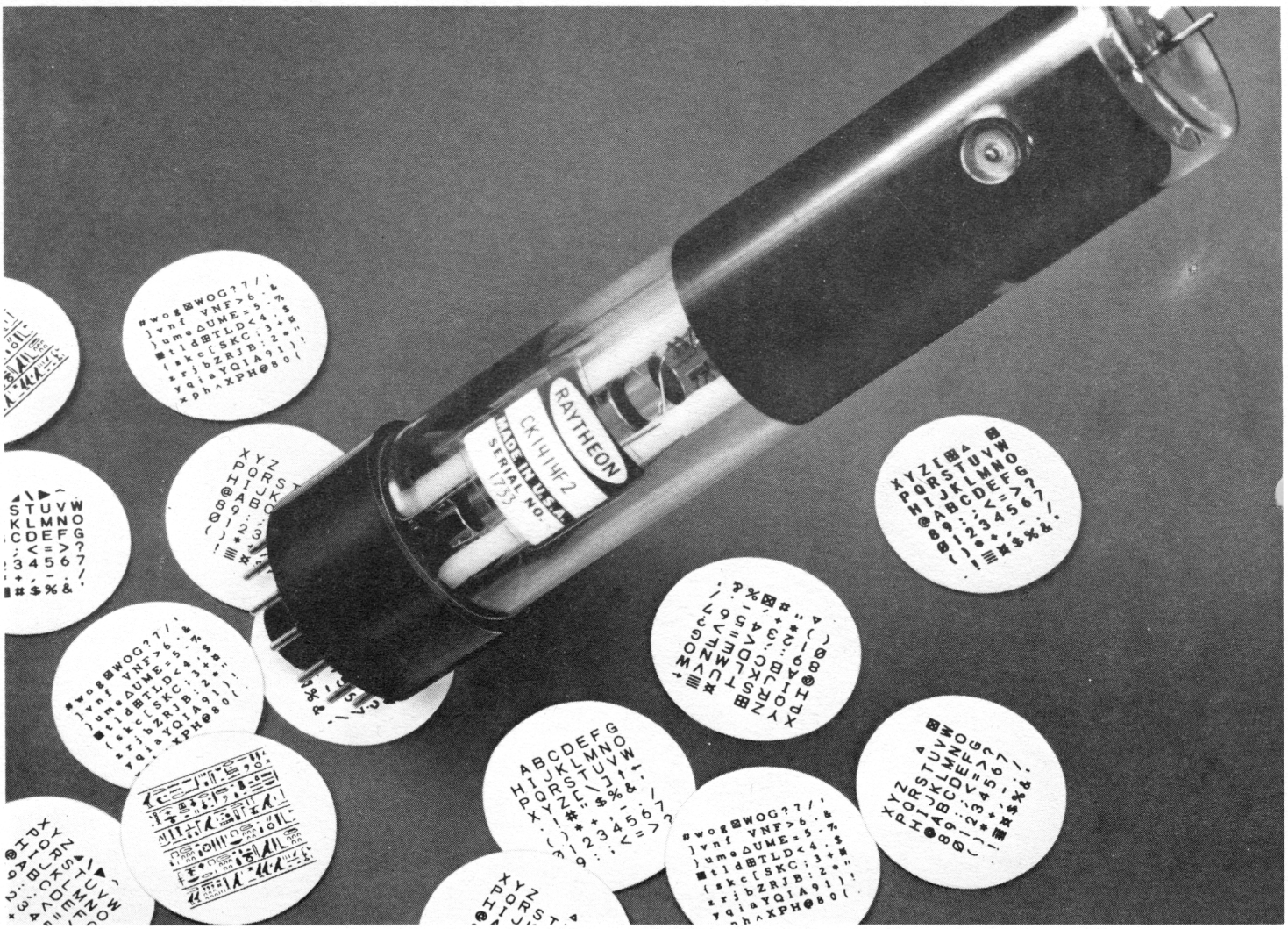
RAYTHEON

SYMBOLRAY™ APPLICATION NOTES

RAYTHEON COMPANY, INDUSTRIAL COMPONENTS OPERATION, 465 CENTRE ST., QUINCY, MASS. 02169

Data Display Devices from Raytheon



A Symbolray* monoscope can generate almost any presentation you can think of. (Hieroglyphics, anyone?)

With a Raytheon Symbolray, you can meet almost any data display requirement for different characters and/or symbols—ranging from standard ASCII† to custom data displays and even hieroglyphics. And we can meet the requirements with only an inexpensive change in the target font design.

An economical method of generating characters. The Symbolray monoscope provides a much more economical method of generating displays than using circuit cards. Only 2" by 12", it costs less than $100 in quantities of 1,000.

