

APPENDIX A : CHARACTER CODES

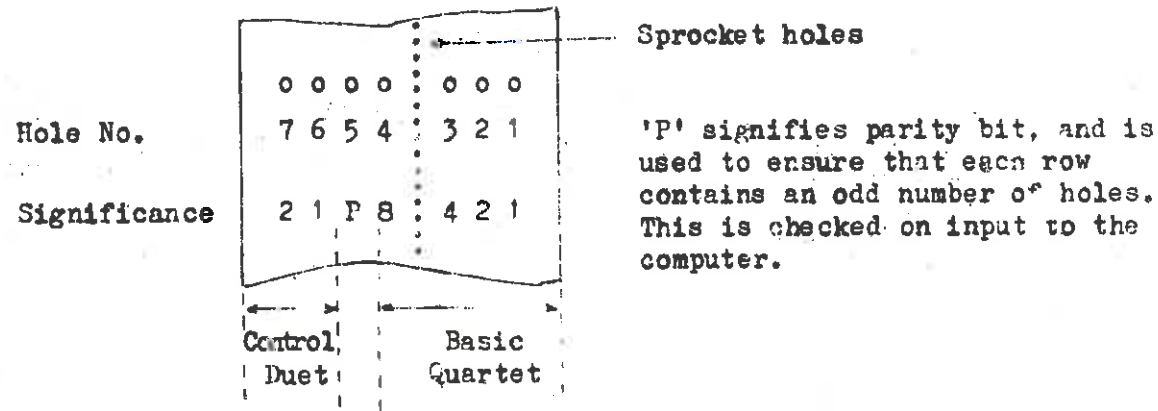
This appendix describes the representation of characters in 'alpha form' (see section 3) in the store of the computer, on the various external media, and in transit.

Although the differences between some of the representations are very slight, they have been included separately for the sake of completeness.

Appendix A

A.1 Character Code for 7-hole Paper Tape

Characters are punched on 7-hole paper tape as follows:



'0' in either the control duet or the basic quartet is represented by no hole in that part of the tape.

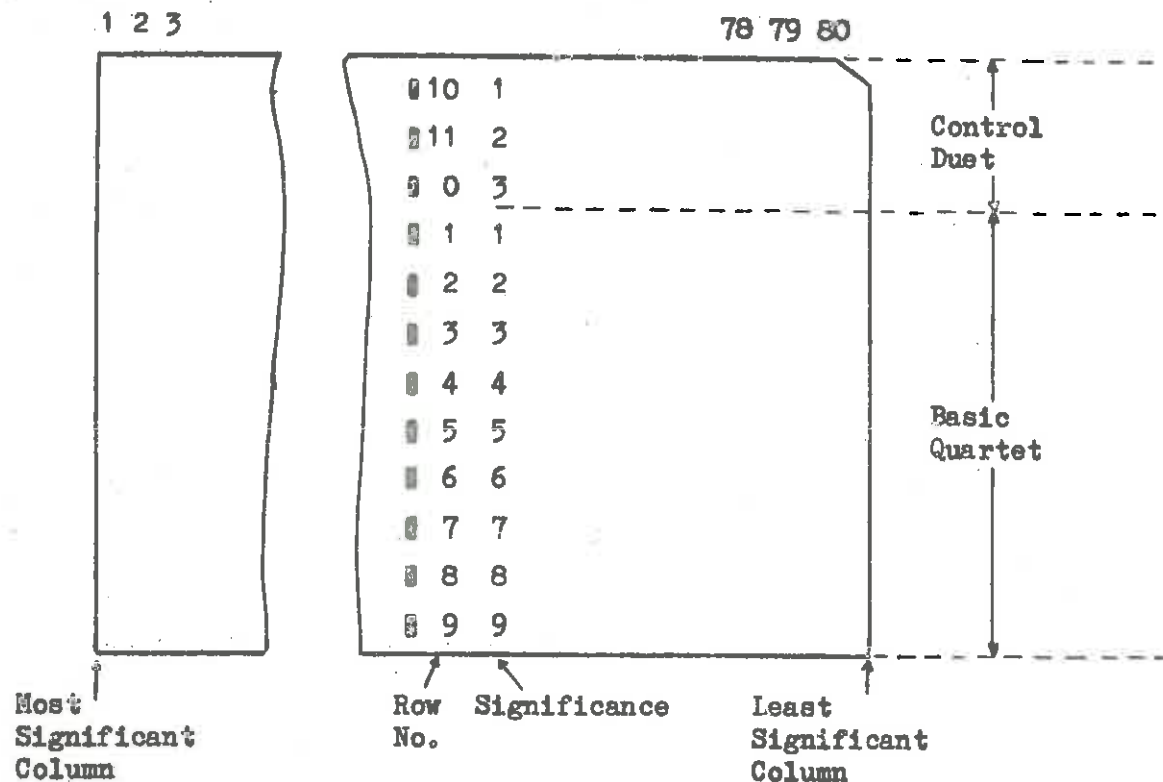
The values of the control duet and basic quartet for each character are given in the following table:

		Basic Quartet															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Duet	0	Sp	1	2	3	4	5	6	7	8	9	10	11	+	:	.	&
	1	-	A	B	C	D	E	F	G	H	I	=	*	'	?	LE	□
	2	&	J	K	L	M	N	O	P	Q	R	→	↯	>	<	½	\
	3	0	/	S	T	U	V	W	X	Y	Z	(	)	,	or;	NE	BE ER

- NE = Number End
  - LE = Line End
  - BE = Block End
  - ER = Erase. This character is ignored on input (although it can be punched on output). Blank tape is also ignored on input.
  - SP = Space
- These two characters are only significant if information is held in variable field form

A.2 Character Code for Punched Cards

Characters are punched on cards as follows:



'0' in either the control duet or basic quartet is represented by no hole in that part of the card.

A basic quartet greater than 9 is represented by punching holes in both the '8' row and the (value -8) row, e.g. to represent basic quartet 12, holes are punched in the '8' and '4' rows.

Note: Punching in the '9' and '3' rows will give a quartet value of 11, not 12, as the patterns generated by the individual holes are mixed not added:

$$\begin{array}{r}
 8 = 1000 \\
 4 = 0100 \\
 \hline
 1100 = 12
 \end{array}$$

but

9 = 1001

3 = 0011

1011 = 11

The values of the control duet and basic quartet for each character are given in the following table:

		Basic Quartet															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Duet	0	Sp	1	2	3	4	5	6	7	8	9	10	11	+	:	.	£
	1	10 or-	A	B	C	D	E	F	G	H	I	=	*	'	?	LE	□
	2	11 or&	J	K	L	M	N	O	P	Q	R	→	%	>	<	½	\
	3	0	/	S	T	U	V	W	X	Y	Z	(	)	,	NE or;	BE	△

- NE = Number End      Significant only if information is held in variable field form
- LE = Line End
- BE = Block End      This does not stop the reading process

A negative number in fixed field form is denoted by punching a hole in the top row in the left-hand column of the group of columns allocated to that number in addition to any other holes punched in that column. (Note: If a column is expected to contain a hole in the 10, 11 or 0 row, an extra column must be allocated for the sign). Negative numbers in variable field form are followed by a '-' sign in a separate column.

Appendix A

A.3 Character Code for Magnetic Tape

Information is held on eight tracks on the magnetic tape, each row representing one character.

These tracks contain the basic quartet, the control duet, a row parity bit, and a 'clock' track to denote the presence or absence of a character.

The values of the control duet and basic quartet for each character are given in the following table:

		Basic Quartet															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Duet	0	Sp	1	2	3	4	5	6	7	8	9	10	11	+	:	.	£
	1	-	A	B	C	D	E	F	G	H	I	=	*	:	?	LE	□
	2	&	J	K	L	M	N	O	P	Q	R	→	%	>	<	½	AM
	3	0	/	S	T	U	V	W	X	Y	Z	(	)	,	NE	BE	△

- NE = Number End
- LE = Line End
- BE = Block End
- AM = Alignment Mark

Note that this character code is designed to agree with the character codes on other media. However, since information on magnetic tape is not read by eye or used for anything other than input to the computer, any character may be used. The only characters which must have the above representation are BE and AM, which must be recognised by the assembler.

A.4 Character Code for Anelex Printer

Characters as defined by the table below are converted by the special Anelex assembler to a matrix which is copied to the printer. If the General Purpose Output assembler or standard Anelex assembler is being used the matrix must be formed in the store before output, e.g. by using the 29/0/1 action.

		Basic Quartet															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Dust	0	Sp	1	2	3	4	5	6	7	8	9	10	11	+	:	.	€
	1	-	A	B	C	D	E	F	G	H	I	=	*	?	≡	□	
	2	&	J	K	L	M	N	O	P	Q	R	→	%	>	<	½	\
	3	0	/	S	T	U	V	W	X	Y	Z	(	)	,	;		Δ

All the above characters can be printed under computer control if the printer is being used in conjunction with the General Purpose Output assembler or standard Anelex assembler.

If the special Anelex printer assembler is being used, the following characters have special meanings and cannot be printed under computer control:

- ≡ = Line End
- ||| = Block End

A.5 Character Code for IBM Typewriter

The values of the control duet and basic quartet for each character are given in the following table:

		Basic Quartet															
		Lower Case									Upper Case						
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Duet	0	Sp	1	2	3	4	5	6	7	8	9	10	11	+	:	.	£
	1	-	A	B	C	D	E	F	G	H	I	=	*	'	?	LE	□
	2	&	J	K	L	M	N	O	P	Q	R	→	%	>	<	½	RS
	3	0	/	S	T	U	V	W	X	Y	Z	(	)	,	NE	BE	A

Sp = Space

NE = Tabulate (Number End)

LE = Carriage return and Line Feed (Line End)

BE = Throw to next form (Block End). This only occurs if a formaliner is fitted, whereupon paper will be fed until a hole is detected in the control tape of the formaliner. BE does not cause carriage return, this must be produced by a LE prior to BE.

RS = Ribbon Shift to Red. The ribbon will return to black on the next LE or BE character or if the initial reset key is operated on the assembler or control desk.

A.6 Character Codes in the Store

Alpha characters in the store are held as a control quartet and basic quartet according to the table below.

The conversion of control duet to quartet is done automatically on input.

On output the value of bit 3 of the control quartet is ignored.

		Basic Quartet															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Quartet	0	Sp															
	1	-															
	2	&															
	3	0															
	4	1	2	3	4	5	6	7	8	9	10	11	+	:	.	£	
	5	A	B	C	D	E	F	G	H	I	=	*	'	?	≡	□	
	6	J	K	L	M	N	O	P	Q	R	→	%	>	<	½	\	
	7	/	S	T	U	V	W	X	Y	Z	(	)	,	;		△	

- = 'Doubtful Block' mark
- \ = Alignment Mark
- ||| = Block End
- ≡ = Line End
- ;
- △ = Erase



## Appendix B

APPENDIX B : CONCISE INSTRUCTION CODE

This appendix lists LEO III Computer Code Actions. The detailed description of each action will be found in the main text.

<u>ACTION 0 : REGISTER FACILITIES</u>	<u>REFERENCE TO MAIN TEXT</u>
A d m	
0 0 0 HALT	17.4
0 0 1 as 0/0/3	
0 d 2 REPLACE (B) by (N)	6.7.1
0 0 3 SET RADIX. COPY (N) into C	6.7.5
0 1 0 COPY REGISTERS (A), (B), (C) to N', N+2', N+4'	17.1.6
0 1 1 REPLACE REGISTERS (A), (B), (C) by (N'), (N+2'), (N+4')	17.1.6
0 1 3 as 0/1/1	
<u>ACTION 1 : ARITHMETIC ON LITERALS, ETC.</u>	
A d m	
1 d 0 TABLE LOOK-UP from N to find L where $(L) \geq (A)$ place L in B. Arithmetic is binary	16.6.2
1 0 1 PREPARE FOR DIGIT COLLATION. Set $\bar{15}$ quartets in B for each bit of N.	6.7.4
1 0 2 ROUND OFF. Add 1 to (A) if Q10 of $B \geq \bar{N}$ and clear B	6.7.3
1 0 3 INTERCHANGE AREA ADDRESSES	16.1.2
1 1 1 ADD $\bar{N}$ to (A)	6.7.2
1 1 2 SUBTRACT $\bar{N}$ from (A)	6.7.2
1 1 3 SELECT $\bar{N}$ into (A)	6.7.2

## Appendix B

ACTIONS 2 - 6 : ARITHMETIC, ETC.

