COLLATION METHODS FOR THE UNIVAC SYSTEM

VOLUME II

iii + 232 pp

Inserted: A memo on the cost of this software (~~$10.5~~ K plus overhead) 2 pp
A memo defining UNIVAC C-10 code. 15 pp

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INTERNAL COLLATION SUBROUTINE

SIXTY-FOUR TWO-WORD ITEMS

COLLATED IN DESCENDING ORDER

KEY WORD IS FIRST WORD

	300	B 402	C 403		rA = unity To start, n = 1
°1	301	B 407	C 342		rA = Y 600 Z 420
	302	B 408	C 316		rA = V 484 W 600
	303	B 409	C 305		rA = L 420 B 484
	304	B 410	C 307		rA = V 420 W 600
°2	305	L (420)	B (484)		rL = (420) = (B) rA = (484 = (C)
	306	00 000	T 316		If (rA) is greater than (rL), transfer to °C1
°B1	307	V (420)	W (600)		rV = two words, beginning with (420) Two words, beginning with (420) transferred to (600, 601)
	308	B 307	A 400		rA = V (420) W (600) rA = V (422) W (602)
	309	C 307	B 305		rA = L (420) B (484) rA = L (422) B (484)
	310	A 399	C 305		rA = V (484) W (600)
	311	B 316	A 398		rA = V (484) W (602)
	312	C 316	B 404		rA = n_1
	313	A 402	L 403		rA = n_1 + 1 = No. of items transferred from a string in B. rL = n = (1)
	314	00 000	Q 325		If (rA) = (rL), transfer to °B3a
	#314	00 000	Q 334		If (rA) = (rL), transfer to °3b
°B2a	315	C 404	U 305		n_1 = previous n_1 + 1 Transfer to °2

3/26/58
Code 3-10

	[illegible]	[illegible]	[illegible]	U	307	n_1 = previous n_1 + 1 Transfer to $^oB1$
	[illegible]	V (484)				rV = two words, beginning with (484)
				W	(600)	Two words, beginning with (484) transferred to (600, 601)
	317	B	316			rA = V (484) W (600)
				A	400	rA = V (486) W (602)
	318	C	316			
				B	305	rA = L (420) B (484)
	319	A	398			rA = L (420) B (486)
				C	305	
	320	B	307			rA = V (420) W (600)
				A	398	rA = V (420) W (602)
	321	C	307			
				B	405	rA = n_2
	322	A	402			rA = n_2+1 = No. items transferred fr a string in C
				L	403	rL = n = (1)
	323	00	000			
				Q	331	If n_2 + 1 = n, transfer to ^oC3a
	323	00	000	Q	328	If n_2 + 1 = n, transfer to ^oC3b
^oC2a	324	C	405			n_2 = previous n_2 + 1
				U	305	Transfer to $^o2$
^oC2b	[illegible]	C	405	U	316	n_2 = previous n_2 + 1. Transfer to [illegible]
^oB3a	325	B	411			rA = 00 000 Q 328
				C	323	
	326	B	412			rA = C 405 U 316
				C	324	
	327	00	000			
				U	316	Transfer to $^oC1$

when n_1 = n, all items in a strin from B have been transferred. Replace instructions 323 and 32 and transfer the remaining items in the corresponding string from C.

	[illegible]	B	[illegible]		rA = 00 000 Q 331	To insert origi
				C 323		nal instructior
	329	B	414		rA = C 405 U 305	in locations 3
				C 324		and 324 after r
	330	00	000			= n following
				U 336	Transfer to test for end of cycle (°	n_1 = n
°03	331	B	415		rA = 00 000 Q 334	when n_2=n, all
				C 314		items in a stri
	332	B	416		rA = C 404 U 307	from C have bee
				C 315		transferred. Re
	333	00	000			place instruc-
				U 307	Transfer to °B1	tions in loca-
						tions 314 and 3
						and transfer th
						remaining items
						in the corres-
						ponding string
						from B
°B3	334	B	417		rA = 00 000 Q 325	To insert origi
				C 314		nal instruction
	335	B	418		rA = C 404 U 305	in locations 31
				C 315		and 315 after
						n_1=n following
						n_2=n
°6	336	C	404		Clear n_1	
				C 405	Clear n_2	
	337	L	305		Test to determine whether 64 items	
				B 419	have been collated in this cycle.	
	338	00	000			
				T 305	If (rA) is greater than (rL) transfe	
					to °2	
	339	B	403		rA = n rX = n	
				X 000	rA = 2n	
	340	L	401		rL = 64	
				Q 346	If (rA) = (rL) collation is complete,	
					transfer to return to main routine	
	341	C	403		New n = 2 previous n	
				L 406	rL = Y 730 Z 550	
°7	342	Y	(600)		rY = 10 words, beginning with (600)	
				Z (420)	Clear (rY) to location (420), ten	
					words at a time	
	343	B	397		rA = 000010 000010	
				A 342	rA = Y (610) Z (430)	

344	00 000	Q 301	If (rA) = (rL) transfer is complete, return to °1
345	C 342	U 342	Advance instructions in location 342 Repeat routine until transfer is complete (°7)
346	00 000	U (C+1)	Transfer to routine at point entered here by a previous instruction

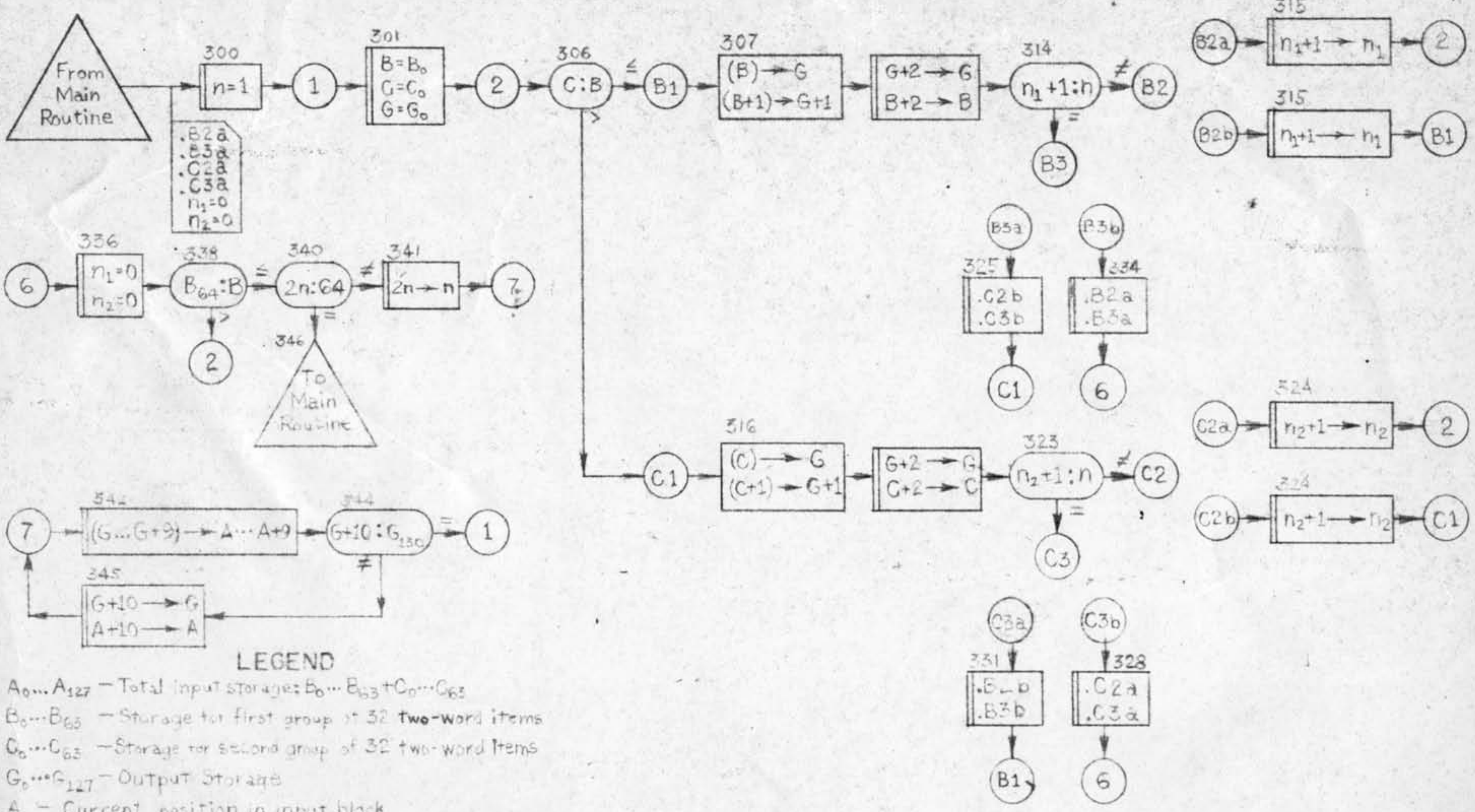
Constants

397	000010	000010	To advance instructions in location 343.
398	000000	000002	Number of words in an item
399	000002	000000	" " " " " "
400	000002	000002	" " " " " "
401	000000	000064	Total number of items to be collated
402	000000	000001	Unity
403	000000	000000	n = Number of items to be compared fo a single string: 1, 2, 4, 8, 16, 32
404	000000	000000	n_1 = Number of items transferred from a string in B
405	000000	000000	n_2 = Number of items transferred from a string in C.
406	Y 730	Z 550	Instructions in location 343 at completion of transfer
407	Y 600	Z 420	To replace instructions at the beginning of a cycle
408	V 484	W 600	
409	L 420	B 484	
410	V 420	W 600	
411	00 000	Q 328	When n_1 = n, these instructions to replace those in locations 323, 324
412	C 405	U 316	
413	00 000	Q 331	When n_2 = n following n_1 = n, original instructions in locations 323, 324 to be replaced
414	C 405	U 305	

To advance instructior

[illegible]	CO	000	Q	334	When $n_2 = n$, these instructions to replace those in locations 314, 315
[illegible]	C	404	U	307	
[illegible]	00	000	Q	325	When $n_1 = n$ following $n_2 = n$, origin instructions in locations 314, 315 t be replaced
418	C	404	U	305	
419	L	484	B	548	Instructions in location 005 at the end of a cycle.
420					Input data, = $B_0 \ldots B_{63}$ — Total input data $A_0 \ldots A_{127}$
483					
484					Input data, = $C_0 \ldots C_{63}$
547					
600					Storage for output data, = $G_0 \ldots G_{127}$
727					

INTERNAL COLLATION SUBROUTINE—DESCENDING ORDER



LEGEND

$A_0 \ldots A_{127}$ — Total input storage: $B_0 \cdots B_{63} + C_0 \cdots C_{63}$

$B_0 \cdots B_{63}$ — Storage for first group of 32 two-word items

$C_0 \cdots C_{63}$ — Storage for second group of 32 two-word Items

$G_0 \cdots G_{127}$ — Output Storage

A — Current position in input block
B — Current position in group 1.
C — Current position in group 2.
G — Current position in output block
n — Number of items in a group to be compared for a single string
n_1 — Number of items transferred from a string in group 1
n_2 — Number of items transferred from a string in group 2

3.1.1.6

A 940-3
INTERNAL COLLATION SUBROUTINE
64 TWO-WORD ITEMS IN DESCENDING ORDER

ECKERT-MAUCHLY COMPUTER CORP. DR. PRO. CH. 6/30/50

NUMBER OF CYCLES REQUIRED TO COMPLETE TWO-WAY INTERNAL COLLATION OF ONE BLOCK OF DATA FOR DIFFERENT ITEM SIZES

Σ	N	W
31 - 60	1	block is collated
21 - 30	2	1
16 - 20	3	2
13 - 15	4	2
11 - 12	5	3
9 - 10	6	3
8	7	3
7	8	3
6	10	4
5	12	4
4	15	4
3	20	5
2	30	5
1	60	6

where

Σ = number of words per item
N = number of items per block
W = number of cycles required for complete collation of block
g = number of items from group 1 to be collated in current cycle
h = number of items from group 2 to be collated in current cycle
R = number of items from each group to be collated together for a string in the current cycle

and $N = \left[\frac{60}{\Sigma}\right]$, $2^W \geq N > 2^{W-1}$

$\underline{W = 0}$
$N = 1$

first cycle

$R = 1$
$g = 0$
$h = 0$

$\underline{W = 1}$
$N = 2$

first cycle

$R = 1$
$g = 1$
$h = 1$

$\underline{W = 2}$
$N = 3$

first cycle	second cycle
$R = 1$	$R = 2$
$g = 1$	$g = 2$
$h = 1$	$h = 1$
	$N = 4$

first cycle	second cycle
$R = 1$	$R = 2$
$g = 2$	$g = 2$
$h = 2$	$h = 2$
	$\underline{W = 3}$
	$N = 5$

first cycle	second cycle	third cycle
$R = 1$	$R = 2$	$R = 4$
$g = 2$	$g = 2$	$g = 4$
$h = 2$	$h = 2$	$h = 1$
	$N = 6$	

first cycle	second cycle	third cycle
$R = 1$	$R = 2$	$R = 4$
$g = 3$	$g = 2$	$g = 4$
$h = 3$	$h = 2$	$h = 2$

Appendix
1/25/50

N = 7

first cycle	second cycle	third cycle
R = 1	R = 2	R = 4
g = 3	g = 4	g = 4
h = 3	h = 3	h = 3

N = 8

first cycle	second cycle	third cycle
R = 1	R = 2	R = 4
g = 4	g = 4	g = 4
h = 4	h = 4	h = 4

W = 4
N = 10

first cycle	second cycle	third cycle	fourth cycle
R = 1	R = 2	R = 4	R = 8
g = 5	g = 4	g = 4	g = 8
h = 5	h = 4	h = 4	h = 2

N = 12

first cycle	second cycle	third cycle	fourth cycle
R = 1	R = 2	R = 4	R = 8
g = 6	g = 6	g = 4	g = 8
h = 6	h = 6	h = 4	h = 4

N = 15

first cycle	second cycle	third cycle	fourth cycle
R = 1	R = 2	R = 4	R = 8
g = 7	g = 8	g = 8	g = 8
h = 7	h = 7	h = 7	h = 7

W = 5
N = 20

first cycle	second cycle	third cycle	fourth cycle	fifth cycle
R = 1	R = 2	R = 4	R = 8	R = 16
g = 10	g = 10	g = 8	g = 8	g = 16
h = 10	h = 10	h = 8	h = 8	h = 4

first cycle	second cycle	third cycle	fourth cycle	fifth cycle
R = 1	R = 2	R = 4	R = 8	R = 16
g = 15	g = 14	g = 16	g = 16	g = 16
h = 15	h = 14	h = 14	h = 14	h = 14

$$\frac{W = 6}{N = 60}$$

first cycle	second cycle	third cycle	fourth cycle
R = 1	R = 2	R = 4	R = 8
g = 30	g = 30	g = 28	g = 32
h = 30	h = 30	h = 28	h = 28

fifth cycle	sixth cycle
R = 16	R = 32
g = 32	g = 32
h = 28	h = 28

INTERNAL COLLATION ONTO TWO TAPES

10-word Item

Keyword = First Word

Key Digits = 12 Digits

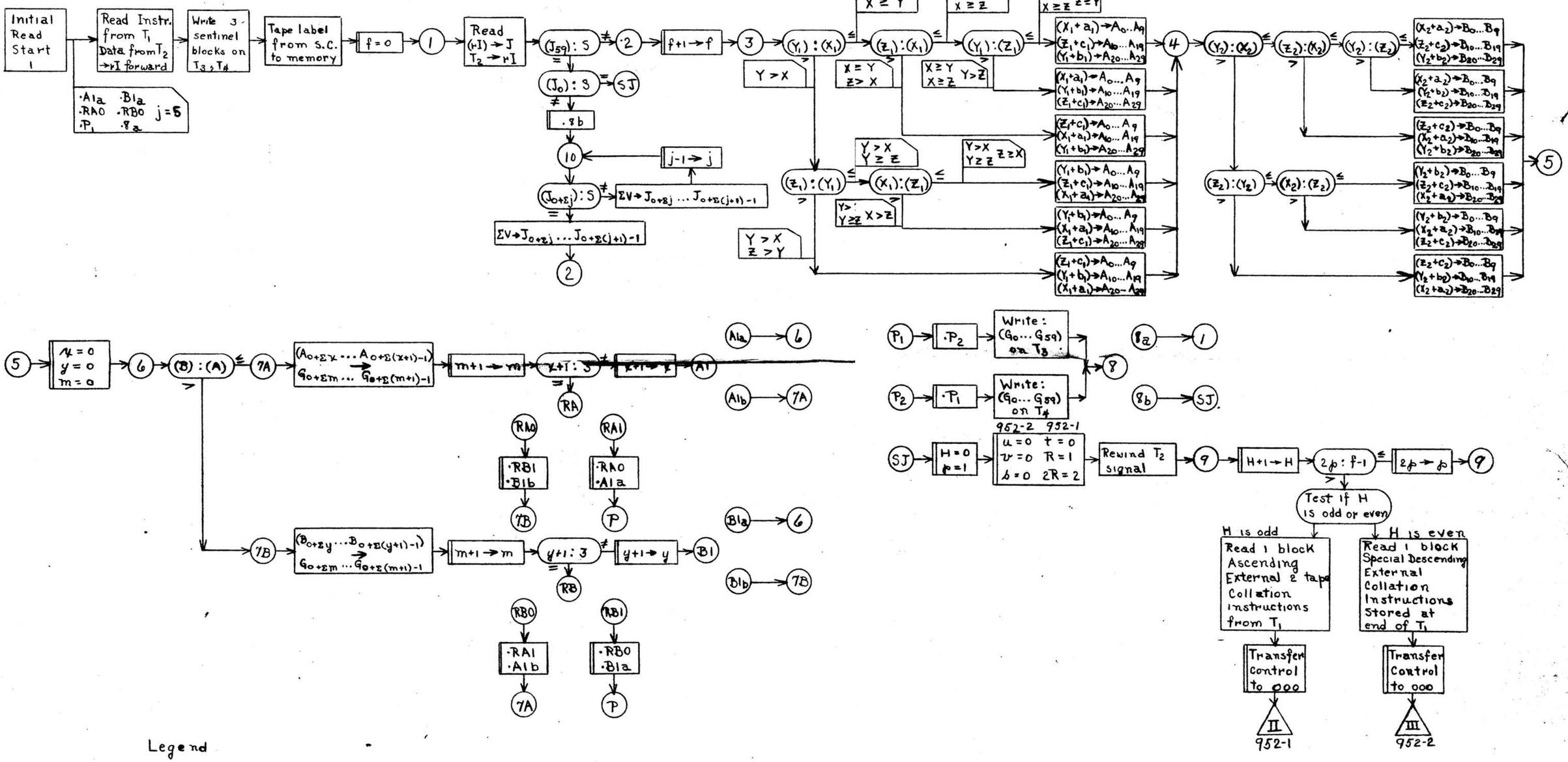
Initial	Read	Start brings first block of instructions into 000-059		
	000	11 000	31 060	Instructions and constants to memo locations. 000-179, Data from T_2 -> rI
	001	32 120	53 130	
	002	53 130	53 130	3 sentinel blocks on T_3 and T_4
	003	54 130	54 130	
	004	54 130	10 971	Tape label from Supervisory Contro to memory
	005	K 000	C 968	f = 0
o_1	006	32 600	B 659	(rI) -> J, Tape 2 -> rI
	007	L 130	Q 114	Sentinel (J_{59}):S
o_2	008	B 968	A 134	
	009	C 968	F 127	f+1 -> f Digit extractor
o_3	010	E 600	K 000	(X_1)
	011	E 610	T 026	(Y_1) $(Y_1):(X_1)$
	012	E 620	T 032	(Z_1) $(Z_1):(X_1)$
	013	K 000	E 610	(Y_1)
	014	Y 600	T 035	(X_1+a_1) $(Y_1):(Z_1)$
	015	Z 700	Y 620	(X_1+a_1) -> $A_0 \ldots A_9$

	016	Z	710			$(Z_1+c_1) \rightarrow A_{10}\ldots A_{19}$
				Y	610	(Y_1+b_1)
	017	Z	720			$(X_1+a_1) \rightarrow A_{20}\ldots A_{29}$
				X	000	
o_4	018	E	630			(X_2)
				X	000	
	019	E	640			(Y_2)
				T	042	$(Y_2):(X_2)$
	020	E	650			(Z_2)
				T	050	$(Z_2):(X_2)$
	021	K	000			
				E	640	(Y_2)
	022	Y	630			(X_2+a_2)
				T	054	$(Y_2):(Z_2)$
	023	Z	730			$(X_2+a_2) \rightarrow B_0\ldots B_9$
				Y	650	
	024	Z	740			$(Z_2+c_2) \rightarrow B_{10}\ldots B_{19}$
				Y	640	
	025	Z	750			$(Y_2+b_2) \rightarrow B_{20}\ldots B_{29}$
				U	062	$\rightarrow o_5$
	026	K	000			
				E	620	(Z_1)
	027	Y	610			(Y_1+b_1)
				T	038	$(Z_1):(Y_1)$
	028	K	000			
				E	600	(X_1)
	029	Z	700			$(Y_1+b_1) \rightarrow A_0\ldots A_9$
				T	041	$(X_1):(Z_1)$
	030	Y	620			
				Z	710	$(Z_1+c_1) \rightarrow A_{10}\ldots A_{19}$
	031	Y	600			(X_1+a_1)
				U	017	$\rightarrow o_4$
	032	Y	620			
				Z	700	$(Z_1+c_1) \rightarrow A_0\ldots A_9$
	033	Y	600			
				Z	710	$(X_1+a_1) \rightarrow A_{10}\ldots A_{19}$
	034	Y	610			(Y_1+b_1)
				U	017	$\rightarrow o_4$
	035	Z	700			$(X_1+a_1) \rightarrow A_0\ldots A_9$
				Y	610	
	036	Z	710			$(Y_1+b_1) \rightarrow A_{10}\ldots A_{19}$
				Y	620	(Z_1+c_1)
	037	00	000			
				U	017	$\rightarrow o_4$

038	Z	710			$(Y_1+b_1) \rightarrow A_{10}\ldots A_{19}$
			Y	620	
039	Z	700			$(Z_1+c_1) \rightarrow A_0\ldots A_9$
			Y	600	(X_1+a_1)
040	00	000			
			U	017	$\rightarrow$ 04
041	Y	600			
			Z	710	$(X_1+a_1) \rightarrow A_{10}\ldots A_{19}$
042	Y	620			(Z_1+c_1)
			U	017	$\rightarrow$ 04
043	K	000			
			E	650	(Z_2)
044	Y	640			(Y_2+b_2)
			T	057	$(Z_2):(Y_2)$
045	K	000			
			E	630	(X_2)
046	Z	730			$(Y_2+b_2) \rightarrow B_0\ldots B_9$
			T	060	$(X_2):(Z_2)$
047	Y	650			
			Z	740	$(Z_2+c_2) \rightarrow B_{10}\ldots B_{19}$
048	Y	630			
			Z	750	$(X_2+a_2) \rightarrow B_{20}\ldots B_{29}$
049	00	000			
			U	062	$\rightarrow$ 05
050	Y	650			
			Z	730	$(Z_2+c_2) \rightarrow B_0\ldots B_9$
051	Y	630			
			Z	740	$(X_2+a_2) \rightarrow B_{10}\ldots B_{19}$
052	Y	640			
			Z	750	$(Y_2+b_2) \rightarrow B_{20}\ldots B_{29}$
053	00	000			
			U	062	$\rightarrow$ 05
054	Z	730			$(X_2+a_2) \rightarrow B_0\ldots B_9$
			Y	640	
055	Z	740			$(Y_2+b_2) \rightarrow B_{10}\ldots B_{19}$
			Y	650	
056	Z	750			$(Z_2+c_2) \rightarrow B_{20}\ldots B_{29}$
			U	062	$\rightarrow$ 05
057	Z	740			$(Y_2+b_2) \rightarrow B_{10}\ldots B_{19}$
			Y	650	

	058	Z	730			$(Z_2+c_2) \rightarrow B_0 \cdots B_9$
				Y	630	
	059	Z	750			$(X_2+a_2) \rightarrow B_{20} \cdots B_{29}$
				U	062	$\rightarrow$ 05
	060	Y	630			
				Z	740	$(X_2+a_2) \rightarrow B_{10} \cdots B_{19}$
	061	Y	650			
				Z	750	$(Z_2+c_2) \rightarrow B_{20} \cdots B_{29}$
05	062	V	141			[x = 0
				W	065	[y = 0
	063	B	143			
				C	067	m = 0
	064	B	144			
				C	074	m = 0
06	065	E	(700)			
				K	000	
	066	E	(730)			
				T	074	(B) : (A)
07A	067	Y	(700)			$(A_{o+\Sigma x} \cdots A_{o+\Sigma(x+1)-1})$
				Z	(600)	to $G_{o+\Sigma m} \cdots G_{o+\Sigma(m+1)-1}$
	068	B	074			
				A	132	
	069	C	074			m+1 $\rightarrow$ m
				B	065	
	070	[L	139			
				Q	081]	x+1:3 $\rightarrow$ ^{o}RA0
	# 070	L	139	Q	084	x+1:3 $\rightarrow$ ^{o}RA1
	071	A	131			
				C	065	x+1 $\rightarrow$ x
	072	B	067			
				A	133	
^{o}Ala	073	[C	067			m+1 $\rightarrow$ m
				U	065]	$\rightarrow$ 06
^{o}Alb	# 073	C	067	U	067	$\rightarrow$ ^{o}7A
07B	074	Y	(730)			$(B_{o+\Sigma y} \cdots B_{o+\Sigma(y+1)-1})$
				Z	(600)	to $G_{o+\Sigma m} \cdots G_{o+\Sigma(m+1)-1}$
	075	B	067			
				A	132	
	076	C	067			m+1 $\rightarrow$ m
				B	066	
	077	[L	140			
				Q	087]	y+1:3 $\rightarrow$ ^{o}RB0
	# 077	L	140	Q	090	y+1:3 $\rightarrow$ ^{o}RB1

INTERNAL COLLATION ON TWO TAPES – DESCENDING SERIES
10 WORD ITEM KEY WORD ≤ 12 DIGITS



·A1a ·B1a ·RA0 ·RB0 j=5 ·P1 ·8a

Legend

- A First group of three items and also, the current location in that group
- B Second group of three items and also, the current location in that group
- G Output block of collated items
- H Number of external cycles needed to collate a tape
- J Input block of random data
- S End of tape sentinel
- S.C. Supervisory Control
- T Tape
- V Word of ignore symbols
- X_1, X_2 Location in data block J of the key words of items 1 and 4 respectively
- Y_1, Y_2 " " " " " " " " 2 and 5 "
- Z_1, Z_2 " " " " " " " " 3 and 6 "
- a Locations of satellite information associated with Key word in X
- b " " " " " " Y
- c " " " " " " Z
- f Number of blocks on output tape
- j Counts items of data in block J
- m Counts items transferred to output block G
- p A power of 2 to determine value of H
- x Counts items transferred from A
- y Counts items transferred from B
- Σ Number of words per item (10 words)

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES TOL UNLESS SPECIFIED OTHERWISE: FRACT. DEC. HOLE ANG.

MAT'L. UNIVAC C 10

Internal Collation on two Tapes - Descending Series
10 Word Key Word ≤ 12 Digits

DR. h.m.d. DATE 3-28-50
CH'K. MCL SCALE
APR. ENG. F. E. S.

C A-940-5

LET.	REVISIONS	DATE	CHK.