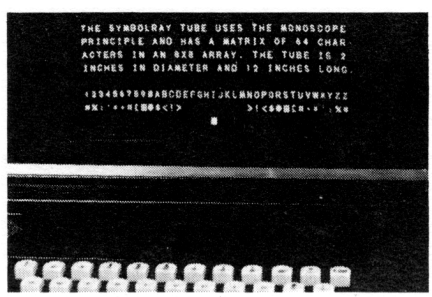
The output of the Symbolray is obtained by electrically deflecting the electron beam to the desired characters on the targets. The characters are scanned sequentially with a small TV raster. The display cathode-ray tube, on which the output is viewed, is scanned in synchronism. The monoscope uses electrostatic deflection and focus.

Full messages can be displayed—as shown at right—when the Symbolray method is used with buffer memory techniques. The monoscope is currently available with 64 and 96 character matrices.

Raytheon Dataray* CRTs include screen sizes from 7" to 24". Electrostatic, magnetic and combination deflection types are available for writing alphanumeric characters while raster scanning.

For Symbolray data—or a demonstration—call your Raytheon regional sales office. Or write: ***Raytheon Company, Components Division, Quincy, Mass. 02169.***

†*American Standard Code for Information Interchange.*



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INTRODUCTION

The SYMBOLRAY™ tube is a cathode-ray device which can be used to generate alphanumeric characters for cathode-ray displays or for hard copy print-out. It provides an inexpensive means for generating well-formed alphanumeric information. It is now in use in a large number of CRT Displays that are the communications links with digital computers. Figure 1 shows such an equipment.

Cathode-ray displays are becoming an important communications link between computer systems and human operators. The major advantage of a CRT display is the fast presentation of information. This is extremely useful for temporary display. These Displays will not replace hard-copy print-out, but are an important supplementary device. A few examples of their use:

Airlines ticket agencies—for reservations control
Government—air traffic control
Production line inventory control information
Remote engineering mathematical computations
Stock market quotations
Hospital—medical consultations
Business report editing

In an airline ticket agency, the ticket agent checks with a centralized computer (perhaps in another city) to find out if seats are available on a specific flight for a customer who wishes to buy a ticket immediately. No permanent record at the agency is required. The computer memory records the seat reservation.