<u>A d m</u>		<u>REFERENCE TO MAIN TEXT</u>
2 d m	TRANSFER (A) to N	6.7.1
3 d m	COPY (A) to N	6.7.1
4 d m	ADD (N) to (A)	6.7.1
5 d m	SUBTRACT (N) from (A)	6.7.1
6 d m	SELECT (N) into A	6.7.1
7 d m	AUGMENT (N) by (A)	6.7.1
8 0 0	MERGE CONSTANT LENGTH	16.6.3
8 1 0	MERGE VARIABLE LENGTH	16.6.3
9 d m	MULTIPLY UNIFORM RADIX. (A)x(N) set in AB	6.7.1
10 d m	MULTIPLY AND ADD (N)x(B) added to (A)	6.7.1
11 d m	MULTIPLY AND SUBTRACT (N)x(B) from (A)	6.7.1
12 d m	CONVERT (N) to radix (C) and place in A	6.7.5
13 d m	DIVIDE UNIFORM RADIX (AB) by (N) Quotient in A remainder in B	6.7.1
14 d m	REPLACE BITS of (N) found in (B) with corresponding bits of (A)	6.7.4
15 d m	COLLATE (N) with (B) and add to (A)	6.7.4
17 0 m	SELECT (N') into A if N is even, otherwise select (N+1'). No change is made to S and C form.	7.1.8
17 1 m	COPY (A) to N' if N is even, otherwise copy to N+1'. No change is made to S and M form.	7.1.8

ACTION 18 : SHIFT OR SCALE

<u>A d m</u>		
18 0 0	LOGICAL SHIFT (A)	6.7.3
18 0 1	ARITHMETIC SHIFT (A)	6.7.3
18 0 2	SCALE NUMERATOR FOR DIVIDE	6.7.3

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<u>A d m</u>		<u>REFERENCE TO MAIN TEXT</u>
13 0 3	BINARY SHIFT (A)	6.7.3
18 1 0	LOGICAL SHIFT (AB)	6.7.3
18 1 1	ARITHMETIC SHIFT (AB)	6.7.3
18 1 2	SCALE DENOMINATOR FOR DIVIDE	6.7.3
18 1 3	BINARY SHIFT (AB)	6.7.3

ACTION 19 : TEST ROUTE N1 ENGAGED and if not:

<u>A d m</u>		
19 0 0	OUTPUT one block to route N1	16.1.3
19 0 1	(Timer) RESET to zero	16.1.3
	(Other) INPUT one block from route N1	
19 0 2	RUN BACK to last mark on route N1	16.1.3
19 0 3	RUN ON to next mark on route N1	16.1.3
19 1 0	STEP BACK one block on route N1	16.1.3
19 1 1	REWIND ROUTE N1	16.1.3
19 1 2	UNLOAD route N1	16.1.3
19 1 3	(MT) INPUT first word of block only	16.1.3
	(Other) SET ROUTE N1 to MANUAL	

} MT only

ACTIONS 20 - 22 : FLOATING POINT ARITHMETIC

<u>A d m</u>		
20 0 m	ADD (N) to (A*)	7.1.7
20 1 m	SUBTRACT (N) from (A*)	7.1.7
21 0 m	TRANSFER (A*) to N	7.1.7
21 1 m	COPY (A*) to N	7.1.7
22 0 m	MULTIPLY (A*) by (N)	7.1.7
22 1 m	DIVIDE (A*) by (N)	7.1.7

## Appendix B

<u>ACTIONS 23 - 27 : MODIFICATION AND SEQUENCE CHANGE, ETC.</u>		<u>REFERENCE TO</u>
<u>A d m</u>		<u>MAIN TEXT</u>
23 0 0	STEP AND TEST INDIRECT MODIFICATION REGISTER	8.4
23 0 1	Spare	
23 0 2	ENTER MASTER PROGRAMME	17.1.5
23 0 3	SELECT TAG OF N into A	17.2.5
23 1 m	SET TAG OF N	17.2.5
24 0 0	MODIFY DIVISION NUMBER AND ADDRESS of next instruction within division, searching for a positive modifier	8.4
24 0 1	MODIFY DIVISION NUMBER AND ADDRESS of next instruction within division by (N)	8.4
24 0 2	SELECT N into A. N is prefixed by current division number	8.5
24 0 3	MODIFY NEXT INSTRUCTION ADDRESS by (N) suppressing current division	8.4
24 1 0	CHANGE SEQUENCE to N	8.1
24 1 1	SET MODIFICATION GROUP	8.3
24 1 2	MODIFY NEXT INSTRUCTION ADDRESS, suppressing current division and searching for a positive modifier	8.4
24 1 3	STORE INDICATORS	17.3
25 0 m	STEP ON AND TEST MODIFICATION REGISTER M	8.3
25 1 0	SET INDICATORS	17.3
25 1 1	CLEAR INDICATORS	17.3
25 1 2	INTERROGATE INDICATORS	17.3
25 1 3	CONDITIONAL HALT	17.3
26 0 0	ENTER SUBROUTINE	8.2
26 0 1	LEAVE SUBROUTINE	8.2
26 0 2	ENTER PRIORITY CONTROL	17.1.4

Appendix B

		<u>REFERENCE TO MAIN TEXT</u>
A d m		
26 0 3	LEAVE MASTER PROGRAMME	17.1.5
26 1 0	TEST ROUTE N1	16.1.1
26 1 m	SET MODIFICATION REGISTER M	8.3
27 0 m	TEST (A) and SEQUENCE CHANGE	8.1
27 1 m	TEST (AB) and SEQUENCE CHANGE	8.1
	m = 0 Test zero	
	m = 1 Test non-zero	
	m = 2 Test positive or zero	
	m = 3 Test negative	

ACTIONS 28 - 29 : COPY/CLEAR/UNPACK/PACK

A d m		
28 0 0	BULK COPY short numeric to short numeric	16.5.2
28 0 1	BULK COPY short numeric to alpha	16.5.2
28 1 0	BULK COPY alpha to short numeric	16.5.2
28 1 1	BULK COPY alpha to alpha	16.5.2
28 0 0	BULK CLEAR short locations from N	16.5.2
28 1 1	BULK CLEAR long locations from N	16.5.2
28 0 2	UNPACK FIXED FIELD DATA	16.2.2
28 0 3	UNPACK VARIABLE FIELD DATA	16.2.2
28 1 2	EDIT	16.3.2
28 1 3	CONDENSE	16.3.2
29 0 0	EDIT FOR HOLLERITH OUTPUT	16.4.2
29 0 1	EDIT FOR ANELEX OUTPUT	16.4.2

ACTIONS 30 - 31 : DOUBLE LENGTH ARITHMETIC

A d m		
30 0 m	TRANSFER (AB) to N+2', N'	7.2
30 1 m	COPY (AB) to N+2', N'	7.2
31 0 m	ADD (N+2'), (N') to (AB)	7.2
31 1 m	SUBTRACT (N+2'), (N') from (AB)	7.2

APPENDIX C : OPERATORS CONTROLS AND INDICATORS

This appendix gives the layouts of the control panels on peripheral equipment, and on the operators' control desk.

It does not show engineers controls, e.g. assembler control panels and engineers' control cabinet.

The following symbols are used on all diagrams:

Lamps



Neons



Keys



Rotary Switches



Abbreviations for lamp colours are as follows:

A : Amber

B : Blue

G : Green

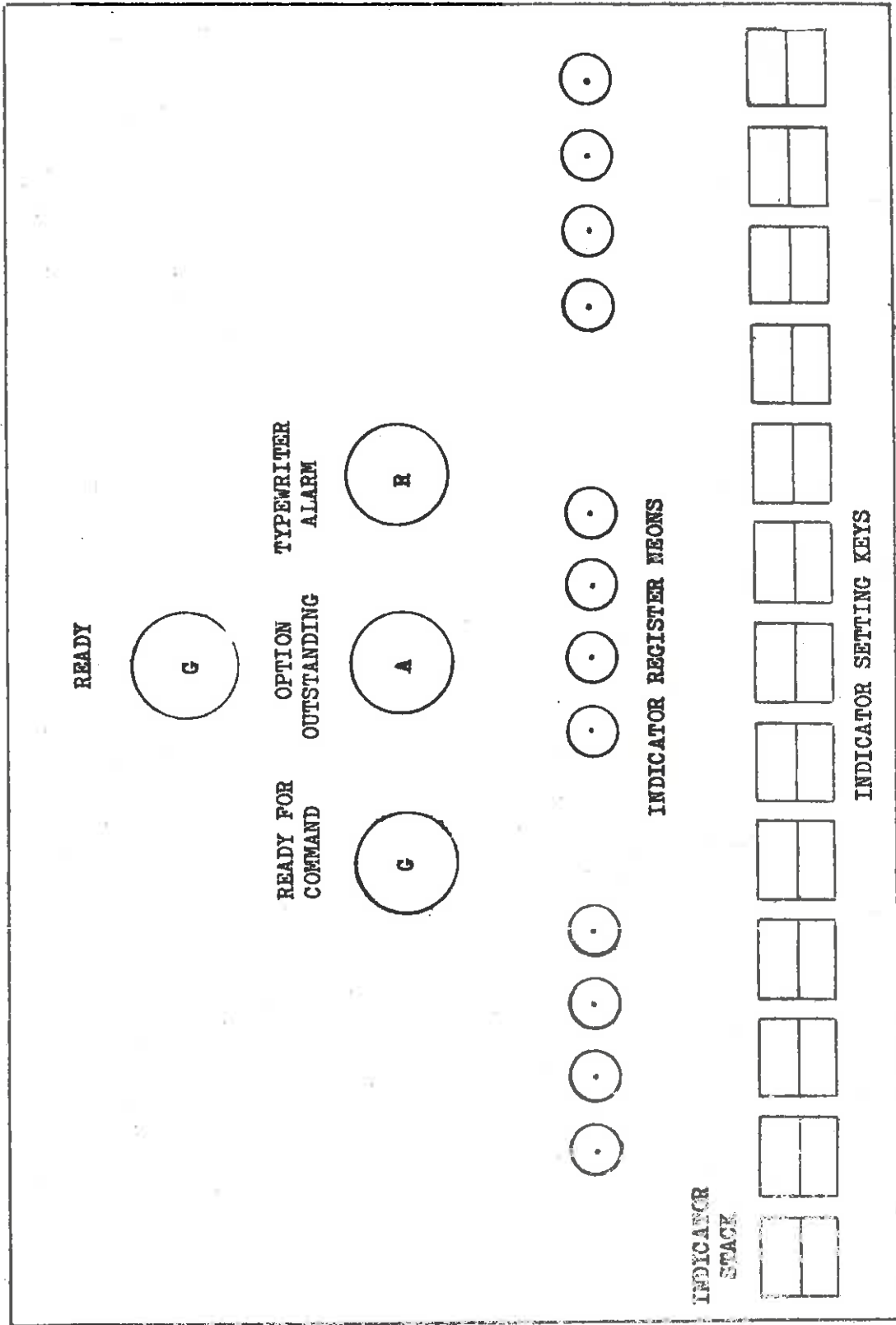
R : Red

W : White

OPERATORS' CONTROL DESK

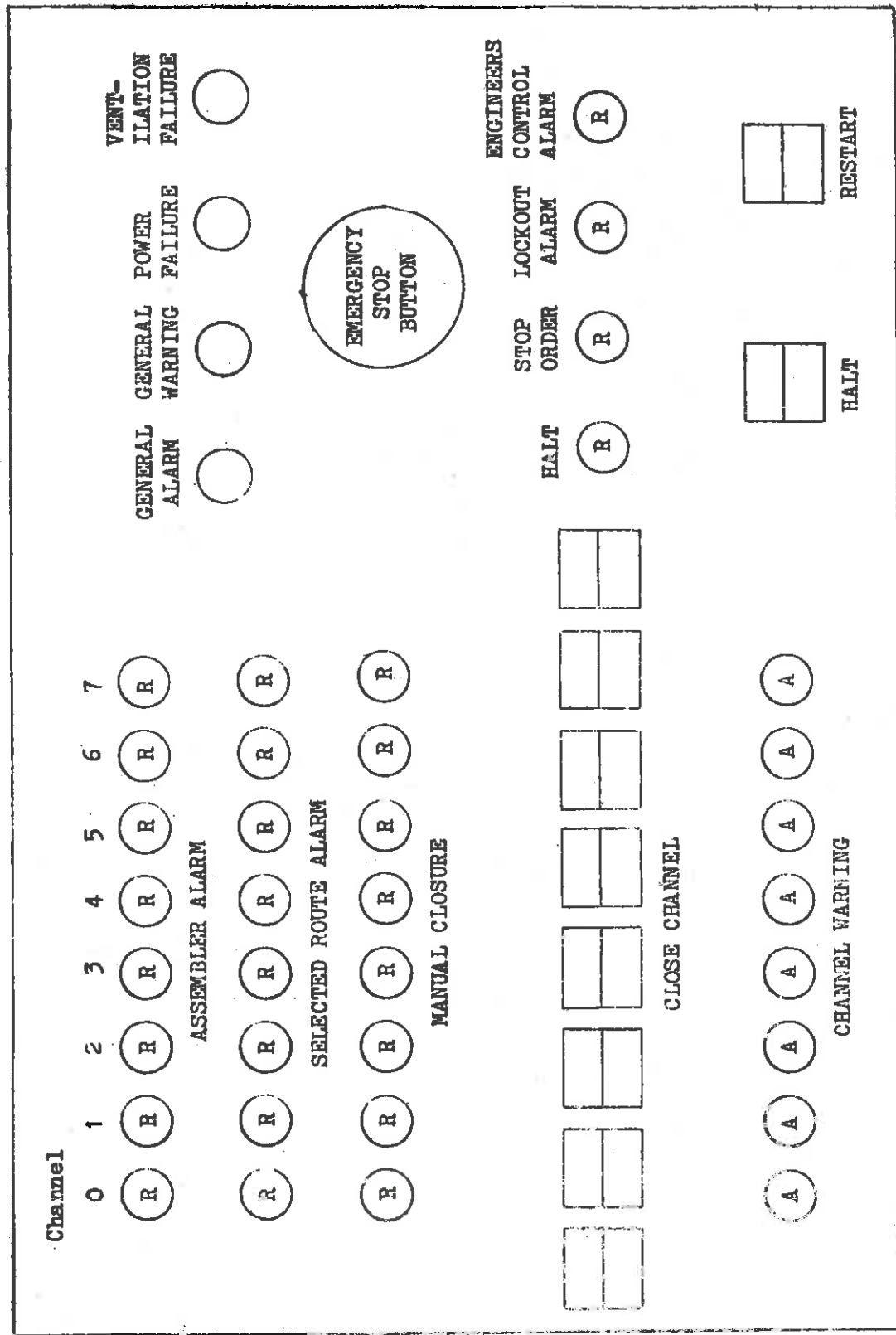
<u>Typewriter Control Panel</u>	<u>Left-Hand Panel</u> (Manual closure keys for all channels; assembler and route alarms; miscellaneous alarms)		<u>Right-hand Panel</u> (Controls for communication between operator and Master Programme)
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OPERATORS' CONTROL DESK  
RIGHT-HAND PANEL

