THE XERONIC PROGRAMMING MANUAL

RANK DATA SYSTEMS DIVISION
THE RANK ORGANISATION
Woodger Road London W12
Shepherds Bush 2050

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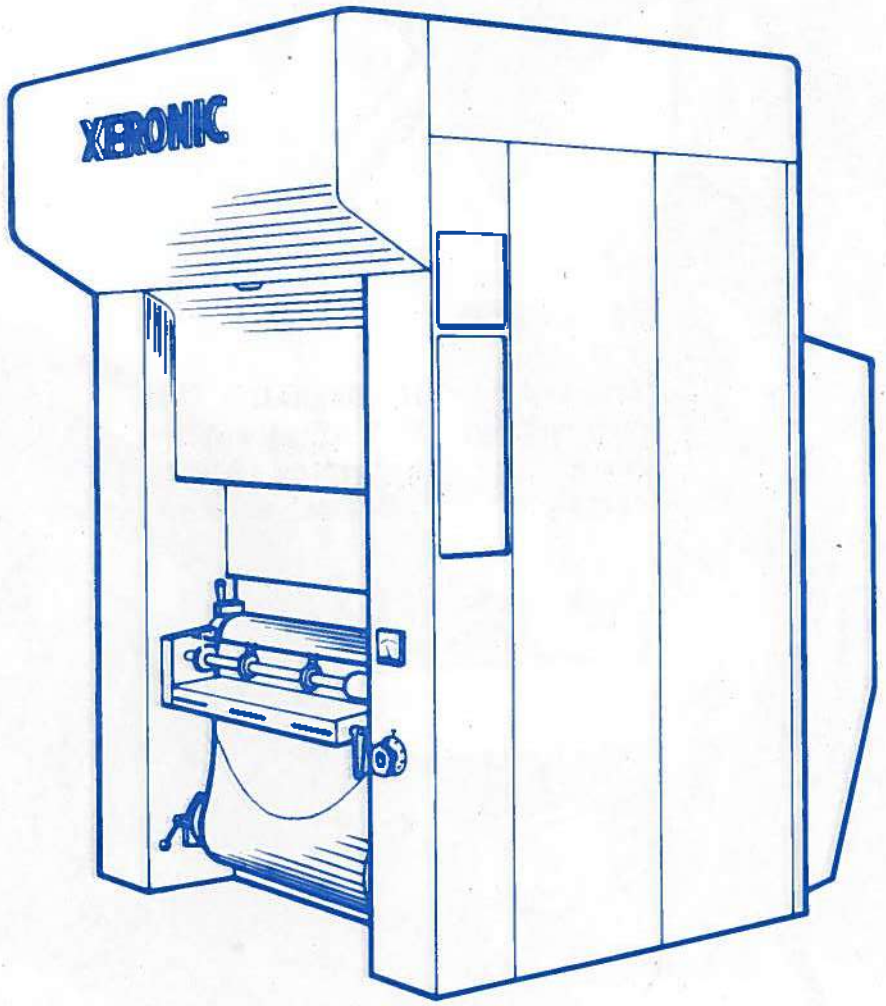

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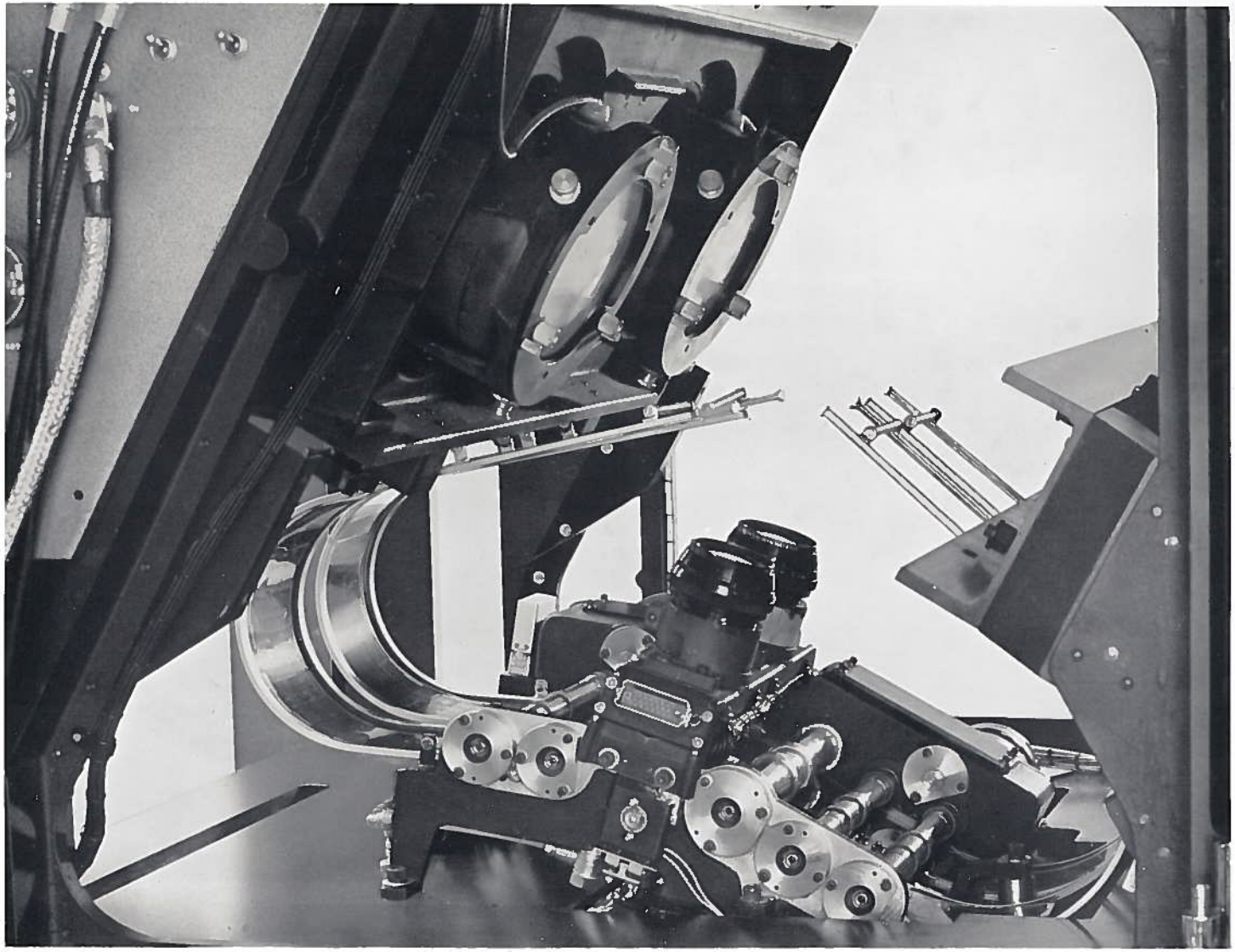

THE FORMHEAD

CONTENTS

1. INTRODUCTION

1.1 GENERAL

The Xeronic printer was designed to fulfil the need for a computer output device that would produce the very large output of printed forms - statements, invoices or pay slips, for example - associated with modern commercial data processing. Its speed is not limited by mechanical considerations for it has no rapidly accelerated type bars or print hammers. Instead it uses electronic character generators to provide visible character displays on a cathode-ray tube and an electrostatic method (xerography) to transform this display into visible printing on a roll of paper. Unprepared, plain paper is used; the form backgrounds are printed at the same time as the variable data; duplicate copies (with omissions if necessary) can be printed side by side; sixteen pre-selected vertical tabulation points and a full range of horizontal tabulation positions can be selected by programme. Firms using the printer naturally require the forms sent out to their clients to be accurate; accordingly the printer includes a comprehensive series of error checking and monitoring circuits which ensure that erroneous forms are clearly marked as such and can be removed by the operator for reprocessing.

The first printers, Series 1, embodied a four-form formhead but these have been superseded by the Series 2 Xeronic, which have a 32-form formhead. It is the standard Series 2 Model that is described in this publication.

1.2 HOW IT IS USED

The Xeronic printer can be used either on-line or off-line, but for its economic advantages and convenience of operation, off-line working is usually adopted and will be assumed in this Manual.

The magnetic tape unit is not part of the printer installation but is normally supplied as part of the computer equipment. Between the tape unit and the Xeronic buffer store is the tape control logic. This, unlike the remainder of the printer logic, is not of a standard pattern but is individually designed to make the best use of the facilities provided in the tape unit.