5 1 2 9

INTERNAL COLLATION ON THREE TAPES

DESCENDING ORDER

6-WORD ITEM - KEY DIGITS IN FIRST WORD ≤ 12 DIGITS

LAST BLOCK MAY BE INCOMPLETE

Initial read places first block of instructions in memory locations 000-059

000	53 010		One block of sentinel on T_3
		11 000	Instructions → rI
001	53 010		S → T_3
		31 060	Instructions: (rI) → m, T_1 → rI
002	54 010		S → T_4
		31 120	Instructions: (rI) → m, T_1 → rI
003	54 010		S → T_4
		32 180	Instructions: (rI) → m; Data: T_2 → rI
004	55 010		S → T_5
		10 971	S.C. to type tape label to memory
005	55 010		S → T_5
		B 080	f = 0
006	C 966		
		00 000	
007	54 010		Extra S on T_4
		U 011	

	008		V = a word of ignore symbols
	009		V
	010		S = End of tape sentinel

01	011	32 540	Data: (rI) → A, T_2 → rI
		B 599	(A_{59})
	012	L 010	S → rL
		Q 104	(A_{59}): S → 012

02	013	B 966	f
		A 141	+1
	014	C 966	f+1 → f
		J 967	R = 1
	015	Y 150	Transfer function table L_i → L
		Z 500	
	016	B 190	J = L_4
		C 962	

	017	B 193	C 963		K = L_9
	018	B 160	C 964		y = y_o = Ly_o
$^o3$	019	C 960	C 961		a = 0 b = 0
$^o4$	020	B (500)	A 148		000000 000(540) = (j) F 143 E 000
	021	C 023	B 149		K 000 E 000
	022	A (505)	C 024		000000 000(570) = (k)
	023	F 143	E (540)		Digit extractor $(A)_{(j)}$
	024	K 000	E (570)		$(A)_{(k)}$
	025	F 140	T 035		000111 000000 $(A)_{(k)}$: $(A)_{(j)}$ → $^oK5$
$^oJ5$	026	B 964	E 020		y $(A)_{(j)} \geq (A)_{(k)}$ (j)
	027	H 029	A 141		+1
	028	C 964	L 962		y+1 → y J
	029	B (500)	C (510)		(j) → y J
	030	B 020	Q 052		j j : J → ^oJ7a
#	030	B 020	Q 058		→ ^oJ7b
	031	A 142	C 020		j+1 → j
	032	B 960	A 141		a +1
	033	L 967	Q 044		R a+1 : R → ^oJ8a
#	033	L 967	Q 048		→ ^oJ8b
^oJ6a	034	C 960	U 020		a+1 → a → $^o4$
^oJ6b #	034	C 960	U 026		→ $^oJ5$
$^oK5$	035	B 964	E 022		y $(A)_{(k)} > (A)_{(j)}$

	036	H	038				
				A	141	+1	
	037	C	964			y+1 → y	
				L	963	K	
	038	[B	(505)			(k) → y	
				C	(510)]		
	039	[B	022			k	
				Q	055]	k : K → °K7a	
#	039	B	022	Q	061	→ °K7b	
	040	A	142			+1	
				C	022	k+1 → k	
	041	B	961			b	
				A	141	+1	
	042	[L	967			R	
				Q	046]	b+1 : R → °K8a	
#	042	L	967	Q	050	→ °K8b	
°K6a	043	[C	961			b+1 → b	
				U	020]	→ °4	
°K6b #	043	C	961	U	035	→ °5	
°J8a	044	V	176			{.K8b	End of string
				W	042	{.K6b	a = R before b
	045	00	000				
				U	035	→ °K5	
°K8a	046	V	173			{.J8b	b = R before a
				W	033	{.J6b	
	047	00	000				
				U	026	→ °J5	
°J8b	048	V	167			{.J8a	a = R after b
				W	033	{.J6a	
	049	K	000				
				U	019	→ °3	
°K8b	050	V	170			{.K8a	b = R after a
				W	042	{.K6a	
	051	K	000				
				U	019	→ °3	
°J7a	052	B	175				End of cycle
				C	039	.K7b	J before K
	053	B	177				
				C	043	.K6b	
	054	00	000				
				U	035	→ °K5	
°K7a	055	B	172				K before J
				C	030	.J7b	
	056	B	174				
				C	034	.J6b	

	057	00 000	U	026	→ °J5	
°J7b	058	B 166	C	030	.J7a	J after K
	059	B 168	C	034	.J6a	
	060	00 000	U	063		
°K7b	061	B 169	C	039	.K7a	K after J
	062	B 171	C	043	.K6a	
	063	B 161	C	020	j = j_o	
°9a	064	[Y 510	Z	500]	(Ly) → L	End of cycle
#	064	L 182	U	082	→ °9b	
	065	B 967	X	000	R 2R	
°10a	066	[L 145	Q	071]	4 2R : 4	
#	066	C 967	U	074	2R → R → °10b	
	067	C 967	B	189	2R → R J = L_3	End of cycle 1
	068	C 962	B	192	K = L_7	
	069	C 963	B	162	k_o = L_4	
	070	C 022	U	018	→ °3	
	071	C 967	B	181	2R → R	End of cycle 2
	072	C 066	B	162	.10b k_o = L_4	
	073	C 022	U	018	→ °3	
°10b	074	B 191	C	962	J = L_7	End of cycle 3
	075	B 179	C	064	.9b	
	076	B 164	C	022	k_o = L_8	
	077	00 000	U	017		

	078	00 000	00 000	
	079	00 000	00 000	
	080	00 000	00 000	= 0
	081	[V 000	W (900)]	m (variable)
$^{o}9b$	082	[B (510)	06 000]	(Ly) Shift left — End of cycle 4
	083	A 081	H 087	Set up instructions for transfer of (A) to G
	084	A 144	H 088	
	085	X 000	H 089	
	086	X 000	E 080	Extractor in rF = 000111 000000
	087	[V (xxx)	W (900)]	Transfer one item
	088	[V (+2)	W (902)]	
	089	[V (+4)	W (904)]	
	090	C 081	B 082	m+1 → m y
	091	[A 142	Q 093]	y+1 : Ly_{10} → $^{o}P1$
#	091	A 142	Q 095	→ $^{o}P2$
#	091	A 142	Q 097	→ $^{o}P3$
	092	C 082	U 082	y+1 → y
$^{o}P1$	093	53 900	B 186	Write($G_0 \ldots G_{59}$) on T_3. Print Out
	094	C 091	U 099	.P2 → $^{o}11$
$^{o}P2$	095	54 900	B 187	Write($G_0 \ldots G_{59}$) on T_4
	096	C 091	U 099	.P_3 → $^{o}11$
$^{o}P3$	097	55 900	B 185	Write($G_0 \ldots G_{59}$) on T_5 .P1
	098	C 091	00 000	
$^{o}11a$	099	[B 178	C 064]	.9a
11b #	099	00 000	U 114	After incomplete last block → ^{o}SA

	100	B 180	C	066	·10a	
	101	B 163	C	022	$k = k_o$	
	102	V 183	W	081	$m = 0$, $y = y_o$	
	103	00 000	U	011	→ $^o1$	
$^o12$	104	B 540	Q	114	(A_o) : S → ^oSA	
$^o13$	105	[B (546)	Q	108]	(A_{o+Zx}) : S, where x = 1 initially	
	106	B 105	A	147		
	107	C 105	U	105	x+1 → x	
$^o14$	108	B 111	E	105		Fill remainder of last block with ignore symbols
	109	L 188	V	008	Ignores → rV	
	110	H 111	A	146	x+1	
	111	W (xxx)	Q	113]	x+1 : N	
	112	00 000	U	110	→ $^o14$	
	113	R 099	U	013	·11b → $^o2$	
^oSA	114	B 966	S	141	f - 1	End of tape
	115	K 000	B	141		
	116	H 973	H	967	p = 1 R = 1	Setting constants for External Collation
	117	X 000	X	000		
	118	C 974	C	975	3R = 3 u = 0	
	119	C 976	C	977	v = 0 w = 0	
	120	C 978	C	979	r = 0 s = 0	
	121	C 980	C	972	t = 0 H = 0	

15	122	B 972			
			A	141	
	123	C 972			H + 1 → H
			B	973	p
	124	X 000			
			X	000	3p
	125	00 000			
			T	127	3p : f-1
	126	C 973			3p → p
			U	122	→ o_{15}
	127	F 972			H
			K	000	Clear rA and rL to zero
	128	K 000			
			E	141	Unity
	129	82 000			Rewind data tape
			Q	133	Test for H: odd or even
	130	31 000			T_1 → rI H is odd
			K	000	
	131	C 981			U = 0
			00	000	
	132	31 000			Instructions for Ascending External Collation (rI) → 000...059; T_1 → rI
			U	000	→ Ascending External Collation
	133	B 141			H is even
			C	981	U = 1
	134	C 982			Counter = 0
			L	165	Number of read instructions required to position special descending series program
	135	31 000			
			B	982	
	136	A 141			Counter +1
			Q	000	→ Special Descending-following-Descending External Collation
	137	C 982			
			U	135	

Constants

140	000111	000000	Instruction extractor
141	000000	000001	
142	000001	000000	
143			Digit extractor
144	000002	000002	
145	000000	000004	
146	000002	000000	
147	000006	000000	
148	F 143	E 000	
149	K 000	E 000	
150	000000	000540	Function table locations L_ℓ
151	000000	000546	
152	000000	000552	
153	000000	000558	
154	000000	000564	
155	000000	000570	
156	000000	000576	
157	000000	000582	
158	000000	000588	
159	000000	000594	
160	B 000	C 510	$y_o = L_{yo}$
161	B 500	A 148	$j_o = L_o$
162	A 504	C 024	$k_o = L_4$
163	A 505	C 024	$k_o = L_5$
164	A 508	C 024	$k_o = L_8$

165					} No. of read instructions required to position special descending series program
166	B	020	Q	052	.J7a
167	L	967	Q	044	.J8a
168	C	960	U	020	.J6a
169	B	022	Q	055	.K7a
170	L	967	Q	046	.K8a
171	C	961	U	020	.K6a
172	B	020	Q	058	.J7b
173	L	967	Q	048	.J8b
174	C	960	U	026	.J6b
175	B	022	Q	061	.K7b
176	L	967	Q	050	.K8b
177	C	961	U	035	.K6b
178	Y	510	Z	500	.9a
179	L	182	U	082	.9b
180	L	145	Q	071	.10a
181	C	967	U	074	.10b
182	B	520	06	000	L_{y10}
183	V	000	W	900	m = 0
184	B	510	06	000	$y_o = L_{yo}$ (for $A_{(y)}$)
185	A	142	Q	093	.P1
186	A	142	Q	095	.P2
187	A	142	Q	097	.P3
188	W	600	Q	113	N (for x)
189	B	503	A	148	$J = L_3$
190	B	504	A	148	$J = L_4$
191	B	507	A	148	$J = L_7$

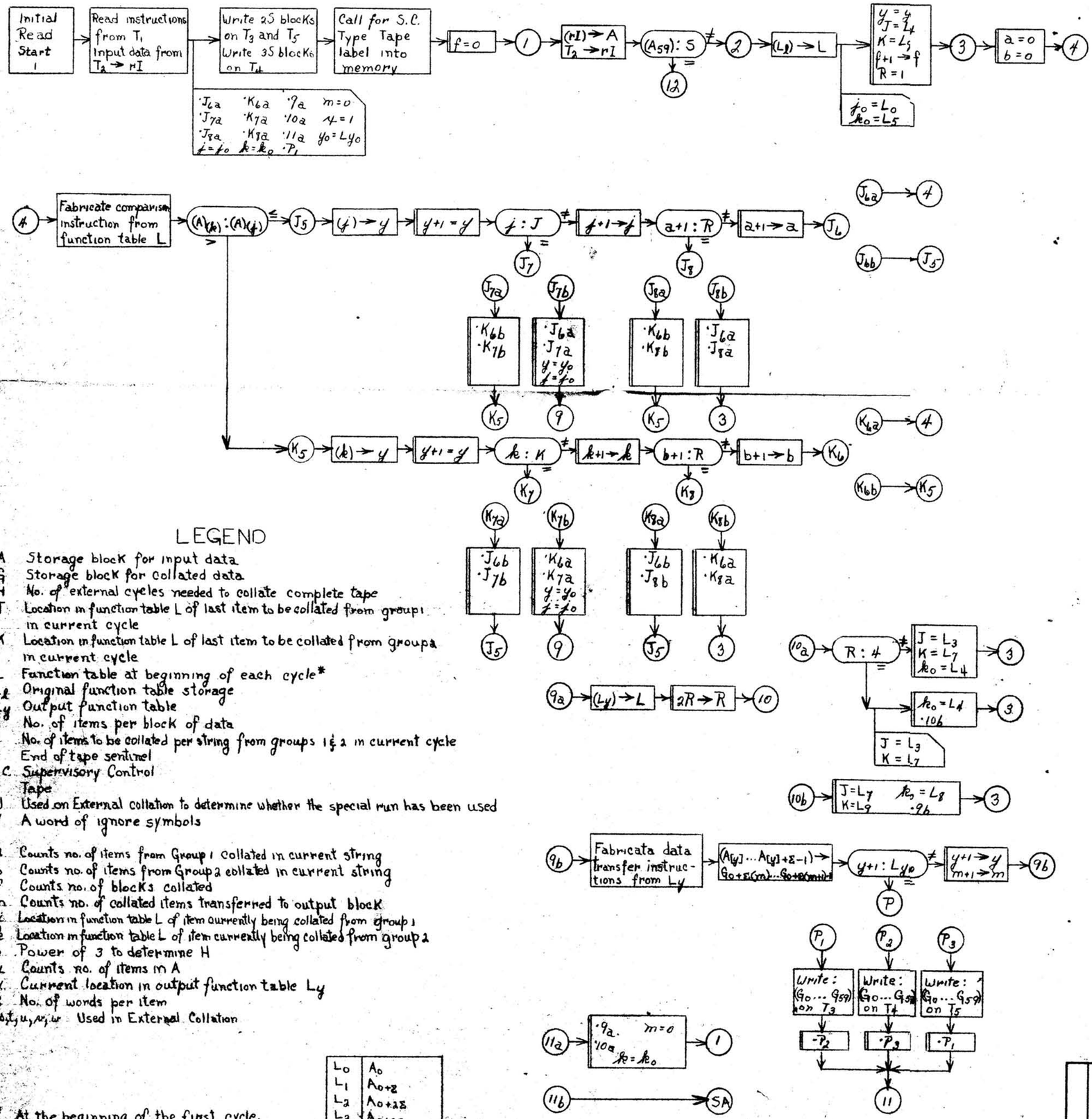
192 A 507 C 024 $K = L_7$

193 A 509 C 024 $K = L_9$

500 - 509	L
510 - 519	L_y
540 - 599	Input block for data (A)
900 - 959	Output block for collated data (G)
960	a = counts no. of items from group 1 collated in current string
961	b = counts no. of items from group 2 collated in current string
962	J = Location in function table L of last item to be collated from group 1 in current cycle
963	K = Location in function table L of last item to be collated from group 2 in current cycle
964	y = Current location in output function table L_y (variable)
966	f = No. of blocks collated
967	R = No. of items to be collated per string from groups 1 and 2 in current cycle (internal collation) R = No. of blocks to be collated per string from each input tape in current cycle (external collation)
970	
971	Tape Label
972	H = No. of external cycles needed to collate complete tape
973	Temporary storage for p = 1,3,9,27,81,etc.
974	3R
975	u
976	v
977	w

978	r
979	s
980	t
981	U = 0 if H is odd; U=1 if H is even
982	Temporary storage for counter

INTERNAL COLLATION ON THREE TAPES – DESCENDING SERIES
6-WORD ITEM – KEY DIGITS ≤ 12 DIGITS



LEGEND

- A Storage block for input data
- G Storage block for collated data
- H No. of external cycles needed to collate complete tape
- J Location in function table L of last item to be collated from group 1 in current cycle
- K Location in function table L of last item to be collated from group 2 in current cycle
- L Function table at beginning of each cycle*
- L_4 Original function table storage
- L_y Output function table
- N No. of items per block of data
- R No. of items to be collated per string from groups 1 & 2 in current cycle
- S End of tape sentinel
- S.C. Supervisory Control
- T Tape
- U Used on External collation to determine whether the special run has been used
- V A word of ignore symbols

- a Counts no. of items from Group 1 collated in current string
- b Counts no. of items from Group 2 collated in current string
- f Counts no. of blocks collated
- m Counts no. of collated items transferred to output block
- j Location in function table L of item currently being collated from group 1
- k Location in function table L of item currently being collated from group 2
- p Power of 3 to determine H
- 4 Counts no. of items in A
- y Current location in output function table L_y
- Σ No. of words per item
- t, A, r, u, v, w Used in External Collation

* At the beginning of the first cycle, L appears as at right.

L_0	A_0
L_1	$A_{0+\Sigma}$
L_2	$A_{0+2\Sigma}$
L_3	$A_{0+3\Sigma}$
L_4	$A_{0+4\Sigma}$
L_5	$A_{0+5\Sigma}$
L_6	$A_{0+6\Sigma}$
L_7	$A_{0+7\Sigma}$
L_8	$A_{0+8\Sigma}$
L_9	$A_{0+9\Sigma}$

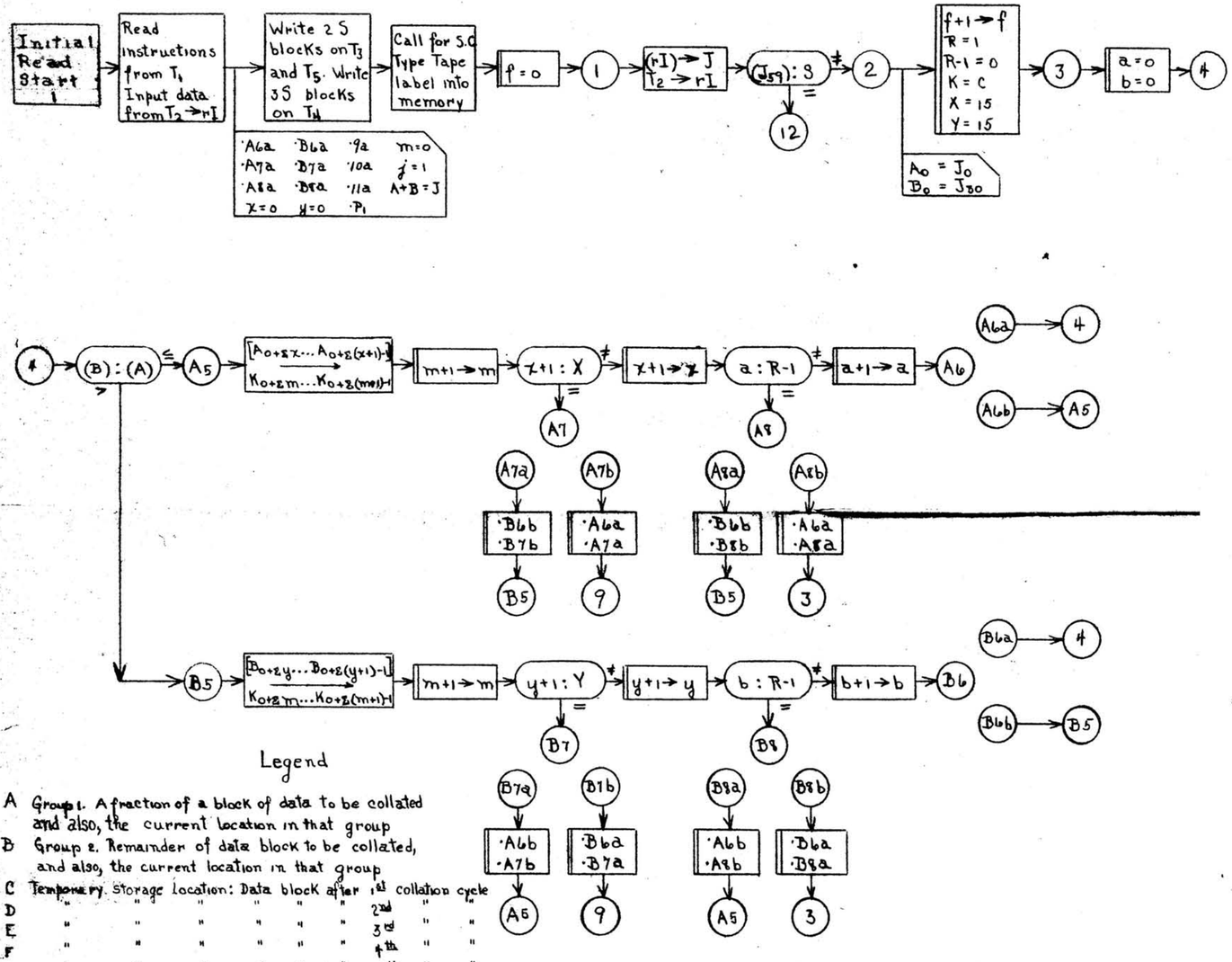
ITEM	QUAN.	DESCRIPTION	MATERIAL
		BILL OF MATERIAL	

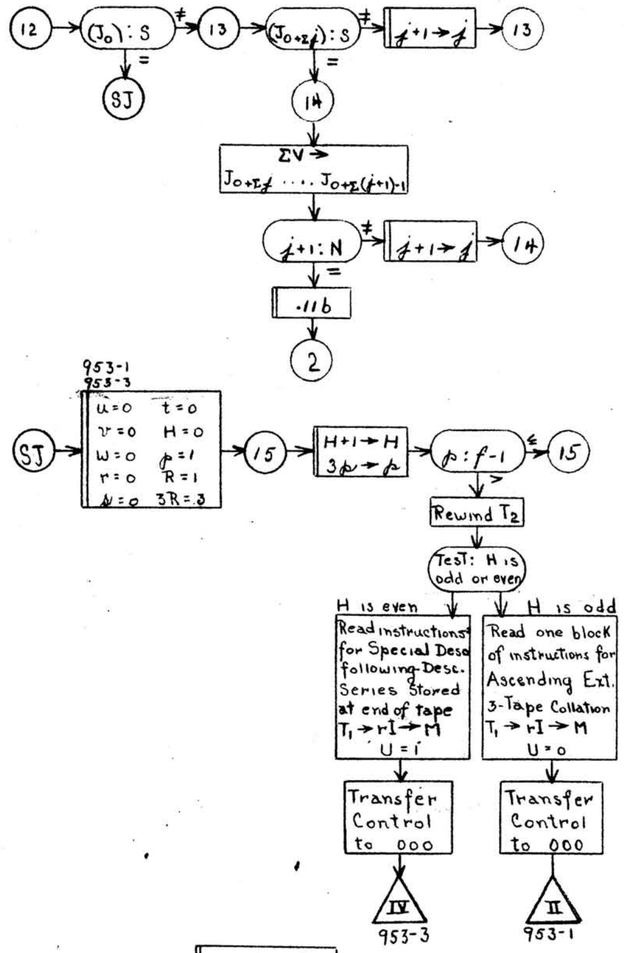
ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

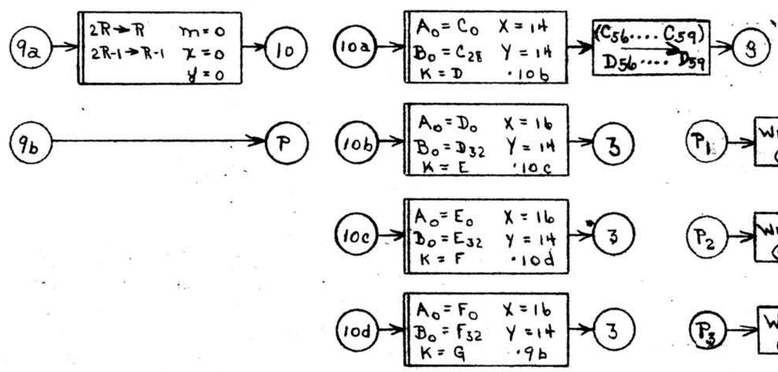
ALL DIMENSIONS ARE IN INCHES TOL. UNLESS SPECIFIED OTHERWISE: FRACT. DEC. HOLE ANG.	MAT'L. UNIVAC C-10
Internal Collation on Three Tapes - Descending Series 6-word Item - Key Digits ≤ 12 Digits	
DR. h.m.d. DATE 2-1-50	CA-940-4
CH'K. SCALE	
APR. ENG. A. B. T.	5 1 3 12

LET.	REVISIONS	DATE	CHK.

INTERNAL COLLATION ON THREE TAPES – DESCENDING SERIES
TWO-WORD ITEM – KEY DIGIT ≤ 12 DIGITS







Legend

- A Group 1. A fraction of a block of data to be collated and also, the current location in that group
- B Group 2. Remainder of data block to be collated, and also, the current location in that group
- C Temporary storage location: Data block after 1st collation cycle
- D " " " " " " 2nd " " "
- E " " " " " " 3rd " " "
- F " " " " " " 4th " " "
- G " " " " " " 5th " " "
- H No. of external cycles needed to collate complete tape
- J Storage Location for one block of input data
- K Current output storage location
- N Number of items in block
- R Internal Collation: No. of items to be collated from groups 1 and 2, per string in current cycle
- R External Collation: No. of blocks to be collated from each tape, per string in current cycle
- S End of tape sentinel
- S.C. Supervisory Control
- T Tape
- U Used on external collation to determine whether the special run has been used.
- V A word of ignore symbols
- X No. of items from group 1 to be collated in current cycle
- Y No. of items from group 2 to be collated in current cycle
- Z No. of words per item
- a Counts no. of items from group 1 collated in current string
- b Counts no. of items from group 2 collated in current string
- f Counts no. of blocks collated
- j Counts no. of items in input block J
- m Counts no. of items transferred to output block K
- p A power of 3 to determine H
- x Counts no. of items in A which have been transferred to K
- y Counts no. of items in B which have been transferred to K
- r, s, t, u, v, w Counters used in external collation

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL UNLESS SPECIFIED OTHERWISE:
FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

Internal Collation on Three Tapes - Descending Series
Two-word Item - Key Digit ≤ 12 Digits

DR. h.m.d. | DATE 3-3-50
CH'K. HAN | SCALE
APR. | ENG. A. B. T.

C A-940-6

LET.	REVISIONS	DATE	CHK.

TWO-TAPE EXTERNAL COLLATION
ASCENDING - DESCENDING SERIES

Six-word Item with Key Digits Split Between First and Second Words

First block of instructions read in from Internal Collation - 2nd block in rI.

	000	31 060	31 120	}	Read in instruction and constants
	001	31 180	30 240	}	
o_1	002	L 966			(t = 0) clear rL
			B 960		H
	003	S 250			H - 1
			Q 005		Test for last cycle
	004	C 960			H - 1 → H
			U 009		
	005	B 177			
			C 046		.P5
	006	B 178			
			C 097		.15b
	007	65 000			Rewind T_5 without interlock
			75 970		Write tape label on T_5 (20/in)
	008	86 000			Rewind T_6 with interlock
			U 012		
	009	[55 210	55 210]	}	3 S to output tapes 5 and 6
	010	[55 210	56 210]	}	
	011	[56 210	56 210]	}	
	012	[00 000	23 000]		T_A → rI, backwards
	013	[43 540			(rI) → A, T_A → rI
			44 600]		(rI) → C, T_B → rI
	014	[44 720			(rI) → B, T_B → rI
			43 780]		(rI) → D, T_A → rI
o_{Q1}	015	[F 218			Set digit extractor
			K 000]		
	016	[E (594)			
			K 000]		
	017	[E (774)			
			T 052]		$(B_a):(A_a)$ → o_3

	018	[00 000	Q 145]	$(B_a):(A_a)$
	019	[00 000	00 000]	
	#009	53 210	53 210	
	#010	53 210	54 210	
	#011	54 210	54 210	
	#012	00 000	25 000	
	#013	45 540	46 600	
	#014	46 720	45 780	
	#015	F 218	K 000	
$^{o}Q2$	#016	E (594)	K 000	
	#017	E (774)	T 020	
	#018	00 000	Q 145	
	#019	00 000	U 052	
$^{o}4$	020	B 017	F 173	Transfer(B); Instruction extractor
	021	R 045	U 036	
$^{o}5B$	022	A 017	L 168	y+1
	023	[H 017		N; y+1 → y
$^{o}B1a$			T 015]	y+1 : N. → ^{o}Q
$^{o}B1b$	#023	H 017	T 020	y+1 → y. → $^{o}4$
oL2	024	B 236	H 157	End of B block; D or F
	025	R 163	U 152	
	026	B 236	H 244	D or F → Z+1
	027	S 237	C 236	

	028	J 237	F 249		010000 000000
	029	B 049	E 217		
	030	C 049			$T_K = T_B$
	031	[L 210	B 720		(B_o)
			Q 092]		S (B_o) : S. → ^oSB_o
	≠031	L 210	Q 097		→ $^oSB1$
	032	B 169	C 017		y = 0
	033	B 963	A 250		v+1
	034	[L 961	Q 072]		R v+1 : R. → ^oRB_o
	≠034	L 961	Q 080		→ $^oRB1$
^oB2a	035	[C 963	U 015]		v+1 → v → ^oQ
^oB2b	≠035	C 963	U 020		→ $^o4$
	036	E 039	H 039		Output subroutine
	037	A 247	H 040		Build up data transfer instructions
	038	X 000	C 041		
	039	[V ( )	W (900)]		(A) → G ; (B) → G
	040	[V (+2)	W (902)]		(A+2) → G+2 ; (B+2) → G+2
	041	[V (+4)	W (904)]		(A+4) → G+4 ; (B+4) → G+4
	042	E 041	X 000		m+1
	043	L 171	Q 046		N m+1 : N. → ^oP
	044	C 039	B 211		m+1 → m
	045	[00 000	U (c+1)]		Re-enter main routine. → $^o5$
$^oP1$	046	[55 900	B 250]		Write $(G_{o...59})$ on T_5
	047	[A 965	H 965]		s+1 → s

^{o}P2	≠046	56	900	B	250	
	≠047	A	966	H	966	t+1 → t
^{o}P3	≠046	53	900	B	250	
	≠047	A	965	H	965	s+1 → s
^{o}P4	≠046	54	900	B	250	
	≠047	A	966	H	966	t+1 → t
^{o}P5	≠046	55	900	U	049	
	≠046	53	900	U	049	After special run
	048	L	964	Q	084	2R → ^{o}7
^{o}9	049	[44	660			(rI) → Z ; T_K → rI } Initial inst. on ascending series
				B	244]	Z+1
	≠049	43	660	B	244	
	≠049	45	660	B	244	
	≠049	46	660	B	244	} Initial inst. on descending series
	≠049	43	600	B	244	
	≠049	44	600	B	244	
	≠049	45	600	B	244	
	≠049	46	600	B	244	
	≠049	43	780	B	244	
	≠049	44	780	B	244	
	≠049	45	780	B	244	
	≠049	46	780	B	244	
	≠049	43	840	B	244	
	≠049	44	840	B	244	
	≠049	45	840	B	244	
	≠049	46	840	B	244	
	050	E	049			
				C	049	Z+1 → Z

	051	B	172	U	044	m = 0
$^{o}3$	052	B	016			Transfer(A)
				F	173	Set instruction extractor
	053	R	045	U	036	
$^{o}5A$	054	A	016			x+1
				L	166	N
	055	[H	016			x+1 → x
$^{o}A1a$				T	015]	x+1:N. → ^{o}Q
$^{o}A1b$	≠055	H	016	T	052	→ $^{o}3$
						End of A block
	056	B	240			
				H	157	C or E
	057	R	163	U	152	
	058	B	240			
				H	244	C or E → Z+1
	059	S	241	C	240	
	060	J	241			
				F	249	010000 000000
	061	B	049	E	216	$T_K = T_A$
	062	C	049			
				B	540	(A_o)
	063	[L	210			S
				Q	088]	(A_o):S. → ^{o}SAo
	≠063	L	210	Q	097	→ $^{o}SA1$
	064	B	167			
				C	016	x = 0
	065	B	962			u
				A	250	u+1
	066	[L	961			R
				Q	068]	u+1:R. → ^{o}RAo
	≠066	L	961	Q	076	→ $^{o}RA1$
	≠066	L	961	Q	095	→ $^{o}RA2$
	067	[C	962			u+1 → u
$^{o}A2a$				U	015]	→ ^{o}Q
$^{o}A2b$	≠067	C	962	U	052	→ $^{o}3$

^{o}RAo	068	B	235	C	035	.B2b
	069	B	224	C	034	.RB1
	070	B	233	C	023	.B1b
	071	C	962	U	020	u = 0 → ^{o}4
^{o}RBo	072	B	221	C	066	.RA1
	073	C	963	B	231	v = 0
	074	C	067	B	229	.A2b
	075	C	055	U	052	.A1b → ^{o}3
^{o}RA1	076	B	230	C	067	.A2a
	077	B	228	C	055	.A1a
	078	B	220	C	066	.RAo
	079	C	962	U	015	u = 0 → ^{o}Q
^{o}RB1	080	B	234	C	035	.B2a
	081	B	232	C	023	.B1a
	082	B	223	C	034	.RBo
	083	C	963	U	015	v = 0 → ^{o}Q
^{o}7a, ^{o}7c	084	V	202	B	204	.7b, .7d
	085	W	046	C	084	s = 0
	086	C	965	B	207	
	087	C	086	U	049	→ ^{o}9

$^{o}7b$,	≠084	V	200	B	205	
$^{o}7d$	≠085	W	046	C	084	.7a, .7c
	≠086	C	966	B	206	t = 0
	≠087	C	086	U	049	

^{o}SAo	088	B	233	C	023	.B1b
	089	B	235	C	035	.B2b
	090	B	226	C	031	.SB1
	091	00	000	U	020	→ $^{o}4$

^{o}SBo	092	B	222	C	066	.RA2
	093	B	226	C	063	.SA1
	094	B	231	U	074	A2b

$^{o}RA2$	095	K	000	C	962	u = 0
	096	00	000	U	052	→ $^{o}3$

$^{o}15a$,	097	[K	000			Clear rA
$^{o}SA1$,				K	000]	Clear rL
$^{o}SB1$.						