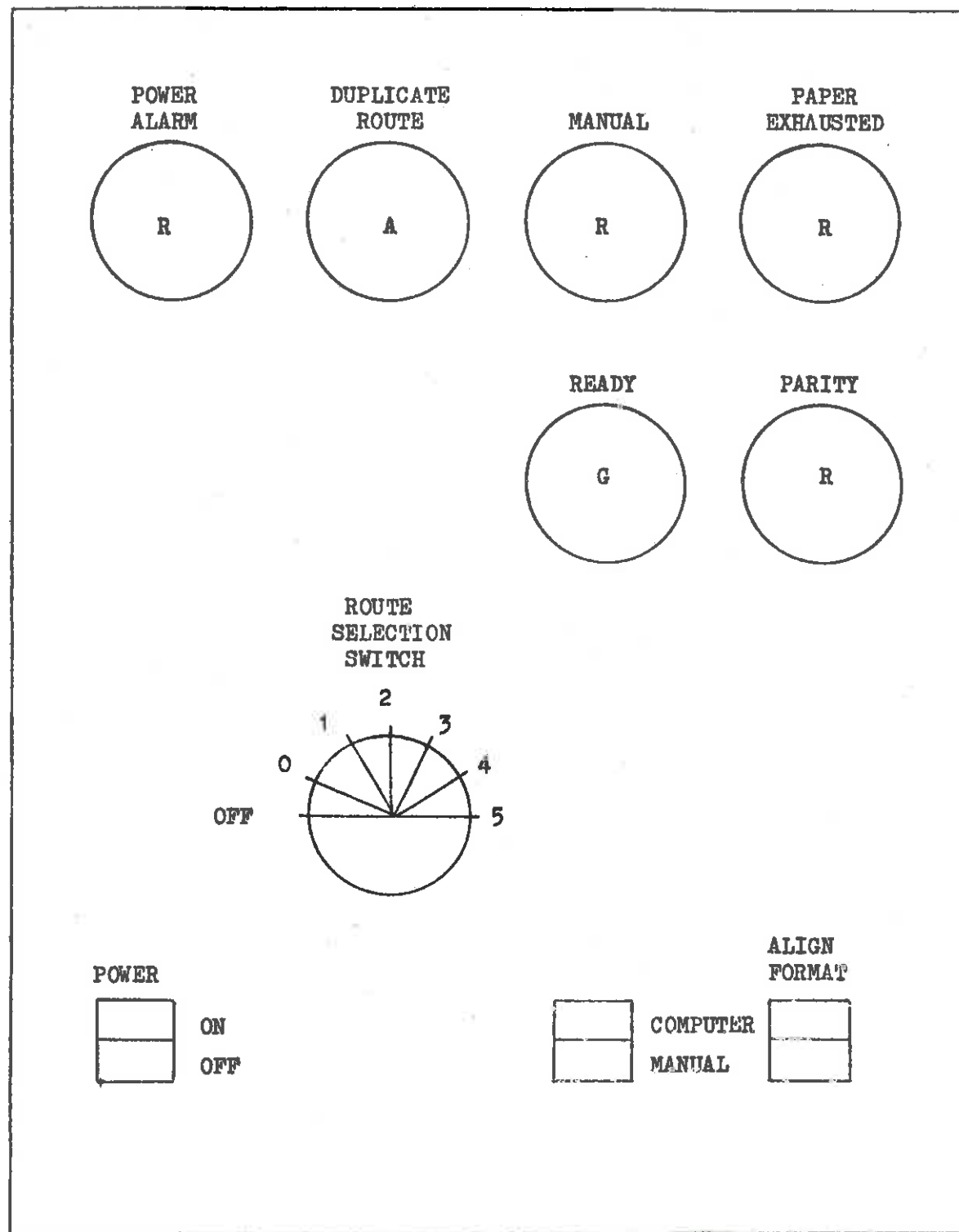




OPERATORS' CONTROL DESK  
LEFT-HAND PANEL



TYPEWRITER CONTROL PANEL



IBM TYPEWRITER KEYBOARD LAYOUT

A

Standard Keyboard

III/2 to III/5 only

)	⊙	*	→	-	=	∕	&	+	(	15	
0	1	2	3	4	5	6	7	8	9	10	11

½		§	¼	£		:				⊙
Q	W	E	R	T	Y	U	I	O	P	&

∕			¼		11		/	Sp	I
A	S	D	F	G	H	J	K	L	-

						;	?	.	O
Z	X	C	V	B	N	M	&	.	/

B

III/1 and III/6 onwards special keyboard

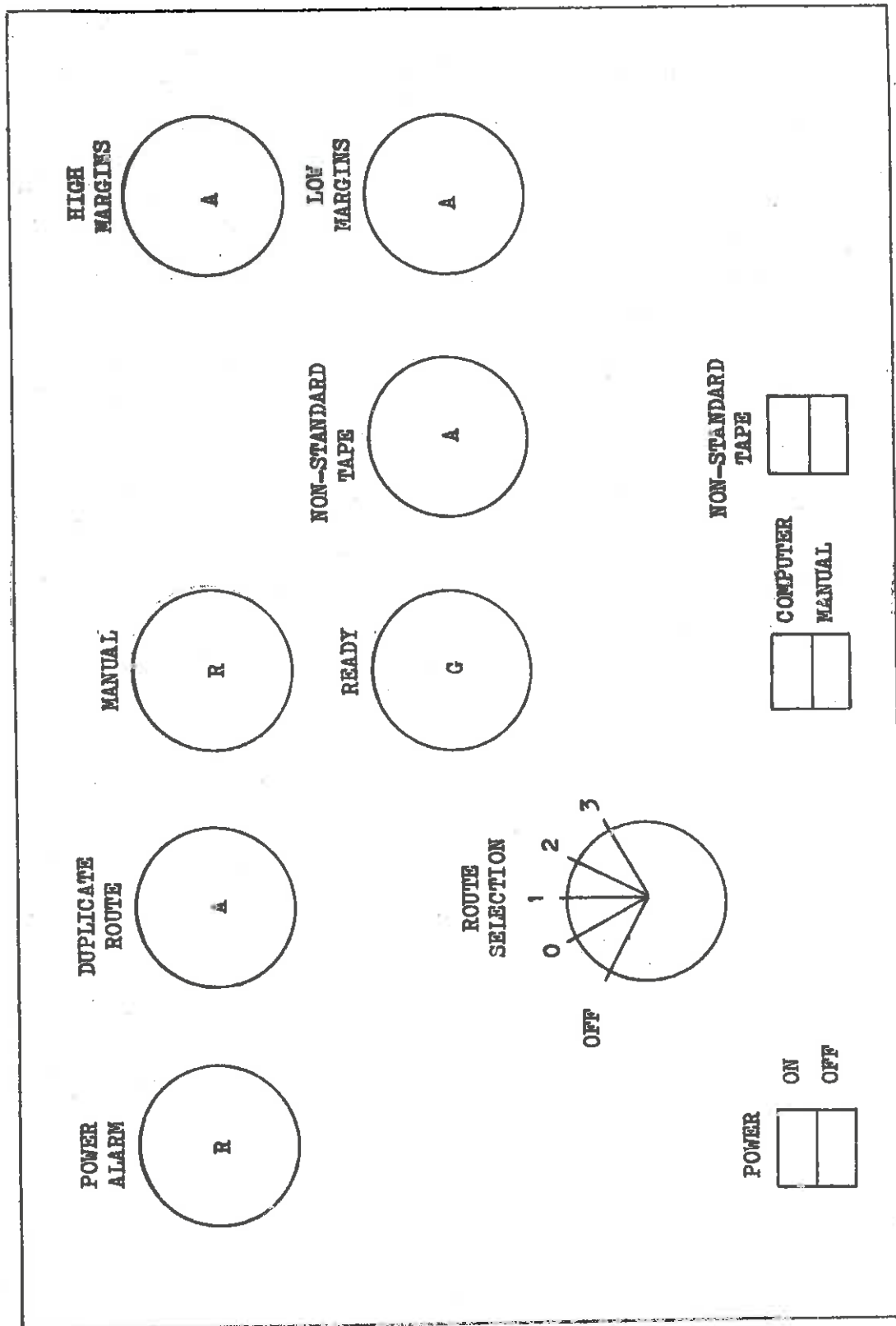
		10	11	+	:	.	£				
0	1	2	3	4	5	6	7	8	9		

		?		)		,		½		
Q	W	E	R	T	Y	U	I	O	P	

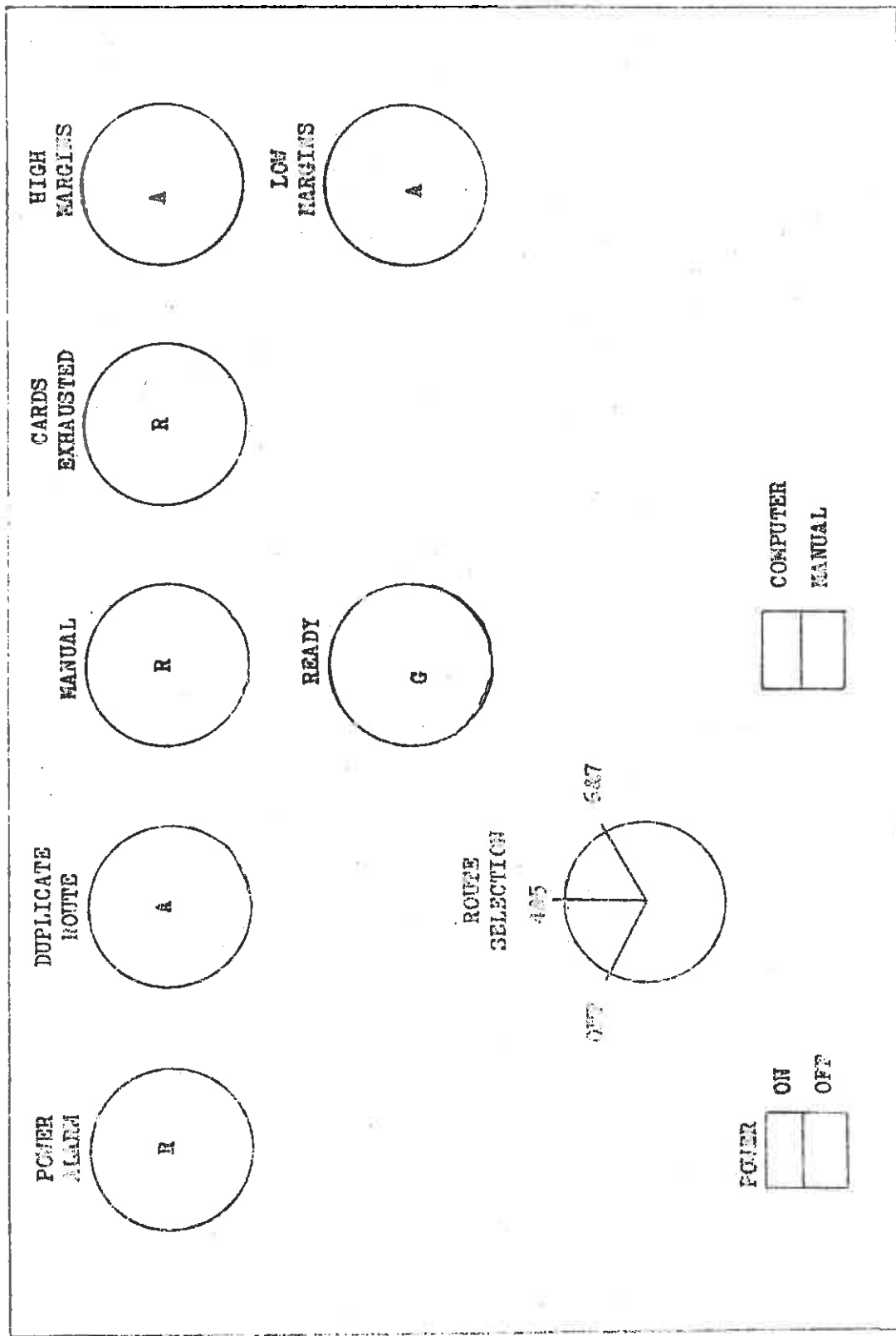
	(	'	□			→	§	Sp		
A	S	D	F	G	H	J	K	L	-	

	△	⊙		=						
Z	X	C	V	B	N	M	&	/		

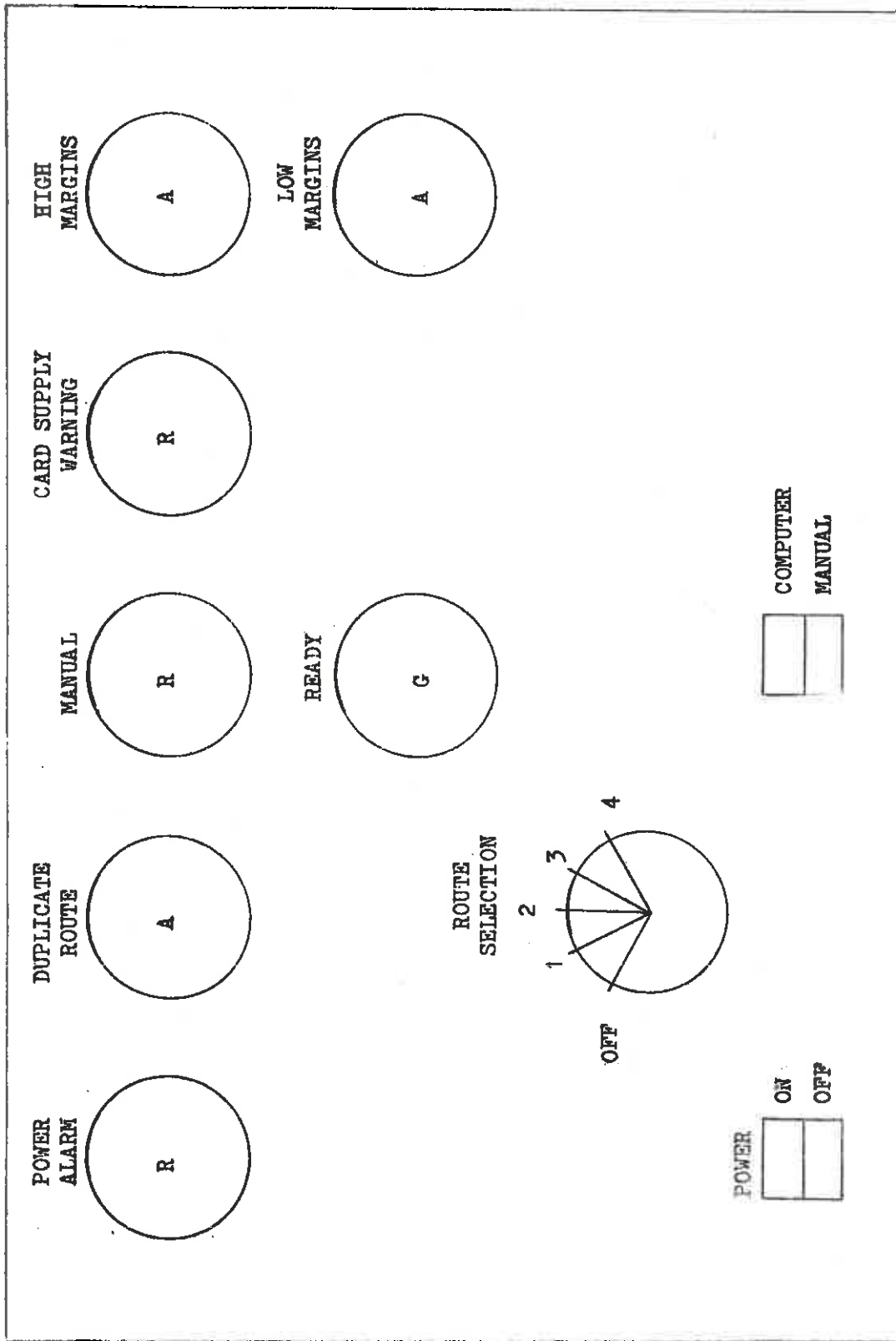