1.3 HOW THE XERONIC PRINTER USES XEROGRAPHY

The xerographic printing mechanism is shown schematically in figure 3. The xerographic drum is coated with a thin film of photo-conductive selenium and rotates at a constant speed of about 10 revolutions a minute. A charging electrode puts a positive charge on the selenium surface and, in the absence of light, the charge is retained. As the drum rotates it is

exposed to two light sources; the first comprises a pair of cathode-ray tubes on which visible characters corresponding to the computer output appear; the second source is a formhead from which negative photographic masters of form layouts can be projected on to the drum. Those portions of the drum surface that have been exposed to light from either of these two sources rapidly lose their charge by leakage to the metallic drum, but the areas that have received no exposure still retain some positive charge.

The charge pattern on the selenium is developed by cascading over it a powder having two components, the carrier and toner; the toner is the material from which the final image on the paper is formed and the carrier provides the means for distributing the toner over the surface of the drum. The toner and carrier are intimately mixed and by tribo-electric action they acquire charges of opposite polarity. The toner, being positively charged is repelled from the positively charged areas of the drum, but is attracted to the edges of the uncharged areas comprising the image. The carrier particles, being heavier, roll off the surface of the drum and are returned to the developing chamber.

As the drum rotates, it comes into contact with paper fed continuously from a roll and the toner is transferred from the drum to the paper by a negative charge applied to the paper by the transfer electrode. The visible images of the characters formed on the faces of the cathode-ray tubes, together with the superimposed outline of the form, are thus transferred to the paper but as yet the toner only adheres to the paper by virtue of the electrostatic charge. To render the image permanent the paper is passed through a fuser where the thermo-plastic part of the toner is melted by heat and fused to the surface of the paper together with the black toner particles forming the image.

Before the surface of the drum is ready to receive a new image, the residual charge must be removed. This is effected by a discharge lamp which illuminates the surface and at the same time a revolving brush removes any remaining particles of toner from the drum.

The xerographic drum revolves continuously so the images thrown on it must also move at the same speed. In the case of character displays the images on the cathode-ray tubes are given a slow vertical deflection for this purpose and in the case of the formhead image the form master is driven slowly at constant speed through the projection gate, a process referred to as scanning.

1.4 THE FORMHEAD

Up to thirty-two different form outlines can be stored on lengths of film known as form masters. Further copies of this form master are readily available and when they become worn or scratched in use they can be easily replaced. If more than 32 form outlines are required, it is the work of a few minutes only to change the masters for films bearing a different set of 32 outlines.

The formhead is a dual unit comprising two similar film positioning mechanisms side by side; the two form masters are identical and are used alternately, one being printed while the other is being positioned. In this way the next form is ready for printing as soon as the previous form has been completed and no time is wasted in the mechanical process of form selection.

The two units have common drive motors which provide

i) A fast drive (70 in. per second) in either direction.

ii) A slow speed drive (4.5 in. per second) in either direction.

iii) A scan motion (approximately 0.73 in. per second) in the forward direction.

The drive shafts rotate continuously and solenoid operated pressure rollers cause the edges of the film to engage the required drive. An important part in film positioning is played by the air pressure/vacuum arrangements; when the film is stationary or moving slowly it is held in close contact with the gate by means of air suction but whenever the fast drive is engaged, air under pressure is admitted and the film runs on an air cushion out of contact with the gate.

Along the edges of the film are nine tracks of markers which are sensed by photocells:

i) Line Start markers which indicate possible positions of lines of variable printing on the form.

ii) V-Tab markers indicating vertical tabulation positions of a form.

iii) A Form End marker, one per form, to give a signal to the printer when the form has been completely scanned.

iv) Thirty-two equally spaced markers providing a fine position indication.

v) Five tracks of coarse position markers which indicate, in parallel binary form, thirty-two unit positions along the film.

The sequence of form selection is as follows. After the conclusion of the previous form the present position of the film, as indicated by the coarse position markers, is compared with the number of the form next required (i.e. the next but one to be printed). If a movement greater than three units is required, the fast drive is engaged and the film moves in the correct direction, floating on the air cushion formed at the gate. As soon as the coarse position markers indicate a position three units away from the required form, the fast drive is disengaged and the slow one engaged, at the same time vacuum is applied to the gate and the film is braked. When coincidence is obtained between the coarse position markers and the required form number, control is switched over to the fine position photocell and as soon as the next fine position marker is sensed the film is stopped in the gate in a position ready to begin a printing scan. At the end of the form concurrently being printed from the other form master, the shutters change over and the scan drive is engaged. As the film is scanned and printed successive Line Start and V-Tab markers are sensed to control the timing of the variable data displayed on the cathode-ray tubes. After an interval, related to the form length, the shutters again change over and the film is re-positioned while the next form is being printed from the other master.

1.5 CHARACTER GENERATION & POSITIONING

Characters to be printed are displayed under control of the input data as a pattern of dots on the face of a cathode-ray tube. This method of generating visible characters is one which combines accuracy of alignment and clarity of outline with simple and reliable circuitry. The actual character generators are, in fact, pairs of resistors which are scanned by the outputs of a 35-stage shift register to generate successive X and Y positioning waveforms. There are separate sets of resistor pairs for each of the characters available. This method of generating the characters has two advantages - the actual components which determine the character shape are stable passive elements of high reliability and different characters or symbols (e.g. foreign language characters) can very easily be incorporated by providing resistors of the appropriate value.

Characters which can be processed by optical document readers can be provided.

Although characters are built up from dots, the spot size on the face of the C.R.T. is such that adjacent dots overlap, giving the appearance of a continuous line in the final print. The particle size of toner is very much less than the diameter of the C.R.T. dot and no grain is visible in the print.

The position of characters in the line and the position of lines of data on the form are under control of the programmer. Possible line positions are pre-assigned but there are sixteen vertical tabulation points which can be called for by a programmed command so that a particular item of data can be positioned in the required line. Horizontal positioning of characters in a line is effected by means of a command which selects any one of the 128 columns as the starting position for the following group of characters.

1.6 THE PAPER GUILLOTINE

The high operating speed of Xeronic makes it essential to use a comparable machine for handling the large output of paper that comes from the printer. This has not been neglected and a paper guillotine, in which the actual position of the cut is determined by marks printed on the form, is provided as part of the installation.

1.7 CONSTRUCTION

The installation comprises four separate units;

i) The xerographic printer. This is the main part of the printer and if necessary it can be divided into two parts for ease of transport and installation.

ii) The auxiliaries unit. This contains the fan for extracting hot air from the fuser, the dust extractor, air pressure and vacuum pumps for the formhead and a solid-state inverter for supplying power to the formhead lamp. It is usual to site the auxiliaries unit outside the building, or at least outside the printer room, up to a maximum of 20 feet (6 metres) from the printer.

iii) Electronic control cabinet. This need not be adjacent to the printer but can be connected to it by up to 50 feet (15 metres) of cable.

iv) The paper guillotine, including reel holder and form stacker. This has no physical or electrical connection with the printer and can be in a different room if necessary.

A typical layout of a Xeronic installation, indicating the minimum working space required, is shown in figure 5.

It is realised that a fault which necessitates the printer being out of use for even a short period, can be the source of much inconvenience - and annoyance - to the user. Consequently every effort has been made to ensure that the 'down time' due to faults is as little as possible. Engineer's

monitoring and checking facilities are built in and all circuit units are constructed on plug-in boards which can be quickly replaced. A Test Generator has been designed to provide test inputs to Xeronic and this is supplied as part of the standard equipment. Test routines are stored on punched plastic cards and emitted as sequences of up to one hundred 10-bit arrays either 'on demand' from the printer, or automatically at regular intervals under control of a built-in timing system.

1.8 EXTRA FACILITIES

Several non-standard features can be incorporated in the printer as extras according to customer's requirements. For example, a camera can be fitted to make a microfilm record of all forms as they emerge from the fuser or special error correcting logic can be built into an off-line installation to make use of redundant bits in the incoming code. Means for repeating a form can also be provided.

Another facility can be provided which allows pre-printed stationery to be used. This mode of operation retains the full automatic form selecting facilities of the formhead but each form could carry, for example, fixed statutory information, conditions of contract or publicity matter, on the back. Alternatively, the front of the form could contain a coloured, pre-printed, heading.

An optional Listing facility is described in section 4.5.

2 - THE FORM AND DATA

2.1 FORM LENGTH

The form length (i.e. the maximum depth of the printing area) determines the number of forms it is possible to select. The standard form length is regarded as six inches, allowing a choice of 32 different forms but the formhead will also accomodate other sizes of forms up to 18 inches long in two-inch steps as shown below.

