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NELSON RESEARCH LABORATORIES
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DEUCE Programme News No. 30, December, 1958.

Programming for a DEUCE Magnetic Tape Installation.

Report by
M.A. Kingsbury.

1. SUMMARY.

This report contains information about the order code, speed of operation and the subroutines written, for the magnetic tape units fitted to DEUCE.

M A Kingsbury.

MATHEMATICS DEPARTMENT.

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DEUCE Programme News No. 30, December, 1958.

Programming for a DEUCE Magnetic Tape Installation.

CONTENTS:

2. REASON FOR REPORT.

This report contains general information on programming for the DEUCE magnetic tape storage system, and should be of use to all contemplating using a tape installation.

3. BASIC PRINCIPLES.

The tape handling equipment is called either a tape deck or a tape transporter, for DEUCE the tape decks are in pairs, these enable the tape to be run in either direction between two reels. The tape runs in the forward direction when it moves from right to left, reading or writing only being possible with the tape moving in the forward direction. Because of the control system adopted it is only possible to select one transporter and obey one tape function at a time. There is one exception to this rule, any number of transporters may be rewinding simultaneously, but if any transporter is selected while it is rewinding, the next tape instruction to enter control is interlocked until the rewind on that tape dock is complete. During tape transfers double store twenty (D.S.20) must only be used for transferring information to and from the tape.

The tape has six parallel channels for storing information, with a seventh channel for giving a parity check on the information. The tape reading or writing heads handle six binary digits of information simultaneously, these six digits being called a character (see Fig. 1).

Because there is not an integral number of characters in a DEUCE word pair, alternative instructions for reading and writing are provided for transferring either ten or eleven characters per word pair.

On transferring 10 characters per word pair, sixty binary digits only are transferred from the word pair, digits P29-P32 of 20, being ignored On writing 11 characters per word pair two additional digits, both zero, are added to the 64 digits in D.S.20, the resulting 66 digits being written on the tape as 11 characters. On reading 11 characters per word pair the two digits which were added are now discarded.

The reasons for providing 10 characters per word pair transfers are:

(a) Up to 10% economy in tape, 10% if there are no block gaps.

(b) If word pairs contain 10 alpha-numeric characters (as read by the I.B.M. 528 eighty column reader), use of 11 character writing on tape merely puts in an extra character. If the tape is to be read back to the computer this does not matter, but it may be a nuisance if a tape printer is to be used.

4. DEFINITION OF TERMS.

4.1 Character.

A character is a six binary digit unit of information, it can represent 0-9, A-Z and a number of symbols.

4.2 Block.

A group of characters on the tape is called a block.

4.3 Block Gap.

This consists of a space on the tape between two blocks, it is produced by the tape running on after the end of write, and running up to speed before writing, thus it is automatically produced. (it is approximately two inches long).

4.4 Record.

This is a group of blocks on the tape.

4.5 Record Gap.

This is a programmed space on the tape between any two records.

5. OPERATING SPEEDS.

Speed of tape when reading or writing.	100 ins./sec.
Packing density of recorded information.	80 chars./in.
Length of a block gap.	2 inches.
Tape starting time.	15 m.s. *
Tape stopping time.	15 m.s.
Rewind time for 2400 feet of tape.	120 secs.
Average rewind time (L in inches).	$20 + L/(240\ ^{+120}_{-60})$ sec.
Write character period.	4 m.c.
Time to write a word pair (10 chars. per word pair)	40 m.c.
(11 chars. per word pair)	44 m.c.
Time to read a word pair (10 chars. per word pair)	(40 ± 4) m.c.†
(11 chars. per word pair)	(44 ± 4) m.c.†
Time to write a one delay line	
Length block is (15 + 22 + 15) m.s. i.e.	52 m.s.
(starting time 15 m.s.	
writing time 22 m.s.	
stopping time 15 m.s.)	
Time to write a block of n characters is $15 + \frac{n}{8} + 15$ m.s.	

When reading, the next tape instruction may be obeyed between two and three major cycles after the last word pair of the block has been read. i.e. time to read a block of N word pairs is

15 + time to read N word pairs + 2 or 3 m.s.

Similarly, when skipping forward or back one block the minimum time between the 'skip' instruction and the next tape instruction is 15 + read N word pairs + 2 or 3 m.s.

Also it should be noted that it is quicker to skip forward or back to the next record gap, than it is to skip blocks, counting the blocks until we reach the required record gap.

Maximum time to read N successive word pairs into a delay line is

$\frac{34+N}{32} + \left\{\frac{N}{n} \text{ rounded up}\right\}$ m.s. Minimum time to read N successive word pairs into a delay line is $\frac{34+N}{32} + \left\{\frac{N}{n} \text{ rounded down}\right\}$ m.s.

Where $n = \frac{32}{(T - 34)}$ and T = time in minor cycles to read a word pair from the tape.

* This time of 15 m.s. will almost certainly be reduced as soon as there is enough operational experience to ensure that a lower specification can always be met by all transporters.

† It is hoped to reduce the tolerance of 4 m.c. at a later date.

6. TAPE INSTRUCTIONS AVAILABLE.

Instruction.	Function.	Note.
16-24		
17-24		
18-24		
19-24		
20-24	Select tape-deck 0-7	6.1
21-24		
22-24		
23-24		
24-24	Read 11 characters per word pair.	6.2
24-24, 1	Write 11 characters per word pair.	6.2
25-24	Read 10 characters per word pair.	6.3
25-24, 1	Write 10 characters per word pair.	6.3
26-24	Write record gap.	6.4
27-24	Rewind.	6.5
28-24	Skip forward one block.	6.6
28-24, 1	Skip forward to next record gap.	6.6
29-24	Skip backward one block.	6.6
29-24, 1	Skip backward to next record gap.	6.6
30-24	Test parity indicator.	6.7
31-24	Inactive or clear write record gap.	6.8

6.1 Up to eight tape decks (transporters) may be connected to DEUCE Initially the installation at N.P.L. Blackheath will have tape decks 0, 1, 2 and 3, but will have circuits designed to permit easy extension to eight decks.

6.2 The transfer of eleven characters per word pair may be used for storing binary, four bit binary coded decimal or alpha-numeric information.

6.3 The transfer of ten characters per word pair will only be used in storing alpha-numeric data.

6.4 The length of a record gap is determined mainly by two factors;

(a) the length of tape required by the machine to recognise a record gap and

(b) the size of the record preceeding the record gap.

Until further notice it is recommended that the minimum length of a record gap should be about one foot of tape, this can be achieved by

26-24
128 major cycle delay.
31-24

The instruction 31-24 is used to clear write record gap.

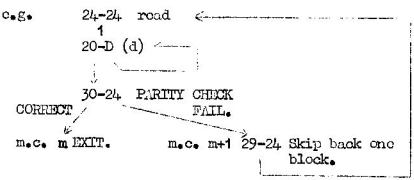
6.5 Rewind is carried out at a higher than normal tape speed, and a 2400 foot reel of tape will be rewound in not more than 120 seconds. During this time all functions on all other tape decks remain available, but any further instruction to a deck when it is rewinding is interlocked until the operation is complete.

After rewind the rewound tape is no longer selected. (After all other functions a tape remains selected.