	≠097	00	000	U	140	

	098	S	966			-t
				Q	102	-t : 0
	099	A	964			2R -t
				H	965	2R -t → s
	100	C	963			2R -t → v
				C	966	t = 0
	101	C	962			u = o
				U	105	
	102	S	965			-s
				Q	139	-s:0
	103	A	964			2R - s
				H	962	2R -s → u

	104	C	965	C	963	2R - s → s v = 0
	105	B	964	H	961	2R → R
	106	X	000	C	964	2(2R) → 2R
°14a	107	[Y	180	B	251]	°Q2
°14b	≠107	Y	190	B	252	°Q1
	108	Z	010			x = 0, y = 0
	109	B	170	C	107	
	110	C	169	L	169	Interchange y = 0 instruction
	111	B	009	J	170	
	112	C	179	L	179	Interchange tape sentinel instructions
	113	[V	214	J	009	
				B	254]	Alternate read setup instructions
	≠113	V	212	B	253	
	114	W	216	C	113	
	115	B	176	L	175	
	116	J	176	H	049	Alternate read instructions. Z = E $T_K = T_B$
	117	C	175	B	245	
	118	C	244	V	238	Z+1 = F
	119	W	236	V	242	.L2a
	120	W	240	B	225	.L1a
	121	C	063	B	227	.SAo
	122	C	031	B	228	.SBo
	123	C	055	B	230	.A1a
	124	C	067	B	220	.A2a
	125	C	066	B	232	.RAo
	126	C	023	B	234	.B1a

	127	C 035			.B2a
			B	223	
	128	C 034			.RBo
			B	208	
	129	L 200			
			J	208	Alternate tape write instructions
	130	H 046			
			C	200	
	131	B 201			
			C	047	Reset 047 to A 965 H 965
	132	B 209			
			L	202	Alternate reserve tape write
	133	J 209			instructions
			C	202	
	134	B 205			
			C	084	Reset 084 to V 202 B 204
	135	B 206			
			C	086	Reset 086 to C 965 B 207
	136	40 540			Clear rI
			B	151	
	137	L 255			
			C	255	Alternate unconditional transfer instructions at end of second word comparison routine
	138	J 151			→ $^{o}1$
			U	002	
	139	C 963			v = 0
			U	101	
$^{o}15b$	140	55 210			
			55	210	Write 3S on T_p
	141	55 210			
			84	000	
	142	83 000			
			81	000	Rewind all tapes
	143	85 000			
			50	140	T_p instruction → SC,
	144	40 000			Clear rI
			90	000	Stop
					First half of key equal
	145	B 016			
			A	246	
	146	C 149			
			00	000	
	147	X 000			Build up comparison instructions
			A	017	
	148	F 219			
			C	150	
	149	E (595)			
			K	000	

150	E (775)	T 052	$(B_{60-\Sigma(y+1)+1}) : (A_{60-\Sigma(x+1)+1})$
151	00 000	U 020	(B) < (A) → $^{0}4$

#151	00 000	U 052	→ $^{0}3$

152	A 248	H 158	Transfer storage block to operation block.
153	X 000	H 159	
154	X 000	H 160	Build up instructions
155	X 000	H 161	
156	X 000	C 162	
157	Y ( )	Z ( )	
158	Y (+10)	Z (+10)	
159	Y (+20)	Z +20	Transfer storage block to working location
160	Y (+30)	Z (+30)	
161	Y (+40)	Z +40	
162	Y +50	Z (+50)	
163	00 000	U (c+1)	

Constants

166	E 539	K 000	N for A
167	E 594	K 000	x = 0
168	E 719	00 000	N for B
169	[E 774	T 052]	y = 0 or E 774 T 020
170	[E 774	T 020]	y = 0 or E 774 T 052
171	V 002	W 960	N for G
172	V 000	W 900	m = 0
173	100000	111111	Instruction extractor
174			
175	[44 660	B 244]	or 46 660 B 244
176	[46 660	B 244]	or 44 660 B 244
177	55 900	U 049	.P5
178	00 000	U 140	.15b
179	[53 210	53 210]	or 55 210 55 210
180	53 210	54 210	
181	54 210	54 210	
182	00 000	25 000	
183	45 540	46 600	
184	46 720	45 780	
185	F 218	K 000	For descending series
186	E 594	K 000	
187	E 774	T 020	
188	00 000	Q 145	
189	00 000	U 052	
190	55 210	56 210	
191	56 210	56 210	
192	00 000	23 000	

193	43 540	44 600	
194	44 720	43 780	
195	F 218	K 000	For ascending series
196	E 594	K 000	
197	E 774	T 052	
198	00 000	Q 145	
199	00 000	00 000	
200	[55 900	B 250]	or 53 900 B 250
201	A 965	H 965	
202	[56 900	B 250]	or 54 900 B 250
203	A 966	H 966	
204	V 200	B 205	
205	V 202	B 204	
206	C 965	B 207	
207	C 966	B 206	
208	[53 900	B 250]	Alternate for 200, · 55 900 B 250
209	[54 900	B 250]	" " 202; · 56 900 B 250
210			End of tape sentinel
211	-00006	000000	
212	030000	000000	
213	040000	000000	
214	050000	000000	
215	060000	000000	
216	[030000	000000]	or 050000 000000
217	[040000	000000]	or 060000 000000

```
218                                  Digit extractor (first half)
219                                  Digit extractor (second half)
220     L  961   Q  068               .RAo
221     L  961   Q  076               .RA1
222     L  961   Q  095               .RA2
223     L  961   Q  072               .RBo
224     L  961   Q  080               .RB1
225     L  210   Q  088               .SAo
226     L  210   Q  097               .SA1, .SB1
227     L  210   Q  092               .SBo
228     H  016   T  015               .A1a
229     H  016   T  052               .A1b
230     C  962   U  015               .A2a
231     C  962   U  052               .A2b
232     H  017   T  015               B1a
233     H  017   T  020               .B1b
234     C  963   U  015               .B2a
235     C  963   U  020               .B2b
236   [ Y (780)  Z  720 ]             or Y  840  Z  720 } For B string
237   [-00060    000000 ]             Minus to start   } input
238     Y  780   Z  720                }
239     -00060   000000               } Constant
240   [ Y (600)  Z  540 ]             or Y  660  Z  540 } For A string
241   [-00060    000000 ]             Minus to start   } input
242     Y  600   Z  540                }
243     -00060   000000               } Constant
```

244	Y (840)	Z (720)	Z+1 or Y 780 Z 720 or Y 600 Z 540 or Y 660 Z 540
245	Y 840	Z 720	Constant
246	000001	000000	
247	000002	000002	
248	000010	000010	
249	010000	000000	
250	000000	000001	
251	Y 190	B 252	Set up for descending series
252	Y 180	B 251	Set up for ascending series
253	V 214	B 254	
254	V 212	B 253	
255	00 000	U 052	or 00 000 U 020
960			H; no. of cycles needed for External Collation
961			R; no. of blocks per input string
962			u; counter for no. of blocks collated from input A
963			v; counter for no. of blocks collated from input B
964			2R; no. of blocks per output string
965			s; counter for no. of blocks collated on first output tape
966			t; counter for no. of blocks collated on second output tape
967			
968			
969			
970			
971			Tape label

540 - 599	A
720 - 779	B
600 - 659	C
780 - 839	D
660 - 719	E
840 - 899	F
900 - 959	G

TWO TAPE EXTERNAL COLLATION

ASCENDING AND DESCENDING SERIES

Connector	Function and Purpose	Entry Point
$^{o}1$	Cycle start. Tests for last cycle. If the current cycle is the last cycle, $^{o}P5$, $^{o}15b$ are set and data is read in from tape A to A, C and rI, from tape B to B and D. The tape label is written on T_p. If the cycle is not the last, the cycle counter is increased and 3 blocks of sentinel are written on each output tape and the data is read in as above.	Entered after instructions and constants have been initially read in. Re-entered at beginning of each cycle.
$^{o}Q1$	Set for every ascending cycle. Compares (A) and (B), transferring to $^{o}3$ if (A) is the lesser and $^{o}4$ if (B) is the lesser. Since the routine handles a split key, it is possible to make two tests on every item and three tests on items whose first half keys are equal.	Entered from $^{o}A1a$, $^{o}B1a$ after transferring any item which is not the last item in its own input block. Entered from $^{o}A2a$, $^{o}B2a$ after transferring the last item in an input block but not the last in an input string. Entered from $^{o}RA1$, $^{o}RB1$ at the end of an output string.
$^{o}Q2$	Set for every descending cycle. Compares (A) and (B) as in $^{o}Q1$ except that the transfer to $^{o}3$ occurs when (A) is the greater and to $^{o}4$ when (B) is the greater.	Entered as in $^{o}Q1$
$^{o}3$	Transfers A item to output. Sets $^{o}5A$.	Entered from $^{o}Q1$ when (A) is less than (B). Entered from $^{o}Q2$ when (A) is greater than (B). Entered from ^{o}RBo, $^{o}A1b$, $^{o}A2b$ after completion of a B string. Entered from ^{o}SBo, $^{o}A1b$, $^{o}A2b$ when B tape is complete and A string is not complete. Entered from $^{o}RA2$, $^{o}A1b$, $^{o}A2b$ when B tape is complete and there is an additional string on A tape.

$^{o}4$	Transfers B item to output. Sets $^{o}5B$.	Entered from $^{o}Q1$ when (B) is less than (A). Entered from $^{o}Q2$ when (B) is greater than (A). Entered from ^{o}RAo, $^{o}B1b$, $^{o}B2b$ after completion of an A string. Entered from ^{o}SAo, $^{o}B1b$, $^{o}B2b$ when the A tape is complete and the B tape is not. In this case the remaining items in the B string will end the B tape, since uneven strings can only occur in A. Entered on equality side of test for end of output.
$^{o}P1$	Initially set for each ascending cycle. Writes output block on tape 5. Tests for end of output string by counter s. If the end of the string has been reached the counter s is set back to zero and the routine transfers to $^{o}7a$ which sets $^{o}7b$, and $^{o}P2$. If the end of the string has not been reached the counter s is increased by unity and the routine transfers to $^{o}9$.	
$^{o}P2$	Alternate print routine for ascending cycles. Writes output block on tape 6. Tests for end of output string by counter t. If the end of the string has been reached the counter t is set back to zero and the routine transfers to $^{o}7b$, which sets $^{o}7a$, and $^{o}P1$. If the end of the string has not been reached the counter t is increased by unity and the routine transfers to $^{o}9$.	As above
$^{o}P3$, $^{o}P4$	Alternating print routines for descending cycles. Transfer to $^{o}7c$ and $^{o}7d$ as $^{o}P1$ and $^{o}P2$ transfer to $^{o}7a$, and $^{o}7b$.	As above
$^{o}P5$	Entered on last cycle only. Transfers directly to $^{o}9$.	As above

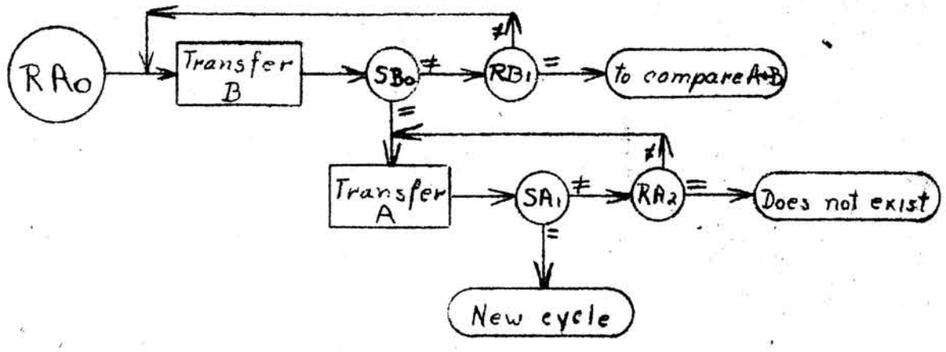
$^{o}9$	Transfers (rI) to Z. Reads T_K to rI. Sets Z+1 equal to Z. Clears output block counter m to zero.	Entered from end of output string comparisons, directly when end of string has not been reached and from $^{o}7$ when end of string has been reached.
$^{o}5A$	Tests for end of A input block. Set by $^{o}3$. If the end of block has not been reached, control transfers to $^{o}A1$. If the end of input block has been reached, control transfers to $^{o}L1$.	Entered on inequality side of test for end of output block or from $^{o}9$.
$^{o}5B$	Tests for end of B input block. Set by $^{o}4$. If the end of block has not been reached, control transfers to $^{o}B1$. If the end of block has been reached, control transfers to $^{o}L2$.	Same as $^{o}5A$.
$^{o}A1a$	Initially set. Reset by $^{o}RA1$ for every new string. Transfers control to ^{o} . Reset by $^{o}14$ for each new cycle.	Entered from inequality side of the test for end of input block, and transfers to ^{o}Q, prior to completion of B string or tape.
$^{o}A1b$	Set by ^{o}RBo, ^{o}SBo. Returns control to $^{o}3$.	Entered from inequality side of the test for end of input block and transfers to $^{o}3$, when current B string or tape is exhausted.
$^{o}B1a$	Initially set. Reset by $^{o}RB1$ for every new string. Transfers control to ^{o}Q. Reset by $^{o}14$ for each new cycle.	Entered from inequality side of the test for end of input block and transfers to ^{o}Q, prior to completion of A string or tape.
$^{o}B1b$	Set by ^{o}RAo, ^{o}SAo. Returns control to $^{o}3$.	Entered from inequality side of the test for end of input block and transfers to $^{o}4$ when current A string or tape is exhausted.
$^{o}L1a$	Transfers auxiliary block C to A. Sets Z+1 equal to C, T_A equal to T_K, $^{o}L1b$. Tests new (A_o) for sentinel. If equal to sentinel transfers control to ^{o}SA. If not equal to sentinel, sets x counter to zero and tests for end of input string. If equal to end of string, transfers to ^{o}RA.	Entered from equality side of test for end of A input block.

	If not equal to end of string, increases u counter by unity and transfers to $^{o}A2$.	
$^{o}L1b$	Transfers auxiliary block E to A. Sets Z+1 equal to E, T_A equal to T_K, $^{o}L1a$. Remainder as in $^{o}L1a$.	See $^{o}L1a$
$^{o}L2a$	Transfers auxiliary block D to B. Sets Z+1 equal to D, T_B equal to T_K, $^{o}L2b$. Tests new(B_o) for sentinel. If equal to sentinel transfers control to ^{o}SB. If not equal to sentinel, sets y counter to zero and tests for end of input string. If equal to end of string, transfers to ^{o}RB. If not equal to end of string, increases v counter by unity and transfers to $^{o}B2$.	Entered from equality side of test for end of B input block.
$^{o}L2b$	Transfers auxiliary block F to B. Sets Z+1 equal to F, T_B equal to T_K, $^{o}L2a$. Remainder as in $^{o}L2a$.	See $^{o}L2a$
$^{o}A2a$	Initially set. Reset in $^{o}RA1$ to begin new string. Reset in $^{o}14$ to begin new cycle.	Entered from inequality side of test for end of string and transfers to ^{o}Q prior to the completion of current B string or tape.
$^{o}A2b$	Set by ^{o}RBo, ^{o}SBo. Returns control to $^{o}3$.	Entered from inequality side of test for end of string and transfers to $^{o}3$ when current B string or tape is exhausted.
$^{o}B2a$	Initially set. Reset in $^{o}RB1$ to begin new string. Reset in $^{o}14$ to begin new cycle.	Entered from inequality side of test for end of string and transfers to ^{o}Q prior to the completion of current A string or tape.
$^{o}B2b$	Set by ^{o}RAo, ^{o}SAo. Returns control to $^{o}4$.	Entered from inequality side of test for end of string and transfers to $^{o}4$ when current A string or tape is exhausted.

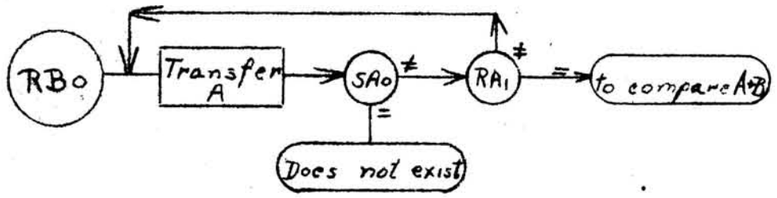
^{o}RAo	Initially set. Reset in ^{o}14 for every new cycle. Sets ^{o}RB1, ^{o}B1b, ^{o}B2b. Clears u counter to zero.	Entered from the equality side of end of string test, when A string is completed and B string is not. Transfers to ^{o}4.
^{o}RA1	Set by ^{o}RBo. Resets ^{o}RAo, ^{o}A1a, ^{o}A2a. Clears u counter to zero.	Entered from the equality side of end of string test, when A string is completed after B string. Transfers to ^{o}Q to start next string.
^{o}RA2	Set by ^{o}SBo. Clears u counter to zero.	Entered from the equality side of end of string test, when A string is completed after B tape and another A string remains. Transfers to ^{o}3.
^{o}RBo	Initially set. Reset in ^{o}14 for every new cycle. Sets ^{o}RA1, ^{o}A1b, ^{o}A2b. Clears v counter to zero.	Entered from the equality side of the end of string test, when B string is completed and A string is not. Transfers to ^{o}3.
^{o}RB1	Set by ^{o}RAo. Resets ^{o}RBo, ^{o}B1a, ^{o}B2a. Clears v counter to zero.	Entered from the equality side of end of string test when B string is completed after A string. Transfers to ^{o}Q to start next string.
^{o}SAo	Initially set. Reset in ^{o}14 for every new cycle. Sets ^{o}SB1, ^{o}B1b, ^{o}B2b. Transfers to ^{o}4.	End of A tape. Entered from equality side of sentinel test in ^{o}L1 when A tape has been exhausted prior to B tape.
^{o}SA1	Set by ^{o}SBo. Transfers to ^{o}15.	End of A tape following end of B tape. Entered as in ^{o}SAo.
^{o}SBo	Initially set. Reset in ^{o}14 for every new cycle. Sets ^{o}RA2, ^{o}SA1, ^{o}A1b, ^{o}A2b. Transfers to ^{o}3.	End of B tape. Entered from equality side of sentinel test in ^{o}L2 when B tape has ended prior to A tapeor last A string.
^{o}SB1	Set by ^{o}SAo. Transfers to ^{o}15.	End of B tape following end of A tape. Entered as in ^{o}SBo.

$^{o}15a$	Initially set. Tests for incomplete output string. Adjusts counters u, v, s for next cycle. Sends 2R to R, 4R to 2R. Transfers to $^{o}14$.	Entered from $^{o}SA1$, $^{o}SB1$ at end of both A and B tapes.
$^{o}15b$	Set on last cycle only from the equality side of the test in $^{o}1$. Problem ends here after writing 3 sentinels on output tape and rewinding all tapes.	Entered as in $^{o}15a$.
$^{o}14a$	Initially set. Alternates with $^{o}14b$ on all ascending cycles. Sets $^{o}P3$; $^{o}7c$; $^{o}Q2$; T_5, T_6 equal T_A and T_B; $^{o}14b$. Resets all other initial conditions.	Entered from $^{o}15a$ to prepare for succeeding cycle.
$^{o}14b$	Set in $^{o}14a$. Resets $^{o}14a$; $^{o}P1$; $^{o}Q1$; $^{o}7a$; T_3, T_4 equal T_A and T_B. Resets all other initial conditions.	Same as $^{o}14a$.
$^{o}14c$, $^{o}14d$	Replace $^{o}14a$ and $^{o}14b$ when first cycle was Special Descending-following-Descending Cycle	Same as $^{o}14a$.

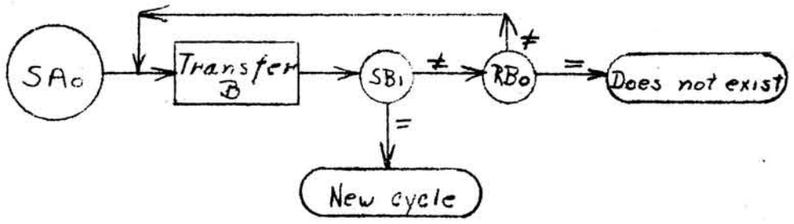
END OF STRING & END OF TAPE FOR TWO TAPE EXTERNAL COLLATION



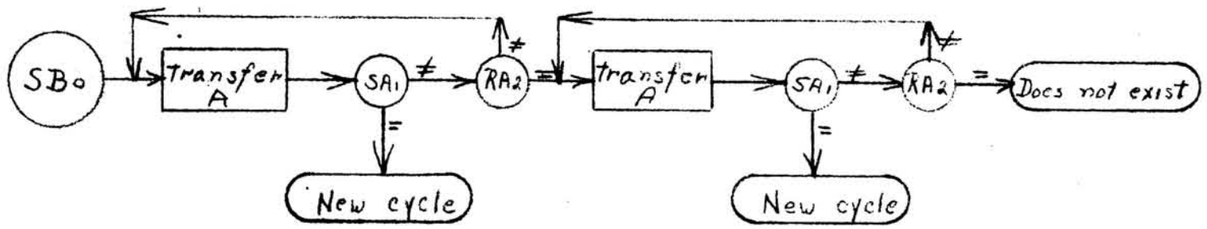
Cases
A → B
A → Bs → As



Case
B → A



Case
As → Bs



Cases
Bs → A → As
Bs → As

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

LET.	REVISIONS	DATE	CHK

ALL DIMENSIONS ARE IN INCHES
TOL. UNLESS SPECIFIED OTHERWISE:
FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC-C10

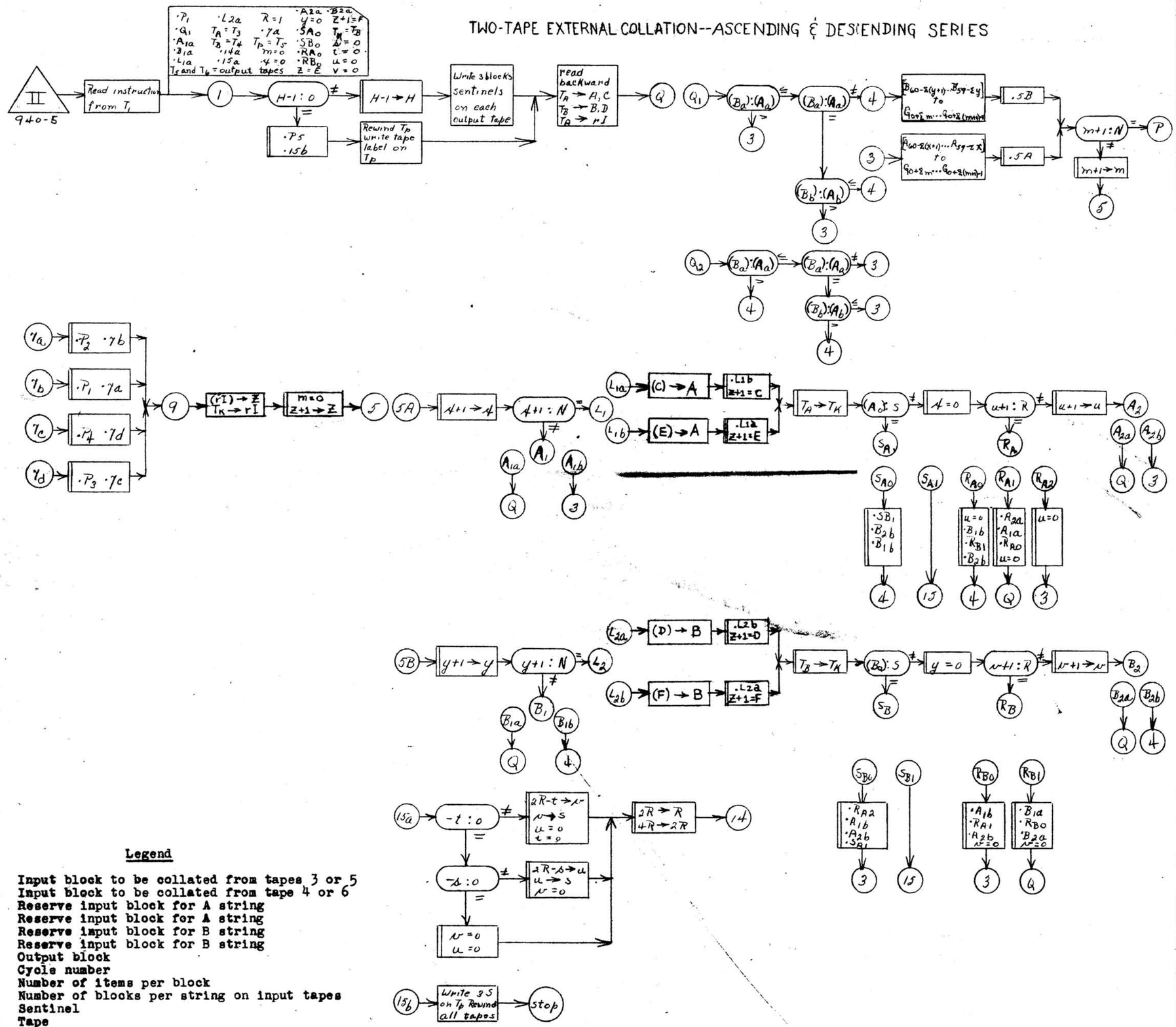
Logical Flow Chart

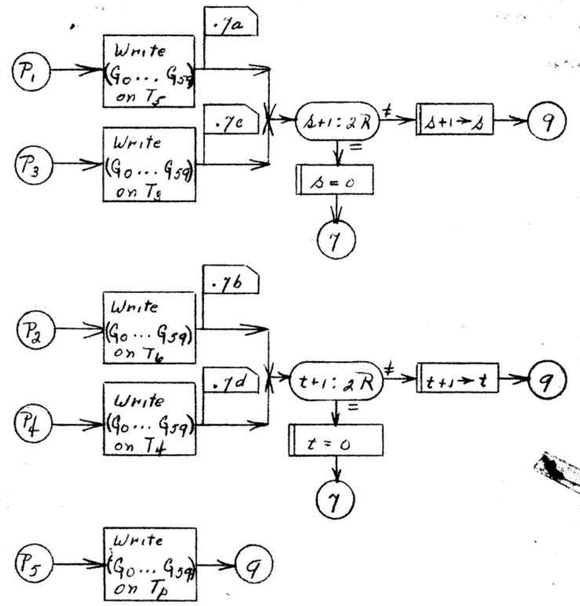
DR. h.m.d | DATE 1-9-5[illegible]
CH'K. M.K.L | SCALE
APR. [illegible] | ENG. F.E.S.

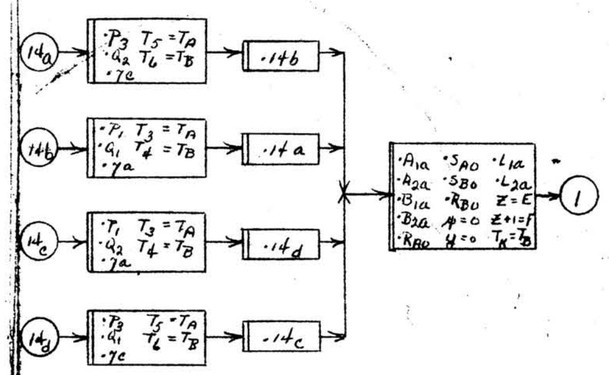
B A-952-1

6 1 1 21

TWO-TAPE EXTERNAL COLLATION--ASCENDING & DESCENDING SERIES







Legend

A	Input block to be collated from tapes 3 or 5
B	Input block to be collated from tape 4 or 6
C	Reserve input block for A string
E	Reserve input block for A string
D	Reserve input block for B string
F	Reserve input block for B string
G	Output block
H	Cycle number
N	Number of items per block
R	Number of blocks per string on input tapes
S	Sentinel
T	Tape
T_k	Current input tape
T_p	Final output tape
Z	Address of block contained in rI
Σ	Number of words per item
a	First half of key
b	Second half of key
m	Counts number of items in G
x	Counts number of items collated from A
y	Counts number of items collated from B
u	Counts number of input blocks for current string tape A
v	Counts number of input blocks for current string tape B
s	Counts number of output blocks for current string tape 3 or 5
t	Counts number of output blocks for current string tape 4 or 6

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL UNLESS SPECIFIED OTHERWISE:
FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

Two-Tape External Collation - Ascending and Descending With Interlock Eliminated (Split Key)

DR. h.m.d | DATE 1-10-50 | C A-952-1
CH'K. M.K.L. | SCALE
APR. F.E.S. | ENG. G.M.-J.J.B.