Form Length	Number of Forms	Units	Sheet Lengths
* Less than 4 inches (10.2 cm)	See Note below		
4 inches (10.2 cm)	31	1	5 inches (12.7 cm)
6 inches (15.3 cm)	32	1	7 inches (17.8 cm)
8 inches (20.4 cm)	16	2	9 inches (22.9 cm)
10 inches (25.4 cm)	16	2	11 inches (28.0 cm)
12 inches (30.6 cm)	16	2	13 inches (33.1 cm)
14 inches (35.7 cm)	10	3	15 inches (38.2 cm)
16 inches (40.8 cm)	10	3	17 inches (43.3 cm)
18 inches (45.8 cm)	10	3	19 inches (48.4 cm)

* Forms of less than 4 inches (10.2 cm) are printed in groups of two or more on a larger size form and subsequently guillotined in a separate operation.

Forms may be of mixed lengths up to a total of 32 units, thus the formhead can accomodate, for example, 10 ten-inch forms (= 20 units), 3 sixteen-inch forms (= 9 units) and 3 four-inch forms (= 3 units) in any order. Because mixed length forms are more difficult to stack and handle, it is preferable to use forms of uniform length whenever possible.

The cutting mark is usually positioned to allow a margin of $\frac{1}{2}$ inch (12 mm) at the top and bottom of the form, consequently the sheet length is one inch greater than the form length.

2.2 SHEET LENGTH

Two modes of operation are possible.

a) The head of one form follows the bottom of the previous one with a fixed gap (usually one inch) between them. This results in the sheet lengths of the cut forms being one inch longer than the form irrespective of form length.

b) The length of the sheet is constant irrespective of the length of the form printed on it. The form is printed near the head of the sheet and the lower margin is such as to make up the difference between the pre-selected sheet length and the form length.

Either mode can be selected by means of a manually operated switch. In the second case the sheet length also is pre-selected in two-inch steps from five to nineteen inches.

2.3 CHARACTER SPACING

Two different character spacings are available. The printer can be constructed to print either at approximately 11 characters per inch (44 characters in 10 cm) or at exactly 10 characters per inch (approximately 40 characters in 10 cm), with a corresponding height to give clear, well-proportioned print. Unless otherwise stated the programming instructions are the same for both machines.

2.4 LINE SPACING

Line spacing, which need not be uniform, is determined by the positions of the Line Start markers on the form master. Lines must not be closer then 1/6 inch (4.2 mm) but apart from this there is no restriction on where the Line Start markers are placed.

2.5 FORM LAYOUT

Printing takes place on a continuously moving web of paper 26 inches (66 cm) wide. Normally two lines, each $11\frac{1}{2}$ in. (29.2 cm) wide, are printed side by side with a $\frac{3}{4}$ in. (19 mm) gap between them as shown in figure 1. The maximum width of the form overlay is 24in. (61 cm). A strip of paper not less than half an inch (12 mm) wide can be trimmed from each edge of the web and continuous longitudinal perforations can be made at any pre-selected positions across the width of the paper.

Each line (in the 11 characters to the inch printer) contains a total of 128 character positions (or columns) and characters may be printed in any of these positions. There are two cathode-ray tubes and normally the input to both is the same so that printing on the left-hand half of the web is duplicated on the right-hand half. Thus the two halves of the resulting form contain identical information.

Facilities are provided by which information may be omitted from selected columns in either or both lines under control of the programme. An operation known as overwriting permits different data to be printed on the two halves of the form.

By an adjustment of each optical system, four lines $5\frac{3}{4}$ in. (14.6 cm) wide, having a $\frac{1}{4}$ in. (6 mm) gap between them and (in the 11 characters to the inch printer) containing 64 columns per line, can be produced as shown in figure 2. The data in line B is the same as that in line A and similarly the data in line C is the same as D. Calling the data in lines A to D, a to d respectively, combination (i) in the table below is possible. By using suppression facilities, data appearing in either A and B or C and D can be

omitted from corresponding positions in the other pair of lines. By overwriting, the four lines can be completely different (vi), and by making data d the same as data a, four similar lines can be produced across the width of the paper (v).

Combination (ii) is the form layout of figure 1 and, because the optical adjustments can be made on each tube independently, combinations (iii) and (iv) are also possible. In the case of (iii) lines A and B form one continuous $11\frac{1}{2}$ inch line separated by a $\frac{1}{2}$ in. gap from line C; in (iv) the layout is similar but with the positions reversed.

TABLE OF FORM LAYOUT

Lines	A	B	C	D
(i)	a	a	d	d
(ii)	a	d	a	d
(iii)	a	d	d	d
(iv)	a	a	a	d
(v)	a	a	a	a
(vi)	a	b	c	d

In the printer adapted for a character spacing of ten characters to the inch, a line $11\frac{1}{2}$ inches (29.2 cm) long contains 114 character positions and the half-line $5\frac{3}{4}$ inches (14.6 cm) long contains 57 character positions. Figures 1 and 2 should, therefore, be modified accordingly.

2.6 DATA INPUT

Data input to Xeronic can be in any binary code as the printer is easily arranged to suit the coding used, provided it is in one of the following forms:

i) 6-bit parallel code, giving a maximum of 56 printable characters.

ii) 6-bit parallel code with case shift commands, giving a maximum of 112 printable characters.

iii) 7-bit parallel code without case shift commands, giving a maximum of 112 printable characters.

An additional bit may be used for parity checking purposes. Additional checking facilities, utilizing longitudinal parity arrays, can be provided if necessary.

The data input includes

i) Printable characters which may be upper or lower case letters, numerals, special symbols or foreign characters as required.

ii) Commands for the control of the printer; these are described below.

iii) Unused arrays; that is unused in Xeronic, they can be control arrays used in other parts of the computer but in the printer they are ignored and have no effect on the printing.

iv) Control arrays for controlling the tape unit.

2.7 ERROR MARK

A number of monitoring circuits are incorporated in the printer to detect some machine faults or certain errors in the input data. Whenever one of these circuits detects a condition that could give rise to an erroneous form, an error mark is placed on that form. The mark is usually arranged to be printed at the extreme right-hand edge of the form; it commences at the line in which the error or fault condition occurs and continues down to the bottom of the form.

It is also possible for the error mark to be printed under control of the input data if a unique code combination is allocated for the 'Print Error' command.

A useful device on the printer is the Error Counter which indicates the number of forms in a run which are marked with the error mark, enabling the operator to check that all erroneous forms have been removed from the stack after cutting.

The standard position of the error mark is at the extreme right-hand edge of a 24-inch wide form. It should be noted, however, that 13-inch wide paper run on the left-hand side of the printer will not receive any error marking.

An alternative arrangement can be provided as an extra, in which the error marker is positioned in the centre of the printer. The error mark is then made down the centre of a 24-inch wide form and at one edge of a form printed on 13-inch wide paper.

The guillotine is fitted with an error-mark detector which causes cutting to stop whenever a form bearing an error mark is reached. This allows the operator to remove the form manually from the stacker before re-starting.

2.8 CUTTING MARK

The guillotine supplied with the Xeronic installation is fitted with a photo-electric sensing head which allows the position of the horizontal cut to be controlled by a cutting mark printed on the form. The mark is accurately positioned and the sheet length is very constant, resulting in easy stacking and handling of the final forms.

The guillotine is also fitted with a device which allows the sensing circuit to differentiate between a cutting mark and lines of print when cutting forms of uniform length, thus there is no need to provide a separate track for the mark. However, when the forms are of mixed lengths ('irregular' mode of cutting) a track one inch (2.5 cm) wide and free from either variable or background print, must be reserved for the cutting mark.

A number of blank forms are automatically printed at the end of a run. These will be the first ones to be cut after a reel of paper has been loaded onto the guillotine and permit the operator to make test cuts before the completely printed forms are reached.

2.9 TOLERANCES

Lateral tolerance in registration between the printed characters and the form background is ± 0.05 in. (1.3 mm), i.e. about half a character width.

The tolerance in the positions of horizontal cutting, vertical perforation and marginal trimming is ± 1/16 in. (1.6 mm).

2.10 COMMANDS

The commands briefly described below are explained in greater detail in the section devoted to programming; some of them are optional and may not be used in a particular installation.

'Select Form' This command occurs at the beginning of each form and indicates which of the form outlines is to be used for the data associated with the form. Because the form master is positioned in advance, the command also includes the number of the next form as well.

'H-Tab' This is the horizontal tabulation command and moves the printing position to the column specified in the command. The 'h-tab' command also controls the suppression of the cathode-ray tubes.

'V-Tab' The 'v-tab' command selects one of the sixteen pre-assigned vertical tabulation points on the form (indicated by markers on the form master).

'LF/CR' 'Line Feed/Carriage Return' is inserted at the end of a line to reset the horizontal printing position to column 0 and to position the following data on the next line (i.e. at the position indicated by the next Line Start marker on the form master).

'Space' This causes the print position to move to the next column.

'Superimpose' This command causes the following two characters to be printed in the same column. It is usually used in conjunction with an underline symbol, but can also be used to insert accents or other marks. This, in effect, extends the number of printable characters available at the expense of increased programming.