6.6 When skipping forward or backward all further tape instructions are interlocked until the skipping is completed.

6.7 The tape system has lateral parity checking on each character, and a longitudinal parity check character at the end of each block. The lateral parity check on a character consists of a digit on the seventh channel of the tape, this digit is a one if the number of ones in the character is even, zero if the number of ones is odd.

The longitudinal parity character after the end of a block has a unit digit if the number of ones in that channel in the last block is odd. Parity digits and characters are generated and written automatically. Parity checks are carried out automatically but to test whether a parity failure has occurred the parity check instruction must be used.



An extra key (see fig. 2) will be added to the DEUCE console, this key will simulate (similarly to the DISCRIM. key),

(a) Parity check O.K.
(b) Parity check fail.
(c) Parity check normal.

6.8 The instruction 31-24 is used to terminate write gap. Also it is used to ensure that a tape function has been completed before proceeding with any further instructions.

7. TO LOAD OR UNLOAD A REEL OF TAPE ON A TAPE TRANSPORTER.

7.1 Open cabinet doors, the OFF lamp (fig. 2) is on and the reel spindles are clamped so that they will not turn.

7.2 Fit reels, r.h.s.reel with or without the write ~~inhibit~~ steel ring, the reel containing the tape normally goes on the right hand spindle. The clip on the empty left hand reel should be on top of the spindle.

7.3 Press the load left button on the tape control panel i.e. 1 (fig. 2). The spindles (and reels) are now free to turn.

7.4 Pull the tape from the R.H. reel across the top of the L.H. reel and clip on, there should only be about 1½ to 2 inches of tape beyond the clip. The oxide surface, that is the rough surface, of the tape should be facing upwards. Then turn the L.H. reel in the clockwise direction for half a turn.

7.5 Slip the tape under the read and erase heads, and over the suction rollers (see fig. 2).

7.6 Check that there are no twists in the tape.

7.7 Close the cabinet doors, the tape will now automatically move into the loaded position, that is with the beginning of tape mark under photo-cell C (fig. 2) and go under DEUCE control.

7.8 In order to unload a reel of tape press the unload button to unload in the appropriate direction, when the complete tape has been unloaded off one reel the reels stop.

7.9 It is possible for some reels to be under computer control while others are under manual control.

8. OPERATING INSTRUCTIONS.

8.1 Reading and Writing.

Following a stim write or read instruction the tape takes between 5-15 m.s. to reach transfer speed, but the first transfer instruction must be presented to T.S. count in not more than 5 m.s. after the stim write or read instruction. The time between successive transfer instructions must not be more than 34 minor cycles for 10 character per word pair transfers, and 36 minor cycles for 11 characters per word pair transfers.

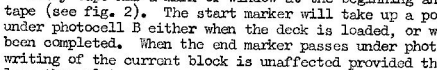
e.g. 24-24 STIM READ.
↑
≤ 5 m.s.
↓
20- STORE 1.
↑
≤ 34 m.c.'s 10 chars./w.p. or 36 m.c.'s 11 chars./w.p.
↓
20- STORE 2.

Writing to the tape will stop if destination 20 is not used for three or more major cycles. If write is called and destination 20 is not used at all a record gap equivalent in length to approximately 10 m.s. will be written. On reading the tape will automatically stop at the end of the block and D.S.20 will contain the last word pair of the block.

8.2 During a skip forward or skip back one block or skip forward to, or backward to next record gap, source and destination 20 may be used.

8.3 Every tape has a mark or window at the beginning and end of the tape (see fig. 2). The start marker will take up a position under photocell B either when the deck is loaded, or when a rewind has been completed. When the end marker passes under photocell H (fig. 2) writing of the current block is unaffected provided that it occupies less than 18 inches of tape, or approximately 1000 characters, also an end of tape warning (E.T.W.) signal is emitted, this has the effect of making any further tape write instruction act similar to a discrimination, write still being called.

e.g. 24-24 1 or 25-24 1



The E.T.W. signal continues to be emitted until the end of the tape marker is re-wound past photocell H.

When the end marker passes under lamp-photocell C the tape will stop and will not move forward any further under computer control, this is the physical end of tape (P.E.T.) In this state further skip forward or read will be interlocked and will need manual release.

The action taken in minor cycle m+1 after a write instruction will depend mainly on the programme, thus if the block length is relatively small ($\leq$ 500 characters say) we could write a special end of tape word pair block which could be recognised when reading. If large blocks are being written we would have to skip back one block and then write end of tape block. An alternative to the end of tape special block, is for a count to be kept on the number of blocks on any particular tape.

DEUCE will have a key on the control panel which on being pressed will simulate end of tape warning.

8.4 Improvements in the range of facilities now provided may be possible at a later stage, for this reason no use of the characteristic digits in tape instructions, other than those specified, should be made.

8.5 The opening move of a programme using tape should be write a record gap on the front of all tapes which are going to be written upon. This is because after a rewind, the tape does not always take up exactly the same position, and so it would be possible for the read/write head to be over the middle of the first block instead of being in front of it. Thus we would be open to error on reading or writing.

8.6 Provision is made for identifying reels of tape in a semi-permanent manner, such that the tapeon the reels so marked cannot be written upon, even under computer fault conditions. The method of marking the reel is by means of a steel ring which fits onto the reel.

When a ring is fitted, the computer will go through the motions of writing, i.e. the tape will move forward, but writing will in fact not be done.

9. TRANSFERS BETWEEN TAPE AND THE HIGH SPEED STORE OR MAGNETIC STORE.

9.1 Various subroutines have been written for transferring information between the tape and high-speed store. These routines are:

(a) Write N ($1 \leq N \leq 12$) delay lines onto the tape from the high speed store forming and writing the delay line sums (11 characters per word pair only) - See Appendix 2, fig. 3.

(b) Read N ($1 \leq N \leq 11$) delay lines into the high speed store from the tape, with delay line sum checks and parity checks. (11 chars./word pair only) see Appendix 3, Fig. 4.

(c) Read or write n ($n \leq 352$) minor cycles from or to the tape. Parity check when reading. See appendix 8, Fig. 9.

The basic instructions for transfers between the high speed store and tape are:

24-24 or 25-24 Stim. read.

$$I - 17_{\_} \quad (20 - B \quad d \quad 30 \quad (16 - N) \quad 28)$$

$$\text{m.c. } 28 \quad (7P_1) \; 17_2 - 0 \;,\; 1 \quad + P_{18} + P_{22}$$

$$(Q_{30} \quad 20 - B_{0,1} \quad (d)$$

NORMAL SPILL

$$\text{m.c. } 29 \qquad 20 - B_{30,31} \quad (d)$$

Parity and/or Sum check.

This loop will transfer up to sixteen consecutive word pairs either from D.L.A or to D.L.B More elaborate forms of transfer can be seen in figs.

9.2 Subroutines have been also written for transferring information between the tape and the magnetic drum store, these are

(a) Transfer N ($1 \leqslant N \leqslant 16$) tracks from the drum to the tape, forming track sums See appendix 4 fig. 5.

(b) Transfer N tracks ($1 \leqslant N \leqslant 16$) from the tape to the drum carrying out sum checks and parity checks. See appendix 5 fig. 6.

(c) As for (a) except no track sums see appendix 6 fig. 7.

(d) As for (b) except no sum check see appendix 7 fig. 8.