LET.	REVISIONS	DATE	CHK.

EXTERNAL COLLATION ON TWO TAPES USING ONLY FOUR UNISERVOS - ASCENDING AND DESCENDING SERIES

TAPE INTERLOCK ELIMINATED

7-WORD ITEM - 7th WORD IS KEYWORD

At the conclusion of Internal Collation, the first block of instructions is in the memory and the second block is in rI.

	000	31 060		31 120	Read instructions for ascending and descending cycles
	001	31 180		31 240	
$^{o}1b$	002	00 000		31 300	Read instructions for Special Descending cycle and transfer to III
	003	31 360		31 420	
	004	30 480		U 300	
$^{o}1a$	# 002	00 000		00 000	Instructions for special cycle: Cleared if number of cycle is odd (see Internal Collation)
	# 003	00 000		00 000	
	# 004	00 000		00 000	
	005	82 000		81 000	Rewind T_1, T_2 and mount new tapes on these UNISERVOS
	006	K 000		K 000	
$^{o}2$	007	43 300		B 960	Tape A → rI H
	# 007	41 300		B 960	
	008	S 201		Q 147	H - 1 : 0 H - 1 → H
	009	C 960		F 285	rF = 000111 000000

	010	51 200	51 200	Every odd cycle
	011	51 200	43 540	Write 3 sentinel blocks on output tapes 1 and 2. With tape moving backward, read data from tape 3 to A,C, rI and from tape 4 to B,D.
	012	52 200	44 600	
	013	52 200	44 720	
	014	52 200	43 780	
$^{o}Q1$	015	B (775)	K 000	Keyword of (B)
	016	B (595)	T 023	Keyword of (A) (A):(B)
	017	00 000	00 000	
$^{o}3$	018	B 206	E 016	B 000 C (906) (A) → output
	019	R 044	U 028	
	# 010	53 200	53 200	Every even cycle
	# 011	53 200	41 540	
	# 012	54 200	42 600	
	# 013	54 200	42 720	
	# 014	54 200	41 780	
$^{o}Q2$	# 015	B 775	K 000	
	# 016	B 595	T 018	
	# 017	00 000	U 023	
	# 018	B 206	E 016	
	# 019	R 044	U 028	
$^{o}5A$	020	L 217	B 016	B 539 T (0xx) → rL (N) x
	021	S 204	Q 058	x+1 x+1 : N Test for end of A block
$^{o}A1a$	022	C 016	U 015	x+1 → x → ^{o}Q
$^{o}A1b$	# 022	C 016	U 018	→ $^{o}3$

	023 B 206	E 015	B 000 C (906) (m)	(B) → output
	024 R 044	U 028		
°5B	025 L 210	B 015	B 719 K 000 (N)	
	026 S 204	Q 069	y y+1 y+1:N. Test for end of B block.	
°B1a	027 C 015	U 015	y+1 > y ---> °Q	
°B1b	# 027 C 015	U 023	→ °4	
	028 L 208	H 041		Transfer to G subroutine
	029 S 205	H 040		
	030 X 000	H 039		Setting up instructions for transfer below
	031 X 000	H 038		
	032 X 000	H 037		
	033 X 000	H 036		
	034 X 000	C 035		
	035 B ( )	C (900)		Transfer 7-word item to output block
	036 B (+1)	C (901)		
	037 B (+2)	C (902)		
	038 B (+3)	C (903)		
	039 B (+4)	C (904)		
	040 B (+5)	C (905)		
	041 B (+6)	C (906)		
	042 B 206	Q 045	B 000 C (906) m+1:N. Test for end of output block	
	043 A 202	C 206	m+1 m+1 → m	
	044 00 000	U (0+1)		

End of G block

$^{o}P1$	045	[51 900	B 965]	Print out a complete block of output s
$^{o}P2$	# 045	52 900	B 966	t
$^{o}P3$	# 045	53 900	B 965	s } Print out on proper tape
$^{o}P4$	# 045	54 900	B 966	t
	046	4(4)(660)		(rI) → Z, T_K → rI
	047	A 201	L 964	2R
			Q 052	+1 s+1:2R
	048	[C 965	00 000]	s+1 → s
#	048	C 966	00 000	t+1 → t.
	049	B 046	E 215	000(840) 000000
	050	C 046		Z+1 → Z
	051	C 206	B 207	m = 0
			U 044	
	052	B 045		End of String
	053	C 045	S 216	
	054	X 000	J 216	Alternate output tape and interchange s and t
	055	A 048	06 000	
	056	C 965	C 048	Clear s and t
	057	00 000	C 966	
			U 049	
	058	B 212		End of A block
	059	R 093	00 000	Y (600) Z 540
			J 080	
	060	E 218		$T_K = T_A$
	061	[B 540	C 046	(A_o)
			Q 110]	(A_o):S Test for end of A tape → $^{o}SA_o$

	# 061	B	540	Q	115	→ °SA1
°L1	062	B	212			
				H	215	
	063	S	213			-(-00060 000000)
				C	212	X
	064	J	213			
				L	961	R
	065	[B	962			u
				A	201]	u+1
°RA2	065	F	285	U	067	
	066	[F	285			rF = 000111 000000
				Q	094]	u+1:R → °RA0
	# 066	F	285	Q	102	→ °RA1
	067	C	962			u+1 → u
				B	256	
	068	[C	016			x = 0
°A2a				U	015]	→ °Q
°A2b	# 068	C	016	U	018	→ °3
	069	B	211			Y (780) Z 720. End of B block
				00	000	
	070	R	093			
				U	080	
	071	E	219			$T_K = T_B$
				C	046	
	072	[B	720			(B_o)
				Q	112]	(B_o) : S Test for end of B tape → °SBo
	# 072	B	720	Q	115	→ °SB1
°L2	073	B	211			
				H	215	
	074	S	214			-(-00060 000000)
				C	211	
	075	J	214			
				L	961	R
	076	B	963			v
				A	201	v+1

Z+1 = X
Alternate X

Z+1 = Y
Alternate Y

	077	[F	285	Q 099]	rF = 000111 000000 v+1 : R. → °RBo
++	077	F	285	Q 107	→ °RB1
	078	C	963	B 255	v+1 → v
°B2a	079	C	015	U 015]	y = 0 → °Q
°B2b ++	079	C	015	U 023	→ °4
	080	H	086		Subroutine: transfer from storage block to A or B
				A 203	000010 000010
	081	H	087	X 000	Setting up transfer instructions
	082	H	088	X 000	
	083	H	089	X 000	
	084	H	090	X 000	
	085	C	091	L 200	S
	086	[Y	( )	Z ( )]	Transfer block
	087	[Y	(+10)	Z (+10)]	
	088	[Y	(+20)	Z (+20)]	
	089	[Y	(+30)	Z (+30)]	
	090	[Y	(+40)	Z (+40)]	
	091	[Y	(+50)	Z (+50)]	
	092	F	218	B 046	Extractor for tape no.
	093	[00	000	U (c+1)]	
°RAo	094	B	228		End of A string before B
	095	C	962	C 077 00 000	.RB1 u = 0

	096	B 230		C 015 U 023	
			H 027	.B1b	
	097	C 079		.B2b	
			U 023		
	098	00 000			
			00 000		
°RBo	099	B 226			End of B string before A
			C 066	.RA1	
	100	B 232		C 016 U 018	
			H 022	.A1b	
	101	C 068		.A2b	
			U 018		
°RA1	102	B 224			End of A string after B
			C 066	.RAo	
	103	B 231		C 016 U 015	
			H 022	.A1a	
	104	C 068		.A2a	
			C 962	u = 0	
	105	V 255		x = 0, y = 0	
			W 015		
	106	C 963		v = 0	
			U 015		
°RB1	107	B 225			End of B string after A
			C 077	.RBo	
	108	B 229		C 015 U 015	
			H 027	.B1a	
	109	C 079		.B2a	
			U 105		
°SAo	110	B 234			End of A tape before B
			C 072	.SB1	
	111	F 285			
			U 096		
°SBo	112	B 227			End of B tape before A
			C 065	.RA2	
	113	B 233		B 540 Q 115	
			C 061	.SA1	
	114	F 285			
			U 100		
°6a	115	[B 224			End of cycle
			C 066]	.RAo	
°6b*	115	00 000	U (c+1)	(Only on last cycle)	

	116	B	225	C	077	.RBo
	117	B	229	H	027	.B1a
	118	C	079	B	231	.B2a
	119	H	068	C	022	.A2a .A1a
	120	B	235	C	061	.SAo
	121	B	236	C	072	.SBo

Resetting controls for next cycle

07	122	Y	240	Z	010	
	123	Y	250	Z	240	
	124	Y	010	Z	250	
	125	[Y	260	B	237]	
**	125	Y	270	B	209	
	126	Z	210	C	125	
	127	B	238	H	007	
	128	S	239	C	238	
	129	[J	239	V	281]	
##	129	J	239	V	283	
	130	W	045	B	129	
	131	S	280	C	129	
	132	J	280	B	223	
	133	C	048	L	964	
	134	X	000	S	965	

Changing instructions for beginning of new cycle

Resetting constants

41 300 B 960

-(-20000 000000)

Change initial read-in

-(-00000 000002)

Change write-out instructions

2R ⟶ rL
rA = 2R
2R - s

135	00 000	Q 138	2R-s : 2R
136	H 962		2R - s → u
		C 965	2R - s → s
137	C 963		v = 0
		U 143	
138	S 966		2R - t
		Q 141	2R - t : 2R
139	H 963		2R - t → v
		C 965	2R - t → s
140	C 962		u = 0
		U 143	
141	K 000		Clear rA
		C 965	s = 0
142	C 962		u = 0
		C 963	v = 0
143	C 966		t = 0
		B 964	2R → rA
144	H 961		2R → R
		X 000	4R → rA
145	C 964		4R → 2R
		U 006	Return to 0_2
146	00 000		
		00 000	
147	61 000		Rewind T_p to leader
		43 540	Read backward: (rI) → A, T_3 → rI
148	F 285		rF = 000111 000000
		71 970	Write tape label on T_p 20/inch .6b
149	R 115		
		U 012	Transfer to 0_2
150	51 200		
		51 200	Three blocks of sentinel on end of
151	51 200		output tape
		82 000	
152	83 000		
		84 000	Rewind all used tapes
153	81 000		
		50 150	T_p → S.C.
154	30 000		
		90 000	Stop program

Constants

200			Sentinel
201	000000	000001	
202	000000	000007	
203	000010	000010	
204	000007	000000	
205	000001	000001	
206	B 000	C (906)	m (variable)
207	B 000	C 906	m = 0
208	B 000	C 955	N(for m)
209	Y 260	B 237	
210	B 719	K 000	N (for y)
211	Y (780)	Z 720	or Y 840 Z 720 (Y)
212	Y (600)	Z 540	or Y 660 Z 540 (X)
213	-00060	000000	or 000060 000000. To alternate X(C,E)
214	-00060	000000	or 000060 000000 To alternate Y(D,F)
215	000(840)	000000	or any other auxiliary storage block (Z+1)
216	-10000	000001	or 010000 000001. To alternate P, s and t
217	B 539	T 023	or B 539 T 018. N(for x)(variable with cycle)
218	030000	000000	or 010000 000000 Tape A
219	040000	000000	or 020000 000000 Tape B
220			
221			
222			
223	C 965	00 000	
224	F 285	0 094	.RAo

225	F	285	Q	099	.RBo	
226	F	285	Q	102	.RA1	
227	F	285	U	067	.RA2	
228	F	285	Q	107	.RB1	
229	C	015	U	015	.B1a, .B2a	
230	C	015	U	023	.B1b, .B2b	
231	C	016	U	015	.A1a, .A2a	
232	C	016	U	018	.A1b, .A2b	
233	B	540	Q	115	.SA1	
234	B	720	Q	115	.SB1	
235	B	540	Q	110	.SAo	
236	B	720	Q	112	.SBo	
237	Y	270	B	209		
238	41	300	B	960	or 43 300 B 960.	Initial read instruction for tape A
239	-20000		000000		or 020000 000000.	To alternate tape A read-in instruction, odd and even cycles
240	53	200	53	200		
241	53	200	41	540		
242	54	200	42	600		
243	54	200	42	720		
244	54	200	41	780		Instructions for next cycle (even, to begin)
245	B	775	K	000		
246	B	595	T	018		
247	00	000	U	023		
248	B	206	E	016		
249	R	044	U	028		
250	51	200	51	200		

251	51 200	43 540	
252	52 200	44 600	
253	52 200	44 720	
254	52 200	43 780	Instructions for next cycle but one, and also current cycle (odd, to begin)
255	B 775	K 000	
256	B 595	T 023	
257	00 000	00 000	
258	B 206	E 016	
259	R 044	U 028	
260	B 719	K 000	
261	Y 780	Z 720	
262	Y 600	Z 540	
263	-00060	000000	
264	-00060	000000	
265	000840	000000	Constants for even cycle
266	-10000	000001	
267	B 539	T 018	
268	010000	000000	
269	020000	000000	
270	B 719	K 000	
271	Y 780	Z 720	
272	Y 600	Z 540	
273	-00060	000000	
274	-00060	000000	Constants for odd cycle
275	000840	000000	
276	-10000	000001	
277	B 539	T 023	
278	030000	000000	

279	040000	000000	
280	[-00000	000002]	or 000000 000002. To alternate read and write instruction constants, odd and even cycles
281	53 900	B 965	
282	42 660	L 964	
283	51 900	B 965	
284	44 660	L 964	
285	000111	000000	

540 - 599	A = current input block from tape A
600 - 719	C and E = storage blocks for A
720 - 779	B = current input block from tape B
780 - 899	D and F = storage blocks for B
900 - 959	G = output block
960	H = no. of cycles needed for collation
961	R = no. of blocks in current string
962	u = no. of A input blocks collated per current string
963	v = no. of B input blocks collated per current string
964	2R
965	s = no. of output blocks onto T_A collated per current string
966	t = no. of output blocks onto T_B collated per current string
971	Tape label

TWO TAPE EXTERNAL COLLATION USING ONLY FOUR UNISERVOS

ASCENDING AND DESCENDING SERIES

Connector	Function	Entry Point and Use
$^{o}1a$	Initially set. Rewinds T_1 and T_2 and replaces them with blank tapes.	Entered following the initial read of instructions and constants when the number of cycles required to complete collation is odd.
$^{o}1b$	Set in Internal Collation. Reads instructions for Special Descending - following - Descending cycle and transfers to special cycle.	Entered following initial read of ascending - and - descending - cycle instructions when the number of cycles required to complete collation is even.
$^{o}2$	Makes test for the last cycle. If the current cycle is the last, rewinds final output tape to the leader. Writes tape label in first block of T_p and reads T_A to A, C and rI, T_B to B,D and sets $^{o}6b$. If the current cycle is not the last, reads T_A and T_B to memory as above, and writes three sentinel blocks on each of the two output tapes.	Entered from $^{o}1$, and re-entered from $^{o}7$ at the beginning of each new cycle.
$^{o}Q1$	Initially set for every ascending cycle. Compares (A) with (B), transferring to $^{o}3$ if (A) is the lesser, and to $^{o}4$ if (B) is the lesser.	Entered from $^{o}A1a$, $^{o}B1a$, after the transfer of any item which is not the last in the respective input block. Entered from $^{o}A2a$, $^{o}B2a$ after the transfer of an item which is the last in the respective current input block, but not the last in the input string. Entered from $^{o}RA1$, $^{o}RB1$, after the completion of an output string.

Q2	Initially set for every descending cycle. Compares (A) with (B), transferring to $^{o}3$ if (A) is the greater, and to $^{o}4$ if (B) is the greater.	Entered as in $^{o}Q1$.
P1	Set at the beginning of every ascending cycle, reset by $^{o}P2$. Writes output block on tape 1, reads a block of data from T_K to rI, transfers data previously stored in rI to Z and substitutes Z+1 for Z. This routine also tests for end of output string (counter s), substituting $^{o}P2$, and s equal to zero if the end has been reached, or increasing s by 1 if not.	Entered from the equality side of the comparison for end of output block.
P2	Set by $^{o}P1$. Performs same operations as $^{o}P1$, but counts blocks per string with counter t. When string is complete, substitutes $^{o}P1$ and t equal to zero again.	See $^{o}P1$.
P3, $^{o}P4$	Alternating print routines for descending cycles, performing same operations as $^{o}P1$ and $^{o}P2$ respectively.	See $^{o}P1$
3	Transfers current A item to output location and sets $^{o}5A$.	Entered from $^{o}Q1$ when (A) is less than (B). Entered from $^{o}Q2$ when (A) is greater than (B). Entered from ^{o}RBo, $^{o}A1b$, $^{o}A2b$, when B string is complete and A string is not. Entered from ^{o}SBo, $^{o}A1b$, $^{o}A2b$ when B tape is complete and A string is not. Entered from $^{o}RA2$, $^{o}A1b$, $^{o}A2b$ when B tape is complete, and A string complete, but A tape is not.
4	Transfers current B item to output location and sets $^{o}5B$.	Entered from $^{o}Q1$ when (B) is less than (A). Entered from $^{o}Q2$ when (B) is greater than (A). Entered from ^{o}RAo, $^{o}B1b$, $^{o}B2b$, when A string is complete and B string is not. Entered from ^{o}SAo, $^{o}B1b$, $^{o}B2b$, when A tape is complete and B tape is not.

°5A	Set by °3. Tests for end of A input block. If block is not exhausted increases x counter and transfers to °A1. If block is exhausted, transfers data in an auxiliary storage block to A block and tests new (A_o) for sentinel. If (A_o) is sentinel, transfers control to °SA; if not, transfers control to °L1.	Entered from inequality side of test for end of output block, or following °P routine.
°5B	Set by °4. Performs same operations for B input block as does °5A for A. If (B_o) is sentinel, transfers control to °SB; if not, transfers control to °L2.	See °5A.
°A1a	Initially set for every new cycle, and reset by °RA1 in preparation for a new string. Returns control to °Q when current A item is not the last in the A block.	Entered from the inequality side of the test for the end of the A block prior to the exhaustion of the current B string or tape.
°A1b	Set by °RBo, °SBo. Returns control to °3 under the same conditions as in °A1a.	Entered from the same point as °A1a when the current B string or tape has been exhausted.
°B1a	Initially set for every new cycle and reset by °RB1 in preparation for a new string. Returns control to °Q when the current B item is not the last in the B block.	Entered from the inequality side of the test for the end of the B block prior to the exhaustion of the current A string or tape.
°B1b	Set by °RAo, °SAo. Returns control to °4 under the same conditions as in °B1a.	Entered from the same point as °B1a when the current A string or tape has been exhausted.
°L1a	Initially set for every new cycle and reset by °L1b. Tests for the end of the A input string. If the string is complete, transfers control to °RA; if not, transfers to °A2. Sets °L1b.	Entered from the inequality side of test for sentinel in °5A, when auxiliary block C has just been transferred to the A storage location.

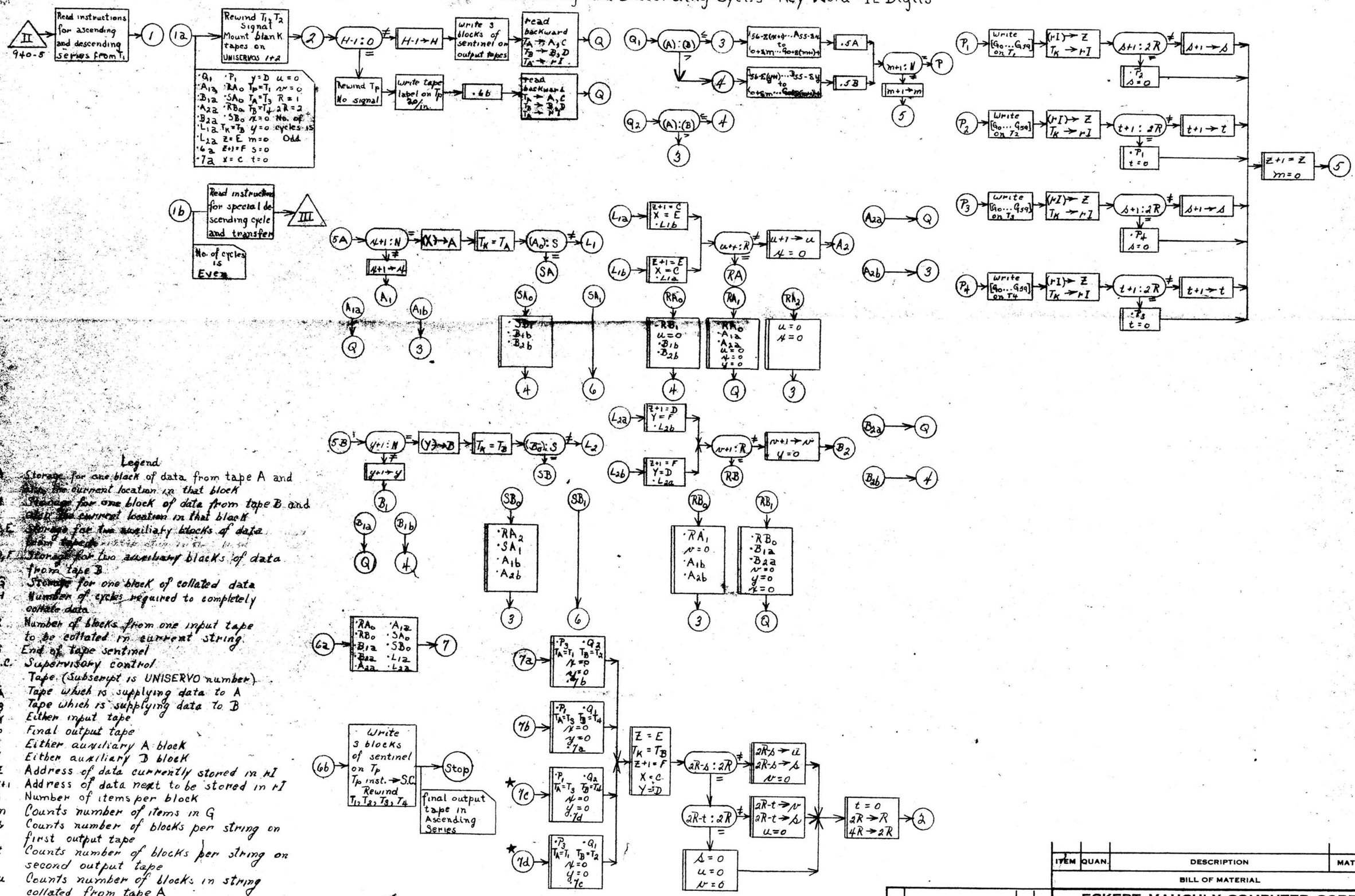
^{o}L1b	Set by ^{o}L1a and resets ^{o}L1a. Otherwise, performs same operations as those done in ^{o}L1a.	Entered from the same point as ^{o}L1a, when auxiliary block E has just been transferred to the A storage location.
^{o}L2a	Initially set for every new cycle, and reset by ^{o}L2b. Tests for the end of the B input string. If the string is complete, transfers control to ^{o}RB, if not, transfers to ^{o}B2. Sets ^{o}L2b.	Entered from the inequality side of the test for sentinel in ^{o}5B, when auxiliary block D has just been transferred to the B storage location.
^{o}L2b	Set by ^{o}L2a and resets ^{o}L2a. Otherwise, performs same operations as those in ^{o}L2a.	Entered from the same point as ^{o}L2a when auxiliary block F has just been transferred to the B storage location.
^{o}A2a	Initially set for every new cycle. Reset by ^{o}RA1 in preparation for a new string. Returns control to ^{o}Q when currently completed A block is not the last in the A string.	Entered from the inequality side of the test for the end of A string in ^{o}L1 prior to the exhaustion of the current B string or tape.
^{o}A2b	Set by ^{o}RBo, ^{o}SBo. Returns control to ^{o}3 under the same conditions as in ^{o}A2a.	Entered from the same point as ^{o}A2a when the current B string or tape has been exhausted.
^{o}B2a	Initially set for every new cycle, and reset by ^{o}RB1. Returns control to ^{o}Q when the currently completed B block is not the last in the string.	Entered from the inequality side of the test for the end of B string in ^{o}L2, prior to the exhaustion of the current A string or tape.
^{o}B2b	Set by ^{o}RAo, ^{o}SAo. Returns control to ^{o}4 under the same conditions as in ^{o}B2a.	Entered from the same point as ^{o}B2a when the current A string or tape has been exhausted.
^{o}SAo	Initially set for every new cycle. Sets ^{o}SB1, ^{o}B1b, ^{o}B2b. Transfers to ^{o}4.	End of A tape. Entered from equality side of test in ^{o}5A when A tape has been exhausted and B tape has not.

SA1	Set by °SBo. Transfers to °6.	End of A tape following end of B tape. Entered from the same point as °SAo when A and B tapes have both been exhausted.
SBo	Initially set for every new cycle. Sets °SA1, °RA2, °A1b, °A2b. Transfers to °3.	End of B tape. Entered from equality side of test in °5B when B tape has been exhausted and A tape has not.
SB1	Set by °SAo. Transfers to °6.	End of B tape following end of A tape. Entered from same point as °SBo when A and B tapes have both been exhausted.
RAo	Initially set for every new string. Sets °RB1, °B1b, °B2b. Resets u equal to 0. Transfers to °4.	End of A string. Entered from equality side of test in °L1 when A string is exhausted and B string is not.
RA1	Set by °RBo. Resets °RAo, u, x and y, °A1a, °A2a for the beginning of a new string. Transfers to °Q.	End of A string following end of B string. Entered from same point as °RAo when A and B strings are both exhausted.
RA2	Set by °SBo. Sets x and u equal to zero and transfers to °3.	End of A string after end of B tape. Entered from same point as °RAo when A string and B tape are both complete, and additional A data remains to be transferred.
RBo	Initially set for every new string. Sets °RA1, °A1b, °A2b. Resets v equal to 0. Transfers to °3.	End of B string. Entered from equality side of test in °L2 when B string is exhausted and A string is not.
RB1	Set by °RAo. Resets °RBo, v, x and y, °B1a, °B2a for the beginning of a new string. Transfers to °Q.	End of B string following end of A string. Entered from same point as °RBo when A and B strings are both exhausted.
6a	Initially set. Resets all controls for string and tape endings preparatory to the beginning of a new cycle. Transfers to °7.	Entered from °SA1 or °SB1 on all cycles but the last.

$^{0}6b$	Set by $^{0}2$ at the beginning of the last cycle (ascending) writes 3 blocks of sentinel on final output tape, rewinds all tapes and stops program.	Entered from $^{0}SA1$ or $^{0}SB1$ on the final cycle.
$^{0}7a$	Initially set and is reset by $^{0}7b$ at the end of the next cycle (descending). Sets $^{0}Q2, ^{0}P3, ^{0}7b$; resets all other controls necessary to initial setting of descending cycle; and determines value of counters u, v and s for next cycle. Transfers to $^{0}2$.	Entered from $^{0}6a$ at the end of the ascending series.
$^{0}7b$	Set by $^{0}7a$ and resets $^{0}7a$. Performs similar functions as $^{0}7a$ at conclusion of descending series in preparation for next ascending cycle. Sets $^{0}Q1, ^{0}P1, ^{0}7a$.	Entered from $^{0}6a$ at the end of the descending series.
$^{0}7c, ^{0}7d$	Analogous routines to $^{0}7a$, $^{0}7b$ used only when Special Descending cycle has been used.	See $^{0}7a, ^{0}7b$

EXTERNAL COLLATION ON TWO TAPES USING ONLY FOUR UNISERVOS –
–TAPE INTERLOCK ELIMINATED

Ascending and Descending Cycles - Key Word = 12 Digits



Legend

- **A** Storage for one block of data from tape A and also the current location in that block
- **B** Storage for one block of data from tape B and also the current location in that block
- **C,E** Storage for two auxiliary blocks of data from tape A
- **D,F** Storage for two auxiliary blocks of data from tape B
- **G** Storage for one block of collated data
- **H** Number of cycles required to completely collate data
- **R** Number of blocks from one input tape to be collated in current string
- **S** End of tape sentinel
- **S.C.** Supervisory control
- **T** Tape (Subscript is UNISERVO number)
- **TA** Tape which is supplying data to A
- **TB** Tape which is supplying data to B
- **TK** Either input tape
- **TP** Final output tape
- **X** Either auxiliary A block
- **Y** Either auxiliary B block
- **Z** Address of data currently stored in rI
- **Z+1** Address of data next to be stored in rI
- **N** Number of items per block
- **m** Counts number of items in G
- **s** Counts number of blocks per string on first output tape
- **t** Counts number of blocks per string on second output tape
- **u** Counts number of blocks in string collated from tape A
- **ν** Counts number of blocks in string collated from tape B
- **x** Counts number of items collated from block A
- **y** Counts number of items collated from block B

★ 7c and 7d are used only when the ascending and descending cycles follow the special descending cycle

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL. UNLESS SPECIFIED OTHERWISE: FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

External Collation on Two Tapes Using Only Four UNISERVOS
Tape Interlock Eliminated Key Word = 12 digits
7, 5, 14, or 28 word item

DR. h.m.d.	DATE 1-18-50	C A-952-3
CH'K. MISL.	SCALE	
APR.	ENG. A.B.T	6 1 = 20

LET. REVISIONS BY CHK.