'Case Shift' Two case shift commands ('Upper Case' and 'Lower Case') are used to select up to 112 printable characters by means of a 6-bit code.

'Repeat' Repeat is an optional facility that can be incorporated as an extra. It allows a single form to be printed repetitively for the number of times specified in the command.

'Stop' This can either be included as part of the input data or it can be generated internally in the printer on the detection of a control array (e.g. 'End of Data') or printer fault.

'Print Error' This command, which can either be included as part of the input data or generated internally, causes the distinctive error mark to be printed on the form.

3 - CONTROLLING THE PRINTER

3.1 PRINTER CONTROL

A block diagram of the printer control logic is shown in figure 4. The printer is controlled by means of commands inserted by the programmer among the data to be printed. The timing of the printer is determined by the constant speed of the selenium drum and arrays are read from the buffer store in response to successive Demands from the printer timing circuits.

Data relating to a form is preceded by a 'Select Form' command which contains not only the number of the outline required for that form but also the number of the form outline required for the next form as well. The command is routed to the formhead and while the current form is being printed from one form master the next form number is compared with the present position of the other form master and as a result the master is repositioned to bring that form into the gate.

As soon as the first Line Start marker on the form being printed is sensed a Demand is emitted and tabulation commands and the first printable character are read in. The printable character is decoded and operates one of the character generating circuits which provide the series of X and Y deflection waveforms necessary to display that character on the C.R.T.

The horizontal position of a character in a line is controlled by a counter called the horizontal address register, which is normally advanced by one position after each character has been printed. Horizontal tabulation is effected by an 'h-tab' command which sets the register to a count corresponding to the column required. Vertical tabulation is effected in a different way because vertical positioning depends on paper movement; when a 'v-tab' command is read in, no more Demands are sent out until the required vertical tabulation marker is sensed in the formhead.

The display is positioned on the face of the cathode-ray tube in the same position as the character will appear in the line, so the X deflection waveform of the character is mixed with the output from the horizontal address register. At the end of a single character display (which takes about 200μs) a Demand is sent out for the next input, which may be either another printable character or a command. At the end of a line a 'Line Feed/Carriage Return' command resets the horizontal address register to column 0 and causes the printer to wait until the next Line Start marker is sensed.

'Space' advances the horizontal address register by one column. 'Superimpose' prevents the advance of the register after the following character, as a result of which two characters are superimposed in one column.

All input arrays are first checked for parity and certain machine functions are monitored; if an error is detected or if the data contains a 'Print Error' command, an error mark is printed on the form and, optionally, the printer is stopped. Lights are provided on the control panel to indicate the cause of an error and error signals are available for external use - in the computer for example - if required.

3.2 MANUAL CONTROL

Some of the printer functions can be operated under manual control for test purposes. In conjunction with the Test Generator this allows an engineer to run parts of the machine under working conditions in the absence of input signals or in the presence of a fault in part of the printer. The manual functions are:

i) DISPLAY. Characters can be displayed on the C.R.T. without running the xerographic printing mechanism.

ii) TEST OSCILLATOR. An oscillator is included to simulate line start signals, allowing characters to be printed at regular three-lines to the inch spacing without using the formhead. This is an engineer's test facility only and cannot be used for normal printing runs, it can, however, be used to print out the contents of magnetic tapes for programme 'debugging' if Listing is not fitted.

iii) C.R.T. SUPPRESSION. A switch is provided to suppress either the left-hand or right-hand cathode-ray tube, overriding the automatic suppression facilities of the 'h-tab' command.

iv) INPUTS FROM MANUAL KEYS. In addition to obtaining test inputs from the Test Generator, an array can be set up on manual key switches and fed to the printer repetitively. Similar keys are provided at the input to the core store so that the store can be filled and tested with simulated inputs.

3.3 ERROR CHECKS

The error conditions which are indicated by lamps on the control panels are:

i) "Tape parity". Indicates a parity error in an array read from the magnetic tape.

ii) "Printer parity". Indicates a parity error in an array read from the Xeronic buffer store.

iii) "E.H.T." Indicates the existence of a fault condition in the cathode-ray tube circuits which causes the E.H.T. to be switched off automatically as a safety measure.

iv) "C.R.T. Error". Indicates that a misfunction has been detected in the operation of the C.R.T. bright-up circuit.

v) "Form End Failure". Indicates a failure in the formhead timing or positioning arrangements.

vi) "Blank Paper". Indicates a fault in the formhead which results in a total cessation of printing.

vii) "Horizontal Overflow". Indicates that a line of printing has not been completed in the time available. This could be due to either a machine or programming error.

viii) "Vertical Overflow". Indicates that the printing of the variable data on a form has not been completed by the time the form outline has been completely printed. This also could be due to either a machine or programming error.

ix) "F.H. Lamp". Indicates a failure of the formhead lamp.

x) "Thermal Interlocks". Indicates either overheating of a motor or failure of the formhead air supplies.

4 - PROGRAMMING

4.1 FORM NUMBERING

The form number is more than a mere reference symbol, it is an indication of the position of the form on the form master and is used as such in the printer. Consequently form numbering must be related to the 32 possible positions on the master as follows, the units being those given in the table in section 2.1.

i) The 32 one-unit forms are numbered 0 - 31.

ii) The 16 two-unit forms must have even number references, 0, 2, 4, 6, 8, ----- 30.

iii) The 10 three-unit forms begin at 0 and thereafter are multiples of three, i.e. 0, 3, 6, 9, 12, 15, 18, 21, 24, 27, .

When the form master comprises forms of different lengths, a first form is always form 0; the form following a single unit form has the next higher consecutive number, the number of the form following a two unit form is two higher than that of the preceding form and the number of a form following a three-unit form is three higher than that of the preceding form. For example, consecutive forms of lengths 12, 16, 6, 10, 4, 14, 14, 8 --- inches would be form 0, form 2, form 5, form 6, form 8, form 9, form 12, form 15, then form 17 and so on.

4.2 BLOCK LENGTH

Maximum and minimum block lengths depend respectively on the capacity of the core store and on certain characteristics of the tape unit.

For the core store having a capacity of 1024 arrays, the maximum block length is 895 arrays. In general for other sizes of store, the maximum block length is 129 arrays less than the capacity of the store. The minimum block length depends on the starting time and reading rate of the tape unit, but with a tape transport mechanism that has a starting delay of 3 milliseconds and a reading rate of 20 kc/s, the block length must not be less than about 120 arrays.

A form may comprise any number of blocks but the size of a repeated form containing the 'Repeat' command must not exceed one block.

4.3 PRINTING LIMITATIONS

The number of character times available for printing a line depends on two factors; one is the paper speed, which is fixed, and the other is the spacing between that line and the one following.

With a spacing equivalent to six lines to the inch, the maximum number of character times is 98, but when the spacing is increased to the equivalent of four lines to the inch, 150 character times are available per line. Two-hundred character times are available at a spacing of three lines to the inch but this is the limit which cannot be exceeded by any further increase in spacing. Although there are only either 114 or 128 character positions in a line, more than this number of character times may be required when over-writing.

For the purpose of this count 'LF/CR' and 'v-tab' commands are regarded as the equivalent of one character time; 'Space', 'Superimpose' and 'Case Shift' commands are equal to one-eighth of a character time and 'h-tab' commands are equal to one and a quarter character times. All other commands may be ignored. Unused arrays occupy one-eighth of a character time and must be included.

Duplicate printing in corresponding positions on the second half of the paper does not involve any extra time and can be ignored when calculating the number of characters it is possible to print in a line. When information is suppressed on one half of the paper and the positions overwritten with different information, the characters overwritten are to be included in the total. Some arrays, including the commands 'Space', 'Superimpose' and 'Case Shift', are read out from the Xeronic buffer store at a rate eight times greater than that of printable characters. It may be necessary, for this reason, to limit the number of such arrays in the store to prevent the store from being emptied by the printer before more data can be written into it. The maximum number of printer commands allowable in the last sequence of 128 arrays in any block depends on the starting delay of the tape unit. If this is 3 milliseconds or less, no restriction is imposed but if the delay is, for example, 6 milliseconds the number of commands must not exceed 110; a delay of 9 milliseconds requires that the number of commands be limited to 95. In making this calculation, the unused arrays are regarded as commands, 'v-tab' as one command and one character, 'h-tab' as two commands and one character and 'Select Form' as three commands. When characters are suppressed on both cathode-ray tubes, all arrays except 'h-tab' and 'Select Form' are read out from the store at the higher rate and so must be regarded as the equivalent of commands.

4.4 PRINTING SPEED

The time required for printing a form (1/8 second per inch) depends only on the length of the form and is independent of the amount of printing on it. An additional 1/8 second must be allowed for the 1 in. (2.5 cm) gap between forms.