These routines are subject to restrictions;

(i) All the tracks are to be from the same head position. This is because there is not enough time in transferring 32 words (22 m.s.) to or from the tape to carry out a magnetic block shift (35 m.s.)

(ii) These routines will only transfer 11 characters per word pair. This is because in transferring 10 characters per word pair we would not have time to write or read more than one track to or from the drum. (For instruction loops see figs. 4, 5, 6 and 7).

9.3 Subroutines 9.1(b), 9.2(b) will both read blocks written by 9.1(a), 9.2(a) similarly subroutines 9.1(c) and 9.2(d) will read blocks written by 9.2(c), 9.1(c)

9.4 The above routines all transfer information to or from m.c.'s 0, 1 first of all and then progressively move down the delay line to m.c.'s 30, 31.

If one wishes to transfer information to or from the tape starting at m.c.'s 30, 31 and moving up tape so that the last word pair transferred from the delay line is m.c. pair 0, 1 the following loop of instructions could be used. (It has not been tested).

m.c. 12 I_1 - 172

m.c. 16 $I_{2,3}$ - 21 (d)

m.c. 20 I_4 - 13

m.c. 23 13 - 17_1 ←

m.c. 25 21_3 - 0

(Q_{27} I_3 20 - $A_{30,31}$ (d))

or $B_{30,31}$ - 20 (d)

→ m.c. 31 ($15P_1$) 17_1 - 0 1 - P_{18} - P_{22}

(Q_1 I_4 20 - $A_{28,29}$ (d)

or $B_{28,29}$ 20 (d)

NORMAL

SPILL DOWN AFTER TRANSFERRING m.c.'s 4 AND 5.

m.c. 30 21_2 - 0

(Q_0 I_2 20 - $A_{2,3}$ (d))

or $B_{2,3}$ - 20 (d)

m.c. 4 (P_{10} or P_5) - 23 (d)

m.c. 8 (P_{10} or P_5) - 26

m.c. 28 $\binom{13P_1}{12P_1}$ 17_2 - 91 $\begin{bmatrix} - P_{10} - P_{22} \\ - P_5 - P_{22} \end{bmatrix}$

(Q_{30} I_1 20 - $A_{0,1}$ (d)

or $B_{0,1}$ 20 (d)

SPILL DOWN AFTER N DELAY LINES

NORMAL

m.c. 22.

Where I_1 = NIS, 20 - (A+1) d 0 (N-1) 23

or = NIS, (B+1) - 20 d 0 (N-1) 23

I_2 = NIS, 20 - A d 0 2

or = NIS, B - 20 d 0 2

I_3 = NIS, 20 - A d 1 2

or = NIS, B - 20 d 1 2

I_4 = NIS, 20 - A d 27 (12) 28

or = NIS, B - 20 d 27 (12) 28

This type of loop will permit transfers of blocks of more than one delay line length, but delay line sum checks cannot be made.

The loop would be of particular interest in the event of a tape printer being produced, because it would enable eighty column cards to be read by the I.B.M. 528 reader, and information being transferred direct to tape and then being printed from the tape, without the information being interfered with by the programmer.

9.5 The delay line or track sums written on the tape immediately after the relative D.L. or track are only used for sum checking, they do not accompany the actual block into the computer.

10. GENERAL INFORMATION.

10.1 The normal length of tape on a reel is 2400 feet, although lengths of 2,000 and 3,000 feet may become available later. The length of useful tape will only be approx. 2,300 feet, for a 2,400 ft. reel.

10.2 Programmes must be arranged in such a manner that if a block A is to be altered all blocks following A up to the beginning of the next record gap must be re-written. This is because tape speeds are not absolutely constant so that on writing over a block the new information may start later and/or occupy a greater length of tape than did the old information.

10.3 Sum checks plus parity checks give a greater degree of safety than only parity checking.

10.4 Information on tape should be ordered in such a manner that the programme or calculation will move progressively along the tape with a minimum of rewinding or skipping back.

10.5 In commercial work it is worth while considering putting the programme on the standing file.

10.6 At the end of a tape programme rewind all decks.

10.7 For updating (commercial) operations put the new record on a new tape and keep the old one in case of accidents later. During or after updating, it is worthwhile considering doing a 'readability' run, that is merely reading through and parity checking each block. There will sometimes be time to skip back and read the block, in parallel with reading a card, to check a block just written.

11. PROGRAMMED ADDRESS SYSTEM FOR TAPE.

Some form of address system for tape maybe required by control programmes, interpretive programmes and for a tape form of scheme B.

The complete address could consist of:

deck number 0-7.
Record number on deck.
Block number in record (1 to 16,383)
Word pair number in block(1 to 4,905)

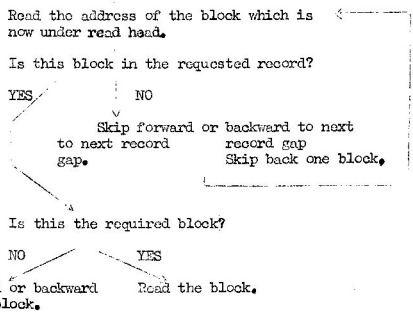
and each block would have its own address located either in the first word pair of the block, or in a word pair auxiliary block in front of the main block.

e.g. Either

or

The case where the address is separate from the main block may be found to be easier to programme for, but it would be exceedingly wasteful in tape storage and speed of operation.

A rough block diagram of a routine which could select the required block is as follows.



12. SUGGESTIONS FOR A TAPE SCHEME B SYSTEM.

12.1 Each matrix to occupy a record. This would enable one to address matrices, and to find any particular matrix fairly easily via a programmed address system.

12.1 The first block of each matrix record to contain

Address.
m P17
n P17
b.p. P17
number of blocks per row and/or record.

12.3 Each row of the matrix to be split into one delay line length blocks, the last block of each row could also be one delay line in length, even though it may only contain one or so minor cycles of information. This size of block would make the programming of the new 'tape bricks' easier, it would also enable one to transfer matrices between the tape and drum regardless of the drum track number.

12.4 G.I.P. and the bricks could be assembled and stored in two ways;

(a) On the drum using the present G.I.P.'s

(b) On a tape using a new G.I.P. This would leave the drum, except for one track, free for matrices or matrix manipulation. The one track not available would be used for storing the 'fetch' routine which would fetch G.I.P. from the tape.

The new tape G.I.P. would have the disadvantage of being slower than the present ones, and it would occupy one tape deck, the advantages are longer scheme B packs could be used and that the whole drum is available for storage.

12.5 All blocks when read from the tape are parity and sum checked.

12.6 A form of programmed address would be necessary for locating both bricks and matrices.

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APPENDIX 1.

Approximate Number of Blocks per 2400 Foot Reel of Tape.

Approximate length of tape = 2300 feet = 27,600 inches.

= 2,208,000 characters.

Block gap $\leq$ 2 inches $\equiv$ 160 characters.