TWO-TAPE EXTERNAL COLLATION DESCENDING-FOLLOWING-DESCENDING FOR SPECIAL EVEN CYCLE RUN

5-word Item
Key Digits in First Word ≤ 12 Digits

First block of instructions read into 000-059 from Internal Collation

	000	31	060			Instructions to memory
				31	120	
	001	31	180			
				43	400	$T_A \longrightarrow$ rI backward
	002	55	200			Sentinel to T_5
				43	500	$T_A \longrightarrow$ A
	003	55	200			Sentinel to T_5
				44	560	$T_A \longrightarrow$ C
	004	55	200			Sentinel to T_5
				44	680	$T_B \longrightarrow$ B
	005	56	200			Sentinel to T_6
				U	107	Transfer for more read-write inst.
	006	K	000			Clear rA
				F	180	Digit extractor to rF
^{o}Q	007	E	(500)			Extract from (A)
				K	000	(A) $\longrightarrow$ rL
	008	E	(680)			Extract from (B)
				T	014	(B):(A)
$^{o}3$	009	B	007			Transfer (A)
				F	181	Instruction extractor to rF
	010	R	032			Record (00 000 U 011) in 032
				U	019	
$^{o}5A$	011	B	007			x
				A	185	x + 1
	012	L	189			N
				Q	037	Test for end of A input block $\longrightarrow$ $^{o}L1$
	013	C	007			$\div$ x + 1 $\longrightarrow$ x
$^{o}A1a$				U	007	Return to compare . . $\longrightarrow$ ^{o}Q
$^{o}A1b$	# 013	C	007	U	009	Return to transfer (A) $\longrightarrow$ $^{o}3$

						Transfer(B)
04	014	B	008			
				F	181	Instruction extractor to rF
	015	R	032			Record (00 000 U 016) in 032
				U	019	
05B	016	B	008			
				A	185	y y + 1
	017	L	190			N
				Q	051	Test for end of B block → 0L2
	018	[C	008			y + 1 → y
B1a				U	007]	Return to compare → 0Q
B1b#	018	C	008	U	014	Return to transfer (B) → 04
						Output Routine
	019	E	024			
				H	024	
	020	A	184			
				H	025	
	021	X	000			Build up data transfer
				H	026	instructions
	022	X	000			
				H	027	
	023	X	000			
				C	028	
	024	[B	( )			
				C	(900)]	(A) → G or (B) → G
	025	[B	( )			
				C	(901)]	(A+1) → G+1 or (B+1) → G+1
	026	[B	( )			
				C	(902)]	(A+2) → G+2 or (B+2) → G+2
	027	[B	( )			
				C	(903)]	(A+3) → G+3 or (B+3) → G+3
	028	[B	( )			
				C	(904)]	(A+4) → G+4 or (B+4) → G+4
	029	E	028			
				A	183	m m+1
	030	L	202			N
				Q	033	Test for end of output block → 0P
	031	C	024			m+1 → m
				F	180	Digit extractor to rF
	032	[00	000			
				U	(C+1)]	Return to test for end of input block → 05

^{o}P	033	44 620			(rI) → Z , T_K → rI End of output block
			B	199	T_K = T_4 to start. Z = E to start
	# 033	43 620	B	199	
	# 033	43 680	B	199	
	# 033	44 680	B	199	
	# 033	43 740	B	199	
	# 033	44 740	B	199	
	# 033	43 800	B	199	
	# 033	44 800	B	199	
	034	E 033			
			C	033	Z+1 → Z
^{o}P1	035	55 900			Write on T_5
			B	201	m = o
^{o}P2	#035	56 900	B	201	Write on T_6 m = o
	036	00 000			
			U	031	
^{o}L1	037	B 207			End of A input block
			H	100	Y 560 Z 500 or Y 620 Z 500
	038	R 106			Record (00 000 U 039) in 109
			U	095	
	039	B 500			(A_6)
			L	200	End of tape sentinel → rL
	040	00 000			
			Q	076	Test for end of A tape → ^{o}SAo
	#040	00 000	Q	088	→ ^{o}SA1
	041	B 207			C or E to Z+1
			H	199	
	042	S 188			-(-00060 000000)
			C	207	

```
       043   J  188              + 60    → 188
                      F   205    030000   000000 to rF
       044   B  033
                      E   205    3
       045  [C  033
                      00 000]    TA   → TK            → °RAo
       ===========================
     #045    C  033   U   065    TA   → TK            → °RA1
     #045    C  033   U   083    TA   → TK            → °RA2
-------------------------------------------------------------------
°RAo   046   B  204              •B1b
                      C   018
       047   B  198
                      C   059    •RB1
       048   B  213
                      C   054    •SB1
       049  00  000
                      U   014    Return to transfer(B). → °4
-------------------------------------------------------------------
°L2a,  050  00  000  00   000
°L2b
       051  [B  208                       End of B block
                      H   100]
==================================
°L2c  *051  00  000   U   088                         → °2T
==================================
       052   R  106              Record (00 000  U  053) in 109
                      U   095
-------------------------------------------------------------------
       053   B  680              (B0)
                      L   200    End of tape sentinel      → rL
       054 [00  000
                      Q   079]   Test for end of B tape    → °SBo
===================================================================
     #054   00  000   Q   083                              → °SB1
===================================================================
       055   B  208
                      H   199    D or F to Z+1
       056   S  187              -(-00060  000000)
                      C   208
       057   J  187              + 60   → 187
                      F   205    030000  000000  → rF
       058   B  033
                      E   206    4
       059  [C  033              TB    → TK
                      00 000]                    --→ °RBo
       ===========================
```

	#059	C	033	U	072	$T_B \rightarrow T_K$ $\rightarrow$ °RB1
°RBo	060	B	196	C	045	•RA1
	061	B	203	C	013	•A1b
	062	00	000	U	009	Return to transfer (A). → °3
	063	00	000	00	000	
	064	00	000	00	000	
°RA1	065	B	195	C	045	•RAo
	066	B	191	C	013	•A1a
°6	067	B	035	S	186	-(-10000 000000)
	068	C	035	J	186	+ 1 to 186
	069	V	193	W	007	y=0
	070	F	180	U	007	→ °Q
	071	00	000	00	000	
°RB1	072	B	195	C	059	•RBo
	073	B	212	C	054	•SBo
	074	B	192	C	018	•B1a
	075	00	000	U	067	→ °6
°SAo	076	B	211	C	051	•L2.c
	077	B	204	C	018	•B1b
	078	00	000	U	014	Return to transfer remainder of (B). → °4

^{o}SBo	079	B	210			
				C	040	•SA1
	080	B	197			
				C	045	•RA2
	081	B	203			
				C	013	•A1b
	082	00	000			
				U	009	Return to transfer (A. → ^{o}3
^{o}SB1	083	B	035			T_P
^{o}RA2				L	209	T_6
	084	00	000			
				Q	087	T_P:T_6
	085	B	214			$T_P \neq T_6$
				C	087	T_5 → T_P
	086	B	183			1
				H	965	1 → s
	087	C	963			1 → v
				56	500	Write last block on T_4: set to start
#	087	C	962	55	500	1 → u, write last block on T_5
^{o}2T						
^{o}SA1	088	B	960			H
				S	183	H-1
^{o}L2c	089	C	960			H-1 → H
				B	215	
	090	H	961			2 → R
				X	000	
	091	C	964			4 → 2R
				00	000	
	092	41	000			
				L	216	6 no. of inst. blocks in special cycle routine
	093	A	183			Move instruction tape backward to read in ascending and descending collation routine
				Q	400	
	094	41	000			
				U	093	
	095	A	182			
				H	101	
	096	X	000			
				H	102	
	097	X	000			Build up instructions
				H	103	

098	X 000	H 104	Transfer intermediate storage block to working location
099	X 000	C 105	
100	Y (	Z ( )	
101	Y (+10)	Z (+10)	
102	Y (+20)	Z (+20)	
103	Y (+30)	Z (+30)	
104	Y (+40)	Z (+40)	
105	Y (+50)	Z (+50)	
106	00 000	U (c+1)	

107	43 740		T_B -> D, T_A -> rI backward
		56 200	Sentinel to T_6
108	56 200		" " T_6
		U 006	Return to main routine

Constants

180			Digit extractor
181	110000	111111	Instruction extractor
182	000010	000010	
183	000000	000001	
184	000001	000001	
185	000005	000000	
186	-10000	000000	Minus to start
187	-00060	000000	Minus to start (used in connection with B block)
188	-00060	000000	Minus to start (used in connection with A block)
189	E 560	K 000	N for A block
190	E 740	T 014	N for B block
191	C 007	U 007	·Ala
192	C 008	U 007	·Bla
193	E 500	K 000	x = 0
194	E 680	T 014	y = 0
195	C 033	00 000	·RAo, ·RBo
196	C 033	U 065	·RA1
197	C 033	U 083	·RA2
198	C 033	U 072	·RB1
199	(000000	000000)	Z+1. Z+1 = F to start
200			End of tape sentinel
201	B 000	C 900	m = 0
202	B 000	C 960	N for G block
203	C 007	U 009	.Alb

204	C 008 U 014	$^{o}B1b$
205	030000 000000	T_A
206	040000 000000	T_B
207	(Y 560 Z 500)	$^{o}L1a$ to start; or Y 620 Z 500 = $^{o}L1b$
208	(Y 740 Z 680)	$^{o}L2a$ to start; or Y 800 Z 680 = $^{o}L2b$
209	56 900 B 201	
210	00 000 Q 088	.SA1
211	00 000 U 088	.I2c
212	00 000 Q 079	.SBo
213	00 000 Q 083	.SB1
214	C 962 55 500	
215	000000 000002	
216	000000 000006	

500 - 559	A
560 - 619	C
620 - 679	E
680 - 739	B
740 - 799	D
800 - 859	F
960	H
961	R
962	u
963	v
964	2R
965	s

This routine is used after the Special Descending - followed - by-Descending Series Program and adjusts the necessary controls in the Two-Tape External Collation Program (952-1).

400	41 240	41 180	Read External Collation instructions, tape moving backward.
401	41 120	41 060	
402	40 000	Y 180	Changes refer to coding 952-1; they alternate the tape numbers for both read and write instructions.
403	Z 010	B 251	
404	C 107	B 430	
405	H 017	C 187	
406	C 019	C 189	
407	B 426	C 197	
408	B 427	C 199	
409	V 431	W 007	
410	B 428	C 009	
411	B 176	L 175	
412	H 049	C 175	
413	J 176	B 208	
414	L 200	H 046	
415	C 200	J 208	
416	V 214	W 216	
417	V 212	W 214	
418	V 216	W 212	
419	B 434	C 177	
420	B 433	C 179	
421	V 428	W 140	
422	B 209	L 202	

423	J 209	C	202	
424	00 000	U	002	⟶ $^{o}1$ programming 952-1

Constants

426	E 774	T	020
427	00 000	U	052
428	53 210	53	210
429	53 210	86	000
430	E 774	T	052
431	63 000	73	970
432	84 000	U	012
433	55 210	55	210
434	53 900	U	049

TWO TAPE EXTERNAL COLLATION - DESCENDING FOLLOWING DESCENDING SERIES FOR SPECIAL EVEN CYCLE RUN

Connector	Function and Purpose	Entry Point
^{O}Q	Compares the magnitude of the current item A with that of the current item B, transferring control to the routine for placing the item of greater magnitude in the output block.	Initially entered following the instructions at the beginning of the program. Entered from $^{O}A1a$, $^{O}B1a$ following the transfer to the output location of an item of data which was not the last in its respective input block. Entered from $^{O}6$ when a block of data from the A tape has been completely collated with a block from the B tape (end of string).
$^{O}3$	Sets $^{O}5A$ and transfers the current item A to the output location. Tests to determine whether or not the end of the current output block has been reached. If the end has not been reached, increases m and transfers control to $^{O}5$. If the end has been reached, transfers control to ^{O}P.	Entered from ^{O}Q when the magnitude of the current item A is greater than that of the current item B. Entered from $^{O}RB0$ and $^{O}A1b$, when the current B string is exhausted prior to the ending of the current A string. Entered from $^{O}SB0$ and $^{O}A1b$, when the current B string and tape end prior to the ending of the current A string.
$^{O}4$	Sets $^{O}5B$ and transfers the current item B to the output location. Tests to determine whether or not the end of the current output block has been reached. If the end has not been reached, increases m and transfers control to $^{O}5$. If the end has been reached, transfers control to ^{O}P.	Entered from ^{O}Q when the magnitude of the current item B is greater than that of the current item A. Entered from $^{O}RA0$ and $^{O}B1b$ when the current A string is exhausted prior to the ending of the current B string. Entered from $^{O}SA0$ and $^{O}B1b$ when the current A string and tape end prior to the ending of the current B string and tape.
$^{O}5A$	Set by $^{O}3$. Tests for the end of input block A. If the end has been reached, transfers to $^{O}L1$. If the end has not been reached, increases x and transfers to $^{O}A1$.	Entered from ^{O}P if the transfer of the current A item completes the current output block. Entered from $^{O}3$ if the transfer of the current A item does not complete the current output block.

5B	Set by $^{o}4$. Tests for the end of input block B. If the end has been reached, transfers to $^{o}L2$. If the end has not been reached, increases y and transfers to $^{o}B1$.	Entered from ^{o}P if the transfer of the current B item completes the current output block. Entered from $^{o}4$ if the transfer of the current B item does not complete the current output block.
$^{o}P1, ^{o}P2$	These routines are similar but operate on different output tapes. $^{o}P1$ is initially set, operates on tape 5 and is reset by $^{o}6b$. $^{o}P2$ is set by $^{o}6a$ and operates on tape 6. Both transfer one block of data from rI to memory, read another to rI from T_K, write one block of output data on T_P, and substitute m = 0 and Z = Z+1. Both transfer control to $^{o}5$.	Entered from $^{o}3$ if the item last transferred to output was an A item which completed the current output block. Entered from $^{o}4$ if the item last transferred to output was a B item which completed the current output block.
$^{o}L1a$	Initially set and reset by $^{o}L1b$. Transfers contents of auxiliary block C to block A, sets Z + 1 = C, $^{o}L1b$, $T_A = T_K$ and tests to determine whether the end of the A tape has been reached. If the end has been reached, transfers control to ^{o}SA. If the end has not been reached, transfers control to ^{o}RA.	Entered from $^{o}5A$ when the current A block is exhausted, and the next block from the A tape is stored in location C.
$^{o}L1b$	Set by $^{o}L1a$. Analogous to $^{o}L1a$, except that it transfers the contents of the second auxiliary block E to block A, sets Z + 1 = E, and sets $^{o}L1a$.	Entered from $^{o}5A$ when the current A block is exhausted, and the next block from the A tape is stored in location E.
$^{o}L2a$	Initially set, and reset by $^{o}L2b$. Transfers contents of auxiliary block D to block B, sets Z + 1 = D. $^{o}L2b$, $T_B = T_K$ and tests to determine whether the end of the B tape has been reached. If the end	Entered from $^{o}5B$ when the current B block is exhausted, and the next block from the B tape is stored in location D.

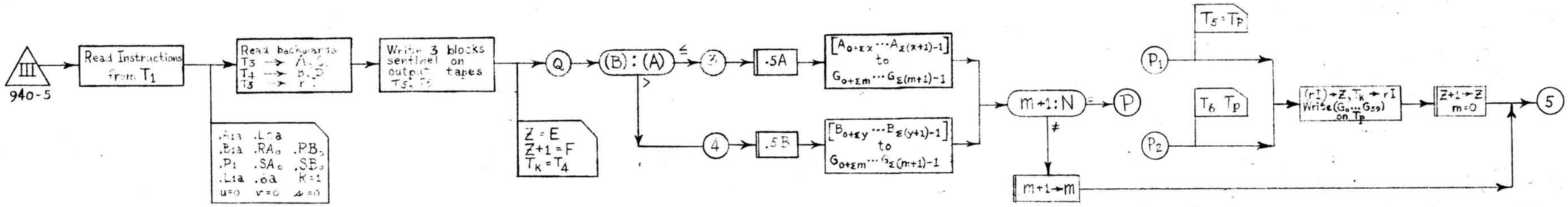
	has been reached, transfers control to ^{O}SB. If the end has not been reached, transfers control to ^{O}RB.	
^{O}L2b	Set by ^{O}L2a. Analogous to ^{O}L2a, except that it transfers the contents of the second auxiliary block F to block B, sets Z + 1 = F and sets ^{O}L2a.	Entered from ^{O}5B when the current B block is exhausted, and the next block from the B tape is stored in location F.
[illegible]	Set by ^{O}SA0. Transfers control to ^{O}2T.	Entered from ^{O}5B when the last B block is exhausted following the ending of the A tape.
^{O}A1a	Initially set. Transfers control to ^{O}Q.	Entered from ^{O}5A when the last item transferred to the output location was an A item which was not the last in the A block, and the B string or tape has not yet been exhausted.
^{O}A1b	Set by ^{O}RB0, ^{O}SB0. Transfers control to ^{O}3.	Entered from ^{O}5A when the last item transferred to the output location was an A item which was not the last in the A block, and there are no more B items to be transferred for the current string or tape.
^{O}B1a	Initially set. Transfers control to ^{O}Q.	Entered from ^{O}5B when the last item transferred to the output location was a B item which was not the last in the B block, and the A string or tape has not yet been exhausted.
B1b	Set by ^{O}RA0, ^{O}SA0. Transfers control to ^{O}4.	Entered from ^{O}5B when the last item transferred to the output location was a B item which was not the last in the B block, and there are no more A items to be transferred for the current string or tape.

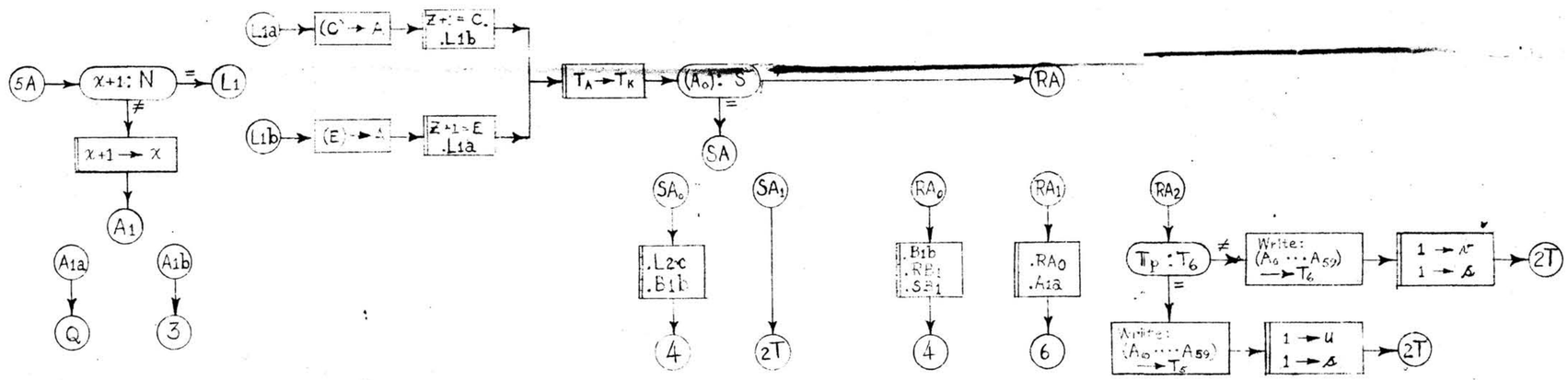
RA	End of A string	All RA connectors are entered from the inequality side of the test for the end of the A tape in ^{o}L1.
RA0	Initially set and reset by ^{o}RA1. Sets ^{o}B1b, ^{o}RB1, ^{o}SB1 and transfers control to ^{o}4.	Entered when the current A string is exhausted prior to the ending of the current B string or tape.
RA1	Set by ^{o}RB0. Sets ^{o}RA0, ^{o}A1a and transfers control to ^{o}6 to set the remainder of the connectors for the new string.	Entered when the current A string is exhausted subsequent to the ending of the current B string.
A2	Set by ^{o}SB0. Tests to determine T_p and then writes contents of current A block on T_p. Increases s and u or v (to indicate the presence of an uneven string) and transfers control to ^{o}2T.	Entered following the exhaustion of the B tape and the current A string, when there is an additional block of data on the A tape.
B	End of B string	All RB connectors are entered from the inequality side of the test for the end of the B tape in ^{o}L2.
B0	Initially set and reset by ^{o}RB1. Sets ^{o}RA1, ^{o}A1b and transfers control to ^{o}3.	Entered when the current B string is exhausted prior to the ending of the current A string.
B1	Set by ^{o}RA0. Sets ^{o}RB0, ^{o}SB0, ^{o}B1a and transfers to ^{o}6 to set the remainder of the connectors for the new string.	Entered when the current B string is exhausted subsequent to the ending of the current A string.
a, ^{o}6b	^{o}6a is initially set. Sets ^{o}P2, ^{o}6b, x=0, y=0 and transfers to ^{o}Q. ^{o}6b is the analogous routine, which continues the alternation of the output tapes by setting ^{o}P1, ^{o}6a.	Entered from ^{o}RA1 or ^{o}RB1, when a block from tape A has been collated with a block from tape B, thus completing the current string on T_p.
A	End of tape A	All SA connectors are entered from the equality side of the test for the end of the A tape in ^{o}L1.

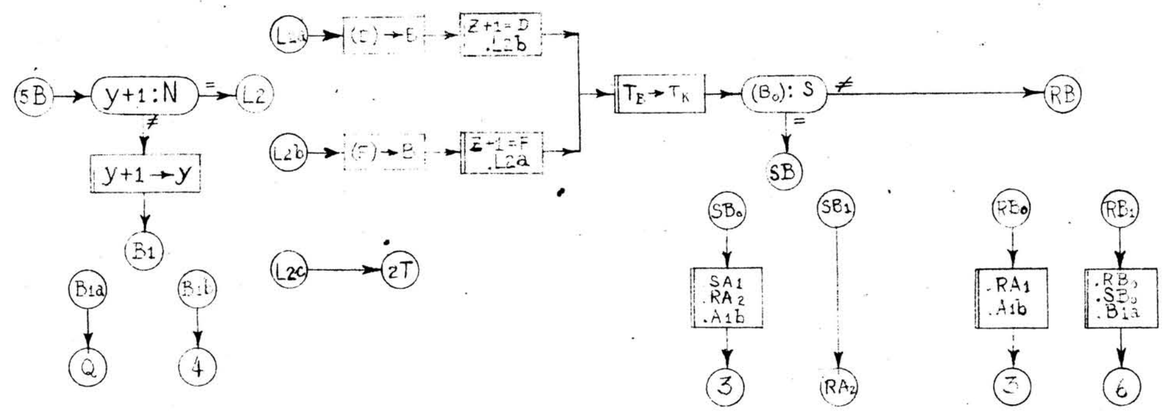
A0	Initially set. Sets ^{o}L2c, ^{o}B1b and transfers control to ^{o}4.	Entered when the A tape ends prior to the exhaustion of the B tape.
A1	Set by ^{o}SB0. Transfers immediately to ^{o}2T.	Entered when the A tape is exhausted following the ending of the B tape.
B	End of tape B	All SB connectors are entered from the equality side of the test for the end of the B tape in ^{o}L2.
B0	Initially set. Sets ^{o}SA1, ^{o}RA2, ^{o}A1b. Transfers to ^{o}3.	Entered when the B tape is exhausted prior to the ending of the A tape or the current A string.
B1	Set by ^{o}RA0. Transfers immediately to ^{o}RA2.	Entered when the B tape is exhausted following the ending of the current A string, and there is one more block of data to be transferred from the A tape.
T	Sets counters R and H for next cycle. Reads instructions for ascending and descending series in to memory and sets ^{o}P3, ^{o}1$\frac{1}{4}$c and $T_P = T_3$. Transfers to ^{o}1 of program 952-1	Entered when both tapes have been completely collated.

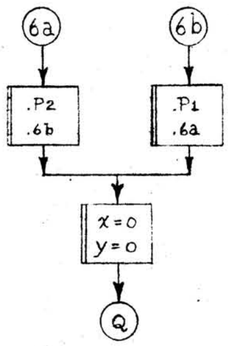
TWO-TAPE EXTERNAL COLLATION DESCENDING FOLLOWING DESCENDING SERIES

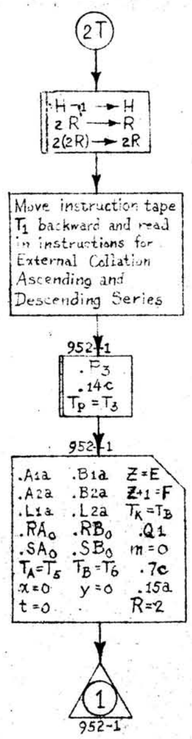
FOR SPECIAL EVEN CYCLE RUN











LEGEND

A – Current block of A data
B – Current block of B data
C – Reserve block of A data
D – Reserve block of B data
E – Reserve block of A data
F – Reserve block of B data
G – Output block for collated data
H – Number of cycles required
N – Number of items per block
K – Number of blocks to be collated together from a single input tape
S – End of tape sentinel
T – Tape
TK – Current input tape
TP – Final output tape
Z – Memory destination of contents of rI
Z+1 – Memory destination of future contents of rI
Σ – Number of words per item
m – Counts number of items in output block G
u – Counts blocks in a string collated from input tape A
w – Counts blocks in a string collated from input tape B
s – Counts blocks in a string on output tape
x – Counts number of items collated from block A
y – Counts number of items collated from block B

Connectors:

·L – Block transfer and read set up routine
·P – Print and read sequence
·Q – Main comparison sequence
·R – End of string routine
·S – End of tape routine
·2T – End of both tapes routine

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES TOL UNLESS SPECIFIED OTHERWISE: FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

Two-Tape External Collation Descending Following Descending Series — For Special Even Cycle Run

DR. [illegible] DATE 5-19-50

CH'K. [illegible] SCALE

APR. ENG. [illegible]

CA 952-2

LET.	REVISIONS	DATE	CHK.