PAPER TAPE READER  
CONTROL PANEL



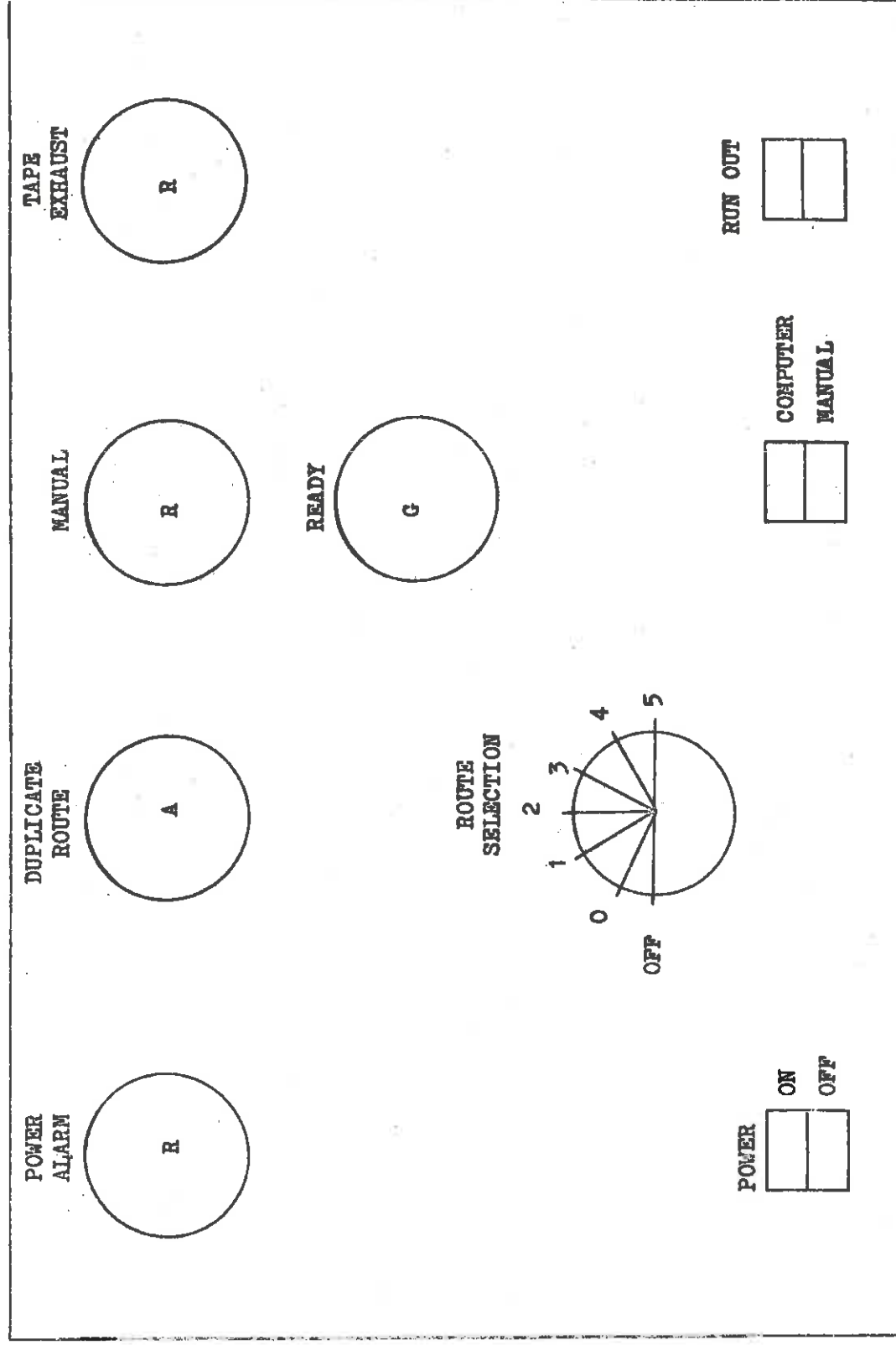
ELLIOTT CARD READER  
CONTROL PANEL



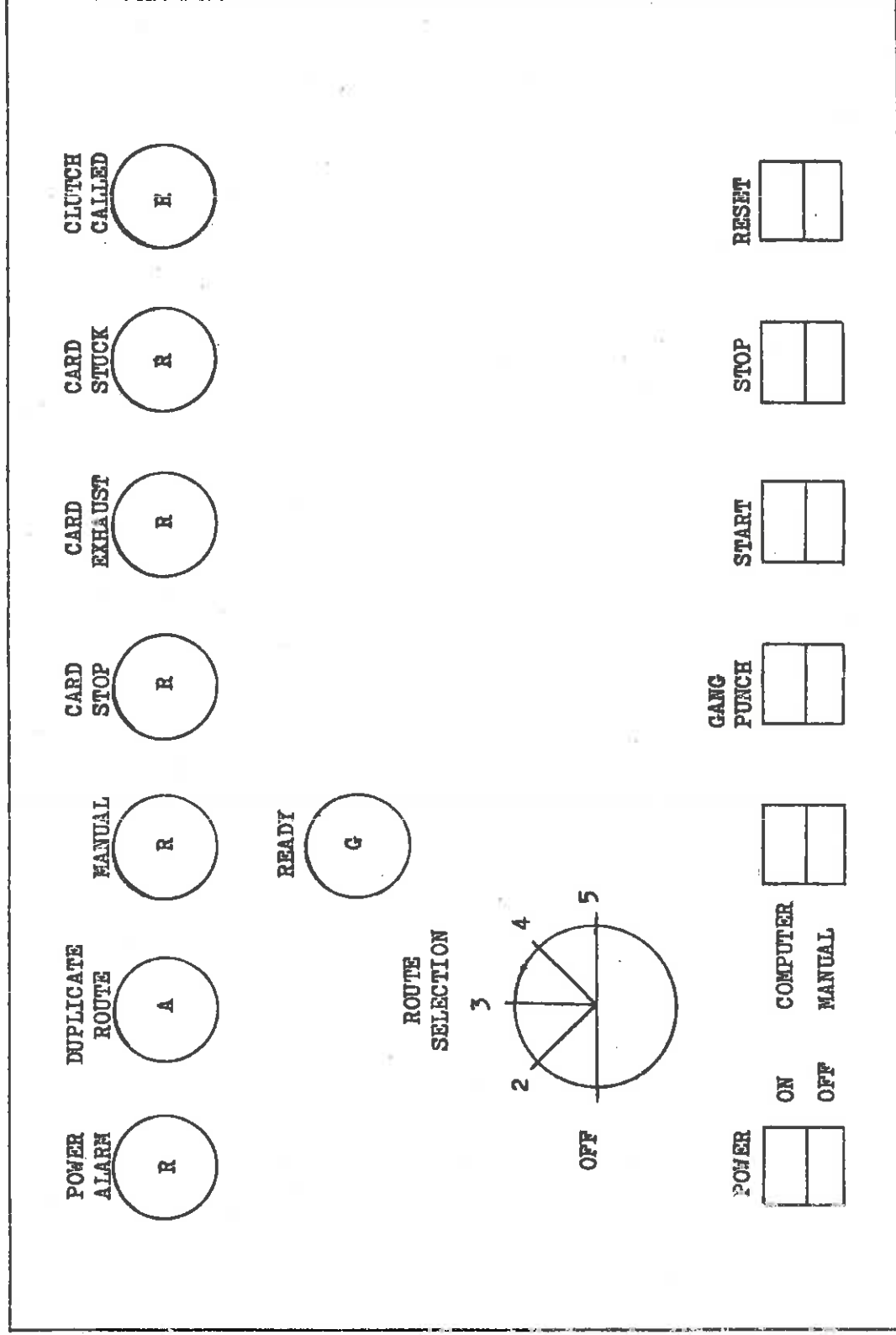
I.C.T. CARD READER  
CONTROL PANEL



PAPER TAPE PUNCH  
CONTROL PANEL

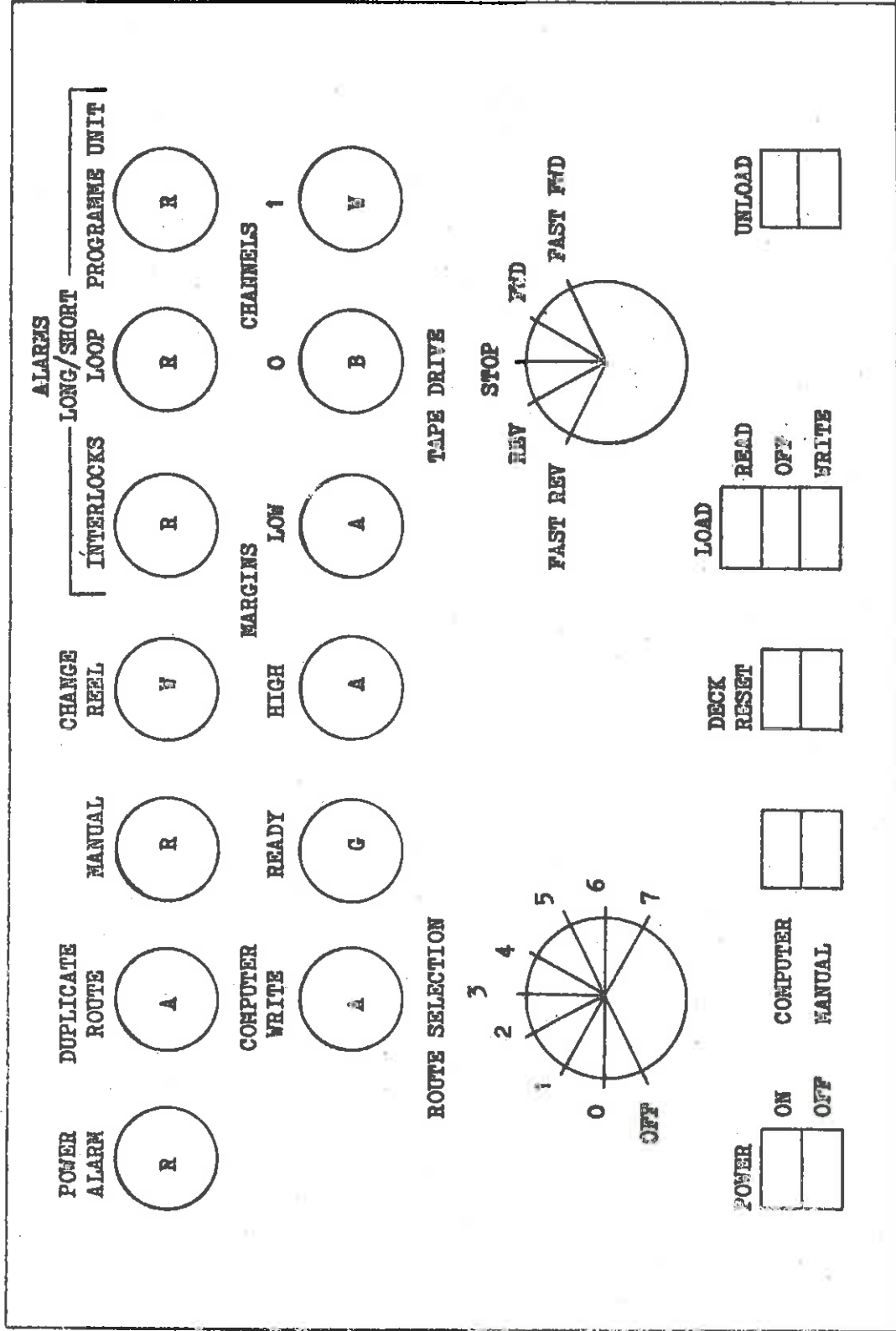


CARD PUNCH  
CONTROL PANEL

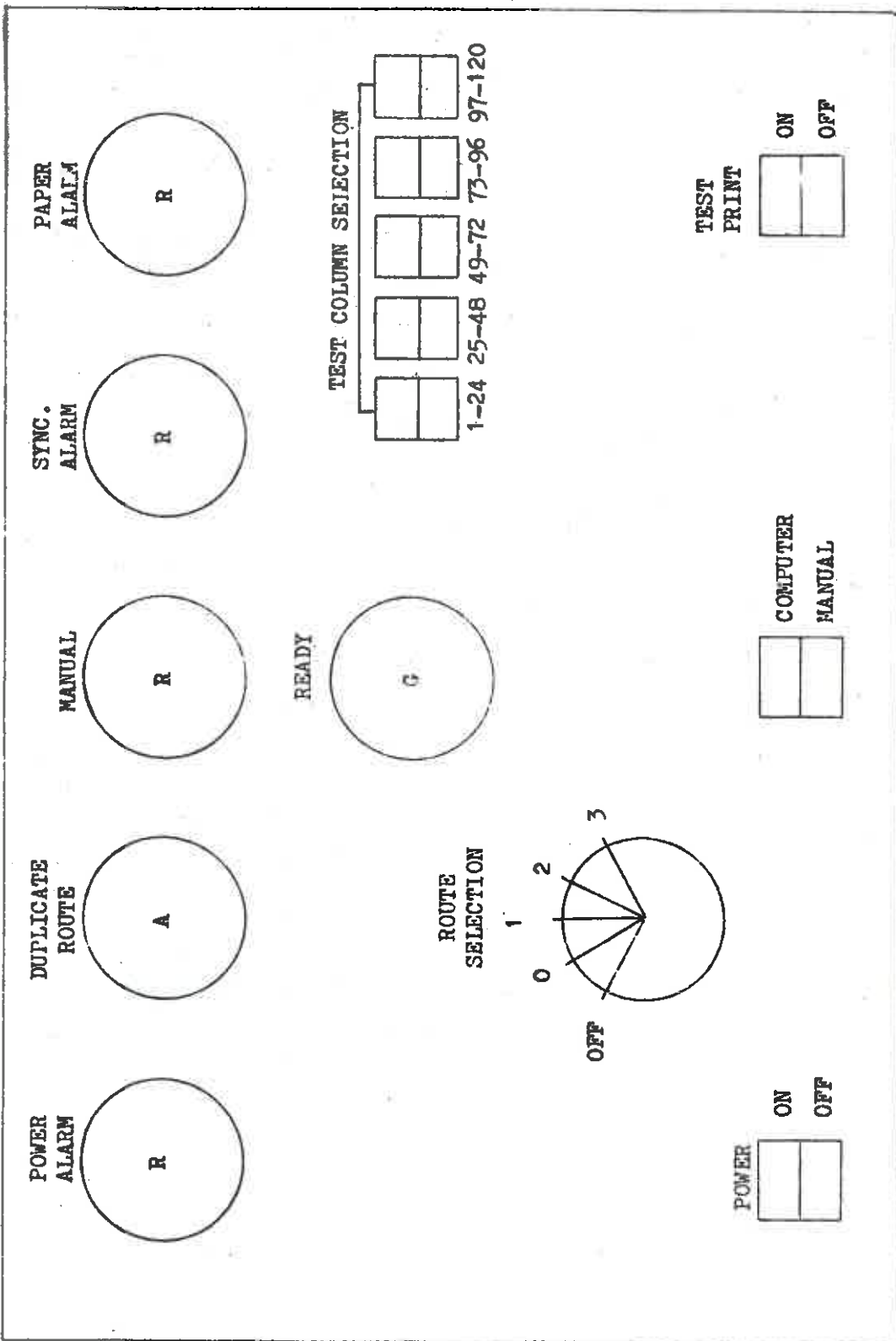




MAGNETIC TAPE DECK  
CONTROL PANEL  
(AmpeX TM2)



PRINTER  
CONTROL PANEL



## Appendix D

### APPENDIX D : SAMPLE COMPUTER CODE ACTION TIMES

This appendix gives approximate action times in units of ten micro-seconds for all computer code instructions. These times are not accurate to more than 10 to 15%.