In calculating the number of forms that can be printed on a roll of paper, an allowance of approximately 25 feet (8 metres) of blank paper must be included for each time the printer is stopped and restarted in the middle of a run.

4.5 LISTING

The optional Listing facility allows the contents of a magnetic tape to be printed out. The formhead is inoperative and commands are printed out in the following manner:

i) Printing is effected at a regular spacing of three lines to the inch.

ii) All lines start at column 0 on the left-hand tube only. If the line occupies more than 114 or 128 columns, printing continues from column 0 on the right-hand tube only.

iii) Horizontal and vertical overflow error circuits are inoperative.

iv) 'LF/CR' and 'v-tab' cause printing to begin on a new line.

v) The first array of a 'Select Form' or 'h-tab' command is printed as a special character and the second and third arrays are interpreted as a printable character or a command. If the array represents a printable character, that character will be printed. If it represents a command, the command will be interpreted in the Listing mode. For example, if the array represents 'v-tab', printing will continue on the next line, although no actual 'LF/CR' or 'v-tab' command appears in the programme at that point. An array representing a command which is printed in Listing as a special symbol, will cause that symbol to be printed.

vi) The first array of a 'v-tab' command is interpreted as 'LF/CR' and the second is treated as its corresponding printable character or command (as in v above).

vii) 'Superimpose', 'Print Error' and 'Stop' commands are not obeyed but are printed as a special symbol.

viii) 'Space' and 'Repeat' commands are obeyed normally.

4.6 COMMANDS

The commands 'Select Form', 'h-tab', 'v-tab' and 'Repeat' include an array or arrays, the less significant bits of which denote a binary number. The unused more significant bits of such arrays can be chosen without restriction.

In codes utilizing case shifts, commands are common to both cases.

4.6.1 'SELECT FORM' k(n1)(n2)

This command comprises three arrays; the first is the Select Form symbol and the second and third are arrays whose five least significant bits represent a binary number from 0 to 31. The command causes the following data to be printed on the form overlay indicated by the second array. The third array is the form outline required for the next form and the same number will therefore appear in the second array of the next 'Select Form' command. If n1 n2 ---- are the numbers of successive form outlines, 'Select Form' commands will appear in the following order.

k(n1)(n2)

k(n2)(n3)

k(n3)(n4)

e.g. k(6)(9), k(9)(3), k(3)(23), k(23)(n), for forms 6, 9, 3, 23, n.

The third array of the last form of a sequence may represent any number because it will not be used for data printing.

A 'Select Form' command must always appear as the first three arrays of every form.

4.6.1.1 PAIRED FORMS

As has already been described the formhead comprises two units using similar form masters, giving 32 unit-length forms. Under one specific condition, however, it is possible to use different form masters on the two units giving a selection of 64 different forms. This condition, known as paired forms, is when a form from master A is selected alternately with one from form master B; that is, an A form is always followed by a B form and a B form is always followed by an A form. The first form must be one from form master A. The forms on the two masters are referenced 0 - 31 and programming is as described above, k(n1)(n2), k(n2)(n3) etc. No explicit indication is required of whether n is on form master A or B but by its position in the sequence n1 n3 n5 ---- will select form n of form master A and n2 n4 n6 ---- will select form n of form master B.

This paired form mode of operation must be regarded as exceptional and used with due regard to its limitations. For example, if the printer is stopped and restarted in the middle of a sequence, the first form printed after the restart will always be an A form, whereas the programmer may have intended it to be a B form by its position in the sequence.

4.6.1.2 BLANK FORMS

If a blank form (i.e. a form outline printed without variable information) is required the programme is:

k(n1)(n2), v(0)

where n1 is the blank form outline and n2 the number of the next form.

If the cutting mark is at the bottom of a form and the cutter is operated in the irregular mode, it will be necessary to programme a blank form at the beginning of a run to ensure correct cutting of the first complete form.

No programming is required for the blank forms which are printed automatically after a logical stop.

4.6.2 'V-TAB' v(n)

This command comprises two arrays; the first is the v-tab symbol and the second an array whose least significant four bits represent a binary number from 0 - 15 defining the tabulation points, designated v(0) - v(15), indicated by markers on the form master. The effect of a 'v-tab' command is to inhibit printing until the paper has moved to the required v-tab point.

It is only permissible to follow a v-tab point by any succeeding one; that is, a 'v-tab' command must always call for a downward movement of the print position.

A 'v-tab' command resets the horizontal printing position to the extreme left-hand margin, column 0.

The first v-tab of a form must be v(0) and this must be inserted in the programme immediately following the 'Select Form' command. If the v-tab point required is other than v(0), v(0) must still be inserted, followed by another 'v-tab' command specifying the position required.

If test printing or Listing is carried out using automatic line spacing with the formhead inoperative, 'v-tab' is interpreted as 'LF/CR' and the second array is printed if it represents a printable character. For convenience in interpreting the print-out, the second array of the command should, therefore, be chosen to represent a printable character.

4.6.3 'H-TAB' h(n)(s)

This command comprises three arrays; the first is the h-tab symbol and the second a binary number representing the column required. The two least significant bits of the third array indicate C.R.T. suppression conditions.

'H-tab' commands may call for columns in any order and may cause the print position to move from right to left if required.

4.6.3.1 ELEVEN CHARACTERS PER INCH - 128 COLUMNS PER LINE

The second array of the command is interpreted differently for the three different codes:

i) Six-bit code without case shifts. In this code there are only 64 different code combinations and these are arranged to denote the even columns as follows - the column position is double the binary value.

e.g. binary 0 selects column 0.
binary 61 selects column 122.

If an odd-numbered column is required, the next lower column (the one to the left of the required point) is selected by the 'h-tab' command and this must be followed by a 'Space'. Thus to tabulate to column m, m being an odd number, the programme would be

$$h\left(\frac{m-1}{2}\right)(s), \text{ Space, data}$$

ii) Six-bit code with case shifts. This code allows all 128 columns to be selected as follows.

A binary number in the lower case condition represents columns 0 - 63 (i.e. n).

A binary number in the upper case condition represents columns 64 - 127 (i.e. n + 64).

The case shift command necessary to distinguish between the lower and higher columns must be inserted before the h-tab symbol. Thus.

lc, h(n)(s) selects column n
uc, h(n)(s) selects column n + 64.

iii) Seven-bit code. In this there are 128 code combinations and the binary value directly represents the column number.

4.6.3.2 TEN CHARACTERS PER INCH - 114 COLUMNS PER LINE

Xeronic printers which use a six-bit code without case-shifting and which have been constructed to print at ten characters per inch (i.e. 114 columns per line), require the 'h-tab' command to be programmed as follows.

Columns 0 - 56

Tabulation to even columns only. The column number is double the binary value of the second array. To tabulate to column m (m being an even number not greater than 56) the command is

$$h\left(\frac{m}{2}\right)(s)$$

Columns 57 - 113

Tabulation to odd columns only. The column number is seven less than double the binary number of the second array. If column m is required (m being an odd number greater than 56) the command is

$$h\left(\frac{m+7}{2}\right)(s)$$

e.g. h(24)(s) selects column 48

h(53)(s) selects column 99

It follows that h-tab 29, 30, 31 and 61, 62, 63 and 64 are never used.

4.6.3.3 C.R.T. SUPPRESSION

The two bits of the third array indicating C.R.T. suppression conditions are used with the following meanings:

00 - No suppression, both copies printed.

01 - Suppress left-hand tube; right-hand copy printed.

10 - Suppress right-hand tube; left-hand copy printed.

11 - Suppress both tubes; neither copy printed.

When an 'h-tab' is received that calls for suppression of a cathode-ray tube, the display on that tube is suppressed until either the next h-tab programmed to cancel the suppression or a 'Select Form' command. Suppression conditions cannot, therefore, be carried over from one form to the next. Although 'v-tab' and 'LF/CR' commands always return the printing position to column 0, they do not cancel any suppression imposed by the last 'h-tab'.

If an h-tab point, h(n)(11), is received that suppresses both tubes, all the following information, including 'v-tab' and 'LF/CR' commands, are skipped until either the next operative h-tab, h(n)(p) where p is 00, 01 or 10, or a 'Select Form' command is received. This means that after a totally suppressed h-tab, an operative h-tab, h(n)(p) must precede the 'v-tab' command to be used for the following data. For example, the programme:

v(6), h(n)(11), data 1, v(7), h(33)(p), data 2

would result in data 2 being printed at v(6). The correct programme to position data 2 at v(7) and, for example, h-tab 33, is

v(6), h(n)(11), data 1, h(n)(p), v(7), h(33)(p), data 2

where h(n)(p) can be any h-tab point, since it is inserted in the programme only to render v(7) effective and does not, in this case, control the positioning of any printing.

