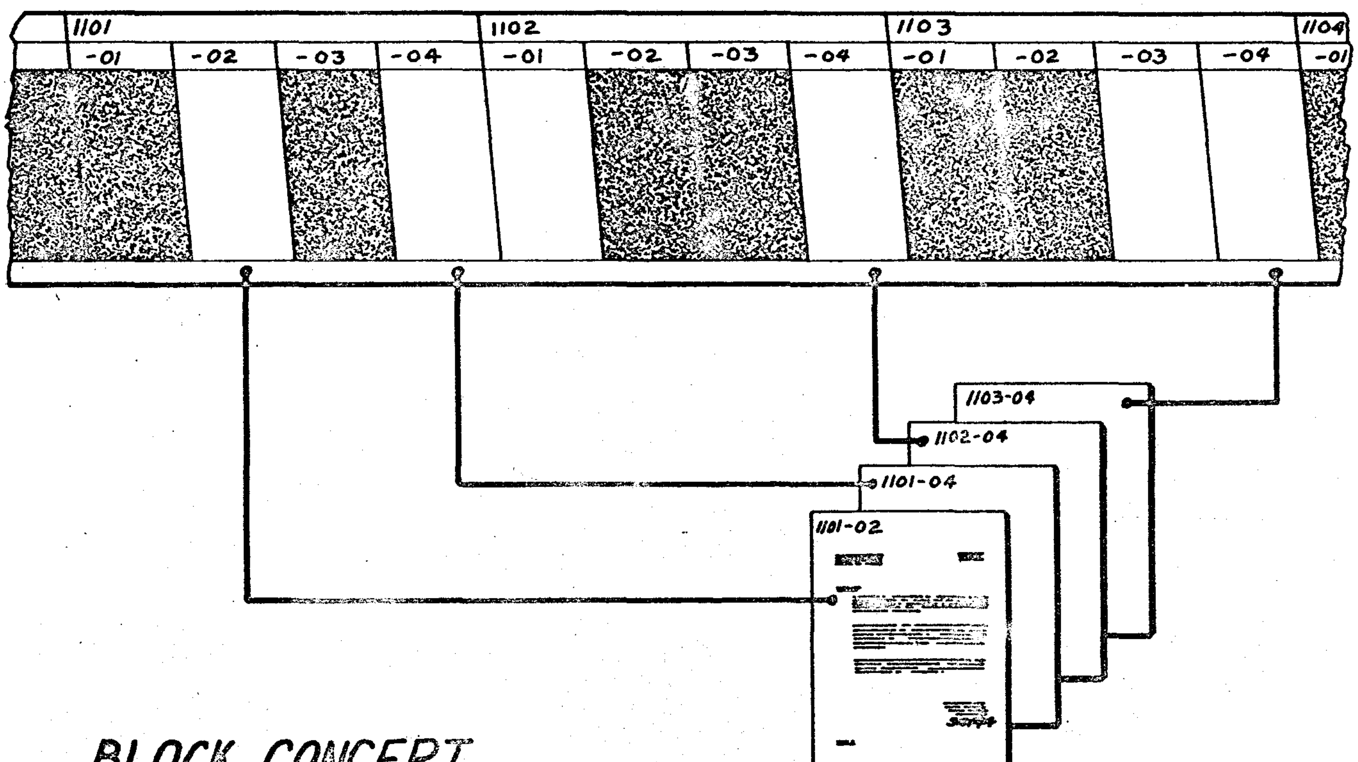
FIGURE VI

FIGURE VII



RANDOM CONCEPT

FIGURE VIII



BLOCK CONCEPT