Appendix D

Action 0 : HALT AND REGISTER FACILITIES

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
0	0	0	HALT	2
0	d	2	SET (N) for collation in B	3
0	0	3	SET RADIX	3
0	1	0	COPY (A), (B), (C)	9
0	1	1	REPLACE (A), (B), (C)	7

## Appendix D

Action 1 : ARITHMETIC ON LITERALS, TABLE LOOK-UP, ROUND OFF AND SPECIAL FACILITIES

<u>Action</u>	<u>d</u>	<u>m</u>		<u>Time in Units</u> <u>of 10 microseconds</u>
1	d	0	TABLE LOOK-UP. K = number of locations inspected	3K
1	0	1	SET QUARTETS for collation in B	4
1	0	2	ROUND OFF	7
1	0	3	INTERCHANGE AREA ADDRESSES	8
1	1	1	ADD literal	5
1	1	2	SUBTRACT literal	4
1	1	3	SELECT literal	4

## Appendix D

Actions 2 - 15 : ARITHMETIC ON VARIABLES, MERGE, CONVERSION AND PATTERN  
MANIPULATION

Action	d	m		<u>Time in Units of 10 microseconds</u>
2	d	m	TRANSFER	4
3	d	m	COPY	4
4	d	m	ADD	4
5	d	m	SUBTRACT	4
6	d	m	SELECT	3
7	d	m	AUGMENT	6
8	d	O	MERGE	11
			n = number of items merged	+15n
			x = number of words written	+ 3x
			p = number of comparisons made	+ 4p
9	d	m	MULTIPLY	40 + 2n
			Repeat with same multiplier	20 + 2n
10	d	m	MULTIPLY and ADD	23 + 21n
			n = sum of digits in multiplier	
11	d	m	MULTIPLY and SUBTRACT	23 + 21n
			n = sum of digits in multiplier	
12	d	m	CONVERT	10 + 20n
			n = sum of digits in number	
13	d	m	DIVIDE	51 + 20n
			n = sum of digits in quotient	
14	d	m	REPLACE by collation	8
15	d	m	COLLATE	5

Modification

If instruction address is modified, add 2 to above figures.

Appendix D

Action 17 : SET AND COPY without change of form

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
17	0	0	SELECT without change of form	6
17	1	0	COPY without change of form	6

Appendix D

Action 18 : SHIFT

Action d m

		<u>Time in Units</u> <u>of 10 microseconds</u>
18	0/1 0/1	SHIFT LEFT n digits
		$3 + n/2$
		SHIFT RIGHT n digits
		$4 + n/2$
18	0/1 2	SCALE for division
		n = number of non-significant zeros in (AB)
		(AB) > 0
		$11 + n/2$
		(AB) < 0
		$12 + 3n/2$
		(AB) = 0
		16
18	0/1 3	BINARY LEFT SHIFT n bits
		$4 + 2n$



Appendix D

Action 19 : FILE CONTROL

Action d m

Time in Units  
of 10 microseconds

19 d m TEST ROUTE engaged and take action  
accordingly.

9

## Appendix D

Actions 20 - 22 : FLOATING POINT ARITHMETIC

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
20	0	m	FLOATING POINT ADD	$23 + 3p/2$
				→ $37 + 3p/2 + 3n/2$
20	1	m	FLOATING POINT SUBTRACT	$24 + 3p/2$
			where:	→ $37 + 3p/2 + 3n/2$
			p = difference between the exponents	
			n = number of bit shifts required to normalise the sum of the 'mantissa with the greater exponent' and 'the right shifted exponent with lesser mantissa'	
21	0	m	FLOATING POINT TRANSFER	13
21	1	m	FLOATING POINT COPY	11
22	0	m	FLOATING POINT MULTIPLY	
			normalised arithmetic	$93 - n$
			significant digit arithmetic	$92 - n + 3/2x + y/2$
			Repeat with same multiplier:	
			normalised arithmetic	$68 - n$
			significant digit arithmetic	$67 - n + 3/2x + y/2$
			where:	
			n = number of zero quartets in modulus of mantissa of multiplier	
			x = number of bit shifts to normalise greater mantissa modulus	
			y = number of bit shifts to normalise lesser mantissa modulus	

Action d m

22 1 m

FLOATING POINT DIVIDE  
 normalised arithmetic  
 significant digit arithmetic  
 where:

Time in Units  
of 10 microseconds

$$47 + 2n_0 + 2n_1$$

$$122 - n_0/2 - n_1/2$$

$n_0$  = number of zero bits in  
 quotient mantissa to the right  
 of most significant bit

$n_1$  = number of unity bits in  
 quotient mantissa

Modification

If the instruction address is modified, add 2 to the  
 above figures.

## Appendix D

Action 23 : INDIRECT MODIFICATION AND LOCKOUT FACILITIES

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
23	0	0	STEP ON and TEST indirect modifier	9
23	0	2	ENTER MASTER PROGRAMME and set TAG	8
23	0	3	SELECT TAG	3
23	1	m	COPY (A) into TAG	4

## Appendix D

Action 24 : MODIFY NEXT INSTRUCTION ADDRESS AND OTHER FACILITIES

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
24	0	0	MODIFY DIVISION NUMBER AND ADDRESS WITHIN DIVISION OF NEXT INSTRUCTION  n = number of compartments searched	3 + 4n
24	0	1	MODIFY DIVISION NUMBER AND ADDRESS WITHIN DIVISION OF NEXT INSTRUCTION BY (N)	4
24	0	2	SELECT N	3
24	0	3	SUPPRESS DIVISION NUMBER OF ADDRESS OF NEXT INSTRUCTION: THEN MODIFY ADDRESS OF NEXT INSTRUCTION BY (N)	4
24	1	0	UNCONDITIONAL SEQUENCE CHANGE	2
24	1	1	SELECT MODIFICATION GROUP	3
24	1	2	SUPPRESS DIVISION NUMBER OF ADDRESS OF NEXT INSTRUCTION AND THEN MODIFY ADDRESS OF NEXT INSTRUCTION  n = number of compartments searched	2 + 4n
24	1	3	COPY INDICATORS	6

Appendix D

Action 25 : MODIFICATION AND INDICATOR FACILITIES

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
25	0	m	STEP ON AND TEST modifier	6
25	1	0	SET INDICATORS	2
25	1	1	RESET INDICATORS	2
25	1	2	COLLATE INDICATORS	2
25	1	3	CONDITIONAL HALT	4

## Appendix D

Action 26 : MODIFICATION AND SUBROUTINE FACILITIES AND TESTS FOR ROUTES

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
26	0	0	ENTER SUBROUTINE	3
26	0	1	LEAVE SUBROUTINE	3
26	0	2	ENTER PRIORITY CONTROL	4
26	0	3	EXIT FROM MASTER PROGRAMME	4
26	1	0	TEST ROUTE	5
26	1	m	SET MODIFICATION REGISTER at (N')	8

## Appendix D

Action 27 : TEST ACCUMULATOR

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
27	0	0	CHANGE SEQUENCE if (A) = 0	3
27	0	1	CHANGE SEQUENCE if (A) $\neq$ 0	3
27	0	2	CHANGE SEQUENCE if (A) $\geq$ 0	2
27	0	3	CHANGE SEQUENCE if (A) < 0	2
27	1	0	CHANGE SEQUENCE if (AB) = 0	4
27	1	1	CHANGE SEQUENCE if (AB) $\neq$ 0	4



Actions 28 and 29 : DATA RE-ARRANGEMENTS

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
28	d	0/1	BULK COPY n short or long words	
			if $n < 16$	$16 + 6n$
			if $n \geq 16$	$16 + 3n$
28	d	0/1	BULK CLEAR n short or long words	
			if $n < 16$	$16 + 5n$
			if $n \geq 16$	$16 + 2n$
28	0	2	UNPACK FIXED FIELD DATA	5+
			n = number of words unpacked	8n
			x = number of words written	+6x
28	0	3	UNPACK VARIABLE FIELD DATA	6
			n = number of words unpacked	+11n
			x = number of words written	+6x
			t = number of table entries	+2t
28	1	2	EDIT	7
			$n_1$ = number of short word items edited	+11 $n_1$
			$n_2$ = number of long word items edited	+6 $n_2$
			x = number of words written	+10x
			d = number of discarded quartets	+d/2
28	1	3	CONDENSE	7
			$n_1$ = number of short word items edited	+8 $n_1$
			$n_2$ = number of long word items edited	+5 $n_2$
			t = number of table entries	+3t
			x = number of words written	+7x
			d = number of quartets discarded from non-zero items	+d/2

## Appendix D

## Actions 28 and 29 (Cont'd)

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
29	0	0	EDIT FOR HOLLERITH OUTPUT	52
			$n_1$ = number of non-space alphabetic characters, etc.	$+14n_1$
			$n_2$ = number of non-zero numeric characters	$+9n_2$
			$n_3$ = number of space characters	$+3n_3$
29	0	1	EDIT FOR ANELEX OUTPUT	12
			$n_1$ = number of non-space characters	$+9n_1$
			$n_2$ = number of space characters	$+4n_2$

## Appendix D

Actions 30 and 31 : DOUBLE LENGTH ARITHMETIC

Action	d	m		<u>Time in Units</u> <u>of 10 microseconds</u>
30	0	m	DOUBLE LENGTH TRANSFER	
			(AB) $\geq$ 0	6
			(AB) < 0	10
30	1	m	DOUBLE LENGTH COPY	
			(AB) $\geq$ 0	6
			(AB) < 0	10
31	0	m	DOUBLE LENGTH ADD	8
31	1	m	DOUBLE LENGTH SUBTRACT	9

Modification

If instructions address is modified, add 2 to the above figures.

APPENDIX E : USE OF STORE COMPARTMENTS IN DIVISION 0

Certain compartments in division 0 of the store have special uses and their use for other purposes should be avoided by programmes.

A full list is given below. Compartments shown as being used by certain actions are working locations used within the actions. Their contents will not necessarily be preserved when these actions are used

<u>Compartment</u>	<u>Use</u>	
0	Actions 18, 29	
1	Actions 8, 19, 20, 21, 22, 28, 29	
2	Current value	} mod. reg. 1
3	End value	
4		
5		} mod. reg. 2
6		
7		
8	Link set up on Interruption	} mod. reg. 3
9	Set up by Master Programme at 26/0/1/0/2	
10		} mod. reg. 1
11		
12		
13		
14		} mod. reg. 2
15		
16	Link set up on lockout	
17	Set up as sequence change to lockout routine	} mod. reg. 3

mod. group 0

Interruption

mod. group 1

Lockout

Appendix B

<u>Compartment</u>	<u>Use</u>	
18	mod. reg. 1	} mod. group 2
19		
20	mod. reg. 2	
21		} Overflow
22	mod. reg. 3	
23		
24	Link set up on overflow	} Overflow
25	Set up as sequence change to overflow routine	
26	mod. reg. 1	} mod. group 3
27		
28	mod. reg. 2	
29		
30	mod. reg. 3	} Actions 8, 28, 29
31		
32		
33		
34		
35		
⋮		
62	Actions 9, 22	} also containing in Q5 key of programme using this route
63		
64	Transit area start location for route 0	
65	Transit area start location for route 1	
⋮		
126	Transit area start location for route 62	
127	Transit area start location for route 63	

Appendix E

<u>Compartment</u>	<u>Use</u>
128	Floating point accumulator (A <sup>2</sup> )
129	
130	
131	
132	Actions 20, 21, 22
133	
134	Action 22
135	
136	
137	No fixed use (used by Master Programs)
138	
139	
⋮	
152	Paper tape assembler; next word to be output
153	
154	
155	24-hour clock; time copied every 6 seconds
156	
157	Millisecond timer; value copied every millisecond
158	
159	

Appendix F

APPENDIX F : TRANSFER RATES FOR PRINTERS AND TAPE DECKS

This appendix gives detailed tables of the transfer rates for the Anelex 56-160 and Series 4 Printer. Tables for the Ampex FR300, TM2 and TM4 decks are also given.