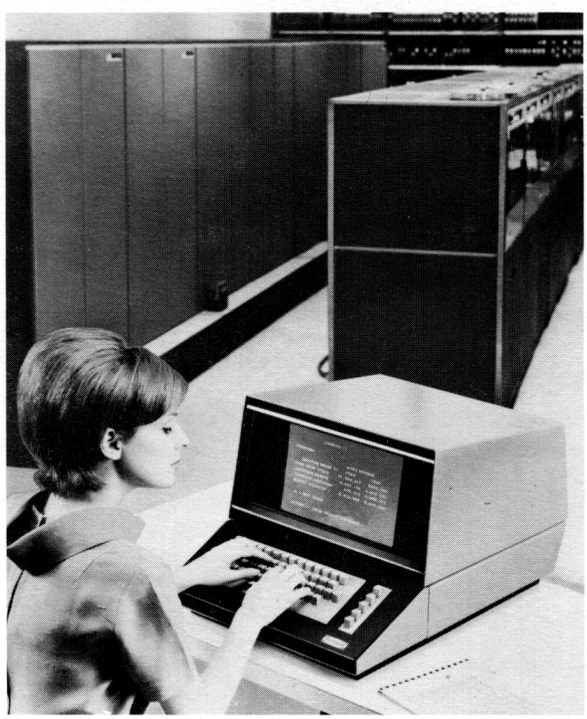


FIGURE 1

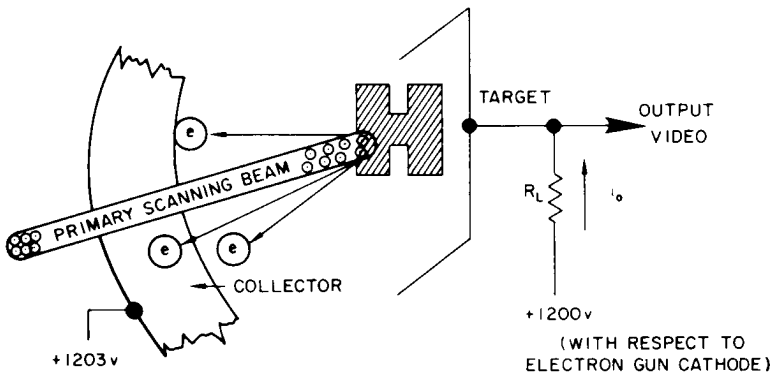
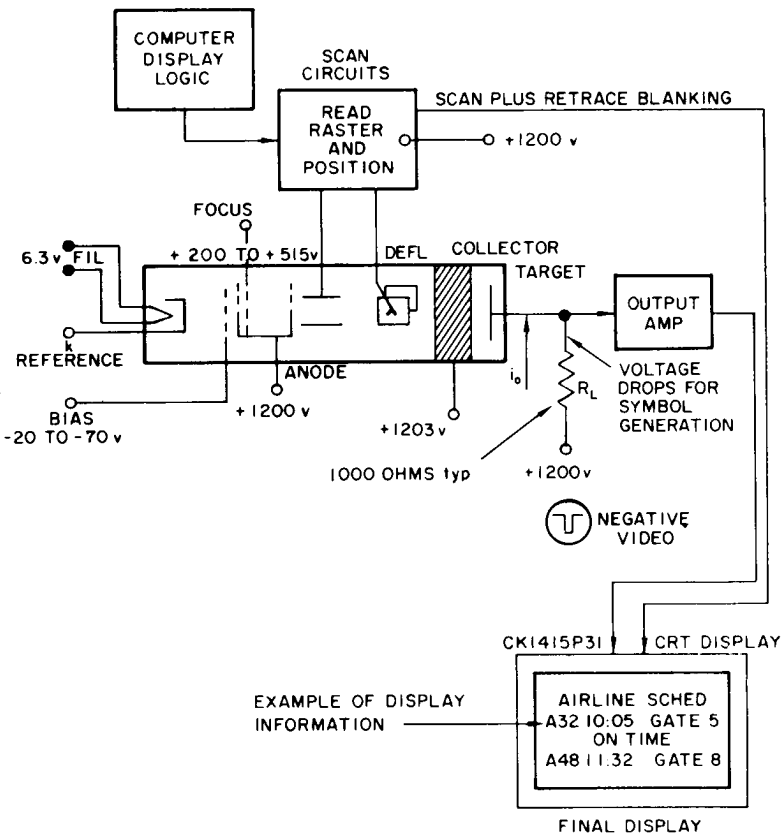


FIGURE 2

FIGURE 3



The heart of this system and the alphanumeric generator is the Raytheon SYMBOLRAY Tube, CK1414F.

This tube is operated as a monoscope with an output signal which is generated by a difference in secondary emission between the target background and printed characters. Figure 2 illustrates this principle. Secondary electrons emitted from the target are attracted to the collector which is at a more positive voltage than the target.

Figure 3 shows the operating voltages together with a block diagram of the operation of the tube. Depending upon logic information from the computer memory, the proper characters to be generated are selected by the scan circuits. By means of a digital-to-analog converter, the proper voltages are developed for the deflection plates and the beam is thereby positioned to the specific character. A small raster is generated by the scan circuits and the deflection voltage causes the electron beam to just over-scan slightly more than the character to be generated. A change in electron current flow through R_L creates the output video signal. This is used (with proper synchronization of scan) to unblank the cathode-ray beam in the CRT display. The fact that a standard magnetic deflection cathode-ray tube similar to television-type picture tubes can be used for the CRT display adds to the simplicity and economy of this type of equipment.

It is recommended that a magnetic shield be used around the SYMBOLRAY tube to nullify effects of stray magnetic fields from nearby transformers and motors. The James B. Millen Company—Malden, Massachusetts is a manufacturer for these shields.

DIGITAL DISPLAY—PRINCIPLE OF OPERATION

Figure 4 shows a block diagram for a Digital Information CRT Display. The original information can be generated from a key-board or be obtained from a computer. When a key on the key-board is touched, a six bit parallel code is generated that is fed to the logic generator. This unit generates the six bit code in time-serial form.

This unit may contain a crystal controlled oscillator that can be both the "clock" for the digital code and the synchronizing signal for cathode-ray sweep. In addition, it can be the generator for the vertical sine-wave sweep used on the CRT and SYMBOLRAY tube. The frequency of the oscillator will be determined by a number of factors such as the field/frame rate of display, the number of characters and symbols in the display, and the number of sine-wave cycles used to scan the "raster" over the symbol to be generated. The frequency can be determined by the following equation:

$$F_o = (L + R_v)\,(C + R_h)Nf$$

Where:

F_o = *Oscillator frequency in Hertz*
L = *Number of lines in the message*
C = *Number of characters/line*
R_v = *Number of lines used during vertical retrace*
R_h = *Number of characters (time) used in horizontal retrace*
f = *Fields per second (refresh rate of the display)*
N = *Number of cycles of sine wave per symbol (including inter-symbol spacing)*

As an example, we might consider a display with a message of 800 characters—20 lines at 40 characters per line—at a refresh rate of 60 fields per second. In order to generate characters that appear completely "filled in," we will use 12 cycles of a sine wave for vertical scan of the raster.