A-953-2
6/15/49
Code C-10

EXTERNAL COLLATION - 3 TAPE

Various chains of operation which can exist from combinations of end of string and end of tape on three-tape External Collation
Series "3" to new string; Series "7" to alternate collation cycle

RA0 to SC1 to SB8 to SA7
RA0 to SC1 to RB9 to SA6 to SB7
RA0 to SC1 to RB9 to SB5 to SA7
RA0 to SB1 to SC8 to SA7
RA0 to RB1 to SC9 to SA6 to SB7
RA0 to RB1 to SC9 to SB5 to SA7
RA0 to RB1 to RC3
RA0 to RC1 to RB3

RB0 to SC2 to RA9 to SB5 to SA7
RB0 to SC2 to RA9 to SA6 to SB7
RB0 to RA2 to SC9 to SB5 to SA7
RB0 to RA2 to SC9 to SA6 to SB7
RB0 to RA2 to RC3
RB0 to RC2 to RA3

RC0 to RB2 to RA3
RC0 to RA1 to RB3

SA0 to SC4 to SB7
SA0 to SB4 to SC7

SB0 to SC5 to SA7
SB0 to SC5 to RA8 to SA7
SB0 to SA5 to SC7
SB0 to RA4 to SC8 to SA7

SC0 to RA6 to SB8 to SA7
SC0 to RA6 to RB5 to SA6 to SB7
SC0 to RA6 to RB5 to SB5 to SA7
SC0 to RB6 to RA5 to SB5 to SA7
SC0 to RB6 to RA5 to SA6 to SB7
SC0 to SA6 to SB7
SC0 to SB5 to SA7
SC0 to SB5 to RA8 to SA7

Index of variable connectors for end of string and end of tape in Three-tape External Collation showing previous variable connector

R = end of string

S = end of tape

RA1 from RC0
RA2 " RB0
RA3 " RB2 or RC2
RA4 " SB0
RA5 " RB6
RA6 " SC0
RA8 " SC5 or SB5
RA9 " SC2

RB1 " RA0
RB2 " RC0
RB3 " RA1 or RC1
RB5 " RA6
RB6 " SC0
RB9 " SC1

RC1 " RA0
RC2 " RB0
RC3 " RA2 or RB1

SA5 " SB0
SA6 " RB5 or SC0 or RA5 or SC9 or RA9 or RB9
SA7 " SB5 or SB8 or RA8 or SC8 or SC5

SB1 " RA0
SB4 " SA0
SB5 " RA5 or RB5 or SC0 or SC9 or RA9 or RB9
SB7 " SA6 or SC4
SB8 " RA6 or SC1

SC1 " RA0
SC2 " RB0
SC4 " SA0
SC5 " SB0
SC7 " SA5 or SB4
SC8 " RA4 or SB1
SC9 " RA2 or RB1

EXTERNAL COLLATION- 3 TAPE

Sequence of Variable Connectors for End of String and Tape

RA0	SC1	SB8	SA7
u = 0 A = 0 B = B1 ·SC1 ·RC1 ·SB1 ·RB1	A = Ao ·B1b ·B2b ·SB8 ·RB9	·SA7 ·A1b ·A2b	Prepare for new cycle
to °Q2	to °6	to °5	

RA0	SC1	RB9	SA6	SB7
		v = o B = B2 C = 0 ·B1a ·B2a ·SA6 ·SB5	·SB7 ·B1b ·B2b	Prepare for new cycle
		to °Q4	to °6	

RA0	SC1	RB9	SB5	SA7
			·SA7 ·A1b ·A2b *·RA8	Prepare for new cycle
			to °5	

RA0	SB1	SC8	SA7
	·SC8 ·C1b ·C2b	A = Ao ·A1b ·A2b ·SA7	Prepare for new cycle
	to °7	to °5	

RA0	RB1	SC9	SA6	SB7
	v = o ·C1b ·C2b ·SC9 ·RC3 ·SBo ·RBo	A = Ao B = B2 C = o ·SA6 ·SB5	·B1b ·B2b ·SB7	Prepare for new cycle
	to °7	to °Q4	to °6	

RA0	RB1	SC9	SB5	SA7
			·A1b ·A2b ·SA7 *·RA8	Prepare for new cycle
			to °5	

RA0	RB1	RC3
u = o	v = o	w = o
A = o	·C1b	·C1a
B = B1	·C2b	·C2a
·SC1	·SC9	·SCo
·RC1	·RC3	·RCo
·SB1	·SBo	A = Ao
·RB1	·RBo	B = Bo
to °Q2	to °7	to °Q1

	RC1	RB3
RAo	w = o	v = o
	A = Ao	
	B = Bo	
	·SBo	
	·RB3	·RBo
	·SCo	
	·RCo	
	·B1b	·B1a
	·B2b	·B2a
	to °6	to °Q1

RBO	SC2	RA9	SB5	SA7
v = o B = 0 ·RC2 ·SC2 ·RA2	·A1b ·A2b ·RA9	u = o B = B2 C = o ·A1a ·A2a ·SA6 ·SB5	·A1b ·A2b ·SA7 *·RA8	Prepare for new cycle
to °Q3	to °5	to °Q4	to °5	

RBo	SC2	RA9	SA6	SB7
			·B1b ·B2b ·SB7	Prepare for new cycle
			to °6	

RBo	RA2	SC9	SB5	SA7
	u = o ·C1b ·C2b ·RA0 ·RC3 ·SC9	*A = Ao B = B2 C = o ·SB5 ·SA6	·A1b ·A2b ·SA7 *·RA8	Prepare for new cycle
	to °7	to °Q4	to °5	

RBO	RA2	SC9	SA6	SB7
			·B1b ·B2b ·SB7	Prepare for new cycle
			to °6	

RBO	RA2	RC3
		w = ∅ *A = Ao B = Bo ·C1a ·C2a ·SCo ·RCo
		to °Q1

RBO	RC2	RA3
	w = o B = Bo ·RA3 ·RCo ·SCo ·A1b ·A2b	u = o ·RAo ·A1a ·A2a
	to °5	to °Q1

RC0	RB2	RA3
w = o B = B2 C = 0 .RA1 .RB2	v = o B = Bo C = Co .RA3 .RB0 .A1b .A2b	u = o .RAo .A1a .A2a
to °Q4	to °5	to °Q1

RCo	RA1	RB3
	u = o B = Bo C = C0 .RA0 .RB3 .B1b .B2b	v = o .RB0 .B1a .B2a
	to °6	to °Q1

SAo	SB4	SC7
A = 0 B = B1 .SC4 .SB4	.C1b .C2b .SC7	Prepare for new cycle
to °Q2	to °7	

SAo	SC4	SB7
	.B1b .B2b .SB7	Prepare for new cycle
	to °6	

SB0	SC5	SA7
B = o .RA4 .SA5 .SC5	.A1b .A2b .RA8 .SA7	Prepare for new cycle
to °Q3	to °5	

SB0	SC5	RA8	SA7
		u = o	Prepare for new cycle
		to °5	

SB0	SA5	SC7
	.C1b .C2b .SC7	Prepare for new cycle
	to °7	

SB0	RA4	SC8	SA7
	u = o .C1b .C2b .SC8	.A1b .A2b .SA7 *A = AO	Prepare for new cycle
	to °7	to °5	

SCO	SB5	SA7
B = B2 C = o ·RA6 ·SA6 ·RB6 ·SB5	·A1b ·A2b ·RA8 ·SA7	Prepare for new cycle
to °Q4	to °5	

SCO	SB5	RA8	SA7
		u = o	Prepare for new cycle
		to °5	

SCO	RB6	RA5	SA6	SA7
	v = o ·A1b ·A2b ·RA5	u = o ·A1a ·A2a	·B1b ·B2b ·SB7	Prepare for new cycle
	to °5	to °Q4	to °6	

SCO	RB6	RA5	SB5	SA7
			·A1b ·A2b ·SA7 *RA8	Prepare for new cycle
			to °5	

SCO	RA6	SB8	SA7
	u = o ·B1b ·B2b ·RB5 ·SB8	·A1b ·A2b ·SA7	Prepare for new cycle
	to °6	to °5	

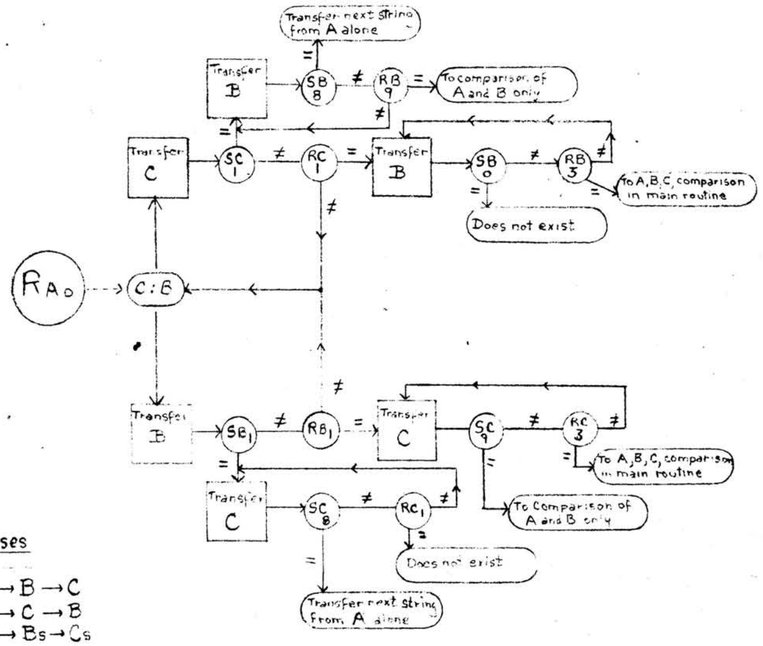
SCO	RA6	RB5	SA6	SB7
		v = o ·B1a ·B2a ·SB5	·B1b ·B2b ·SB7	Prepare for new cycle
		to °Q4	to °6	

SCO	RA6	RB5	SB5	SA7
			·A1b ·A2b ·SA7 *·RA8	Prepare for new cycle
			to °5	

	SA6	SB7
SCO	·B1b ·B2b ·SB7	Prepare for new cycle
	to °6	

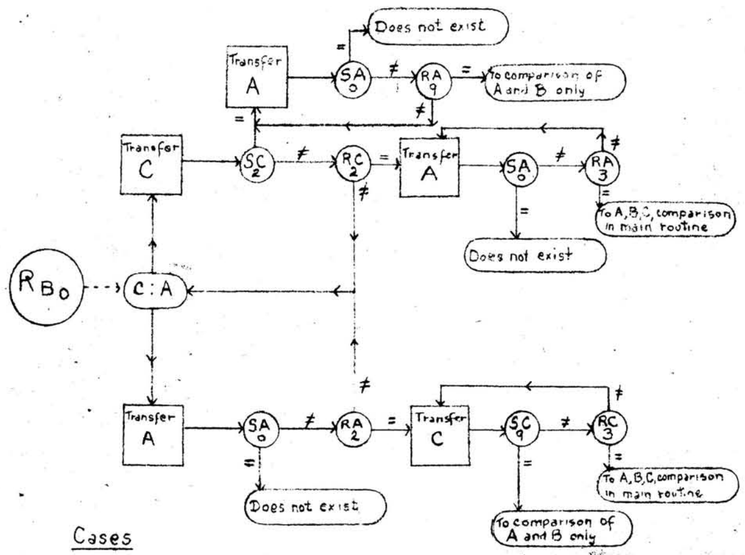
* not needed in particular operation

3 TAPE EXTERNAL COLLATION - HANDLING OF END OF STRING (R) AND END OF TAPE (S)



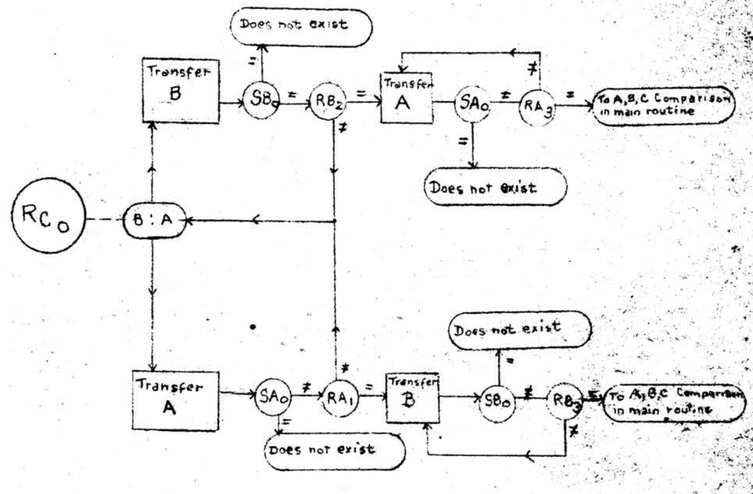
Cases

A → B → C
A → C → B
A → Bs → Cs
A → Cs → Bs
A → B → Cs
A → Cs → B



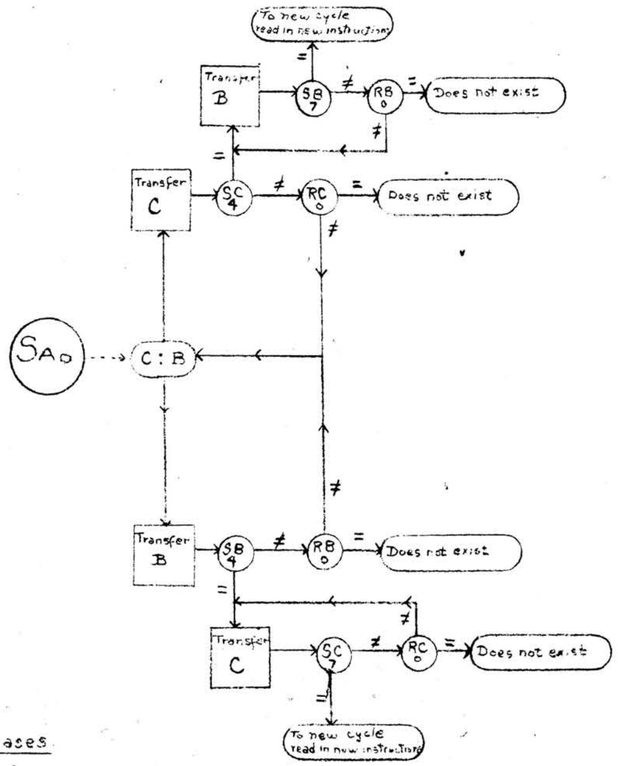
Cases

B → A → Cs
B → Cs → A
B → A → C
B → C → A



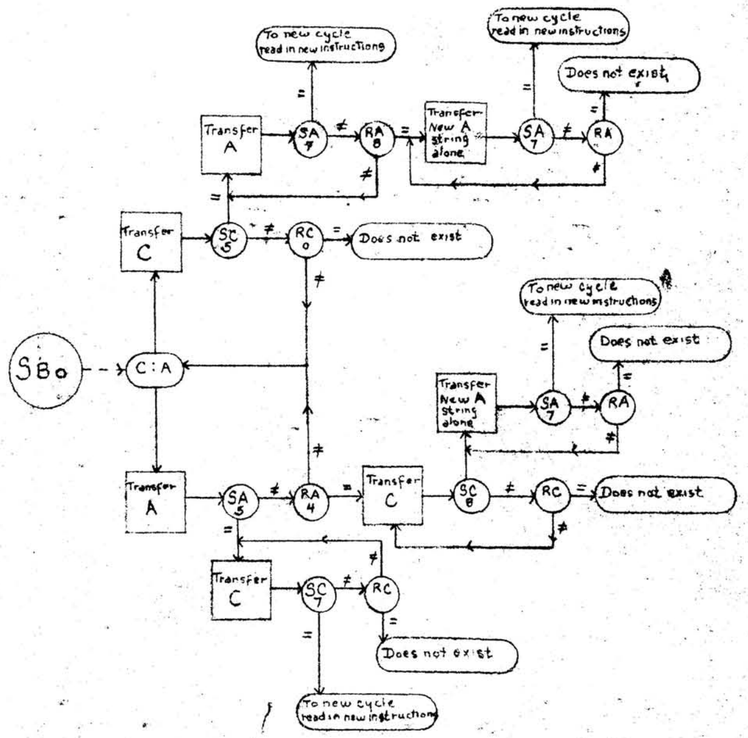
Cases

C → A → B
C → B → A



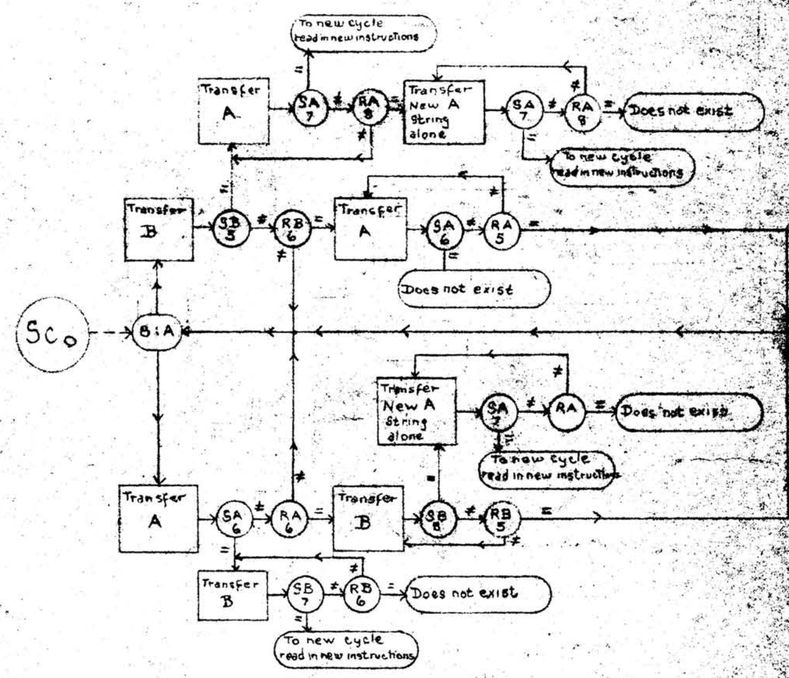
Cases

As → Bs → Cs
As → Cs → Bs



Cases

Bs → As → Cs
Bs → Cs → As
Bs → Cs → A → As
Bs → A → Cs → As



Cases

Cs → As → Bs
Cs → Bs → As
Cs → Bs → A → As
Cs → A → Bs → As
Cs → A → B
Cs → B → A

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL. UNLESS SPECIFIED OTHERWISE:
FRACT. ± DEC. ± ANG. ±

MAT'L. UNIVAC C-10

Logical Flow Chart for Handling of End of String (R) and End of Tape (S)
3 Tape External Collation

REVISIONS	DATE	DR. EEE	DATE 8/9/48	C A-953-0
		CH'K.	SCALE	
		APR.	ENG. F.E. Swanson	

3 TAPE EXTERNAL COLLATION

ASCENDING SERIES

4-WORD ITEM

KEY DIGITS IN WORD 1 ≤ 12-DIGITS

First block of instructions has been read into 000 - 059 and second block in rI from either Internal Collation, External Descending Collation, or Special External Descending Collation.

	000	31 060			Instructions to 000 - 419
			31 120		
	001	31 180			
			31 240		
	002	31 300			
			30 360		
	003	L 980			0 (t=0)
			B 972		H
	004	S 304			H-1
			Q 265		H-1 : 0
	005	C 972			H-1 → H
			L 304		1
σ_1	006	B 981			U
			Q 268		U : 1
σ_{2a}	007	23 000			T_A → rI
			58 300		Sentinel → T_Z
	008	43 540			(rI) → A, T_A → rI
			58 300		Sentinel → T_Z
	009	44 720			(rI) → D, T_B → rI
			57 300		Sentinel → T_Y
	010	44 600			(rI) → B, T_B → rI
			57 300		Sentinel → T_Y
	011	[45 780			(rI) → E, T_C → rI
			56 300]		Sentinel → T_X
#	011	45 780	U 285		(rI) → E, T_C → rI. Transfer to σ_{2b}
	012	45 660			(rI) → C, T_C → rI
			56 300		Sentinel → T_X

Q1	013	F 301	00 000		Digit extractor
	014	[E (596)	K 000]		(A)
	015	[E (656)	T 041]		(B) (B):(A)
	016	[K 000	00 000]		
	017	[E (716)	T 063]		(C):(B)
Q2	# 014	00 000	00 000	A=0	End of A string. Compare B and C
	# 015	E (656)	00 000	B=B1	
	# 016	K 000	00 000		
	# 017	E (716)	T 063	(C):(B)	
Q3	# 014	E (596)	K 000	(A)	End of B string. Compare A and C
	# 015	00 000	U 041	Transfer to compare (C):(A)	
	# 016	K 000	00 000		
	# 017	E (716)	T 063	(C):(A)	
Q4	# 014	E (596)	K 000		End of C string, Compare A and B
	# 015	E (656)	T 043	(B):(A)	
	# 016	00 000	U 063		
	# 017	E (716)	T 063		
					(C) routine, <(A) or (B)
7	018	F 302	B 017		110000 111111 instruction extractor
	019	R 090	U 083	.8C	C = J, z = j → Data transfer routine
8C	020	B 041	L 320	z N	
	021	S 305	T 038	z+1 z+1:N	
	022	B 314	H 041	z=0	End of C input block
	023	A 299	C 017	z=0	

°L3	024	B	337					
	025	C	026	A	332	.L3		
°L3c	026	[45	840	B	309	(rI) → F, T_C → rI	After special run [48	840 L 300]
				L	300]			
°L3a #	026	45	720	L	300	(rI) → D, T_C → rI	[48	720 L 300]
°L3b #	026	45	780	L	300	(rI) → E, T_C → rI	[48	780 L 300]
	027	C	337			.Lc		
	028	Z	660	Y	840			
	029	Z	670	Y	850			
	030	Z	680	Y	860			
	031	Z	690	Y	870	(F) → C		
	032	Z	700	Y	880			
	033	Z	710	Y	890			
	034	[00	000	B	660	(C_o)		
				Q	135]	(C_o):S → °SCo		
#	034	00	000	Q	211	→ °SC1		
#	034	00	000	Q	190	→ °SC2		
#	034	00	000	Q	207	→ °SC4		
#	034	00	000	Q	188	→ °SC5		
#	034	00	000	Q	246	→ °SC7		
#	034	00	000	Q	183	→ °SC8		
#	034	00	000	Q	157	→ °SC9		
	035	B	977			w		
	036	[L	967	A	304	w+1		
				Q	117]	w+1:R → °RCo		

	#036	L	967	Q	202	→	°RC1
	#036	L	967	Q	176	→	°RC2
	#036	L	967	Q	238	→	°RC3
°C2a	037	[C	977			w+1 → w w+1 ≠ R	
				U	014]	→ °Q	
°C2b	#037	C	977	U	018	w+1 → w → °7	
	038	H	041			z+1 → z	
				A	299		
°C1a	039	[C	017			z+1 → z	
				U	014]	→ °Q	
°C1b	#039	C	017	U	018	→ °7	
	040	00	000	00	000		
	041	E	(716)				
				T	043	(C):(A)	
	042	00	000				
				U	018	→ °7	
°5	043	F	302			Instruction extractor. (A routine. < (B) or (C)	
				B	014		
	044	R	090			.8A A=J, x=j	
				U	083	→ Data transfer routine	
°8A	045	B	014			x	
				L	318	N	
	046	S	305			x+1	
				T	062	x+1:N	
	047	B	310				
				C	014	x = 0	
°L1	048	B	337			} .L1	
				A	330		
	049	C	050				
				B	307		
°L1c	050	[43	840				After special run
				L	300]	(rI) → F, T_A → rI	[46 840 L 300]
°L1a	#050	43	720	L	300	(rI) → D, T_A → rI	[46 720 L 300]
°L1b	#050	43	780	L	300	(rI) → E, T_A → rI	[46 780 L 300]

	051	C	337			.La
	052	Z	540	Y	720	
	053	Z	550	Y	730	
	054	Z	560	Y	740	
	055	Z	570	Y	750	(D) → A
	056	Z	580	Y	760	
	057	Z	590	Y	770	
	058	[00	000	B	540	(A_o)
				Q	124]	(A_o):S, → ^oSA_o
#	058	00	000	Q	224	→ $^oSA5$
#	058	00	000	Q	207	→ $^oSA6$
#	058	00	000	Q	246	→ $^oSA7$
	059	B	975			u
				A	304	u+1
	060	[L	967			R
				Q	104]	u+1:R, → ^oRA_o
#	060	L	967	Q	194	→ $^oRA1$
#	060	L	967	Q	236	→ $^oRA2$
#	060	L	967	Q	143	→ $^oRA3$
#	060	L	967	Q	219	→ $^oRA4$
#	060	L	967	Q	144	→ $^oRA5$
#	060	L	967	Q	217	→ $^oRA6$
#	060	L	967	Q	166	→ $^oRA8$
#	060	L	967	Q	163	→ $^oRA9$
12a	061	[C	975			u+1 → u
				U	014]	→ ^oQ
12b #	061	C	975	U	043	u+1 → u → $^o5$

°A1a	062	C	014	U	014	x+1 → x
°A1b	062	C	014	U	043	x+1 → x → °5
°6	063	F	302	B	015	Instruction extractor. B routine. < A or C
	064	R	090	U	083	.8B B=J y=j → Data transfer routine
°8B	065	B	015	L	319	y N
	066	S	305	T	082	y+1 y+1:N
	067	B	338	C	015	End of B input block y = 0
°L2	068	B	337	A	331	.L2
	069	C	070	B	308	
°L2c	070	44	840	L	300	After special run (rI) → F, T_B → rI [47 840 L 300]
°L2a	070	44	720	L	300	(rI) → D, T_B → rI [47 720 L 300]
°L2b	070	44	780	L	300	(rI) → E, T_B → rI [47 780 L 300]
	071	C	337			.Lb
	072	Z	600	Y	780	
	073	Z	610	Y	790	
	074	Z	620	Y	800	
	075	Z	630	Y	810	(E) → B
	076	Z	640	Y	820	
	077	Z	650	Y	830	
	078	00	000	B	600	(B_o)
				Q	130	(B_o):S → °SBo

#078	00 000	Q	220	→ °SB1	
#078	00 000	Q	224	→ °SB4	
#078	00 000	Q	188	→ °SB5	
#078	00 000	Q	246	→ °SB7	
#078	00 000	Q	184	→ °SB8	
079	B 976	A	304	v v+1	
080	L 967	Q	112	R v+1:R. → °RBo	
#080	L 967	Q	228	→ °RB1	
#080	L 967	Q	168	→ °RB2	
#080	L 967	Q	154	→ °RB3	
#080	L 967	Q	151	→ °RB5	
#080	L 967	Q	192	→ °RB6	
#080	L 967	Q	147	→ °RB9	
'B2a 081	C 976	U	014	v+1 → v → °Q	
'B2b #081	C 976	U	063	v+1 → v → °6	
'B1a 082	C 015	U	014	y+1 → y → °Q	
'B1b #082	C 015	U	063	y+1 → y. → °6	
083	E 336	H	085	$G_{o+\Sigma m}$	Data transfer routine
084	A 303	C	086		
085	V ( )	W	(900)	$(J_{60-\Sigma(j+1)} \cdots J_{59-\Sigma j}) \rightarrow$	
086	V ( )	W	(902)	$G_{o+\Sigma m} \cdots G_{\Sigma(m+1)-1}$	
087	B 336	L	325	m N-1	
088	F 301	Q	091	rF = digit extractor m:N-1	

```
        089   A  306                 m+1
                           C  336    m+1 --> m
8       090   [00 000
                           U  045]    --> °8A
===============================================================
      #090    00 000       U  065     --> °8B

      #090    00 000       U  020     --> °8C
===============================================================
        091   B  324
                           C  336    m = 0
'P      092   B  304                 1
                           L  974    3R
        093   [56 900                Write(G_o...G_59) on tape X
                                                   After special run
                           A  978]   r + 1              [53 900 A  978]
==========================================
      #093    57 900       U  096    Write(G_o...G_59) on tape Y --> °P2
                                                        [54 900 U  096]
      #093    58 900       U  100    Write(G_o...G_59) on tape Z --> °P3
                                                        [55 900 U  100]
==========================================
P1      094   00 000
                           Q  296    r+1:3R
        095   C  978                 r+1  --> r
                           U  090     --> °8
---------------------------------------------------------------
'P2     096   A  979                 s+1
                           Q  098    s+1:3R
        097   C  979                 s+1 --> s
                           U  090     --> °8
---------------------------------------------------------------
        098   B  323                          s+1 = 3R
                           C  093    .P3
        099   C  979                 s = 0
                           U  090     --> °8
---------------------------------------------------------------
P3      100   A  980                 t+1
                           Q  102    t+1:3R
        101   C  980                 t+1  --> t
                           U  090     --> °8
---------------------------------------------------------------
        102   B  321                   t+1 = 3R
                           C  093    .P1
        103   C  980                 t = 0
                           U  090     --> °8
---------------------------------------------------------------
```

Ao	104	B	312			u+1 = R
				C	338	B=B1
	105	F	302			
				B	015	
	106	E	338			
				C	015	B=B1
	107	B	381			
				C	034	.SC1
	108	B	373			
				C	036	.RC1
	109	B	367			
				C	078	.SB1
	110	B	356			
				C	080	.RB1
	111	C	975			u=0
				U	129	→ $^{o}Q2$
Bo	112	B	316			
				C	015	B=0
	113	B	374			
				C	036	.RC2
	114	B	382			
				C	034	.SC2
	115	B	341			
				C	060	.RA2
	116	C	976			v=0
				U	014	→ $^{o}Q3$
Co	117	B	015			
				A	298	
	118	C	015			B=B2
				B	313	
	119	C	338			B=B2
				B	317	
	120	C	016			C=0
				B	340	
	121	C	060			.RA1
				B	357	
	122	C	080			.RB2
				C	977	w=0
	123	C	000			
				U	014	→ $^{o}Q4$
Ao	124	B	312			
				C	338	B=B1
	125	F	302			
				B	015	
	126	E	338			
				C	015	B=B1
	127	B	383			
				C	034	.SC4
	128	B	368			
				C	078	.SB4

	129	C	014		A=0
				U 013	→ °Q2
°SBo	130	B	316		
				C 015	B=0
	131	B	343		
				C 060	.RA4
	132	B	352		
				C 058	.SA5
	133	B	384		
				C 034	.SC5
	134	00	000		
				U 014	→ °Q3
°SCo	135	B	015		
				A 298	
	136	C	015		B=B2
				B 313	
	137	C	338		B=B2
				B 317	
	138	C	016		C=0
				B 345	
	139	C	060		.RA6
				B 353	
	140	C	058		.SA6
				B 360	
	141	C	080		.RB6
				B 369	
	142	C	078		.SB5
				U 014	→ °Q4
°RA3	143	B	339		
				C 060	.RAo
°RA5	144	V	391		
				W 061	.A1a, .A2a
	145	K	000		
				C 975	u=0
	146	00	000		
				U 014	→ °Q1 or °Q4
°RB9	147	B	313		
				H 015	B=B2
	148	C	338		B=B2
				B 317	
	149	C	016		C=0
				B 353	
	150	C	058		.SA6
				00 000	
°RB5	151	B	369		
				C 078	.SB5
	152	V	395		
				W 081	.B1a, .B2a

	153	C	976	U	014	v=0 → $^{o}Q4$
RB3	154	V	395	W	081	.B1a, .B2a
	155	B	355	C	080	.RBo
	156	C	976	U	014	v=0 → $^{o}Q1$
SC9	157	B	310	C	014	A=Ao
	158	B	313	H	015	B=B2
	159	C	338	B	317	B=B2
	160	C	016	B	353	C=0
	161	C	058	B	369	.SA6
	162	C	078	U	014	.SB5 → $^{o}Q4$
RA9	163	V	391	W	061	.A1a, .A2a
	164	K	000	C	975	u=0
	165	00	000	U	158	
RA8	166	K	000	C	975	u=0
	167	00	000	U	043	→ $^{o}5$
RB2	168	B	311	H	015	B=Bo
	169	C	338	B	315	B=Bo
	170	C	016	B	342	C=Co
	171	C	060	B	355	.RA3
	172	C	080	V	393	.RBo
	173	W	061	C	976	.A1b, .A2b v=0
	174	00	000	U	043	→ $^{o}5$
	175	00	000	00	000	

RC2	176	B	311			
				C	015	B=Bo
	177	B	342			
				C	060	.RA3
	178	B	372			
				C	036	.RCo
	179	B	380			
				C	034	.SCo
	180	V	393			
				W	061	.A1b, .A2b
	181	C	977			w=0
				U	043	→ $^{o}5$
	182	00	000			
				00	000	
SC8	183	B	310			
				C	014	A=Ao
SB8	184	B	354			
				C	058	.SA7
	185	V	393			
				W	061	.A1b, .A2b
	186	00	000			
				U	043	→ $^{o}5$
	187	00	000			
				00	000	
SB5, SC5	188	B	346			
				C	060	.RA8
	189	00	000			
				U	184	
SC2	190	B	347			
				C	060	.RA9
	191	00	000			
				U	185	
RB6	192	B	344			
				C	060	.RA5
	193	C	976			v=0
				U	185	
RA1	194	B	315			
				C	016	C=Co
	195	B	339			
				C	060	.RAo
	196	C	975			u=0
				00	000	
	197	B	358			
				C	080	.RB3