Basis of Table 1

$$\frac{60 \times 1000}{\text{r.p.m.}} + \frac{14.6L + 25.2}{2} \text{ milliseconds}$$

	<u>56/160</u>	<u>4/1000</u>
Acceleration Time	= 1.3 mS	1.1 mS
Paper Movement	= 6.6 mS per line	8 mS per line
Stop Time	= 10 mS	2.4 mS

Note: On the Anelex 56/160 the sum of items 1, 2 and 3 cannot be less than 30 milliseconds. All times shown are the average of the 56/160 and the 4/1000 printers. Use for LEO III/1 only.

## Appendix F

TABLE 1 : TRANSFER TIME, AVERAGE OF ANELEX 56/160 and 4/1000

One line of print preceded by the following paper movement (L)	800 r.p.m.	1200 r.p.m.
1 Line Feed	95	70
2	102	77
3	110	85
4	117	92
5	124	99
6 (1")	131	105
7	139	114
8	146	121
9	153	128
10	161	136
11	168	143
12 (2")	175	150
13	183	158
14	190	165
15	197	172
16	204	179
17	212	187
18 (3")	219	194
19	226	201
20	234	209
21	241	216
22	248	223
23	256	231
24 (4")	263	238

milliseconds



Appendix F

Basis of Table 2

$$\frac{60 \times 1000}{\text{r.p.m.}} + 8L + 11.5 \text{ milliseconds}$$

Acceleration Time = 1.1 mS  
Paper Movement = 8 mS per line at 21 inches per second  
Stop Time = 2.4 mS

Note: This table is for use with all machines from LEO III/2 other than those noted in table 3 basis.

## Appendix F

TABLE 2 : TRANSFER TIME, ANELEX 4/1000

One line of print preceded by the following paper movement (L)	800 r.p.m.	1200 r.p.m.
1 Line Feed	95	70
2	103	78
3	111	86
4	119	94
5	127	102
6 (1")	135	110
7	143	118
8	151	126
9	159	134
10	167	142
11	175	150
12 (2")	183	158
13	191	166
14	199	174
15	207	182
16	215	190
17	223	198
18 (3")	231	206
19	239	214
20	247	222
21	255	230
22	263	238
23	271	246
24 (4")	279	254

milliseconds

Basis of Table 3

$$\frac{60 \times 1000}{\text{r.p.m.}} + 8L + 11.5 \text{ milliseconds}$$

Acceleration Time	=	1.1 mS
Paper Movement	=	8 mS per line at 21 inches per second
Stop Time	=	8 mS
Master Programme Time	=	2.4 mS

Note: This table is for use for printers having the faster motor.

TABLE 3 : TRANSFER TIME, ANELEX 4/1000

One line of print preceded by the following paper movement (L)	1000 r.p.m.	1500 r.p.m.
1 Line Feed	80	60
2	88	68
3	96	76
4	104	84
5	112	92
6 (1")	120	100
7	128	108
8	136	116
9	144	124
10	152	132
11	160	140
12 (2")	168	148
13	176	156
14	184	164
15	192	172
16	200	180
17	208	188
18 (3")	216	196
19	224	204
20	232	212
21	240	220
22	248	228
23	256	236
24 (4")	264	244

milliseconds

## Appendix F

TABLE 4 : CURRENT DATA FOR ANPEX MAGNETIC TAPE DECKS TYPES FR300, TM2, TM4

	FR300	TM2	TM4
Packing density, ch./in.	375	375	375
Packing density, ch./ft.	4,500	4,500	4,500
Interblock time*, sec.	0.01395	0.01395	0.01965
Interblock time*, min.	.0002325	.0002325	.0003275
Interblock gap, in.	1.30	1.27	1.25
Interblock gap, ft.	.108333	.105833	.104167
Transfer rate, ch./sec.	45,000 <sub>6</sub>	45,000 <sub>6</sub>	28,125
Transfer rate, ch./min.	$2.7 \times 10^6$	$2.7 \times 10^6$	$1.6875 \times 10^6$
Tape speed, in./sec.	120	120	75
Tape speed, ft./sec.	10	10	6.25
Rewind speed, in./sec.	180	240	180
Rewind speed, ft./min.	900	1000	900

\* includes Master Programme time of 3.1 milliseconds.

Appendix F

TABLE 5 : TRANSFER TIME, AMPEX FR300

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	.03	.03	.04	.04	.04	.05	.05	.05	.06	.06	.07
200	.06	.07	.07	.08	.09	.09	.10	.11	.12	.12	.13
300	.10	.10	.11	.12	.13	.14	.15	.16	.17	.19	.20
400	.13	.14	.14	.16	.17	.19	.20	.22	.23	.25	.26
500	.16	.17	.18	.20	.22	.24	.25	.27	.29	.31	.33
600	.19	.20	.22	.24	.26	.28	.30	.33	.35	.37	.39
700	.23	.24	.25	.28	.30	.33	.36	.38	.41	.43	.46
800	.26	.27	.29	.32	.35	.38	.41	.44	.46	.49	.52
900	.29	.30	.32	.36	.39	.42	.46	.49	.52	.56	.59
1000	.32	.34	.36	.40	.43	.47	.51	.54	.58	.62	.66
2000	.64	.68	.72	.79	.87	.94	1.01	1.09	1.16	1.24	1.31
3000	.96	1.02	1.08	1.19	1.30	1.41	1.52	1.63	1.74	1.85	1.96
4000	1.29	1.36	1.43	1.58	1.73	1.88	2.03	2.17	2.32	2.47	2.62
5000	1.61	1.70	1.79	1.98	2.16	2.35	2.53	2.72	2.90	3.09	3.27
6000	1.93	2.04	2.15	2.37	2.59	2.82	3.04	3.26	3.48	3.71	3.93
7000	2.25	2.38	2.51	2.77	3.03	3.29	3.55	3.80	4.06	4.32	4.58
8000	2.57	2.72	2.87	3.16	3.46	3.76	4.05	4.35	4.64	4.94	5.24
9000	2.89	3.06	3.22	3.56	3.89	4.22	4.56	4.89	5.22	5.56	5.89
10000	3.21	3.40	3.58	3.95	4.32	4.69	5.06	5.43	5.80	6.16	6.55
20000	6.42	6.79	7.16	7.91	8.65	9.39	10.13	10.87	11.61	12.35	13.09
30000	9.64	10.19	10.75	11.86	12.97	14.08	15.19	16.30	17.41	18.53	19.64
40000	12.85	13.59	14.33	15.81	17.29	18.77	20.26	21.74	23.22	24.70	26.18
50000	16.06	16.99	17.91	19.76	21.62	23.47	25.32	27.17	29.02	30.88	32.72
60000	19.27	20.38	21.49	23.72	25.94	28.16	30.38	32.61	34.83	37.05	39.27
70000	22.48	23.78	25.07	27.67	30.26	32.85	35.45	38.04	40.63	43.23	45.82
80000	25.70	27.18	28.66	31.62	34.59	37.55	40.51	43.47	46.44	49.40	52.36
90000	28.91	30.57	32.24	35.58	38.91	42.24	45.58	48.91	52.24	55.58	58.91

Transfer time (T) given in minutes

Basic formula for table:  $T = \frac{NC}{2,700,000} + .000284167N$

Appendix F

TABLE 6 : TAPE LENGTH, AMPEX FR300

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	13	14	15	18	20	22	24	26	29	31	33
200	26	28	31	35	39	44	48	53	57	62	66
300	39	43	46	53	59	66	73	79	86	93	99
400	52	57	61	70	79	88	97	106	114	123	132
500	65	71	76	88	99	110	121	132	143	154	165
600	78	85	92	105	118	132	145	158	172	185	198
700	91	99	107	123	138	154	169	185	200	216	231
800	104	113	122	140	158	176	193	211	229	247	264
900	118	128	138	158	178	198	218	238	258	278	298
1000	131	142	153	175	197	219	242	264	286	308	331
2000	261	283	306	350	394	439	483	528	572	617	661
3000	392	425	458	525	592	658	725	792	858	925	992
4000	522	567	611	700	789	878	967	1056	1144	1233	1322
5000	653	708	764	875	986	1097	1208	1319	1431	1542	1653
6000	783	850	917	1050	1183	1317	1450	1583	1717	1850	1983
7000	914	992	1069	1225	1381	1536	1692	1847	2003	2158	2314
8000	1044	1133	1222	1400	1578	1755	1933	2111	2289	2467	2644
9000	1175	1275	1375	1575	1775	1975	2175	2375	2575	2775	2975
10000	1305	1417	1528	1750	1972	2194	2417	2639	2861	3083	3305
20000	2611	2833	3055	3500	3944	4389	4833	5278	5722	6167	6611
30000	3917	4250	4583	5250	5917	6583	7250	7917	8583	9250	9917
40000	5222	5667	6111	7000	7889	8778	9667	10556	11444	12333	13222
50000	6528	7083	7639	8750	9861	10972	12083	13194	14306	15417	16528
60000	7833	8500	9167	10500	11833	13167	14500	15833	17167	18500	19833
70000	9139	9917	10694	12250	13806	15361	16917	18472	20028	21583	23139
80000	10444	11333	12222	14000	15778	17555	19333	21111	22889	24667	26444
90000	11750	12750	13750	15750	17750	19750	21750	23750	25750	27750	29750

Number of Blocks (N)

Tape length (L) given in feet.

Basic formula for table:  $L = \frac{NC}{4,500} + .108333N$

Appendix F

TABLE 7 : REWIND TIME, AMPEX FR300

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	.02	.02	.02	.02	.02	.02	.03	.03	.03	.03	.04
200	.03	.03	.03	.04	.04	.05	.05	.06	.06	.07	.07
300	.04	.05	.05	.06	.07	.07	.08	.09	.10	.10	.11
400	.06	.06	.07	.08	.09	.10	.11	.12	.13	.14	.15
500	.07	.08	.09	.10	.11	.12	.13	.15	.16	.17	.18
600	.09	.09	.10	.12	.13	.15	.16	.18	.19	.21	.22
700	.10	.11	.12	.14	.15	.17	.19	.21	.22	.24	.26
800	.12	.13	.14	.16	.18	.20	.22	.24	.25	.27	.29
900	.13	.14	.15	.18	.20	.22	.24	.26	.29	.31	.33
1000	.15	.16	.17	.19	.22	.24	.27	.29	.32	.34	.37
2000	.29	.32	.34	.39	.44	.49	.54	.59	.64	.69	.74
3000	.44	.47	.51	.58	.66	.73	.81	.88	.95	1.03	1.10
4000	.58	.63	.68	.78	.88	.98	1.07	1.17	1.27	1.37	1.47
5000	.73	.79	.85	.97	1.10	1.22	1.34	1.47	1.59	1.71	1.84
6000	.87	.94	1.02	1.17	1.32	1.46	1.61	1.76	1.91	2.06	2.20
7000	1.02	1.10	1.19	1.36	1.53	1.71	1.88	2.05	2.23	2.40	2.57
8000	1.16	1.26	1.36	1.56	1.75	1.95	2.15	2.35	2.54	2.74	2.94
9000	1.31	1.42	1.53	1.75	1.97	2.19	2.42	2.64	2.86	3.08	3.31
10000	1.45	1.57	1.70	1.94	2.19	2.44	2.69	2.93	3.18	3.43	3.67
20000	2.90	3.15	3.40	3.89							

Rewind time (R) given in minutes.