Therefore:

$N = 12$
$L = 20$
$C = 40$
$R_v = 2$
$R_h = 4$
$f = 60$

R_v and R_h will primarily be determined by the characteristics of the deflection circuits and the deflection yoke used with the CRT. The above figures are typical

$$F_o = (20 + 2) \cdot (40 + 4) \cdot 12 \cdot 60$$
$$= 696{,}960\ Hz$$

The crystal-controlled oscillator would be designed to operate at this frequency. It is also possible to obtain additional "fill-in" by a 180° phase shift of the sine-wave scan on alternate fields. This is similar to interlace used on standard television.

N is chosen as a multiple of 6 so that this frequency may also be the "clock" for the digital circuits as previously stated.

In this manner, the scanning for the CRT display tube and the SYMBOLRAY tube can be synchronized with the digital bit code.

This serial 6 bit code is transferred to a memory device which is capable of storing an entire message in digital form. The digital code bit information is circulated in the memory system at the repetition field rate for the entire message as it appears in the final cathode-ray display. This is the refresh rate and should be high enough (60 frames per second) so that no flicker is seen by the operator.

Flicker might also be reduced by operation with long persistence phosphors or the new "Square Wave" phosphors. This type of operation would permit slower scan rates allowing narrower band-width with more economic designs. There will, however, be a loss of light output and slightly longer editing time.

A suggested memory device can be a magnetostrictive torsional delay line that produces the proper delay. The signals are regenerated and fed back into the memory device. These are manufactured by:

Digital Devices, Inc.
Syosett
Long Island, New York

Anderson Labs
Hartford,
Connecticut

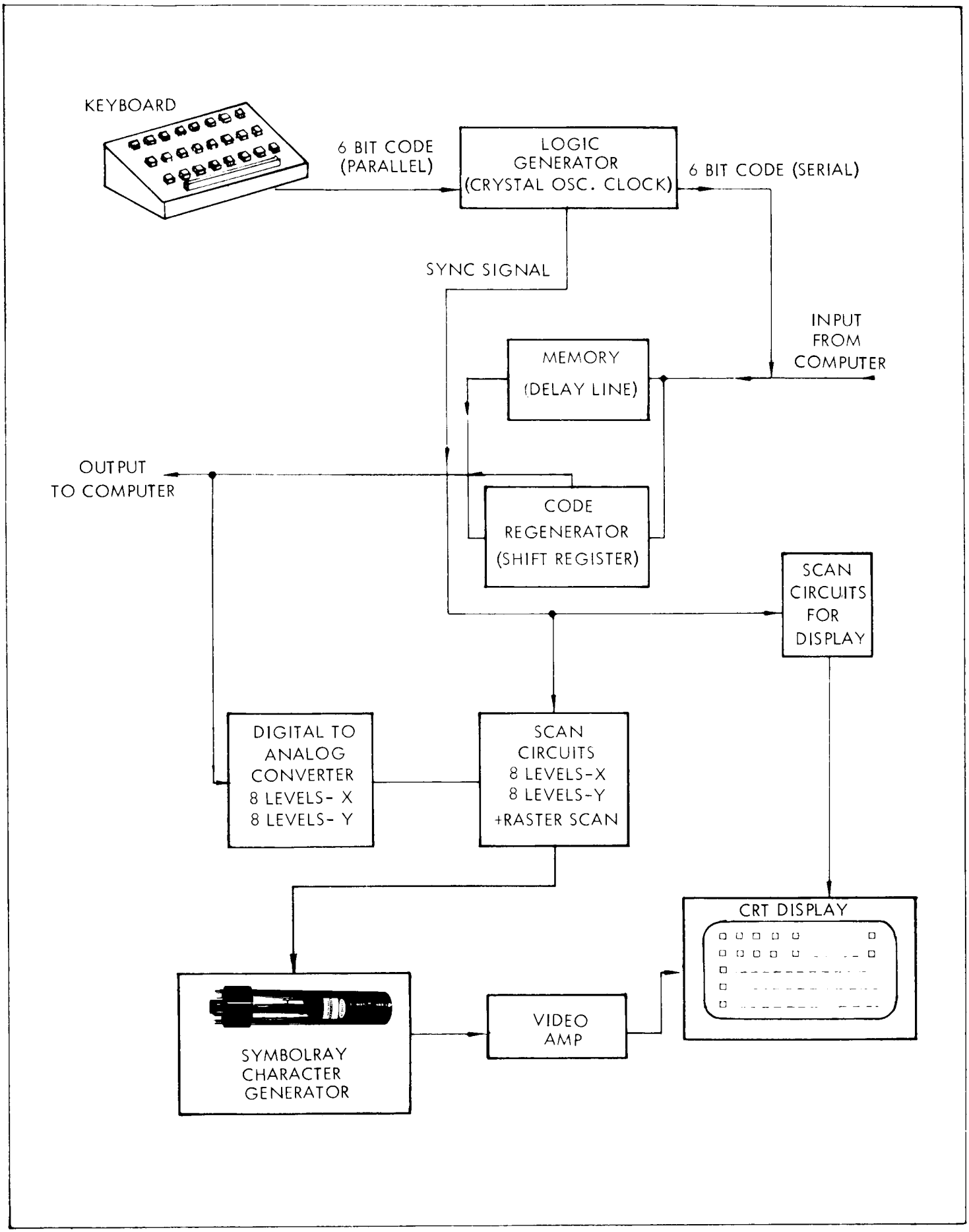

KEYBOARD
6 BIT CODE (PARALLEL)
LOGIC GENERATOR (CRYSTAL OSC. CLOCK)
6 BIT CODE (SERIAL)
SYNC SIGNAL
INPUT FROM COMPUTER
MEMORY (DELAY LINE)
OUTPUT TO COMPUTER
CODE REGENERATOR (SHIFT REGISTER)
SCAN CIRCUITS FOR DISPLAY
DIGITAL TO ANALOG CONVERTER 8 LEVELS- X 8 LEVELS- Y
SCAN CIRCUITS 8 LEVELS-X 8 LEVELS-Y +RASTER SCAN
CRT DISPLAY
SYMBOLRAY CHARACTER GENERATOR
VIDEO AMP

FIGURE 4

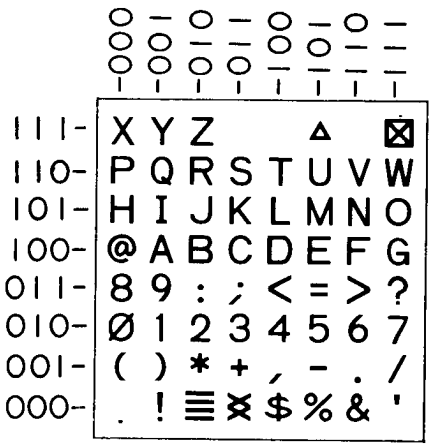


FIGURE 5

MODIFIED ASCII CHARACTER MATRIX
SHOWING DIGITAL CODE

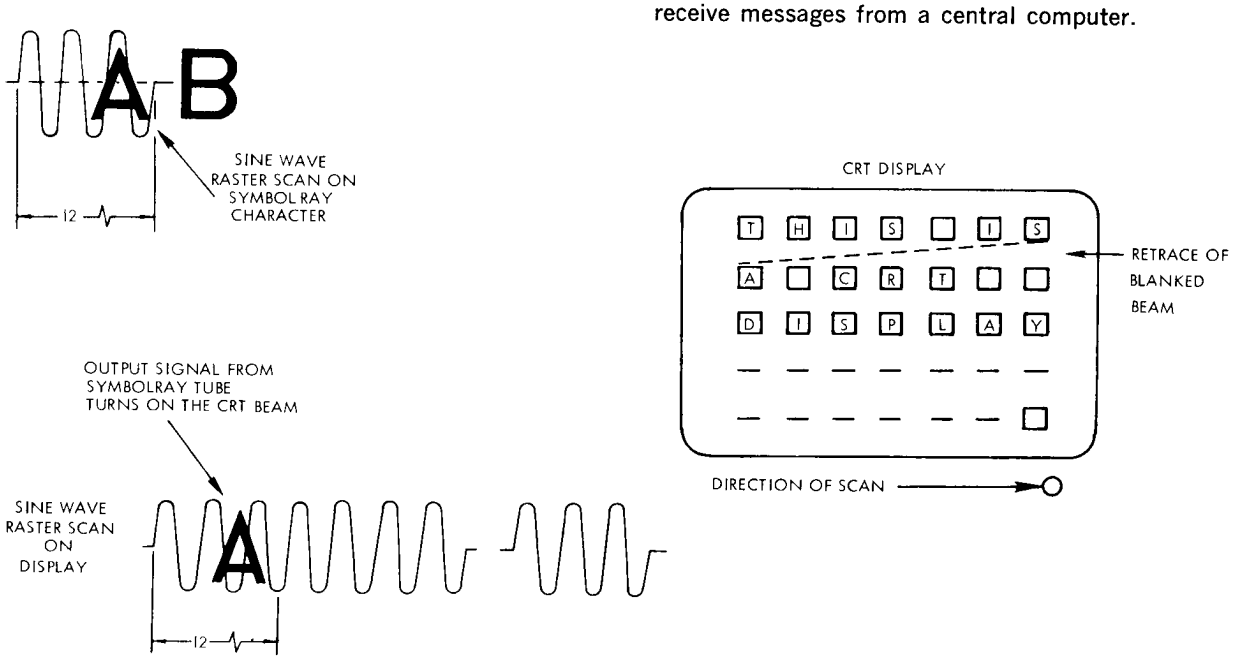
The digital code signals are then fed to the digital-to-analog converter. The purpose of this digital-to-analog conversion is to sequentially select and generate voltage to deflect the SYMBOLRAY beam to symbols on the target. Figure 5 represents a typical target pattern matrix with the digital code for this matrix. This is a modified ASCII (American Standard Code for Information Interchange).