	198	V	397	W 081	.B1b, .B2b
	199	B	311	C 338	B=Bo
	200	00	000	U 063	→ °6
	201	00	000	00 000	
'RC1	202	B	310	C 014	A=Ao
	203	B	366	C 078	.SBo
	204	B	372	C 036	.RCo
	205	B	380	C 034	.SCo
	206	C	977	U 197	w=0
'SA6, SC4	207	B	370	C 078	.SB7
	208	V	397	W 081	.B1b, .B2b
	209	00	000	U 063	→ °6
	210	00	000	00 000	
'SC1	211	B	310	C 014	A=Ao
	212	B	361	C 080	.RB9
	213	B	371	C 078	.SB8
	214	V	397	W 081	.B1b, .B2b
	215	00	000	U 063	→ °6
	216	00	000	00 000	
RA6	217	B	359	C 080	.RB5
	218	C	975	U 213	u=0
RA4	219	K	000	C 975	u=0

SB1	220	B	377		
				C 039	.C1b
	221	B	379		
				C 037	.C2b
	222	B	386		
				C 034	.SC8
	223	00	000		
				U 018	→ $^{o}7$
SA5, SB4	224	B	377		
				C 039	.C1b
	225	B	379		
				C 037	.C2b
	226	B	385		
				C 034	.SC7
	227	00	000		
				U 018	→ $^{o}7$
RB1	228	B	355		
				C 080	.RBo
	229	B	366		
				C 078	.SBo
	230	C	976		v=0
				00 000	
	231	B	377		
				C 039	.C1b
	232	B	379		
				C 037	.C2b
	233	B	375		
				C 036	.RC3
	234	B	387		
				C 034	.SC9
	235	00	000		
				U 018	→ $^{o}7$
RA2	236	B	339		
				C 060	.RAo
	237	C	975		u=0
				U 231	
RC3	238	B	310		
				C 014	A=Ao
	239	B	311		
				H 015	B=Bo
	240	C	338		B=Bo
				C 977	w=0
	241	B	380		
				C 034	.SCo
	242	B	372		
				C 036	.RCo
	243	B	376		
				C 039	.C1a

	244	B	378			
				C	037	.C2a
	245	00	000			
				U	014	→ °Q1
°SA7, SB7, °SC7	246	[K	000			End of all 3 tapes
				K	000]	
#	246	56	300	U	288	→ °9b
#	246	53	300	U	294	→ °9c
°9a	247	S	978			-r
				Q	251	-r:0
	248	A	974			3R - r
				H	975	3R - r → u
	249	C	978			u → r
				C	976	v=0 ∴ s and t =0 if r ≠ 0
	250	C	977			w=0
				U	260	
	251	C	975			u=0
				S	979	-s
	252	00	000			
				Q	256	-s:0
	253	A	974			3R-s
				H	976	3R-s → v
	254	C	978			v → r
				C	979	s=0
	255	C	977			w=0
				U	260	
	256	C	976			v=0
				S	980	-t
	257	00	000			
				Q	264	-t:0
	258	A	974			3R-t
				H	977	3R-t → w
	259	C	978			w → r
				C	980	t = 0
	260	B	974			3R
				H	967	3R → R
	261	X	000			
				X	000	
	262	C	974			3(3R) → 3R
				31	000	Read one block of descending instruct-
	263	31	000			tions→000 - 059
				U	000	To descending series
	264	C	977			w=0
				U	260	

	265	B 326			H-1=0
			C 011	.2b	Final Cycle
	266	B 327			
			C 277	.3b	
	267	L 304			
			U 006		
	268	V 334			U=1
			W 322		$T_3 = T_X$
	269	B 333			$T_4 = T_Y$
			H 321		$T_5 = T_Z$
	270	C 093			
			V 388		$T_6 = T_A$
	271	W 330			$T_7 = T_B$
			B 390		$T_8 = T_C$
	272	C 332			
			26 000		$T_A \rightarrow$ rI
3a	273	55 300			Sentinel $\rightarrow T_Z$
			46 540		(rI) $\rightarrow$ A, $T_A \rightarrow$ rI
	274	55 300			Sentinel $\rightarrow T_Z$
			47 720		(rI) $\rightarrow$ D, $T_B \rightarrow$ rI
	275	54 300			Sentinel $\rightarrow T_Y$
			47 600		(rI) $\rightarrow$ B, $T_B \rightarrow$ rI
	276	54 300			Sentinel $\rightarrow T_Y$
			48 780		(rI) $\rightarrow$ E, $T_C \rightarrow$ rI
	277	53 300			Sentinel $\rightarrow T_X$
			48 660		(rI) $\rightarrow$ C, $T_C \rightarrow$ rI
	# 277	63 000			Wind tape 6 to the front leader to be ready for final output tape
			U 280		$\rightarrow {}^{o}3b$
	278	53 300			Sentinel $\rightarrow T_X$
			U 013		$\rightarrow {}^{o}Q1$
	279	00 000			
			00 000		
3b	280	48 660			(rI) $\rightarrow$ C $T_C \rightarrow$ rI
			50 093		$T_3 \rightarrow$ S.C to tell operator which is final collated tape
	281	73 970			Identification block to T_3 (20/in)
			B 329		${}^{o}9c$
	282	C 246			.9b or .9c
			L 300		S

	283	B 660	Q 135	(C_o):S. → ^oSC_o
	284	K 000	U 013	→ $^oQ1$
b	285	66 000		Wind tape 6 to the front leader to be ready for final output tape.
			45 660	(rI) → C, T_C → rI
	286	50 093		T_6 → S.C. to tell operator which is final collated tape
			76 970	Tape label to T_6(20/in)
	287	B 328		^o9b
			U 282	→ $^o4$
b	288	56 300		3 sentinel blocks to final T_6
			56 300	
	289	81 000		Rewind all tapes
			83 000	
	290	84 000		
			85 000	
	291	30 000		
			87 000	
	292	88 000		
			86 000	
	293	00 000		Stop
			90 000	
c	294	53 300		3 sentinel blocks to final T_3
			53 300	
	295	00 000		
			U 289	→ rewind all tapes and stop
	296	B 322		r+1 = 3R
			C 093	.P2
	297	C 978		r=0
			U 090	→ $^o8$

Constants

298	000000	000002	
299	000000	000020	
300			End of tape sentinel
301			Digit extractor
302	110000	111111	
303	000002	000002	
304	000000	000001	
305	000004	000000	
306	000000	000004	
307	40 720	L 300	Tape read instruction .La
308	40 780	L 300	" " " .Lb
309	40 840	L 300	" " " .Lc
310	E 596	K 000	Ao
311	E 656	T 041	Bo
312	E 656	00 000	B1
313	E 656	T 043	B2
314	E 716	T 043	Co
315	K 000	00 000	Reset 016
316	00 000	U 041	Set 015
317	00 000	U 063	Set 016 with B2
318	E 539	00 000	N for x
319	E 599	00 000	N for y
320	E 659	00 000	N for z
321	56 900	A 978	.P1
322	57 900	U 096	.P2
323	58 900	U 100	.P3

After special
53 900 A 978
54 900 U 096
55 900 U 100

```
324    V  000   W  900     m=0
325    V  000   W  956     N-1 for m
326   45  780   U  285     .2b
327   63  000   U  280     .3b
328   56  300   U  288     .9b
329   53  300   U  294     .9c
330  030000  000000  T3
331  040000  000000  T4
332  050000  000000  T5
333   53  900   A  978     .P1
334   54  900   U  096     .P2
335   55  900   U  100     .P3
336  [V  000   W  900]     m (m=0 to start):variable
337  [40  840  L  300]     .L (Lc to start):variable
338  [E  656   T  041]     B (Bo to start):variable
339    L  967   Q  104     .RAo
340    L  967   Q  194     .RA1
341    L  967   Q  236     .RA2
342    L  967   Q  143     .RA3
343    L  967   Q  219     .RA4
344    L  967   Q  144     .RA5
345    L  967   Q  217     .RA6
346    L  967   Q  166     .RA8
347    L  967   Q  163     .RA9
348
349
350
```

After special
060000 000000
070000 000000
080000 000000

```
351
352     00 000    Q  224   . SA5
353     00 000    Q  207   . SA6
354     00 000    Q  246   . SA7
355     L  967    Q  112   . RBo
356     L  967    Q  228   . RB1
357     L  967    Q  168   . RB2
358     L  967    Q  154   . RB3
359     L  967    Q  151   . RB5
360     L  967    Q  192   . RB6
361     L  967    Q  147   . RB9
362
363
364
365
366     00 000    Q  130   . SBo
367     00 000    Q  220   . SB1
368     00 000    Q  224   . SB4
369     00 000    Q  188   . SB5
370     00 000    Q  246   . SB7
371     00 000    Q  184   . SB8
372     L  967    Q  117   . RCo
373     L  967    Q  202   . RC1
374     L  967    Q  176   . RC2
375     L  967    Q  238   . RC3
376     C  017    U  014   . C1a
377     C  017    U  018   . C1b
```

378	C	977	U	014	.C2a
379	C	977	U	018	.C2b
380	00	000	Q	135	.SCo
381	00	000	Q	211	.SC1
382	00	000	Q	190	.SC2
383	00	000	Q	207	.SC4
384	00	000	Q	188	.SC5
385	00	000	Q	246	.SC7
386	00	000	Q	183	.SC8
387	00	000	Q	157	.SC9
388	060000		000000		T_6
389	070000		000000		T_7
390	080000		000000		T_8
391	C	975	U	014	.A2a
392	C	014	U	014	.A1a
393	C	975	U	043	.A2b
394	C	014	U	043	.A1b
395	C	976	U	014	.B2a
396	C	015	U	014	.B1a
397	C	976	U	063	.B2b
398	C	015	U	063	.B1b

Variables

967	R
971	Tape label
972	H
974	3R
975	u
976	v
977	w
978	r
979	s
980	t
981	U. o or 1 , 1 = Special
540 - 599	Storage for one block of data from tape A (A)
600 - 659	Storage for one block of data from tape B (B)
660 - 719	Storage for one block of data from tape C (C)
720 - 779	Storage for one auxiliary block from tape A (D)
780 - 839	Storage for one auxiliary block from tape B (E)
840 - 899	Storage for one auxiliary block from tape C (F)
900 - 959	Storage for collated data (output; G)

A-953-1
A-953-2
Code C-10
1/9/50

THREE TAPE EXTERNAL COLLATION

CONNECTORS FOR ASCENDING AND DESCENDING SERIES

Connector	Series	Purpose and Function	Entry Point and Use
$^{o}1$	Asc.only	Tests whether or not the Special Descending - following - Descending cycle has been used. If it has not, tapes 3,4 and 5 are read to memory backward, and control is transferred to $^{o}2$. If the special cycle has been used tapes 6,7 and 8 are read to memory backward, substitutions are made throughout the instructions to set tapes X,Y and Z to be tapes 3,4 and 5 respectively, and control is transferred to $^{o}3$. An analogous routine is present in the initial part of the descending series, combining the above with the operations of $^{o}2a$ and $^{o}3a$ as described below. However, in this series, former tapes X,Y and Z are tapes A,B and C and vice versa.	Entered from either side of test for last cycle.
$^{o}2a, ^{o}3a$	Asc.only	Initially set. Places two sentinel blocks at the beginning of each of the three respective output tapes, tapes X,Y,Z. Similar routines are present in the descending series as part of the initial instructions.	When the current cycle is not the last, $^{o}2a$ is entered from the inequality side of the comparison in $^{o}1$, and $^{o}3a$ is entered from the equality side of the same comparison.

$^{0}2b, ^{0}3b$	Asc.only	Set on equality side of test for last cycle. Each routine rewinds the respective tape X to the leader, writes an instruction on supervisory control to indicate the final UNISERVO number to the operator, and writes (20/in.) an identification block on tape X which contains the tape label in the second word. There is no analogous routine in the descending series, as the last cycle will always be an ascending one. Routine $^{0}2b$ sets $^{0}9b$ and transfers to $^{0}4$. Routine $^{0}3b$ sets $^{0}9c$ and transfers to $^{0}4$.	When the current cycle is the last, $^{0}2b$ is entered from the inequality side of the comparison in $^{0}1$, and $^{0}3b$ is entered from the equality side of the same comparison.
$^{0}4$	Asc.only	Tests (C_o) with end-of-tape sentinel. If they are equal, transfers control to ^{0}SCo. If they are unequal, transfers control to ^{0}Q. No analogous routine is to be found in the descending series; the C tape cannot be entirely absent (if ever) until the last ascending cycle.	Entered from $^{0}2b$ and $^{0}3b$.
$^{0}Q1$	This and all following routines up to but not including $^{0}9a$ are found in both the ascending and descending series	Initially set, and reset at the end of every string ($^{0}RA3, ^{0}RB3, ^{0}RC3$).	Entered from $^{0}2a$ or $^{0}3a$ in the ascending series if current cycle is not the last.
		Compares current A,B, and C items.	Entered from $^{0}4$ in the ascending series if the last cycle involves three tapes.
		Following the comparison in the ascending series, control is transferred to the routine which will transfer the item with the least value to the output location.	Entered from initial routines in descending series.

	Following the comparison in the descending series, control is transferred to the routine which will transfer the item with the greatest value to the output location.	In either series: at any time prior to the ending of an input string or tape, °Q1 is re-entered from °A1a, °B1a, °C1a after the transfer of an item to the output block if that item is not the last in its respective input block; from °A2a, °B2a, °C2a after reading in a new input block, if that block is not the end of a string or a tape and from °RA3, °RB3 or °RC3 following the end of an output string.
°Q2	Set by °RAo, °SAo at the end of A string or tape. Compares current C and B items in the same routine as °Q1, changing the Bo line of coding only slightly as required (B1).	Entered from °RAo or °SAo following the completion of A string or tape. Re-entered from °B1a, °C1a and from °B2a, °C2a under the conditions outlined above.
°Q3	Set by °RBo, °SBo at the end of B string or tape. Compares current A and C item.	Entered from °RBo or °SBo following the completion of B string or tape. Re-entered from °A1a, °C1a, and from °A2a, °C2a under the conditions outlined under °Q1.
°Q4	Set by °RCo, °SCo, °RA5, °RA9, °RB5, °RB9, °SC9 at the end of C string or tape. Compares current B and A items in the same routine as °Q1, changing the Bo line of coding only slightly as required (B2)	Entered from °RCo, °SCo, °RA5, °RA9, °RB5, °RB9, °SC9 following the completion of the C string or tape. Re-entered from °B1a, °A1a and from °A2a, °B2a under the conditions outlined under °Q1.

$^{o}5$

Transfers current A item to output block. Sets $^{o}8A$ and tests for end of output block. If output block is complete, transfers control to ^{o}P, if not, transfers control to $^{o}8$.

Entered following the main comparison ($^{o}Q1$) if (A) is the item of least value (ascending series) or of greatest value (descending series).

Entered from $^{o}Q3$ or $^{o}Q4$ under similar circumstances.

Entered whenever only A items are to be transferred as listed below:

From:	After Ending
$^{o}RB2, {}^{o}RC2$	B, C strings
$^{o}SC2, {}^{c}RB6$	B str, tape C
$^{o}RA8, {}^{o}SC8, {}^{c}SB8$	A str., tapes B and C
$^{o}SC5, {}^{o}SB5$	tapes B and C

$^{o}6$

Transfers current B item to output block. Sets $^{o}8B$ and tests for end of output block. If output block is complete, transfers control to ^{o}P, if not, transfers control to $^{o}8$.

Entered from $^{o}Q1, {}^{o}Q2, {}^{o}Q4$ if (B) is the item of least or greatest value under conditions listed under $^{o}5$.

Entered whenever only B items are to be transferred as listed below:

From:	After Ending
$^{o}RA1, {}^{o}RC1$	A and C str.
$^{o}SC1, {}^{o}RA6$	A str, tape C
$^{o}SC4, {}^{o}SA6$	tapes A and C

$^{o}7$

Transfers current C item to output block. Sets $^{o}8C$ and tests for end of output block. If output block is complete transfers control to ^{o}P, if not, transfers control to $^{o}8$.

Entered from $^{o}Q1, {}^{o}Q2, {}^{o}Q3$ if (C) is the item of least or greatest value under conditions listed under $^{o}5$.

Entered whenever only C items are to be transferred, as listed below:

From:	After Ending
^{o}RA2, ^{o}RB1	A and B str.
^{o}RA4, ^{o}SB1	A str, tape B
^{o}SB4, ^{o}SA5	tapes A and B

^{o}8A	Set by ^{o}5. Tests for end of current A block. If block is exhausted, sets x equal to zero, and transfers to ^{o}L1. If A is not exhausted, advances x by one, and transfers to ^{o}A1.	Entered following the transfer of every A item, either from the inequality side of the test for end of output block, or following the ^{o}P routine.
^{o}8B	Set by ^{o}6. Tests for end of current B block. If block is exhausted, sets y equal to zero and transfers to ^{o}L2. If block is not exhausted, advances y by one, and transfers to ^{o}B1.	Entered following the transfer of every B item, either from the inequality side of the test for end of output block, or following the ^{o}P routine.
^{o}8C	Set by ^{o}7. Tests for end of current C block. If block is exhausted, sets z equal to zero and transfers to ^{o}L3. If block is not exhausted, advances z by one, and transfers to ^{o}C1.	Entered following the transfer of every C item, either from the inequality side of the test for end of output block, or following the ^{o}P routine.
^{o}P1	Initially set and reset by ^{o}P3. Writes contents of output block on tape X and tests for end of output string. If string is not complete, advances counter r by one and transfers to ^{o}8. If string is complete, sets r equal to zero, sets ^{o}P2, and transfers to ^{o}8.	Entered from equality side of test for end of output block in ^{o}5, ^{o}6, ^{o}7.
^{o}P2	Set by ^{o}P1 when a complete output string has been written on tape X. Writes contents of output block on tape Y and tests for end of output string. If string is not	Entered from equality side of test for end of output block in ^{o}5, ^{o}6, ^{o}7.

	complete, advances counter s by one and transfers to $^{o}8$. If string is complete, sets s equal to zero, sets $^{o}P3$, and transfers to $^{o}8$.	
$^{o}P3$	Set by $^{o}P2$ whenever a complete output string has been written on tape Y. Writes contents of output block on tape Z and tests for end of output string. If string is not complete, advances counter t by one, and transfers to $^{o}8$. If string is complete, sets t equal to zero, sets $^{o}P1$ again, and transfers to $^{o}8$.	Entered from equality side of test for end of output block in $^{o}5$, $^{o}6$, $^{o}7$.
$^{o}A1a$	Initially set. Reset by $^{o}RA3$, $^{o}RA5$, $^{o}RA9$. Returns control to ^{o}Q after x has been advanced.	Entered from the inequality side of the test in $^{o}8A$, when current A block is not yet exhausted.
$^{o}A2a$	Initially set. Reset by $^{o}RA3$, $^{o}RA5$, $^{o}RA9$. Returns control to ^{o}Q after u has been advanced.	Entered from the inequality side of test for end of A string in $^{o}L1$, when completed A block is neither the last on the tape, nor the last in the string.
$^{o}B1a$	Initially set. Reset by $^{o}RB3$, $^{o}RB5$, $^{o}RB9$. Returns control to ^{o}Q after y has been advanced.	Entered from the inequality side of the test in $^{o}8B$ when the current B block is not yet exhausted.
$^{o}B2a$	Initially set. Reset by $^{o}RB3$, $^{o}RB5$, $^{o}RB9$. Returns control to ^{o}Q after v has been advanced.	Entered from the inequality side of the test for end of B string in $^{o}L2$ when the completed B block is neither the last on the tape nor the last in the string.

^{o}C1a	Initially set. Reset by ^{o}RC3. Returns control to ^{o}Q after z has been advanced.	Entered from the inequality side of the test in ^{o}8C when the current C block is not yet exhausted.
^{o}C2a	Initially set. Reset by ^{o}RC3. Returns control to ^{o}Q after w has been advanced.	Entered from the inequality side of the test for end of C string in ^{o}L3 when the completed C block is neither the last on the tape nor the last in the string.
^{o}A1b, ^{o}A2b	Set by ^{o}RB2, ^{o}RC2, ^{o}SC2, ^{o}RB6, ^{o}RA8, ^{o}SC8, ^{o}SB8, ^{o}SC5, ^{o}SB5. Return to transfer another A item after x and u respectively have been advanced.	See ^{o}A1a, ^{o}A2a. This occurs when there are only A items to transfer.
^{o}B1b, ^{o}B2b	Set by ^{o}RA1, ^{o}RC1, ^{o}SC1, ^{o}RA6, ^{o}SC4, ^{o}SA6. Return to transfer another B item after y and v respectively have been advanced.	See ^{o}B1a, ^{o}B2a. This occurs when there are only B items to transfer.
^{o}C1b, ^{o}C2b	Set by ^{o}SB4, ^{o}SA5, ^{o}RA2, ^{o}RB1, ^{o}RA4, ^{o}SB1. Return to transfer another C item after z and w respectively have been advanced.	See ^{o}C1a, ^{o}C2a. This occurs when there are only C items to transfer.
^{o}L1	Carries out instruction of ^{o}La, ^{o}Lb or ^{o}Lc as indicated below. Transfers contents of storage block D to A location, reads in new block from tape A to rI, sets ^{o}La and tests new (A_o) for sentinel. If next block is sentinel block, transfers control to ^{o}SA; if not, tests for end of A string. If string is complete, transfers control to ^{o}RA; if not, transfers to ^{o}A2.	Entered from the equality side of the test for end of input block in ^{o}8A.

$^{o}L2$	Carries out instruction of ^{o}La, ^{o}Lb or ^{o}Lc as indicated below. Transfers contents of storage block E to B location, reads in new block from tape B to rI, sets ^{o}Lb and tests new (B_o) for sentinel. If next block is sentinel block, transfers control to ^{o}SB; if not, tests for end of B string. If string is complete, transfers control to ^{o}RB; if not, transfers to $^{o}B2$.	Entered from the equality side of the test for end of input block in $^{o}8B$.
$^{o}L3$	Carries out instruction of ^{o}La, ^{o}Lb or ^{o}Lc as indicated below. Transfers contents of storage block F to C location, reads in new block from tape C to rI, sets ^{o}Lc, and tests new (C_o) for sentinel. If next block is sentinel block, transfers control to ^{o}SC; if not, tests for end of C string. If string is complete, transfers control to ^{o}RC; if not, transfers control to $^{o}C2$.	Entered from the equality side of the test for end of input block in $^{o}8C$.
^{o}La	Set by $^{o}L1$. Transfers contents of rI (A data) to auxiliary block D.	See $^{o}L1$, $^{o}L2$, $^{o}L3$.
^{o}Lb	Set by $^{o}L2$. Transfers B data previously stored in rI to auxiliary block E.	See $^{o}L1$, $^{o}L2$, $^{o}L3$
^{o}Lc	Initially set. Reset by $^{o}L3$. Transfers C data previously stored in rI to auxiliary block F.	See $^{o}L1$, $^{o}L2$, $^{o}L3$

^{o}RA	All ^{o}RA connectors set counter u equal to zero (end of A string)	All ^{o}RA connectors are entered from the equality side of the test for end of string in ^{o}L1.
^{o}RAo	Initially set. Reset by ^{o}RA1, ^{o}RA2, ^{o}RA3 prior to the beginning of a new string. Sets new ^{o}RB, ^{o}SB, ^{o}RC, and ^{o}SC connectors and transfers to ^{o}Q2.	Entered only when A string ends prior to the ending of B and C strings or tapes B and C.
^{o}RA1	Set by ^{o}RCo. Sets new ^{o}RB connector, and transfers to ^{o}6.	Entered only when A string ends following the ending of C string
^{o}RA2	Set by ^{o}RBo. Sets new connectors for ^{o}RA, ^{o}RC and ^{o}SC, and transfers to ^{o}7.	Entered only when A string ends following ending of B string.
^{o}RA3	Set by ^{o}RB2, ^{o}RC2. Sets ^{o}RAo for beginning of new string and transfers to ^{o}Q1.	Entered only when A string ends following ending of B and C strings.
^{o}RA4	Set by ^{o}SBo. Sets new connector for ^{o}SC, and transfers to ^{o}7.	Entered only when A string ends following ending of tape B.
^{o}RA5	Set by ^{o}RB6. Sets ^{o}Q4 and returns to ^{o}Q.	Entered only when A string ends following ending of tape C and B string.
^{o}RA6	Set by ^{o}SCo. Sets new connectors for ^{o}RB and ^{o}SB, and transfers to ^{o}6.	Entered only when A string ends following ending of C tape.
^{o}RA8	Set by ^{o}SB5, ^{o}SC5. Transfers to ^{o}5.	Entered only when A string ends following ending of tapes B and C

^{o}RA9	Set by ^{o}SC2. Sets new connectors for ^{o}SA, and ^{o}SB, and transfers to ^{o}Q4.	Entered only when A string ends following ending of B string and tape C.
^{o}SA	End of A tape.	All ^{o}SA connectors are entered from the equality side of the test for sentinel in ^{o}L1.
^{o}SAo	Initially set. Sets new connectors for ^{o}SB and ^{o}SC and transfers to ^{o}Q2.	Entered only when tape A ends prior to ending of tapes B and C.
^{o}SA5	Set by ^{o}SBo. Sets new connector for ^{o}SC, and transfers to ^{o}7.	Entered only when tape A ends folliwing ending of tape B.
^{o}SA6	Set by ^{o}SCo, ^{o}RB9, ^{o}SC9, ^{o}RA9. Sets new connector for ^{o}SB and transfers to ^{o}6.	Entered only when tape A ends following ending of tape C.
^{o}RB	All ^{o}RB connectors set counter v equal to zero (end of B string).	All ^{o}RB connectors are entered from the equality side of the test for end of string in ^{o}L2.
^{o}RBo	Initially set. Reset by ^{o}RB1, ^{o}RB2, ^{o}RB3. Sets new connectors for ^{o}RA, ^{o}RC, ^{o}SC and transfers to ^{o}Q3.	Entered only when B string ends prior to the ending of A and C strings and tape C.
^{o}RB1	Set by ^{o}RAo. Sets new connectors for ^{o}SB, ^{o}RC, ^{o}SC, and transfers to ^{o}7.	Entered only when B string ends following ending of A string.
^{o}RB2	Set by ^{o}RCo. Sets new connectors for ^{o}RB, ^{o}RA and transfers to ^{o}5.	Entered only when B string ends following ending of C string.

°RB3	Set by °RA1, °RC1. Sets °RBo for beginning of new string and transfers to °Q1.	Entered only when B string ends following ending of A and C strings.
°RB5	Set by °RA6. Sets new °SB connector and transfers to °Q4.	Entered only when B string ends following ending of tape C and A string
°RB6	Set by °SCo. Sets new connector for °RA and transfers to °5.	Entered only when B string ends following ending of tape C.
°RB9	Set by °SC1. Sets new connectors for °SA, °SB, and transfers to °Q4.	Entered only when B string ends following ending of A string and tape C.
°SB	End of B tape.	All °SB connectors are entered from the equality side of the test for sentinel in °L2.
°SBo	Initially set. Reset by °RC1, °RB1. Sets new connectors for °RA, °SA and °SC and transfers to °Q3.	Entered only when tape B ends prior to the ending of tapes A and C, and A string.
°SB1	Set by °RAo. Sets new connector for °SC, and transfers to °7.	Entered only when tape B ends following the ending of A string.
°SB4	Set by °SAo. Sets new connector for °SC and transfers to °7.	Entered only when tape B ends following the ending of tape A.
°SB5	Set by °SCo, °RB5, °SC9, °RA9, °RB9. Sets new connectors for °RA, °SA and transfers to °5.	Entered only when tape B ends following the ending of tape C.
°SB8	Set by °SC1, °RA6. Sets new connector for °SA and transfers to °5.	Entered only when tape B ends following ending of A string and tape C.

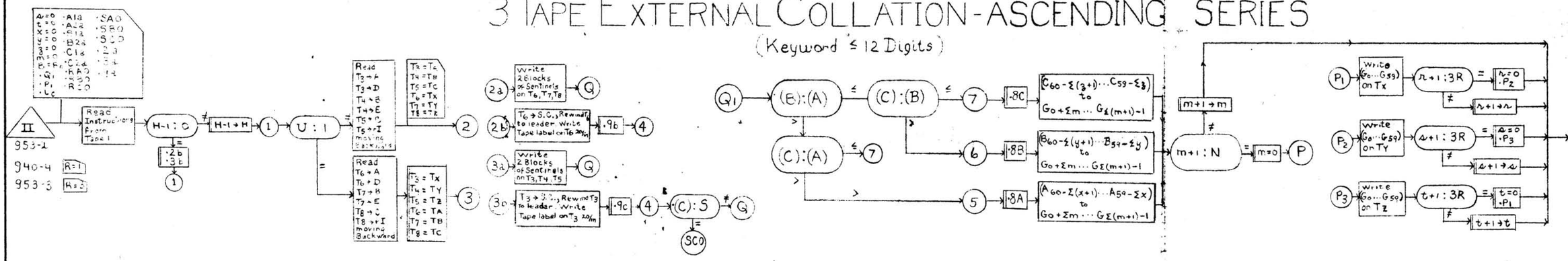
^{o}RC	All ^{o}RC connectors set counter w equal to zero (end of C string).	All ^{o}RC connectors are entered from the equality side of the test for end of string in $^{o}L3$.
^{o}RCo	Initially set. Reset by $^{o}RC1, ^{o}RC2, ^{o}RC3$. Sets new connectors for ^{o}RA, ^{o}RB and transfers to $^{o}Q4$.	Entered only when string C ends prior to the ending of strings A and B.
$^{o}RC1$	Set by ^{o}RAo. Sets new connectors for $^{o}RB, ^{o}SB$, $^{o}RC, ^{o}SC$ and transfers to $^{o}6$.	Entered only when string C ends following ending of A string.
$^{o}RC2$	Set by ^{o}RBo. Sets new connectors for $^{o}RA, ^{o}RC$, ^{o}SC and transfers to $^{o}5$.	Entered only when C string ends following ending of B string.
$^{o}RC3$	Set by $^{o}RA2, ^{o}RB1$. Sets new connector for ^{o}SC, sets ^{o}RCo for the beginning of a new string and transfers to $^{o}Q1$.	Entered only when C string ends following ending of A and B strings.
^{o}SC	End of C tape	All ^{o}SC connectors are entered from the equality side of the test for sentinel in $^{o}L3$.
^{o}SCo	Initially set. Reset by $^{o}RC1, ^{o}RC2, ^{o}RC3$. Sets new connectors for ^{o}RA, $^{o}SA, ^{o}RB$, ^{o}SB and transfers to $^{o}Q4$.	Entered only when tape C ends prior to the ending of B and A tapes and B and A strings.
$^{o}SC1$	Set by ^{o}RAo. Sets new connectors for $^{o}RB, ^{o}SB$ and transfers to $^{o}6$.	Entered only when tape C ends following the ending of A string.
$^{o}SC2$	Set by ^{o}RBo. Sets new connector for ^{o}RA, and transfers to $^{o}5$.	Entered only when tape C ends following the ending of B string.