4.6.3.4 OVERWRITING

By taking advantage of the fact that backward h-tabs are permitted, the portions left blank on one half may be overwritten with other information, producing a form having different information in corresponding columns of the two halves.

To effect overwriting in the character positions beginning at h-tab 38 for example, the programme would be

h(38)(10), data 1, h(38)(01), data 2

where data 1 and data 2 are the characters in the same column positions of the left-hand and right-hand lines respectively. The first 'h-tab' causes the data to be printed on the left-hand half of the form, the corresponding positions of the right-hand half being left blank to be filled subsequently by the effect of the second 'h-tab' command. No further printing will take place in the already-printed columns of the left-hand half of the form.

When calculating the number of characters that can be printed in a line, it should be noted that overwriting in x columns represents the equivalent of $(2x + 2\frac{1}{2})$ character times, that is x characters in data 1, x characters in data 2 and two 'h-tab' commands.

4.6.4 'LINE FEED/CARRIAGE RETURN' (LF/CR)

The effect of this command is to delay printing until the paper is positioned at the next Line Start marker. At the same time the horizontal printing position is reset to column 0.

A 'LF/CR' command must be included at the end of every line except:

i) the line immediately preceding a 'v-tab' command;

ii) the last line of a form.

A 'LF/CR' command in either of these two positions may give rise to an erronous form.

'LF/CR' is the vertical equivalent of the horizontal 'Space' and several 'LF/CR' commands may be used in succession to skip one or more lines, although when more than two lines are to be skipped, the use of a v-tab for this purpose is more economical.

4.6.5 'SPACE'

Although from a programmer's point of view, a space can more properly be regarded as a character, in Xeronic it is treated as a command and causes the print position to move one column to the right along the line.

4.6.6 'SUPERIMPOSE'

This command, which is normally (but not necessarily) only used in connection with the underline or accents, causes the two following characters to be printed in the same column. It does not matter which of the two characters is printed first.

4.6.7 'UPPER CASE'

This command signifies that all the following arrays are to be interpreted as upper case until the next 'Lower Case' command is given.

4.6.8 'LOWER CASE'

This command signifies that all the following arrays are to be interpreted as lower case until the next 'Upper Case' command is given.

4.6.9 'PRINT ERROR'

This causes the distinctive error mark to be printed down the form, from the line in which the command was received to the bottom.

4.6.10 'STOP'

For reliable operation the printer is arranged so that it will only stop if the command occurs at least twice in a form; a single Stop is ignored. The two commands need not be consecutive but the second should preferably occur at the end of the form.

Two conditions arise:

i) 'Stop' commands inserted by the programmer. The printer will stop when the second command is read out from the store and the remainder of the information in the store will be destroyed.

ii) 'Stop' commands generated internally in the logic as a result of detecting an error or a machine fault. Wherever possible this will allow the store to be emptied and the last form in it to be printed before the printer stops, thus no information is lost.

4.6.11 'REPEAT'

This command comprises two arrays; the first is the repeat symbol and the second a binary array representing the number of repetitions required.

The programme for this command is:

k(n)(n), v(0), h(m)(11), r(x), v(0), h(y)(p), data

where n is the form outline required for the repeated forms, h(m)(11) is a totally suppressed h-tab, (m being any valid number), and h(y)(p) is an 'h-tab' command which causes printing from at least one cathode-ray tube (i.e. p must be 00, 10 or 01). r is the Repeat symbol and x is the number of repetitions required, i.e. one less than the total number of identical forms printed.

At the conclusion of Repeat it is necessary to select the form for the subsequent data. This cannot be done in the normal way because the previous 'Select Form' command had to be k(n)(n) as described above. It is accordingly necessary to programme a blank form thus

k(n)(m), v(0), k(m)(x), v(0), data

where n is the same as the repeated form and m is the form next required.

The whole of the form to be repeated must be contained within a single block and cannot, therefore, exceed the maximum block length.

5 - ABRIDGED SPECIFICATION

PAPER SPEED	40 ft. (12.2 m) per minute.
PRINTING SPEED	4,700 characters per second maximum 2,880 lines per minute maximum.
PAPER WIDTH	26 inches (66 cm) although paper 13 in. (33 cm) wide can be used.
SPOOL SIZE	12 in. (30.5 cm) maximum outside diameter on a $2\frac{3}{4}$ in. (7 cm) bore core.
PAPER QUALITY	Must be in the range 45 - 120 grams per sq. metre.
LENGTH OF PAPER ON SPOOL	Approximately 2000 ft. (600 m) of average thickness paper.
FORM SIZE	24 in. (61 cm) wide x 18 in. (45.8 cm) deep maximum.
LINE WIDTH	i) 2 x 128 or 4 x 64 character positions ii) 2 x 114 or 4 x 57 character positions
CHARACTER SIZE	i) Approximately 11 per in. (44 per 10 cm). ii) 10 per in. (approximately 40 per 10 cm).
LINE SPACING	Unrestricted provided it is greater than 1/6 in. (4.2 mm).
CHARACTERS AVAILABLE	56 characters or symbols as standard, up to 112 as an extra.
TABULATION	16 vertical tabulation points; horizontal tabulation to any column.
FORMHEAD	Up to 32 forms available for automatic selection.
INPUT	6-bit code without case shift, plus parity. 6-bit code with case shift, plus parity. 7-bit code, plus parity.
PAPER PERFORATORS	4 fitted but more can be supplied.

NOTE :- New machines have:-

Printing speed 7,200 characters per second maximum.

Input up to 8-bit code, plus parity.

Store capacity up to 2048 arrays.

EDGE TRIMMERS	2 fitted.
STORE CAPACITY	Either 512 or 1024 arrays.
AUXILIARIES UNIT AIR FLOW	400 cubic feet (11 cubic metres) per minute.
POWER SUPPLY	415 volts 3-phase 50 cycles. Other inputs to order.
POWER CONSUMPTION	Approximately 12 kVA.

APPROXIMATE DIMENSIONS (British units in feet and cwt.)

	Width		Depth		Height	Weight
Xerographic Printer	$4\frac{3}{4}$	x	$5\frac{3}{4}$	x	$7\frac{1}{4}$	22
Auxiliaries Unit	$5\frac{1}{4}$	x	$2\frac{3}{4}$	x	6	16
Electronic Cubicle	$5\frac{1}{2}$	x	2	x	$6\frac{1}{4}$	14
Paper Guillotine	3	x	$4\frac{1}{2}$	x	4	4

APPROXIMATE DIMENSIONS (Metric units in metres and kilograms)

Xerographic Printer	1.45	x	1.75	x	2.21	1120
Auxiliaries Unit	1.60	x	0.84	x	1.83	815
Electronic Cubicle	1.68	x	0.61	x	1.92	713
Paper Guillotine	0.92	x	1.37	x	1.22	204

FOR FURTHER INFORMATION WRITE TO

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Telephone: Shepherds Bush 2050.