10 Character/Word Pair Transfers.		Approximate Number of Blocks/Tape.	Number of Useful Alpha-Numeric Characters/Tape.
2	m.c.'s = 10 chars.	12,980	129,800
4	m.c.'s = 20	12,260	245,200
8	m.c.'s = 40	11,040	441,600
16	m.c.'s = 80	9,200	736,000
24	m.c.'s = 120	7,880	945,600
32	m.c.'s = 160	6,900	1,104,000
40	m.c.'s = 200	6,130	1,226,000
48	m.c.'s = 240	5,520	1,324,800
56	m.c.'s = 280	5,010	1,402,800
64	m.c.'s = 320	4,600	1,472,000
3	D.L. = 480	3,450	1,656,000
4	D.L. = 640	2,760	1,766,400
5	D.L. = 800	2,300	1,840,000
6	D.L. = 960	1,970	1,891,200
7	D.L. = 1120	1,720	1,926,400
8	D.L. = 1280	1,530	1,958,400
9	D.L. = 1440	1,380	1,987,200
10	D.L. = 1600	1,250	2,000,000
11	D.L. = 1760	1,150	2,024,000
12	D.L. = 1920	1,060	2,035,200
16	D.L. = 2560	810	2,073,600

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APPENDIX 1 CONT'D.

11 Characters Per Word Pair Transfers.

Block Length		Approximate Number of Blocks/Tape.
2 m.c.	11 chars.	12,910
4 m.c.	22 "	12,130
8 m.c.	44 "	10,820
16 m.c.	88 "	8,900
24 m.c.	132 "	7,560
32 m.c.	176 "	6,570
40 m.c.	220 "	5,810
48 m.c.	264 "	5,200
56 m.c.	308 "	4,710
64 m.c.	352 "	4,310
3 D.L.	528 "	3,200
4 D.L.	704 "	2,550
5 D.L.	880 "	2,120
6 D.L.	1056 "	1,810
7 D.L.	1232 "	1,580
8 D.L.	1408 "	1,400
9 D.L.	1584 "	1,260
10 D.L.	1760 "	1,150
11 D.L.	1936 "	1,050
12 D.L.	2112 "	970
16 D.L.	2816 "	740

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APPENDIX 2.

Subroutine to write N delay lines onto the tape (Flow diagram and coding fig. 3).

Description.

Write a N ($1 \leq N \leq 12$) D.L. length block, from D.L.A to D.L.A + N - 1, onto the tape, D.L. sums are formed and written on the tape after each D.L.

This routine will only transfer 11 characters/word pair.

Stores Used. T.S.'s 13, 14, 15, 16.
D.S. 20, 21. Q.S. $17_{0,1,2}$

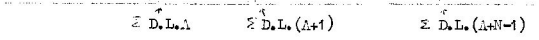
Occupies. D.L. 2_0, 2-4, 6, 8, 10, 12-31.

Parameters. Link in T.S.16
N P_{22} in T.S.15.
A P_5 in T.S.14.
End of tape instruction in 2_{26}.

Entry. 2_{13}

Time. 15 + (N x 23.375) + 15 m.s.

Block Shape.



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APPENDIX 3.

Read a N D.L. length block. Flow diagram and coding in fig. 4.

Description.

The subroutine reads a N ($1 \leq N \leq 11$) D.L. length block of information from the tape to D.L.A to D.L.(A + N - 1). Each D.L. being sum checked and the whole block being parity checked.

This S.R. will only transfer 11 characters /word pair.

Stores Used.	T.S.'s 13, 14, 15, 16.
	D.S.'s 19, 20, 21.
	Q.S.'s 17_1, 17_2, 17_3.
Occupies.	D.L. 2_{0-21}, $23-31$, D.L. $3_{0,1}$
Parameters.	Link in T.S.16 AP_5 in T.S.14. N P_{22} in T.S.15. Link for failure in 3_1
Entry.	2_{30}
Failure.	31-24 X Sum check failure.
	30-28 X Parity check failure.

S.S. skips back one block and re-reads the block.

Stop machine, DISCRIM. key on, single shot, DISCRIM. key off, machine to normal, programme will now obey failure link.

Time.	15 + (N x 23.375) + 15 m.s.
Block Shape.	As for routine in appendix 2.

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Continuation to: NS y 117
Sheet No.: 17.

APPENDIX 4.

Write N tracks from magnetic drum to tape. Flow diagram and coding on Fig. 5.

Description.

Writes N ($1 \leq N \leq 16$) tracks from tracks A/B to A/B+N-1 to the tape, track sums are formed and written on the tape after each track. All tracks are to be read from the same head position. This routine will only transfer 11 characters/wordpair.

Stores Used. T.S.13, 16.
D.S.20
Q.S.17$_{1,2}$
D.L. 10, 11.

Occupies. D.L. 2_{0-4}, 6, 12-15, 17, 18, 20, 22, 24-31

Parameters. Link in T.S.16

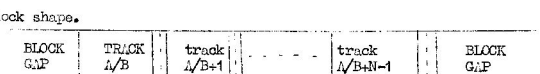
$BP_5 + (16 - N)\ P_{22}$ in T.S.13.

End of tape link in 2_{13}.

Entry. 2_{29}.

Time. $15 + (N \times \frac{23.375}{23.357}) + 15$ m.s.

Block shape.



NOTE. An instruction A-31 must be obeyed before entering the subroutine.

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APPENDIX 5.

Read a block of N tracks to the magnetic drum Flow diagram and coding on fig. 6.

Description.

The subroutine reads a block of N ($1 \leq N \leq 16$) tracks from the magnetic tape to drum tracks A/B to A/B+N-1, all the tracks are in the same head position. Each track is sum checked and the whole block is parity checked.

This routine will only transfer 11 characters/word pair.

Stores Used.	T.S. 13, 14. D.S. 20 Q.S. $17_{2,3}$ D.L.'s 10, 11.
Occupies.	D.L. 2_{0-5}, $15-31$.
Parameters.	LINK in T.S.16 $B.P_5 + (16 - N)\ P_{22}$ in T.S.~~13~~ 14. Failure link in 2_{16}.
Entry.	2_{17}
Failure.	31-24 X Sums check failure 30-28 X Parity failure.

S.S. forces a skip back one block and re-read block.

Stop machine, DISCRIM. key on, single shot, DISCRIM. key off, the programmes will now obey the failure link.

Time.	$15 + (N \times 23.375) + 15$ m.s.
Block Shape.	As for appendix 4.

NOTE. An instruction A-31, 1 must be obeyed at least 14 m.s. before entering the subroutine.

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APPENDIX 6.

Write N tracks to the tape. For flow diagram and coding see fig. 7

Description.

This subroutine writes N ($1 \leq N \leq 16$) tracks from the magnetic drum, tracks A/B to A/B+N-1, to the tape, no track sums are formed. This routine will only transfer 11 characters/word pair.

Stores Used.	T.S. 13, 16.
	D.S. 20
	Q.S. $17_{0,1}$
	D.L.'s 10,11.
Occupies.	D.L. 2_{0}, 3, 5, 16-31.
Parameters.	Link in T.S.16
	$BP_5 + (16-N)\ P_{22}$ in T.S.13.
	End of tape link in 2_{17}
Entry.	2_{21}
Time.	15 + (N x 22) +15 m.s.

Block Shape.

BLOCK GAP	BLOCK OF N TRACKS	BLOCK GAP

NOTE: An instruction A-31 must be obeyed at least 14 m.s. before entering the subroutine.

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Continuation to: NS y 117
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APPENDIX 7.

Read N tracks from the magnetic tape to the magnetic drum.
For the flow diagram and coding see fig. 8.

Description.

This subroutine reads a block of N ($1 \leq N \leq 16$) tracks in length from the tape to the magnetic drum. Tracks A/B to A/B+N-1, all the tracks being in the same head position. The routine carries out a parity check on the block, but there is no sum check.