Basic formula for table:  $R = \frac{NC}{4,050,000} + .000120371N$



Appendix F

TABLE 8 : TRANSFER TIME, AMPEX TM2

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	.05	.03	.04	.04	.04	.05	.05	.05	.06	.06	.07
200	.06	.07	.07	.08	.09	.09	.10	.11	.12	.12	.13
300	.10	.10	.11	.12	.13	.14	.15	.16	.17	.19	.20
400	.13	.14	.14	.16	.17	.19	.20	.22	.23	.25	.26
500	.16	.17	.18	.20	.22	.24	.25	.27	.29	.31	.33
600	.19	.20	.22	.24	.26	.28	.30	.33	.35	.37	.39
700	.23	.24	.25	.28	.30	.33	.36	.38	.41	.43	.46
800	.26	.27	.29	.32	.35	.38	.41	.44	.46	.49	.52
900	.29	.30	.32	.36	.39	.42	.46	.49	.52	.56	.59
1000	.32	.34	.36	.40	.43	.47	.51	.54	.58	.62	.66
2000	.64	.68	.72	.79	.87	.94	1.01	1.09	1.16	1.24	1.31
3000	.96	1.02	1.08	1.19	1.30	1.41	1.52	1.63	1.74	1.85	1.96
4000	1.29	1.36	1.43	1.58	1.73	1.88	2.03	2.17	2.32	2.47	2.62
5000	1.61	1.70	1.79	1.98	2.16	2.35	2.53	2.72	2.90	3.09	3.27
6000	1.93	2.04	2.15	2.37	2.59	2.82	3.04	3.26	3.48	3.71	3.93
7000	2.25	2.38	2.51	2.77	3.03	3.29	3.55	3.80	4.06	4.32	4.58
8000	2.57	2.72	2.87	3.16	3.46	3.76	4.05	4.35	4.64	4.94	5.24
9000	2.89	3.06	3.22	3.56	3.89	4.22	4.56	4.89	5.22	5.55	5.89
10000	3.21	3.40	3.58	3.95	4.32	4.69	5.06	5.43	5.80	6.18	6.55
20000	6.42	6.79	7.16	7.91	8.65	9.39	10.13	10.87	11.61	12.35	13.09
30000	9.64	10.19	10.75	11.86	12.97	14.08	15.19	16.30	17.41	18.53	19.64
40000	12.85	13.59	14.33	15.81	17.29	18.77	20.26	21.74	23.22	24.70	26.18
50000	16.06	16.99	17.91	19.76	21.62	23.47	25.32	27.17	29.02	30.88	32.72
60000	19.27	20.38	21.49	23.72	25.94	28.16	30.38	32.61	34.83	37.05	39.27
70000	22.48	23.78	25.07	27.67	30.26	32.85	35.45	38.04	40.63	43.23	45.82
80000	25.70	27.18	28.66	31.62	34.59	37.55	40.51	43.47	46.44	49.40	52.36
90000	28.91	30.57	32.24	35.58	38.91	42.24	45.58	48.91	52.24	55.58	58.91

Transfer time (T) given in minutes

Basic formula for table:  $T = \frac{NC}{2,700,000} + .00284167N$

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TABLE 9 : TAPE LENGTH, AMPEX TM2

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	13	14	15	17	20	22	24	26	28	31	33
200	26	28	30	35	39	43	48	52	57	61	66
300	38	42	45	52	58	65	72	78	85	92	98
400	51	56	60	69	78	87	96	105	113	122	131
500	64	70	75	86	97	109	120	131	142	153	164
600	77	84	90	104	117	130	144	157	170	184	197
700	90	97	105	121	136	152	167	183	199	214	230
800	102	111	120	138	156	174	191	209	227	245	262
900	115	125	135	155	175	195	215	235	255	275	295
1000	128	139	150	173	195	217	239	261	284	306	328
2000	256	278	301	345	389	434	478	523	567	612	656
3000	384	418	451	518	584	651	718	784	851	918	984
4000	512	557	601	690	779	868	957	1046	1134	1223	1312
5000	640	696	751	863	974	1085	1196	1307	1418	1529	1640
6000	768	835	902	1035	1168	1302	1435	1568	1702	1835	1968
7000	896	974	1052	1208	1363	1519	1674	1830	1985	2141	2296
8000	1024	1113	1202	1380	1558	1736	1913	2091	2269	2447	2624
9000	1153	1253	1353	1553	1753	1953	2153	2353	2553	2753	2953
10000	1281	1392	1503	1725	1947	2169	2392	2614	2836	3058	3281
20000	2561	2783	3006	3450	3894	4339	4783	5228	5672	6117	6561
30000	3842	4175	4508	5175	5842	6508	7175	7842	8508	9175	9842
40000	5122	5567	6011	6900	7789	8678	9567	10456	11344	12233	13122
50000	6403	6958	7514	8625	9736	10847	11958	13069	14180	15292	16403
60000	7683	8350	9017	10350	11683	13017	14350	15683	17017	18350	19683
70000	8964	9742	10519	12075	13631	15186	16742	18297	19853	21408	22964
80000	10244	11133	12022	13800	15578	17355	19133	20911	22689	24467	26244
90000	11525	12525	13525	15525	17525	19525	21525	23525	25525	27525	29525

Tape length (L) given in feet.

Basic formula for table:  $L = \frac{NC}{4,500} + .105833N$

TABLE 10 : REWIND TIME, AMPEX TM2

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	.01	.01	.01	.01	.02	.02	.02	.02	.02	.03	.03
200	.02	.02	.03	.03	.03	.04	.04	.04	.05	.05	.05
300	.03	.04	.04	.04	.05	.05	.06	.07	.07	.08	.08
400	.04	.05	.05	.06	.07	.07	.08	.09	.10	.10	.11
500	.05	.06	.06	.07	.08	.09	.10	.11	.12	.13	.14
600	.06	.07	.08	.09	.10	.11	.12	.13	.14	.15	.16
700	.08	.08	.09	.10	.11	.13	.14	.15	.17	.18	.19
800	.09	.09	.10	.12	.13	.15	.16	.17	.19	.20	.22
900	.10	.10	.11	.13	.15	.16	.18	.20	.21	.23	.25
1000	.11	.12	.13	.14	.16	.18	.20	.22	.24	.26	.27
2000	.21	.23	.25	.29	.33	.36	.40	.44	.47	.51	.55
3000	.32	.35	.38	.43	.49	.54	.60	.65	.71	.77	.82
4000	.43	.46	.50	.58	.65	.72	.80	.87	.95	1.02	1.09
5000	.53	.58	.63	.72	.81	.90	1.00	1.09	1.18	1.27	1.37
6000	.64	.70	.75	.86	.97	1.09	1.20	1.31	1.42	1.53	1.64
7000	.75	.81	.88	1.01	1.14	1.27	1.40	1.53	1.65	1.78	1.91
8000	.85	.93	1.00	1.15	1.30	1.45	1.59	1.74	1.89	2.04	2.19
9000	.96	1.04	1.13	1.29	1.46	1.63	1.79	1.96	2.13	2.29	2.46
10000	1.07	1.15	1.25	1.44	1.62	1.81	1.99	2.18	2.36	2.55	2.73
20000	2.13	2.32	2.50	2.88							

Rewind time (R) given in minutes.

$$\text{Basic formula for table: } R = \frac{NC}{5,400,000} + .0000881944N$$

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TABLE 11 : TRANSFER TIME, AMPEX TM4

Block Length in Characters (C).

	100	150	200	300	400	500	600	700	800	900	1000
100	.04	.05	.05	.06	.06	.07	.07	.08	.09	.09	.10
200	.09	.09	.10	.11	.12	.14	.15	.16	.17	.18	.19
300	.13	.14	.15	.17	.19	.20	.22	.24	.26	.27	.29
400	.18	.19	.20	.22	.25	.27	.29	.32	.34	.37	.39
500	.22	.23	.25	.28	.31	.34	.37	.40	.43	.46	.49
600	.26	.28	.30	.33	.37	.41	.44	.48	.51	.55	.58
700	.31	.33	.35	.39	.43	.47	.51	.56	.60	.64	.68
800	.35	.37	.40	.45	.49	.54	.59	.64	.68	.73	.78
900	.40	.42	.45	.50	.56	.61	.66	.72	.77	.82	.88
1000	.44	.47	.50	.56	.62	.68	.74	.79	.85	.91	.97
2000	.88	.94	1.00	1.11	1.23	1.35	1.47	1.59	1.71	1.83	1.94
3000	1.32	1.40	1.49	1.67	1.85	2.03	2.20	2.38	2.56	2.74	2.92
4000	1.75	1.87	1.99	2.23	2.47	2.70	2.94	3.18	3.41	3.65	3.89
5000	2.19	2.34	2.49	2.79	3.08	3.38	3.67	3.97	4.27	4.56	4.85
6000	2.63	2.81	2.99	3.34	3.70	4.05	4.41	4.76	5.12	5.48	5.83
7000	3.07	3.28	3.48	3.90	4.31	4.73	5.14	5.56	5.97	6.39	6.80
8000	3.51	3.74	3.98	4.46	4.93	5.40	5.88	6.35	6.83	7.30	7.77
9000	3.95	4.21	4.48	5.01	5.55	6.08	6.61	7.15	7.68	8.21	8.75
10000	4.38	4.68	4.93	5.57	6.16	6.75	7.35	7.94	8.53	9.12	9.72
20000	8.77	9.36	9.95	11.14	12.32	13.51	14.69	15.88	17.06	18.25	19.44
30000	13.15	14.04	14.95	16.71	18.49	20.26	22.04	23.82	25.60	27.37	29.15
40000	17.54	18.72	19.91	22.28	24.65	27.02	29.39	31.76	34.13	36.50	38.87
50000	21.92	23.40	24.88	27.85	30.81	33.77	36.74	39.70	42.66	45.62	48.59
60000	26.31	28.08	29.86	33.42	36.97	40.53	44.08	47.64	51.19	54.75	58.31
70000	30.69	32.76	34.84	38.99	43.13	47.28	51.43	55.58	59.73	63.87	68.02
80000	35.07	37.44	39.81	44.56	49.30	54.04	58.78	63.52	68.26	73.00	77.74
90000	39.46	42.13	44.79	50.12	55.46	60.79	66.12	71.46	76.79	82.12	87.46

Transfer time (T) given in minutes.

Basic formula for table:  $T = \frac{NC}{1.6875 \times 10^5} + .000379157N$

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TABLE 12 : TAPE LENGTH, AMPEX TM4

Block Length in Characters (C)

	100	150	200	300	400	500	600	700	800	900	1000
100	13	14	15	17	19	22	24	26	28	30	33
200	25	28	30	34	39	43	48	52	56	61	65
300	38	41	45	51	58	65	71	78	85	91	98
400	51	55	59	68	77	86	95	104	113	122	131
500	63	69	74	85	97	108	119	130	141	152	163
600	76	83	89	103	116	129	143	156	169	183	196
700	89	96	104	120	135	151	166	182	197	213	229
800	101	110	119	137	154	172	190	208	226	243	261
900	114	124	134	154	174	194	214	234	254	274	294
1000	126	138	149	171	193	215	238	260	282	304	326
2000	253	275	297	342	386	431	475	519	564	608	653
3000	379	413	446	513	579	646	713	779	846	913	979
4000	506	550	594	683	772	861	950	1039	1128	1217	1306
5000	632	688	743	854	965	1076	1188	1299	1410	1521	1632
6000	758	825	892	1025	1158	1292	1425	1558	1692	1825	1958
7000	885	963	1040	1196	1351	1507	1663	1818	1974	2129	2285
8000	1011	1100	1189	1367	1544	1722	1900	2078	2256	2433	2611
9000	1138	1238	1338	1538	1738	1938	2138	2338	2538	2738	2938
10000	1264	1375	1486	1708	1931	2153	2375	2597	2819	3042	3264
20000	2528	2750	2972	3417	3861	4306	4750	5194	5639	6083	6528
30000	3792	4125	4458	5125	5792	6458	7125	7792	8458	9125	9792
40000	5056	5500	5944	6833	7722	8611	9500	10389	11278	12167	13055
50000	6319	6875	7431	8542	9653	10764	11875	12986	14097	15208	16319
60000	7583	8250	8917	10250	11583	12917	14250	15583	16917	18250	19583
70000	8847	9625	10403	11958	13514	15069	16625	18180	19736	21292	22847
80000	10111	11000	11889	13667	15444	17222	19000	20778	22555	24333	26111
90000	11375	12375	13375	15375	17375	19375	21375	23375	25375	27375	29375

Tape length (L) given in feet.

Basic formula for table:  $L = \frac{NC}{4,500} + .104167N$