Thus the digital-to-analog converter will change the code 100001 to the proper deflection plate voltages to center on the letter "A". 001 represents the *column* to be scanned and 100 the *row*. Similarly, the number "4" will be selected from the code 100 for the *column* and 010 for the *row*.

As the digital-to-analog converter generates the proper voltages for the deflection plates, the small sine wave raster appears in voltage form on the SYMBOLRAY deflection plates so that the electron beam is scanned over the symbol. The fast vertical scan of the high frequency sine wave together with a linear horizontal scan is used. See figure 6. The electron beam of the CRT display is being scanned in synchronism. The same sine-wave vertical scan is used in a line-by-line scanned raster. The CRT display is then unblanked with the amplified video from the monoscope tube to display the character. As stated earlier, the entire message is repeated at the refresh rate as determined by the recycling to the memory system. Thus a flickerless display is generated. A typical display format may have 20 lines in the message made up of 40 characters per line. This adds up to a message total of 800 characters. Displays have been made with as many as 2000 characters for the whole displayed message.

Since the digital information CRT display has its own digital code generator and memory, it can generate messages which can be transmitted to a central computer and in turn receive messages from a central computer.

FIGURE 6



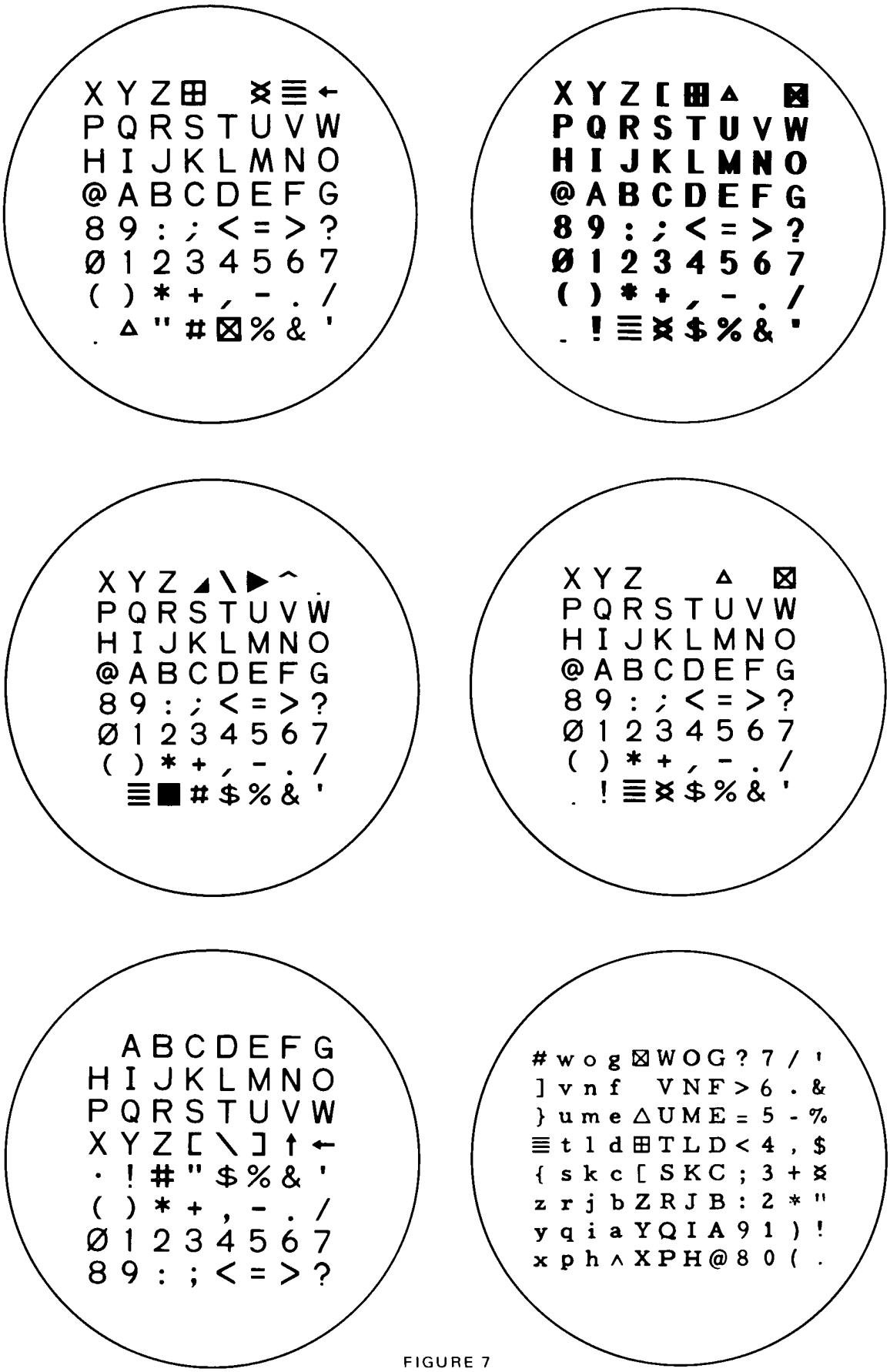

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FIGURE 7

VARIOUS TARGET FONTS AVAILABLE FOR SYMBOLRAY TUBE

The SYMBOLRAY tube design permits flexibility in character style to be used in a system. Figure 7 shows samples of different fonts that have been used.

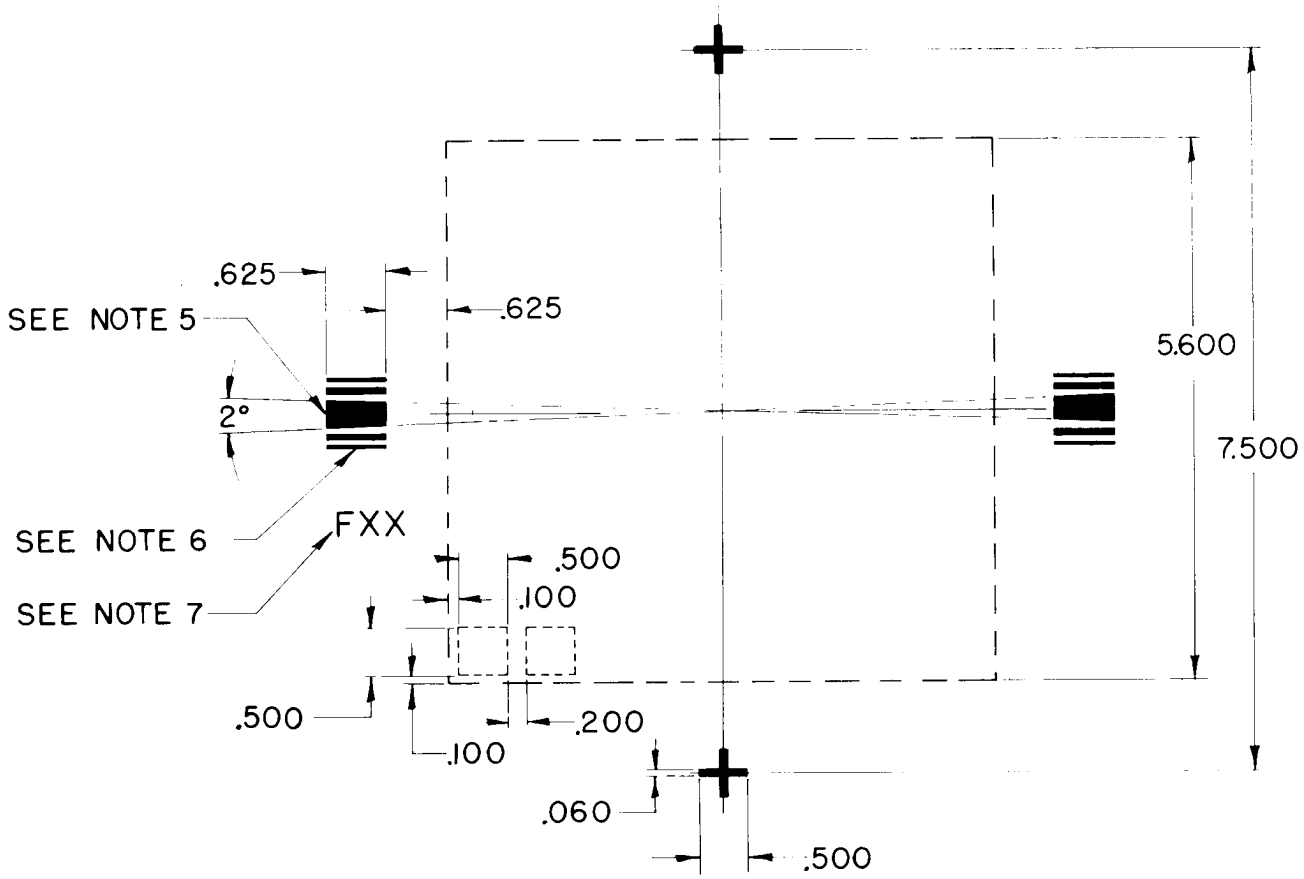
The layout in the matrix of the position of the characters can ease circuit design in the digital-to-analog converter. Most of the targets shown in Figure 7 were laid out to work with a modified ASCII code. The target (upper right hand corner) with thicker vertical lines was designed for an application where, because of time limitations, there were only a few cycles in the raster covering each character. This improves the final display of characters on the CRT display. It is also possible to change the aspect ratio of the scan on characters to make the characters higher or wider on the final display.