This routine will only transfer 11 characters per word pair.

Stores Used.	T.S. 13, 14, 16 D.S. 20 Q.S. $17_{1,2}$ D.L. 10, 11
Occupies.	D.L. 2_{14-31}
Parameters.	Link in T.S.16 BP_5 + (16-N) P_{22} in T.S.14 Parity failure link in 2_{15}
Entry.	2_{18}
Failure.	30-28 X Parity failure. S.S. skips back one block and re-reads block.

If we stop the machine, DISCRIM. key ON, single shot, DISCRIM key normal, the programme will now obey the failure link.

Time.	15 + (N x 22) + 15 m.s.
Block Shape.	As for appendix 6.

NOTE. An instruction A-31, 1 must be obeyed before entering the subroutine. at least 14 m.s.

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APPENDIX 8.

Read or Write N consecutive minor cycles to or from the magnetic tape. For flow diagram and coding see Fig. 9.

Description.

The subroutine can carry out two operations:

(a) It will write N ($2 \leq N \leq 384$) minor cycles from D.L. A, D.L. (A+1) etc. to the magnetic tape. NO delay line or block sums are formed.

(b) The routine will read N ($2 \leq N \leq 352$) minor cycles from the tape to the high speed store, D.L. A,(A+1) etc. where $A > 1$. A parity check on the block is carried out.

The routine will transfer 10 or 11 characters/word pair.

Stores Used.	T.S. 13, 14, 15, 16.
	D.S. 19, 20, 21, and 17_2
Occupies.	D.L. 1, $2_{0,2}$
Parameters.	AP_5 in T.S.13
	NP_{17} in T.S.14
	Link in T.S.16
	End of tape link in 2_3
	Parity failure link in 1_{10}
Entry.	(a) Write. 2_0
	(b) Read 1_6.
Failure.	30-28X Parity failure. To skip back and re-read block give a single shot.

If we stop the machine, DISCRIM. key ON, single shot, DISCRIM key normal, the machine will obey the parity failure link.

Time. $15 + (N \times 11/16) + 15$ m.s.

Block Shape.

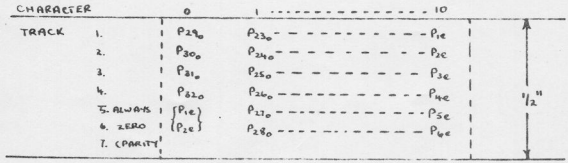
BLOCK GAP	BLOCK OF N m.c.'s	BLOCK GAP

NOTE: N should be even, if N is odd N-1 minor cycles will be transferred.

← 20₂ →							← 20₂ →				
P_{1-6}	P_{7-12}	P_{13-18}	P_{19-24}	P_{25-30}	P_{31} ∴ 4	P_{5-10}	P_{11-16}	P_{17-22}	P_{23-28}	P_{29-32}

CHARACTERS:	10	9	8	7	6	5	4	3	2	1	0	11 chars/w.p.
CHARACTERS:	10	9	8	7	6	5	4	3	2	1	·	10 chars/w.p.

LAYOUT OF CHARACTERS IN A DOUBLE STORE

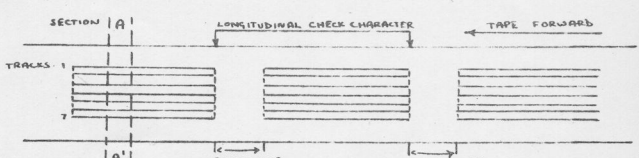


CHRACTER 0 IS NOT PRESENT FOR 10 CHARS/WORD PAIR TRANSFERS

P_{Ne} IS A DIGIT OF AN EVEN MINOR CYCLE

P_{No} IS A DIGIT OF AN ODD MINOR CYCLE

LAYOUT OF WORD PAIRS ON THE TAPE (SECTION AA')



LONGITUDINAL CHECK CHARACTER IS THE LAST CHARACTER OF A BLOCK

LATERAL PARITY IS ON TRACK 7.

LAYOUT OF INFORMATION ON TAPE

Fig. 1.

Date

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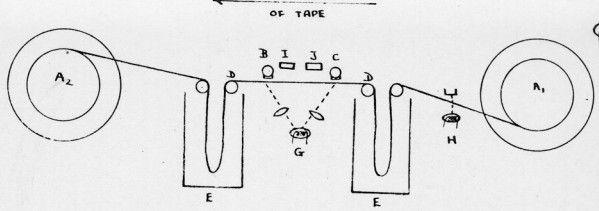
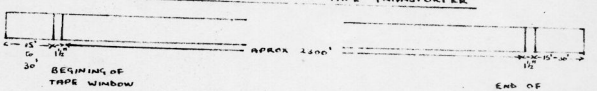


A1, A2 ≡ TAPE REELS.
B ≡ } PHOTO CELLS.
C ≡ } PHOTO CELLS.
D ≡ SUCTION ROLLERS.
E ≡ ARMS.
F ≡ WARNING LAMP, INDICATES WHEN IT IS IMPOSSIBLE TO WRITE ON TAPE.
G ≡ LAMP FOR PHOTO CELLS AT B AND C FOR FINDING BEGINING AND END OF TAPE WINDOWS.
H ≡ LAMP AND PHOTO CELL FOR FINDING END OF TAPE WINDOW IN ADVANCE OF PHOTO CELL C.
I ≡ READ AND WRITE HEAD.
J ≡ ERASE HEAD.

DECK LAYOUT

○ INDICATE BUTTONS OR SWITCHES.

CONTROL PANEL OF A TAPE TRANSPORTER



MARKERS ON A TAPE

TAPE DECK SELECTION

○ 0. ○ 1. ○ 2. ○ 3. ○ 4. ○ 5. ○ 6. ○ 7. [GREEN LAMPS]

TAPE DECK OPERABLE

○ ○ ○ ○ ○ ○ ○ ○ [RED LAMPS]

R_1 = READ H CHARS } U.P.
R_2 = READ H CHARS } L.P.
W_1 = WRITE H CHARS } U.P.
W_2 = WRITE H CHARS } L.P.
SF = SKIP FORWARD
SB = SKIP BACK
SFR = SKIP FORWARD RECORD
SBR = SKIP BACK RECORD
WG = WRITE GAP
RWD = REWIND
CTS = CLEAR TAPE FUNCTIONS.

TAPE FUNCTION

○ R_1 ○ R_2 ○ W_1 ○ W_2 ○ SF ○ SB ○ SFR ○ SBR [WHITE LAMPS]

○ WG ○ RWD

○ TEST ○ PARITY CHECK OFF ○ TAPE END

MWS

○ PARITY CHECK ON ○ CTS.

MAGNETIC TAPE LAMPS AND SWITCHES FOR THE REUCI CONSOLE

Fig. 2.

Date

File Ref. NS y 117

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L - 16
NP_{22} - 15 No of D.L's
AP_5 - 14 1st D.L.