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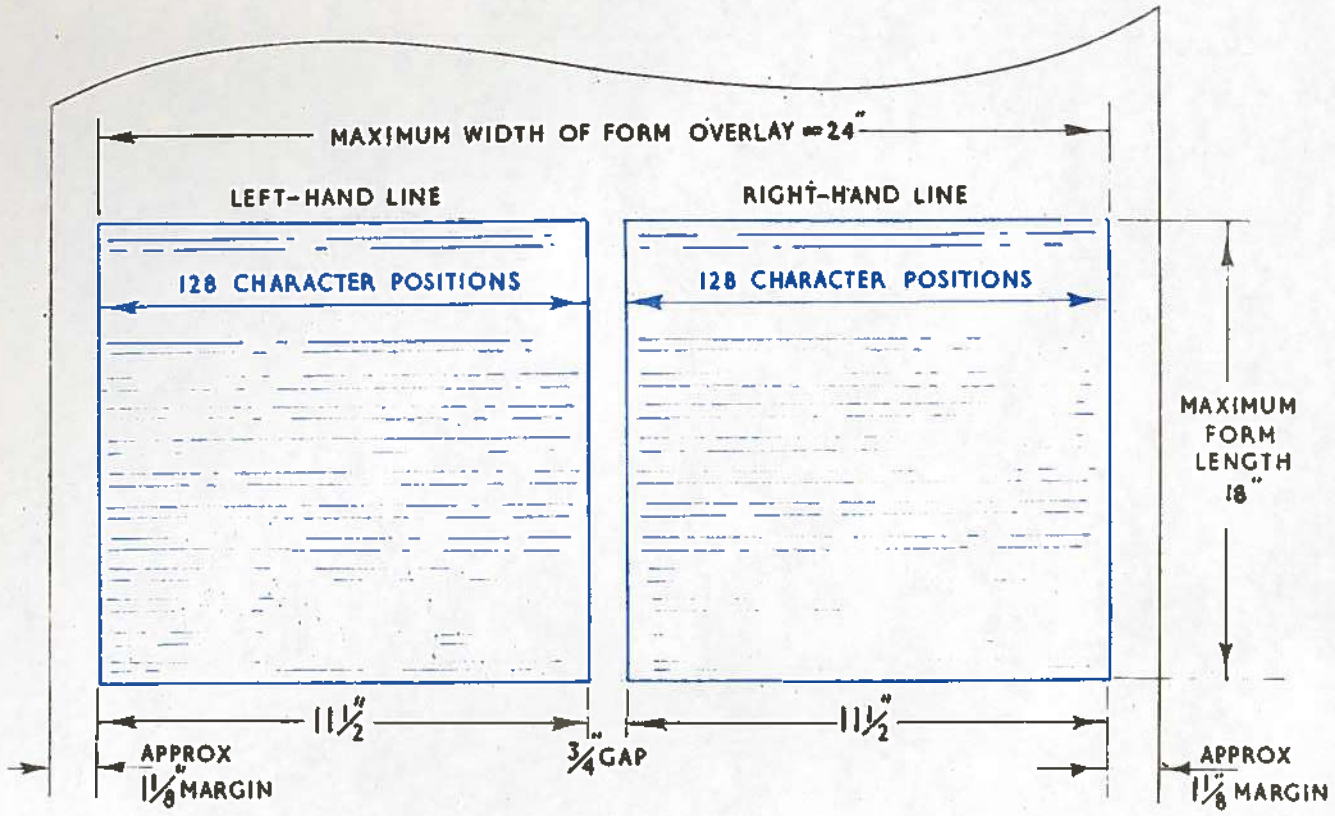
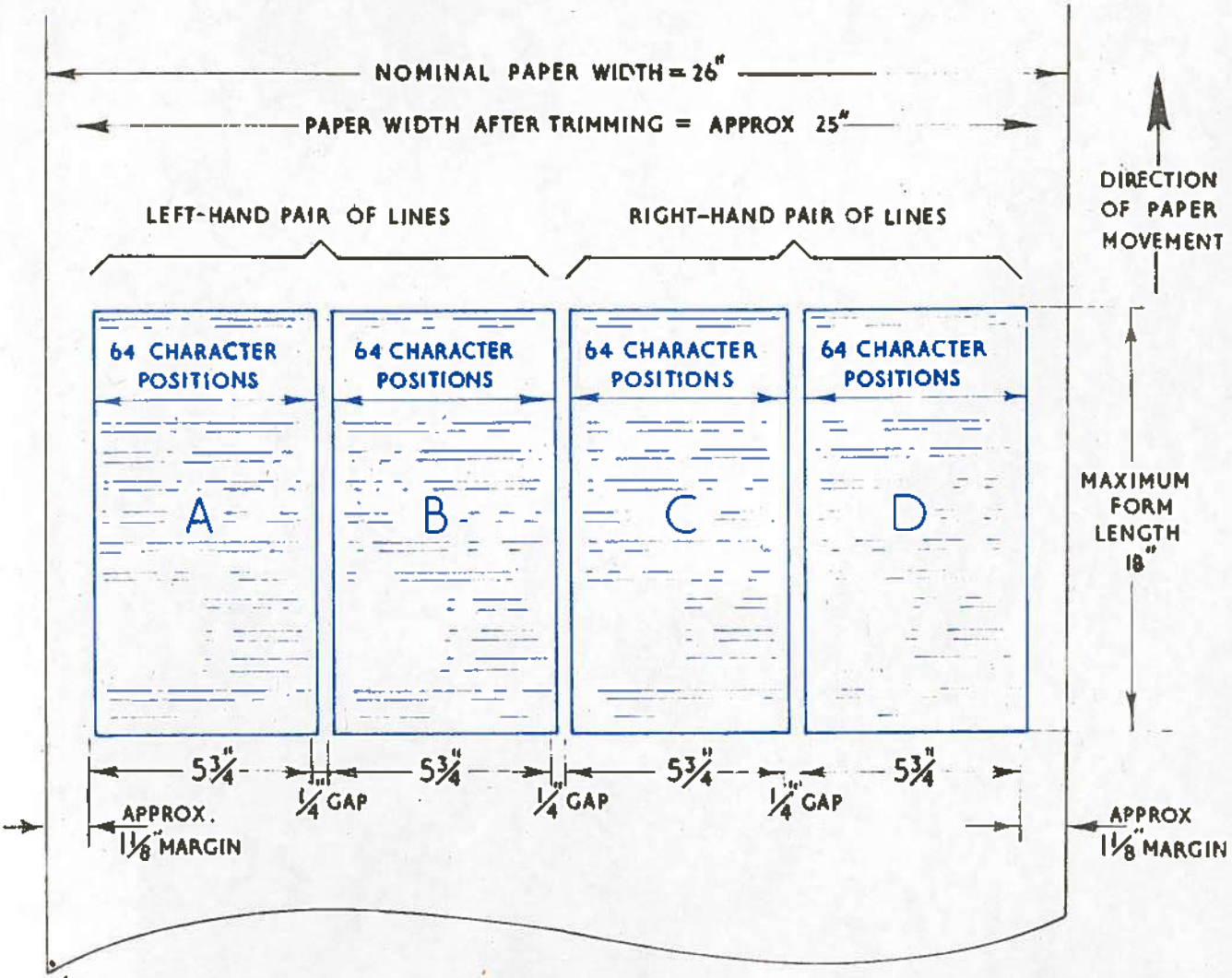


TWO- LINE LAYOUT

FIG 1



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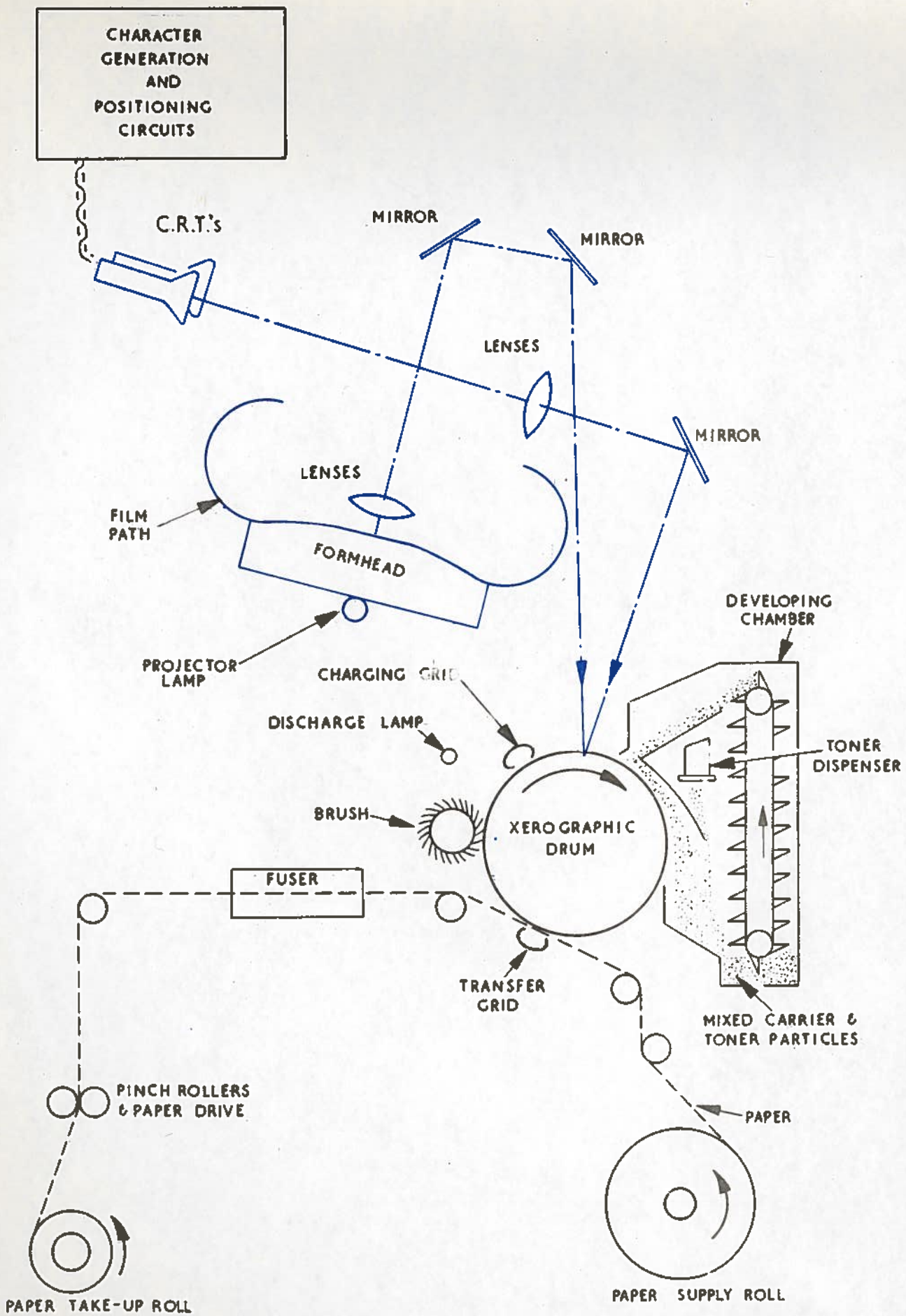
FOUR- LINE LAYOUT