It should be noted that targets have been designed to contain an 8 x 12 matrix or as many as 96 characters. This includes all standard punctuation, capital letters and small letters of the alphabet.

Most applications of computer digital displays require some variation in the character font. Figure 8 shows the information needed to design the art work for these special fonts. Many equipment designers have facilities to design fonts for the SYMBOLRAY tube. However, if desired, Raytheon will do the font design at a nominal charge.

SPECIAL APPLICATIONS:

The SYMBOLRAY tube has been used to generate alphanumerics on a time-shared basis on radar displays and with vector information. In these instances, the alphanumeric identified either targets or points on the vectors. Since this is a fast method to generate symbols, it lends itself to this type of application.



NOTES:

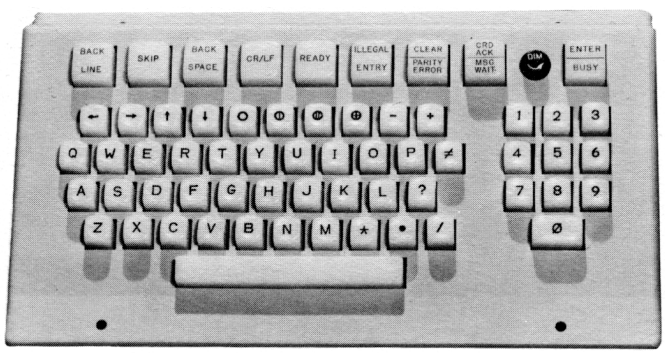
1. ORIGINAL ARTWORK SHOULD BE 4X TO 5X THE SCALE SHOWN FOR SHARP CHARACTERS; THEN PHOTOGRAPHICALLY REDUCED TO DIMENSIONS SHOWN.
2. OUTLINE IS QUALITY AREA FOR CHARACTERS.
3. NOMINAL LINE THICKNESS FOR CHARACTERS = .060".
4. CHARACTER ALIGNMENT (ROWS AND COLUMNS) IS IMPORTANT.
5. WEDGE IS 2° ANGLE. (FOR TRACE ALIGNMENT).
6. RESOLUTION BARS: .060"AND .030" THICK; SPACING .060".
7. REQUEST "F" NUMBER FROM RAYTHEON. TO BE PRINTED IN THIS AREA. THIS IS YOUR FONT DESIGNATION AND SHOULD BE USED WHEN ORDERING SYMBOLRAY® TUBE., E. G. CK1414F33.
8. RAYTHEON WILL PHOTOGRAPHICALLY REDUCE BY A FACTOR OF 5.
9. FOR A TYPICAL FONT, CHARACTER HEIGHT TO LINE WIDTH RATIO IS 8:1.

FIGURE 8

CATHODE-RAY TUBE—FINAL DISPLAY

Raytheon manufactures a wide range of cathode-ray tubes for use in digital CRT displays. These are electrostatic focus and magnetic deflection tubes of rather standard design. This permits economical final display. Particular types that are offered are the CK1415P31 and CK1439P31. The P31 phosphor is offered because it has very high efficiency and high light output. However, other standard phosphors are also available.

Obviously, any available CRT could be used in the final display. Choice of the particular tube depends on the ease of designing scan circuits to operate it.



RAYTHEON KEY SWITCHES AND KEYBOARDS

Raytheon makes available switches and complete keyboards for use in Digital CRT Display controls. Write for technical information.

RAYTHEON

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TWX: 910-376-4395

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