D.L. 2 Card Nos.			Track					
mc	N.S	S	D	C	W	T		
								Y
								X
								0
								1
0	2	13	20	D	0	1		2
1								3
2	2	21	17		0	0		4
3	(6P)	17	0	L	0	0		5
4	2	2	21		0	2		6
5								7
6	2	0	20	D	30	(1)	28	8
7								9
8	2	14	22		0	0		Y
9								X
10	2	15	26		0	0		0
11								1
12	2	2	14		0	1		2
13	2	2	21	D	1	4		3
14		P_5						4
15	2	13	17		0	1		5
16	2	31	19	D	0	1		6
17	2	0	25	L	0	31		7
18	2	30	13		0	4		8
19	2	24	24	L	0	4		9
20	(0P)	17	0		6	6		Y
21	2	14	22	D	0	1		X
22	2	1	1	D	31	31		0
23	0	16	0	L	6	5		1
24	2	21	17		0	2		2
25	2	2	13		0	3		3
26		E.T.W.						4
27	2	30	13		31	15		5
28	(7P)	17	0	L	0	0		6
29	2	21	2		0	21		7
30	2	14	22	D	0	2		8
31	←				→			9

2_{13} 2_{16} - 21 (d) [2,31 - 19 d 0, 1 / 2,0 - 25 ℓ 0, 31]
2_{19} 24 - 24 ℓ Stim tape write
End of tape warning 2_{26}
N
2_{25} 2_{27} - 13 [2,30 - 13, 31, 15]
2_{30} 14 - 22 (d)
2_2 21_2 - 17_0
2_4 2_6 - 21_2 [2,0 - 20 d 30 (1) 28]
2_8 14 - 22_2
2_{10} 15 - 26
2_{12} 2_{14} - 14 [P_5]
2_{15} 13 - 17_1
2_{18} 30 - 13
2_{24} 21_2 - 17_2
2_{26} (7P) 17_2 - 0 ℓ (P_{18} + P_{22})
Q_{30} (2_6) A_0 - 20 (d)
N.
SPILL
2_{29} 21_3 - 2_{31} [2_{17}]
2_{30} (0P) 17_0 - 0 [P_5]
N-1 times.
Q_{28} (2_{16}) A_{30} - 20 (d)
2_{31} A - 25 (32 mc) 36 mc
2_0 13 - 2 (d)
2_3 (6P) 17_1 - 0 ℓ (P_{17} + P_{22})
Q_5 (2_{27}) 30 - 13
SPILL
N
Wait 4 m.s before Link.
2_{22} 1 - 1 (d) ω = T
2_{21} 14 - 22 (d) [P_5]
2_{23} 16 - 0 ω > T
Q_{30} LINK.

Words	13	14	15	16	20 21	$17_{0,1,2}$
Entry		AP_5	NP_{22}	LINK		
Exit	zero	P_5	NP_{22}	LINK.		

Block Shape:

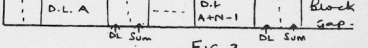

FIG 3

Write N. D.L's on tape. D.L's A to A+N-1 forming D.L. Sums.
11 ch/wp only, 36 m.c between D.S 20.

Date
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L - 16
A_{P_3} - 14
($N_{P_{22}}$ - 15)

2_{30} 24 - 24 Strip tape read
2_1 24 - 14 (5mc)
2_7 2_9 - 21 (d) [2,20 - 21 ℓ 11, 12 / 2,20 - 0 d 30(1)28]
2_{12} 14 - 22 (d)
2_{15} 21_3 - 17_1
2_{17} 2_{21} - 21_5 [2,0 - 25 ℓ 0,31]
2_{25} 23 - 14 (5mc)
2_3 14 - 22_3
2_6 2_8 - 13 [2,19 - 22 d 31,15]
2_{11} 15 - 26
2_{13} 13 - 17_3
2_{16} 2_{18} - 19 (d) [P_{10}, P_5]
2_{20} 30 - 13
2_{23} 21_2 - 17_2
2_{25} (7P) 17_2 - 0 ℓ [P_8 + P_{32}]
Q_{30} (2_{10}) 20 - A_0 (d)
N
SPILL
2_{29} 21_3 - 2_{31}
2_{28} (6P) 17_1 - 0 [+P_{10}]
P_{17} (2_9) 20 - A_{30} (d)
2_{31} A - 25 (32 mc) 36 mc
2_0 20_2 - 26
2_2 13 - 28 Sum Check
Z
N.Z
2_4 (6P) 17_3 - 0 ℓ [P_{17} + P_{22}]
2_5 31 - 24 ×
P_7 (2_8) 19 - 22 (d)
N
SPILL
2_{24} 30 - 24 Parity check.
FAIL
2_{26} 16 - 0
Q_{30} LINK
2_{27} 38 - 28 ×
N.Z.
L
3_1 Failure LINK
3_0 29 - 24
Skip back

Block Shape.

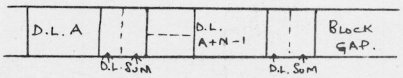

FIG. 4.

Read N D.L.'s from tape to D.L.'s A ··· A+N-1 checking D.L. Sums
Ilch/wp only. 36 m.c. between D.S. 20

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THE ENGLISH ELECTRIC CO. LTD.

Date

Sheet No. 81/11,460

Deuce Programme

Read N D.L's from tape to D.L's A, A+1 . . . . A+N-1

Together with Sum Check

FIG. 4 cont.

D.L. 2 Track — Card Nos.							D.L. 3 Track — Card Nos.							D.... Track — Card Nos.							
mc	NIS	S	D	C	W	T	mc	NIS	S	D	C	W	T	mc	NIS	S	D	C	W	T	
																					Y
																					X
																					0
																					1
0	2	20	26		0	0	0	2	29	24		0	28	0							2
1	2	24	14	L	0	4	1	←					→	1							3
2	2	13	28		0	0	2							2							4
3	2	14	22		0	1	3							3							5
4	(6P)	17	0	L	1	1	4							4							6
5	2	31	24		0	20	5							5							7
6	2	2	13		C	3	6							6							8
7		2	2	21	D	C	3	7							7							9
8	2	19	22	D	31	15	8							8							Y
9	2	20	31	L	11	12	9							9							X
10	2	20	0	D	30	(1)28	10							10							0
11	2	15	26		0	0	11							11							1
12	2	14	22	D	C	1	12							12							2
13	2	13	17		0	1	13							13							3
14	(1P)	17	0		1	1	14							14							4
15	2	21	17		0	0	15							15							5
16	2	2	19	D	0	C	16							16							6
17	2	2	21		2	6	17							17							7
18		P_{10}					18							18							8
19		P_5					19							19							9
20	2	30	13		0	1	20							20							Y
21	2	0	25	L	0	31	21							21							X
22							22							22							0
23	2	21	17		1	3	23							23							1
24	2	30	24		0	0	24							24							2
25	2	23	14	L	4	8	25							25							3
26	0	16	0		2	2	26							26							4
27	3	30	28		0	3	X 27							27							5
28	(1P)	17	0	L	0	0	28							28							6
29	2	21	2		0	15	29							29							7
30	2	24	24		0	1	30							30							8
31		←			→		31							31							9