FIG 2



TP/79 THE XEROGRAPHIC PRINTER FIG 3

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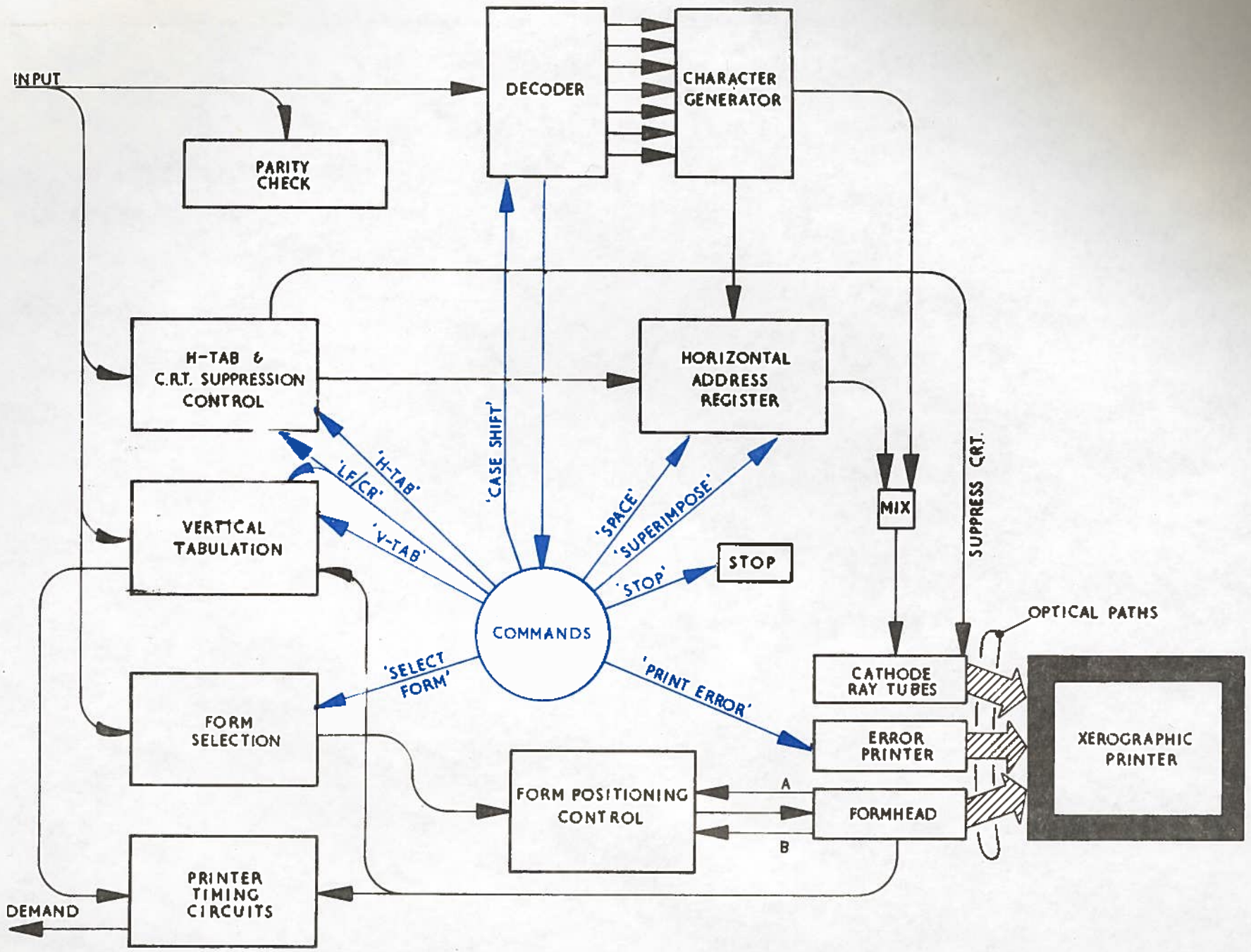
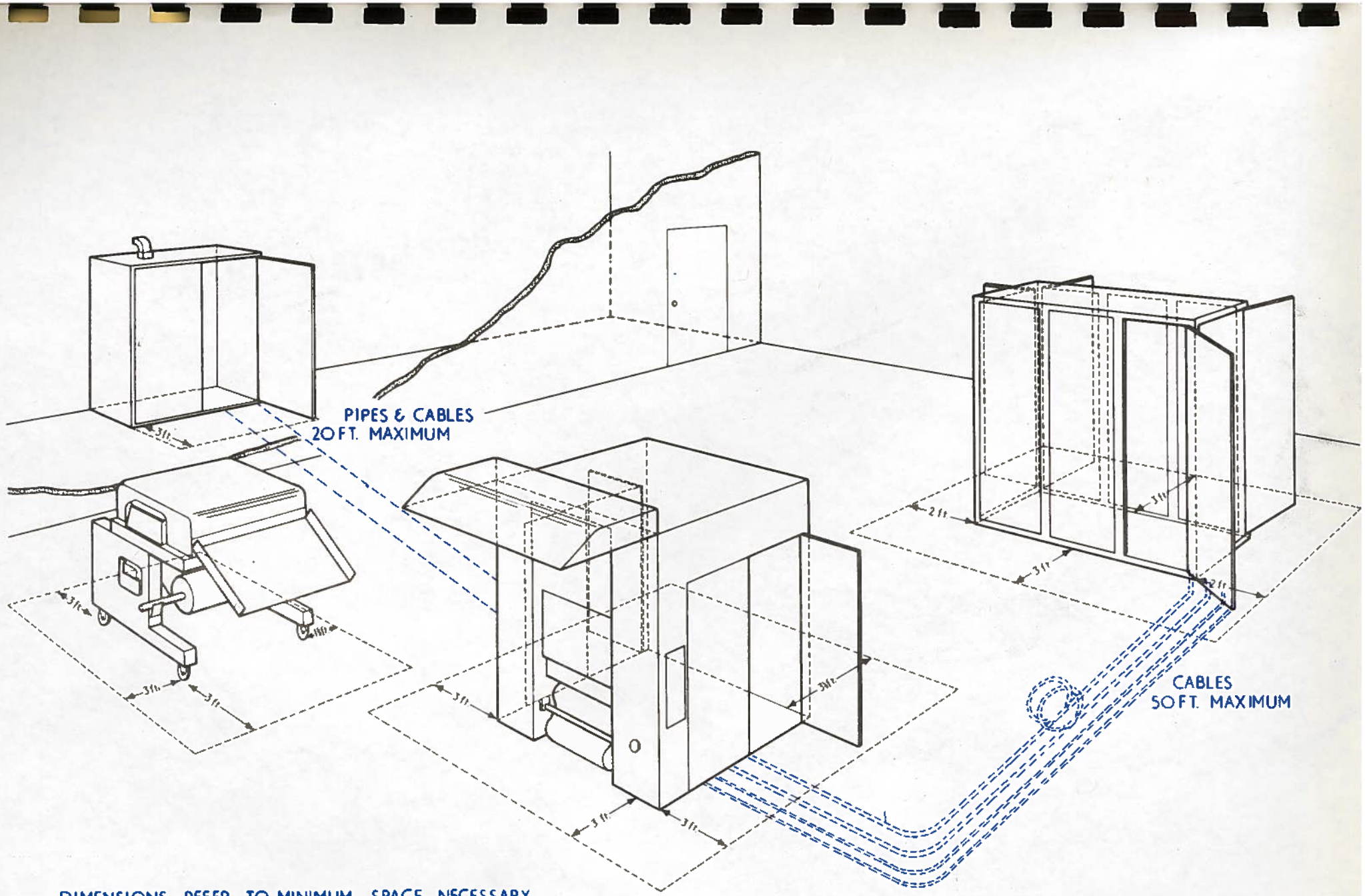


BLOCK DIAGRAM OF PRINTER CONTROL

FIG·4



DIMENSIONS REFER TO MINIMUM SPACE NECESSARY FOR DOOR CLEARANCE ETC.

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TYPICAL XERONIC INSTALLATION

FIG. 5