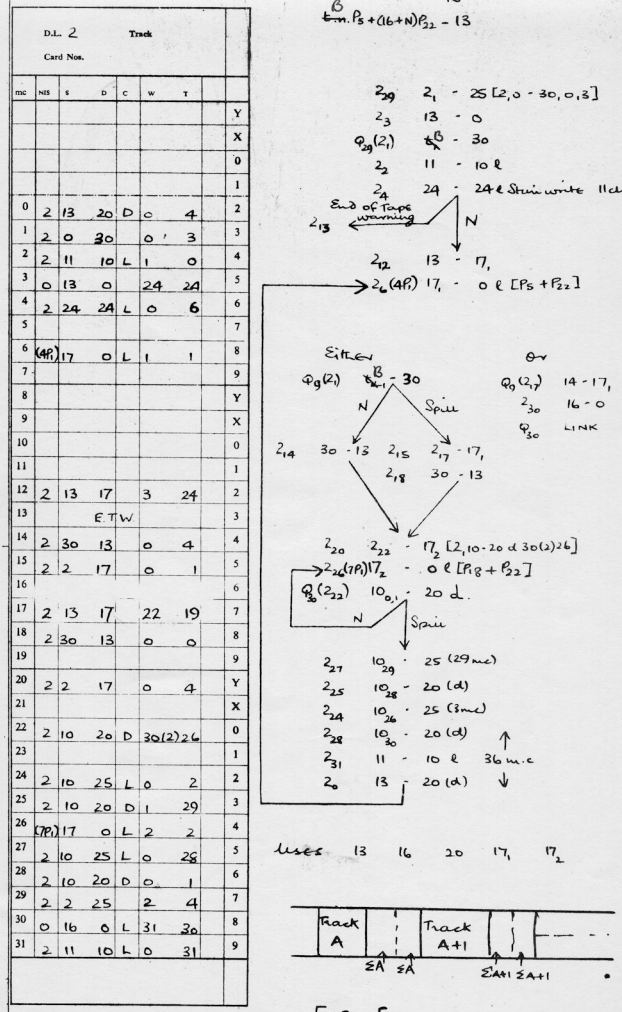

FIG. 5

Transfer from drum to tape forming track runs.
11 character/word pair only

N tracks from A/B to A/B+N-1 (1 ≤ N ≤ 16)

Date

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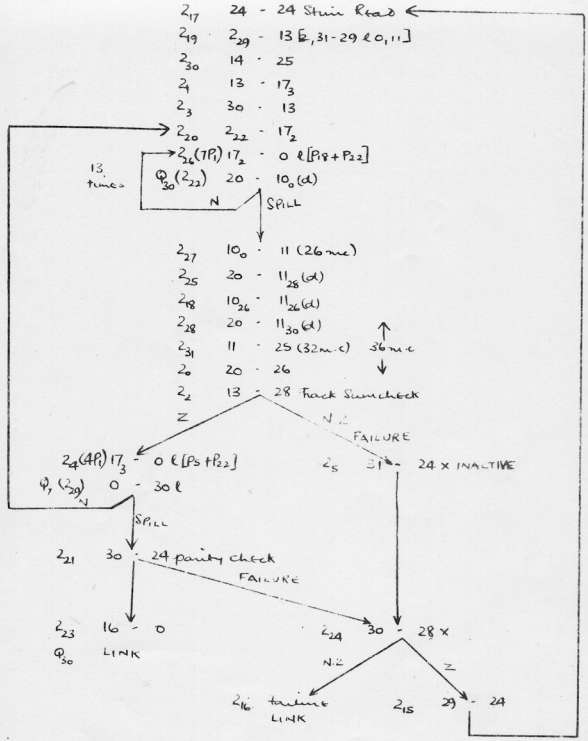


L - 16

C.W - 14 [LB.P5 + (16↑N) P22]

Uses 13 14 20 $17_{2,3}$ D.L.'s 10, 11

Occupies D.L. $2_{0-5, 15-31}$.

FIG. 6

Transfer a block from Tape to Drum with Parity check and Sum check 11 character (word pair only.	Date File Ref. NS y 117 Sheet Ref. 31/11462

Deuce Programme

Tape to Drum.
With Parity check and Sum check.
Transfer N track from the Tape to the Drum (All tracks to same head)
FIG. 6 cont.

D.L. 2 Track Card Nos.								D.L. Track Card Nos.								D.L. Track Card Nos.							
mc	NIS	S	D	C	W	T		mc	NIS	S	D	C	W	T		mc	NIS	S	D	C	W	T	
							Y								Y								Y
							X								X								X
							0								0								0
							1								1								1
0	2	20	26		0	0	2	0							2	0							2
1	2	13	17		0	0	3	1							3	1							3
2	2	13	28		0	0	4	2							4	2							4
3	2	30	13		0	15	5	3							5	3							5
4	(4P)	17	0	L	1	1	6	4							6	4							6
5	2	31	24		0	17	x 7	5							7	5							7
6							8	6							8	6							8
7							9	7							9	7							9
8							Y	8							Y	8							Y
9							X	9							X	9							X
10							0	10							0	10							0
11							1	11							1	11							1
12							2	12							2	12							2
13							3	13							3	13							3
14							4	14							4	14							4
15	2	29	24		0	0	5	15							5	15							5
16	←				—	→	6	16							6	16							6
17	2	24	24		0	0	7	17							7	17							7
18	2	10	11	D	6	8	8	18							8	18							8
19	2	2	13		8	9	9	19							9	19							9
20	2	2	17		0	4	Y	20							Y	20							Y
21	2	30	24		0	0	X	21							X	21							X
22	2	20	10	D	30	(2)26	0	22							0	22							0
23	0	16	0		5	5	1	23							1	23							1
24	2	30	28		0	21	x 2	24							2	24							2
25	2	20	11	D	1	23	3	25							3	25							3
26	(7P)	17	0	L	2	2	4	26							4	26							4
27	2	10	11	L	3	28	5	27							5	27							5
28	2	20	11	D	0	1	6	28							6	28							6
29	2	31	29	L	0	11	7	29							7	29							7
30	2	14	25		0	1	8	30							8	30							8
31	2	11	25	L	0	31	9	31							9	31							9

D.L. 2 Track

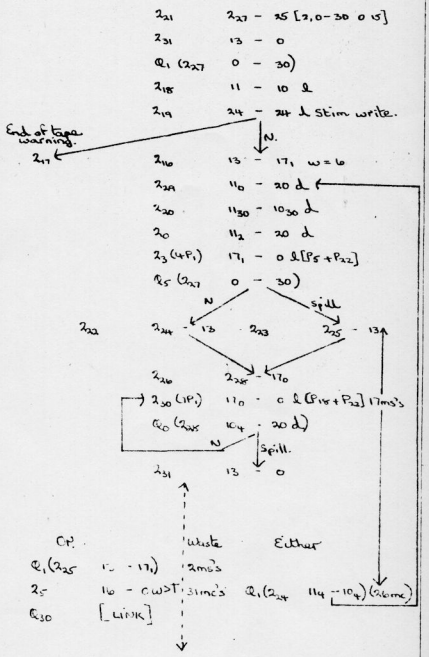
Card Nos.

	nic	nis	s	D	C	w	T	
								Y
								X
								0
								1
0		2	11	20	2	0	1	2
1								3
2								4
3		4P1	17	0	1	0	0	5
4								6
5		0	16	0	1	24	33	7
6								8
7								9
8								Y
9								X
10								0
11								1
12								2
13								3
14								4
15								5
16		2	13	17		3	11	6
17		←					→	7
18		2	11	10	1	0	31	8
19		2	24	24	1	0	27	9
20		2	11	10	2	8	10	Y
21		2	2	35		4	8	X
22		2	2	13		0	2	0
23		2	2	13		0	1	1
24		2	11	10	1	1	36	2
25		2	13	17		6	2	3
26		2	2	17		0	2	4
27		2	0	30		0	15	5
28		2	10	20	2	0	(2) 38	6
29		2	11	20	2	1	21	7
30		7P1	17	0	1	0	0	8
31		0	13	0		0	0	9

L = 16

BP5 + (16-N) P22 = 13

A = 31



Block Gap.	N Tracks	Block Gap.
Uses. 13	16 20 17$_{0,1}$ 10	11

Fig. 7

Transfer Drum to Tape. N tracks from A/B to A/B+N-1, 0 ≤ B+N-1 ≤ 16; (No track sums)
11 ch/w.p. only.

Date

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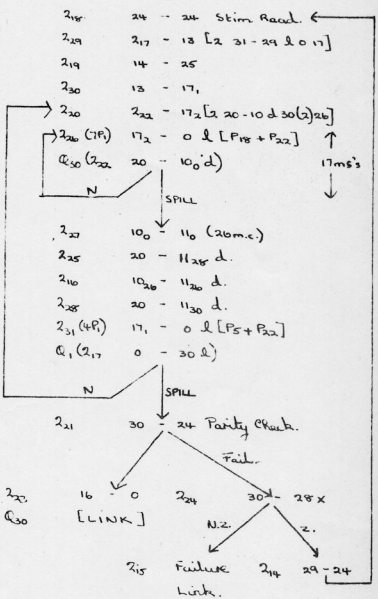
L - 16

t.n.B.P.S + (16 - N) P_{32} - 14

A - 31 ℓ

D.L. 2 Track Card Nos.							
mc	NS	S	D	C	W	T	
							Y
							X
							0
							1
0							2
1							3
2							4
3							5
4							6
5							7
6							8
7							9
8							Y
9							X
10							0
11							1
12							2
13							3
14	2	29	24		0	2	4
15	(					→	5
16	2	10	11	2	8	10	6
17	2	31	29	1	0	17	7
18	2	24	24		0	9	8
19	2	14	25		0	9	9
20	2	3	17		0	4	Y
21	2	30	24		0	0	X
22	2	20	10	2	30 (2)	26	0
23	0	16	0		5	5	1
24	2	30	28		0	30	X 2
25	2	20	11	2	1	21	3
26	$7P_1$	17	0	1	2	2	4
27	2	10	11	1	3	25	5
28	2	20	11	2	0	1	6
29	2	2	13		15	20	7
30	2	13	17		1	20	8
31	$4P_1$	17	0	1	0	0	9



Block Sap.	N. Tracks.	Block Sap.

Uses. 13. 14 + 20 16 17_2 10 11

Fig. 8

Tape to Drum N tracks 1 & NS 16 from track A/8 to tracks A/8 + N - 1 [11 ch/sap only] with Parity checks

N_3 Sum checks.

Date

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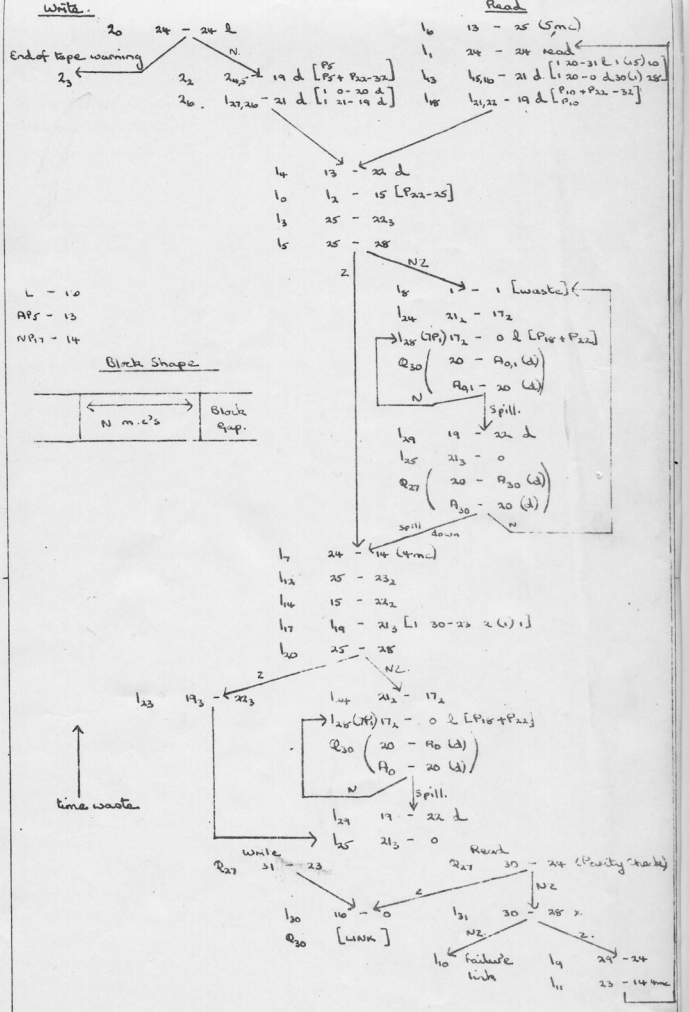

Fig. 9.

Read or write N mc's from or to the tape with Parity Check.
Without such checks.

Date	
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Deuce Programme

Read or write N mc's from or to the tape.

With Parity check.

Without Sum check FIG 9 CONTINUED.

D.L. 1 Track Card Nos.							D.L. 2 Track Card Nos.							D.L. Track Card Nos.							
mc	NIS	S	D	C	W	T	mc	NIS	S	D	C	W	T	mc	NIS	S	D	C	W	T	
																					Y
																					X
																					0
																					1
0	1	1	15	0		1	write → 0	2	24	24	1	0	0	0							2
1	1	24	24	0		10	1							1							3
2				P22-25			2	2	2	19	3	0	2	2							4
3	1	25	22	0		0	3 ←						→	3							5
4	1	13	22	2	0	26	4		P5					4							6
5	1	25	28	0		0	5		P5				P22-32	5							7
6	1	13	25	1	21	25	6	1	1	21	3	18	28	6							8
7	1	24	14	1	0	3	7							7							9
8	1	1	1	0		14	8							8							Y
9	1	29	24	0		0	9							9							X
10	←					→	10							10							0
11	1	23	14	1	17	20	11							11							1
12	1	25	23	0		0	12							12							2
13	1	1	21	2	0	3	13							13							3
14	1	15	22	0		1	14							14							4
15	1	20	31	1	1	(15) 10	15							15							5
16	1	20	0	2	30	(1) 28	16							16							6
17	1	1	21	0		1	17							17							7
18	1	1	19	3	1	16	18							18							8
19	1	30	33	2		(1) 1	19							19							9
20	1	25	28	0		1	20							20							Y
21		P10		P22-32			21							21							X
22		P10					22							22							0
23	1	19	22	0		0	23							23							1
24	1	21	17	0		2	24							24							2
25	0	21	0	0		0	25							25							3
26	1	0	20	2	30	(1) 28	26							26							4
27	1	31	19	2	1	(15) 10	27							27							5
28	1	17	0	1	0	0	28							28							6
29	1	19	32	2	1	26	29							29							7
30	0	16	0	1	31	30	30							30							8
31	1	30	28		0	9 X	31							31							9