^{o}SC4		Set by ^{o}SAo. Sets new connector for ^{o}SB and transfers to ^{o}6.	Entered only when tape C ends following the ending of tape A.
^{o}SC5		Set by ^{o}SBo. Sets new connector for ^{o}RA, ^{o}SA and transfers to ^{o}5.	Entered only when tape C ends following the ending of tape B.
^{o}SC8		Set by ^{o}SB1, ^{o}RA4. Sets new connector for ^{o}SA and transfers to ^{o}5.	Entered only when tape C ends following the ending of A string and tape B (either one first).
^{o}SC9		Set by ^{o}RB1, ^{o}RA2. Sets new connector for ^{o}SA, ^{o}SB and transfers to ^{o}Q4.	Entered only when tape C ends following the ending of A and B strings.
^{o}SA7, ^{o}SB7, ^{o}SC7		Set by ^{o}SB5, ^{o}SB8, ^{o}SC5, ^{o}SC8; ^{o}SA6, ^{o}SC4; and ^{o}SA5, ^{o}SB4 respectively. Transfers to routine described under ^{o}9.	Entered only at end of all input tapes, when cycle is complete.
^{o}9a	Asc.only	Initially set. Sets counters u,v,w,r,s,t, R and 3R for the next cycle. Reads in one block of instructions for next cycle and transfers control to 000. The same routine is present in the descending series also, but is part of the ^{o}SA7, ^{o}SB7, ^{o}SC7 routine.	Entered from ^{o}SA7, ^{o}SB7, ^{o}SC7 on any cycle prior to the last.
^{o}9b, ^{o}9c	Asc.only	Set by ^{o}2b and ^{o}3b respectively. Writes three sentinel blocks on tape X, rewinds data and instruction tapes and stops program.	Entered from ^{o}SA7, ^{o}SB7, ^{o}SC7 on the last ascending cycle.

For list of all possible combinations of string and tape endings, see separate sheet.

3 TAPE EXTERNAL COLLATION - ASCENDING SERIES

(Keyword ≤ 12 Digits)



Legend

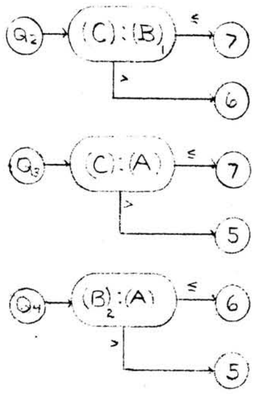
A	Input block to be collated
B	" " " "
C	" " " "
D	Additional input block for A string
E	" " " " B "
F	" " " " C "
G	Output block for collated data
H	No. of cycles needed to collate complete tape
N	No. of items in a block
R	No. of blocks to be collated together from a single input tape
S	End of tape sentinel
S.C.	Supervisory Control
T	Tape
U	When U = 1 Special Descending cycle has been used
X	Output string or tape; becomes A on Descending Series
Y	Output string or tape; becomes B on Descending Series
Z	Output string or tape; becomes C on Descending Series
Σ	No. of words per item
m	Counts no. of items in output block G
r	Counts blocks in a string on output tape X
s	Counts blocks in a string on output tape Y
t	Counts blocks in a string on output tape Z
u	Counts blocks in a string collated from input tape A
v	Counts blocks in a string collated from input tape B
w	Counts blocks in a string collated from input tape C
x	Counts no. of items collated from block A
y	" " " " " " " B
z	" " " " " " " C

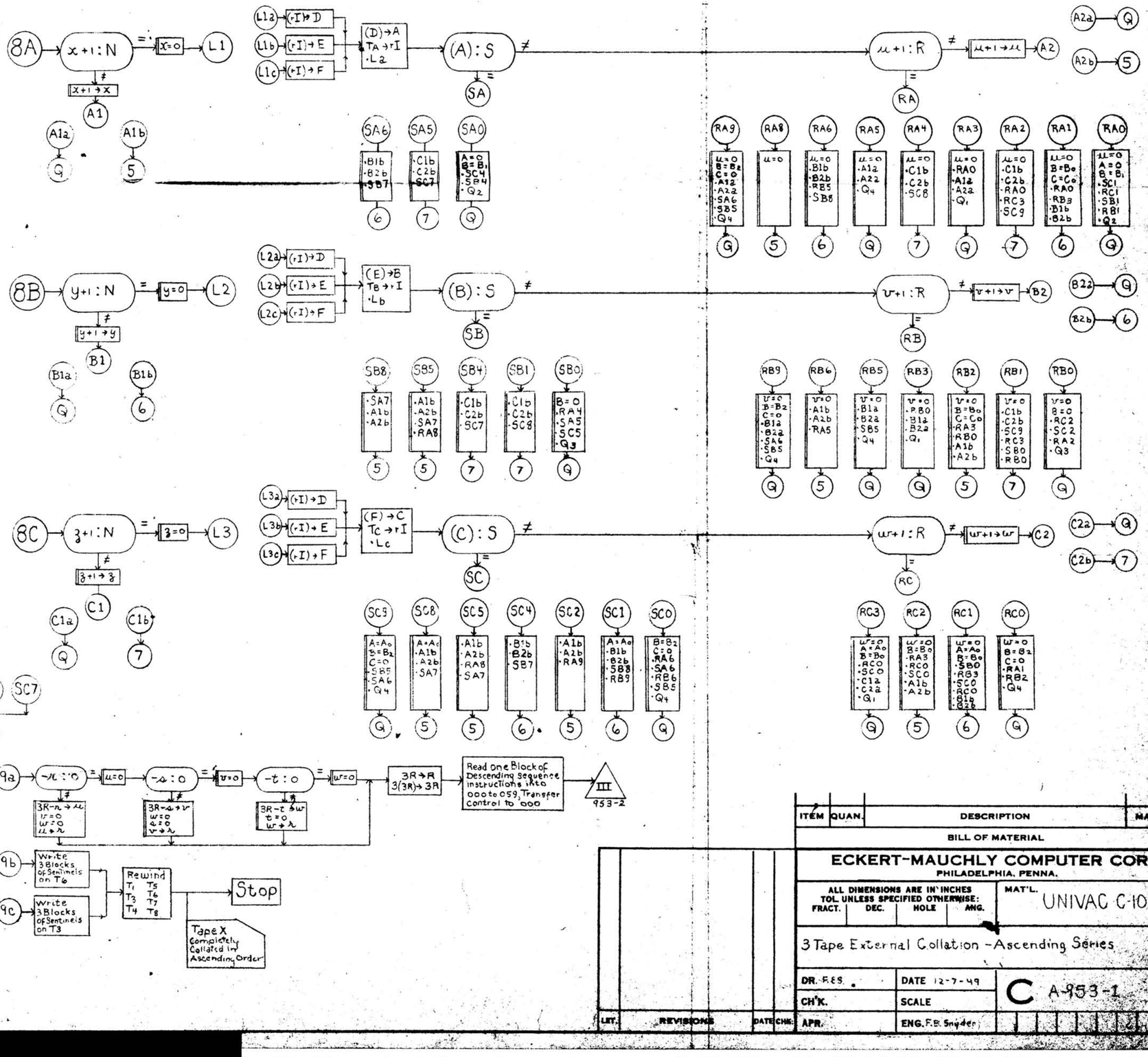
Connectors

- •L Read routine
- •P Print routine
- •Q Comparison routine
- •R End of string routine
- •S End of tape routine

Note:

Routines Q_2, Q_3, and Q_4 use same lines of coding as Q_1 with a limited number of changes. B_1 and B_2 in comparison boxes represent a change in the line of coding. A = 0 means, line of coding involving the A comparison is blanked out.





ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL. UNLESS SPECIFIED OTHERWISE: FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

3 Tape External Collation - Ascending Series

DR. F.E.S.	DATE 12-7-49	C A-953-1
CH'K.	SCALE	
APR.	ENG. F.E. Snyder	

LIT. | REVISIONS | DATE | CHK.

THREE-TAPE EXTERNAL COLLATION

DESCENDING SERIES

Six-word Item, Keyword is First Word
Key Digits ≤ 12 Digits

First block of instructions has been read into locations 000-059 and second block into rI at end of ascending series.

	000	31 060	31 120	Instructions and constants to memory	
	001	31 180	31 240		
	002	30 300	U 339	→ To routine to test for previous use of Special Series	
	003	53 300		Sentinel block to T_X	
			46 540	Read backward → A	
	004	53 300		Sentinel block to T_X	
			47 720	Read backward → D	
	005	54 300		Sentinel block to T_Y	
			47 600	Read backward → B	
	006	54 300		Sentinel block to T_Y	
			48 780	Read backward → E	
	007	55 300		Sentinel block to T_Z	
			48 660	Read backward → C, T_8 → rI	
	008	55 300		Sentinel block to T_Z	
			00 000		
Q1	009	F 301	00 000	Digit extractor	
	010	[E (594)	K 000]	Ao	
	011	[E (654)	T 029]	Bo Test (B) and (A)	
	012	[E (714)	T 047]	Co Test (C) and (A)	(A)>(B)
Q2	# 010	00 000	00 000	A = 0	End of A string, compare B and C
	# 011	E (654)	U 029	B = B1	
	# 012	E (714)	T 047	Co	
Q3	# 010	E (594)	K 000	Ao	End of B string, compare A and C
	# 011	00 000	00 000	B = 0	
	# 012	E (714)	T 047	Co	

24	# 010	E (594)	K	000	Ao	End of C string, compare A and B
	# 011	E (654)	T	031	B = B2	
	# 012	00 000	00 000		C = 0	
5	013	F 302			111000 111111	Routine: (A)▶(B) or (C)
			B	010	E (594) K 000	
	014	E 323			V (594) W (900)	
			L	316	V 000 W 958	
	015	R 073				
			U	065	To word transfer and output routine	
8A	016	B 010			E 594 K 000 = x	
			L	317	E 539 00 000 = N	
	017	S 305			x+1	
			T	028	x+1:N Transfer if not at end of A input block	
	018	B 310				
			C	010	x = 0, A = Ao	
	019	B 324				
			C	020	.L	
	020	[40(840)				
			L	300]	S	
	021	26 000			T_6 → rI [23 000 B 307 after Special Series]	
			B	307		
	022	C 324			$^oL = {}^oLa$	
			B	327		
	023	R 999				
			U	092	To input block transfer	
	024	[B 540			(A_o)	
			Q	117]	(A_o):S → ^oSAo	
	# 024	B 540	Q	215	→ $^oSA5$	
	# 024	B 540	Q	198	→ $^oSA6$	
	# 024	B 540	Q	237	→ $^oSA7$	
	025	B 975			u	
			A	304	u + 1	
	026	[L 967			R	
			Q	098]	u + 1:R → ^oRAo	
	# 026	L 967	Q	185	→ $^oRA1$	
	# 026	L 967	Q	227	→ $^oRA2$	
	# 026	L 967	Q	135	→ $^oRA3$	
	# 026	L 967	Q	210	→ $^oRA4$	

	#026	L	967	Q	136	→ °RA5
	#026	L	967	Q	208	→ °RA6
	#026	L	967	Q	157	→ °RA8
	#026	L	967	Q	154	→ °RA9
A2a	027	[C	975	U	009]	u + 1 → u → °Q
A1a	028	[C	010	U	009]	x + 1 → x → °Q
A2b	#027	C	975	U	013	u + 1 → u → °5
A1b	#028	C	010	U	013	x + 1 → x → °5
	029	K	000	00	000	
	030	E	(714)	T	047	
6	031	F	302	B	011	111000 111111 Routine: (B) > (A) or (C) E (654)T 029
	032	E	323	L	316	V (654)W (900) V 000 W 958
	033	R	073	U	065	To word transfer and output routine
8B	034	B	011	L	318	E (654) T 029 = y N
	035	S	305	T	046	y + 1 y + 1:N
	036	B	325	C	011	y = 0
	037	B	324	C	038	.L
	038	[40	(840)	L	300]	S
	039	27	000	B	308	T_7 → rI [24 000 B 308 after Special Series]
	040	C	324	B	328	°L = °Lb
	041	R	999	U	092	To input block transfer
	042	[B	600	Q	123]	$\{B_o\}$ / $\{B_o\}$: S → °SBo

≠	042	B	600	Q	211	→ °SB1
≠	042	B	600	Q	215	→ °SB4
≠	042	B	600	Q	179	→ °SB5
≠	042	B	600	Q	237	→ °SB7
≠	042	B	600	Q	175	→ °SB8
	043	B	976			v
				A	304	v + 1
	044	[L	967			R
				Q	106]	v + 1:R → °RBo
≠	044	L	967	Q	219	→ °RB1
≠	044	L	967	Q	159	→ °RB2
≠	044	L	967	Q	146	→ °RB3
≠	044	L	967	Q	142	→ °RB5
≠	044	L	967	Q	183	→ °RB6
≠	044	L	967	Q	139	→ °RB9
°B2a	045	[C	976			v + 1 → v
				U	009]	→ °Q
°B1a	046	[C	011			y + 1 → y
				U	009]	→ °Q
°B2b ≠	045	C	976	U	031	v + 1 → v. → °6
°B1b ≠	046	C	011	U	031	y + 1 → y. → °6
°7	047	F	302			111000 111111 Routine: (C) > (A) or (B)
				B	012	E (714)T 047
	048	E	323			V (714)W (900)
				L	316	V 000 W 958
	049	R	073			
				U	065	To word transfer and output routine
°8C	050	B	012			E (714)T 047 = z
				L	319	N
	051	S	305			z + 1
				T	063	z + 1:N
	052	B	314			
				H	012	z = 0

	053	C	030	B	324	
	054	C	055	00	000	.L
	055	[40	(840)	L	300]	S
	056	28	000	B	309	T_8 → rI [25 000 B 309 after Special Series]
	057	C	324	B	329	$^oL = {}^oLc$
	058	R	999	U	092	To input block transfer
	059	[B	660	Q	127]	(Co) (Co):S. → ^oSCo
#	059	B	660	Q	202	→ $^oSC1$
#	059	B	660	Q	181	→ $^oSC2$
#	059	B	660	Q	198	→ $^oSC4$
#	059	B	660	Q	179	→ $^oSC5$
#	059	B	660	Q	237	→ $^oSC7$
#	059	B	660	Q	174	→ $^oSC8$
#	059	B	660	Q	148	→ $^oSC9$
	060	B	977	A	304	w w + 1
	061	[L	967	Q	111]	R w + 1:R. → ^oRCo
#	061	L	967	Q	193	→ $^oRC1$
#	061	L	967	Q	167	→ $^oRC2$
#	061	L	967	Q	229	→ $^oRC3$
C2a	062	[C	977	U	009]	w + 1 → w → ^oQ
C1a	063	H	012	C	030	z + 1 → z
	064	[00	000	U	009]	→ ^oQ
C2b #	062	C	977	U	047	w + 1 → w. → $^o7$
C1b #	064	00	000	U	047	→ $^o7$

	065	H 068			Word transfer and output routine.
	066	H 069	A 303		Build up 2-word transfer instructions
	067	C 070	X 000		
	068	[V ( )	E 070		V 000 W (9xx) = m
	069	[V ( )	W (900)]		Execution of three 2-word transfers
	070	[V ( )	W (902)]		
	071	00 000	W (904)]		
	072	A 306	Q 074		m:N-1
	073	[00 000	C 323		m+1 → m
			U (c+1)]		→ °8
	074	B 315			
	075	B 326	C 323		m = 0
			C 076		
°P1	076	[53 900	B 978]	r	[56 900 B 978 after Special Series]
#	076	54 900	U 082		→ °P2 [57 900 U 082 after Special Series]
#	076	55 900	U 087		→ °P3 [58 900 U 087 after Special Series]
	077	A 304			r + 1
	078	00 000	L 974		3R
	079	C 978	Q 080		r + 1 : 3R
			U 073		r + 1 → r → °8
	080	B 320			
	081	C 978	C 326		.P2
			U 073		r = 0 → °8
°P2	082	B 979		s	Current output tape = T_4
	083	L 974	A 304		s + 1 3R
	084	C 979	Q 085		s + 1 : 3R
			U 073		s + 1 → s → °8

```
      085   B 321
                    C 326   .P3
      086   C 979           s = 0
                    U 073    ──> o8
────────────────────────────────────────────────────────────
P3    087   B 980           t                 Current output tape = T5
                    A 304   t + 1
      088   L 974           3R
                    Q 090   t + 1 : 3R
      089   C 980           t + 1 ──> t
                    U 073    ──> o8
────────────────────────────────────────────────────────────
      090   B 322
                    C 326   .P1
      091   C 980           t = 0
                    U 073   ───> o8
────────────────────────────────────────────────────────────
      092   H 993           Y  ( ) Z  ( )  Input block transfer
                    A 330
      093   H 994           Y (+10) Z (+10)
                    X 000
      094   H 995           Y (+20) Z (+20)
                    X 000
      095   H 996           Y (+30) Z (+30)
                    X 000
      096   H 997           Y (+40) Z (+40)
                    X 000
      097   C 998           Y (+50) Z (+50)
                    U 993
────────────────────────────────────────────────────────────
:Ao   098   B 312
                    C 325   B = B1 (end of block reset)
      099   C 010           A = 0
                    B 011
      100   E 325
                    C 011   B = B1 (variable)
      101   B 276
                    C 044   .RB1
      102   B 287
                    C 042   .SB1
      103   B 293
                    C 061   .RC1
      104   B 332
                    C 059   .SC1
      105   C 975           u = 0
                    U 009    ──> oQ2
────────────────────────────────────────────────────────────
3o    106   B 260
                    C 026   .RA2
      107   B 294
                    C 061   .RC2
```

	108	B	333	C	059	.SC2
	109	C	011	C	976	B = 0 v = 0
	110	00	000	U	009	→ °Q3
°RCo	111	B	259	C	026	.RA1
	112	B	277	C	044	.RB2
	113	B	313	C	325	B = B2 (end of block reset)
	114	B	011	A	306	
	115	C	011	C	012	B = B2 C = 0
	116	C	977	U	009	w = 0 → °Q4
°SAo	117	B	288	C	042	.SB4
	118	B	334	C	059	.SC4
	119	B	312	C	325	B = B1 (end of block reset)
	120	B	011	E	325	
	121	C	011	C	010	B = B1 A = 0
	122	00	000	U	009	→ °Q2
°SBo	123	B	262	C	026	.RA4
	124	B	272	C	024	.SA5
	125	B	335	C	059	.SC5
	126	C	011	U	009	B = 0 → °Q3
°SCo	127	B	264	C	026	.RA6
	128	B	273	C	024	.SA6
	129	B	280	C	044	.RB6
	130	B	289	C	042	.SB5
	131	B	011	A	306	
	132	C	011	B	313	B = B2

	133	C	325			B = B2 (end of block reset)
				C	012	C = 0
	134	00	000			
				U	009	→ $^{o}Q4$
$^{o}RA3$	135	B	258			
				C	026	.RAo
$^{o}RA5$	136	B	267			
				C	027	.A2a
	137	B	269			
				C	028	.Ala
	138	C	975			u = 0
				U	009	→ $^{o}Q1$ or $^{o}Q4$
$^{o}RB9$	139	B	313			
				H	011	B = B2
	140	C	325			B = B2 (end of block reset)
				C	012	C = 0
	141	B	273			
				C	024	.SA6
$^{o}RB5$	142	B	289			
				C	042	.SB5
	143	B	282			
				C	045	.B2a
	144	B	284			
				C	046	.Bla
	145	C	976			v = 0
				U	009	→ $^{o}Q4$ or $^{o}Q1$
$^{o}RB3$	146	B	275			
				C	044	.RBo
	147	00	000			
				U	143	
$^{o}SC9$	148	B	310			
				C	010	A = Ao
	149	B	313			
				H	325	B = B2 (end of block reset)
	150	C	011			B = B2
				00	000	
	151	B	273			
				C	024	.SA6
	152	B	289			
				C	042	.SB5
	153	C	012			C = 0
				U	009	→ $^{o}Q4$
$^{o}RA9$	154	B	267			
				C	027	.A2a
	155	B	269			
				C	028	.Ala
	156	C	975			u = 0
				U	149	

)RA8	157	K	000		
				C 975	u = 0
	158	00	000		
				U 013	→ 05
)RB2	159	B	311		
				H 011	B = Bo
	160	C	325		B = Bo (end of block reset)
				B 314	
	161	C	012		C = Co
				C 976	v = 0
	162	B	261		
				C 026	.RA3
	163	B	275		
				C 044	.RBo
	164	B	268		
				C 027	.A2b
	165	B	270		
				C 028	.A1b
	166	00	000		
				U 013	→ 05
)RC2	167	B	325		
				C 011	B = Bo
	168	B	261		
				C 026	.RA3
	169	B	292		
				C 061	.RCo
	170	B	331		
				C 059	.SCo
	171	B	268		
				C 027	.A2b
	172	B	270		
				C 028	.A1b
	173	C	977		w = 0
				U 013	→ 05
)SC8	174	B	310		
				C 010	A = Ao
)SB8	175	B	274		
				C 024	.SA7
	176	B	268		
				C 027	.A2b
	177	B	270		
				C 028	.A1b
	178	00	000		
				U 013	→ 05
)SB5,)SC5	179	B	265		
				C 026	.RA8
	180	00	000		
				U 175	

°SC2	181	B	266			
				C	026	.RA9
	182	00	000			
				U	176	
°RB6	183	B	263			
				C	026	.RA5
	184	C	976			v = 0
				U	176	
°RA1	185	B	314			
				C	012	C = Co
	186	C	975			u = 0
				00	000	
	187	B	258			
				C	026	.RAo
	188	B	278			
				C	044	.RB3
	189	B	283			
				C	045	.B2b
	190	B	285			
				C	046	.B1b
	191	B	311			
				C	325	B = Bo (end of block reset only)
	192	00	000			
				U	031	→ °6
°RC1	193	B	310			
				C	010	A = Ao
	194	B	286			
				C	042	.SBo
	195	B	292			
				C	061	.RCo
	196	B	331			
				C	059	.SCo
	197	C	977			w = 0
				U	188	
°SA6, °SC4	198	B	290			
				C	042	.SB7
	199	B	283			
				C	045	.B2b
	200	B	285			
				C	046	.B1b
	201	00	000			
				U	031	→ °6
°SC1	202	B	310			
				C	010	A = Ao
	203	B	281			
				C	044	.RB9
	204	B	291			
				C	042	.SB8
	205	B	283			
				C	045	.B2b

	206	B	285		
				C 046	.B1b
	207	00	000		
				U 031	→ °6
°RA6	208	B	279		
				C 044	.RB5
	209	C	975		u = 0
				U 204	
°RA4	210	K	000		
				C 975	u = 0
°SB1	211	B	297		
				C 062	.C2b
	212	B	299		
				C 064	.C1b
	213	B	337		
				C 059	.SC8
	214	00	000		
				U 047	→ °7
°SB4, °SA5	215	B	297		
				C 062	.C2b
	216	B	299		
				C 064	.C1b
	217	B	336		
				C 059	.SC7
	218	00	000		
				U 047	→ °7
°RB1	219	B	275		
				C 044	.RBo
	220	B	286		
				C 042	.SBo
	221	C	976		v = 0
				00 000	
	222	B	297		
				C 062	.C2b
	223	B	299		
				C 064	.C1b
	224	B	295		
				C 061	.RC3
	225	B	338		
				C 059	.SC9
	226	00	000		
				U 047	→ °7
°RA2	227	B	258		
				C 026	.RAo
	228	C	975		u = 0
				U 222	

°RC3	229	B	310			
				C	010	A = Ao
	230	B	311			
				H	325	B = Bo (end of block reset)
	231	C	011			B = Bo
				C	977	w = 0
	232	B	331			
				C	059	.SCo
	233	B	292			
				C	061	.RCo
	234	B	296			
				C	062	.C2a
	235	B	298			
				C	064	.C1a
	236	00	000			
				U	009	→ °Q1
°SA7	237	K	000			End of all tapes
°SB7,				K	000	(rL) = 0
°SC7	238	S	978			-r
				Q	242	-r : 0
	239	A	974			3R - r
				H	975	3R - r → u
	240	C	978			u → r
				C	976	v = 0 s and t = 0 if r ≠ 0
	241	C	977			w = 0
				U	251	
	242	C	975			u = 0
				S	979	-s
	243	00	000			
				Q	247	-s:0
	244	A	974			3R - s
				H	976	3R - s → v
	245	C	978			v → R
				C	979	s = 0
	246	C	977			w = 0
				U	251	
	247	C	976			v = 0
				S	980	-t
	248	00	000			
				Q	257	-t:0
	249	A	974			3R - t
				H	977	3R - t → w
	250	C	978			w → r
				C	980	t = 0
	251	B	974			3R
				H	967	3R → R
	252	X	000			
				X	000	
	253	C	974			3(3R) → 3R
				B	972	

254	S	304	C	972	H - 1 → H
255	31	000	31	000	Clear rI, T_1 → rI One block of ascending series instructions to memory
256	00	000	U	000	To ascending series instructions
257	C	977	U	251	w = 0

Constants

258	L	967	Q	098	.RAo
259	L	967	Q	185	.RA1
260	L	967	Q	227	.RA2
261	L	967	Q	135	.RA3
262	L	967	Q	210	.RA4
263	L	967	Q	136	.RA5
264	L	967	Q	208	.RA6
265	L	967	Q	157	.RA8
266	L	967	Q	154	.RA9
267	C	975	U	009	.A2a
268	C	975	U	013	.A2b
269	C	010	U	009	.A1a
270	C	010	U	013	.A1b
271	B	540	Q	117	.SAo (not used)
272	B	540	Q	215	.SA5
273	B	540	Q	198	.SA6
274	B	540	Q	237	.SA7
275	L	967	Q	106	.RBo
276	L	967	Q	219	.RB1
277	L	967	Q	159	.RB2
278	L	967	Q	146	.RB3
279	L	967	Q	142	.RB5
280	L	967	Q	183	.RB6
281	L	967	Q	139	.RB9
282	C	976	U	009	.B2a
283	C	976	U	031	.B2b
284	C	011	U	009	.B1a
285	C	011	U	031	.B1b
286	B	600	Q	123	.SBo
287	B	600	Q	211	.SB1
288	B	600	Q	215	.SB4
289	B	600	Q	179	.SB5
290	B	600	Q	237	.SB7
291	B	600	Q	175	.SB8
292	L	967	Q	111	.RCo

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293   L  967  Q  193     .RC1
294   L  967  Q  167     .RC2
295   L  967  Q  229     .RC3
296   C  977  U  009     .C2a
297   C  977  U  047     .C2b
298   00 000  U  009     .C1a
299   00 000  U  047     .C1b
300                      Sentinel
301                      Digit Extractor
302   111000  111111
303   000002  000002
304   000000  000001
305   000006  000000
306   000000  000002
307   40 720  L  300     Tape read instruction °La
308   40 780  L  300      "    "       "      °Lb
309   40 840  L  300      "    "       "      °Lc
310   E  594  K  000     Ao
311   E  654  T  029     Bo
312   E  654  U  029     B1
313   E  654  T  031     B2
314   E  714  T  047     Co
315   V  000  W  900
316   V  000  W  958
317   E  539  00 000
318   E  599  00 000
319   E  659  00 000
320   54 900  U  082     .P2   [57 900 U  082 after Special
                                Series]
321   55 900  U  087     .P3    58 900 U  087 after Special
                                Series]
322   53 900  B  978     .P1   [56 900 B  978 after Special
                                Series]
323   V ( )   W (900)]   m : variable
324   40 840  L  300     °L (°Lc to start) : variable
325   E  654  T  029     B : variable
326   53 900  B  978     P : variable  [56 900 B  978 after
327   Y  720  Z  540                    Special Series]
328   Y  780  Z  600
329   Y  840  Z  660
330   000010  000010
331   B  660  Q  127     .SCo
332   B  660  Q  202     .SC1
333   B  660  Q  181     .SC2
334   B  660  Q  198     .SC4
335   B  660  Q  179     .SC5
336   B  660  Q  237     .SC7
337   B  660  Q  174     .SC8
338   B  660  Q  148     .SC9
```

Coding

339	B	981		U
			L 304	unity
340	00	000		
			Q 342	Test for previous use of Special Descending-following-Desc. series program
341	26	000		$T_6 \rightarrow rI$
			U 003	→ Place sentinels on output tapes
342	23	000		$T_3 \rightarrow rI$ Special series program has been used; change tape instructions
			56 300	Sentinel → T_X
343	43	540		$T_A \rightarrow A$
			56 300	Sentinel → T_X
344	44	720		$T_A \rightarrow D$
			57 300	Sentinel → T_Y
345	44	600		$T_B \rightarrow B$
			57 300	Sentinel → T_Y
346	45	780		$T_B \rightarrow E$
			58 300	Sentinel → T_Z
347	45	660		$T_C \rightarrow C$, $T_C \rightarrow rI$
			58 300	Sentinel → T_Z
348	B	354		
			C 021	$T_3 = T_A$
349	B	355		
			C 039	$T_4 = T_B$
350	B	356		
			C 056	$T_5 = T_C$
351	B	357		
			H 322	
352	C	326		$T_6 = T_X$
			V 358	
353	W	320		$T_7 = T_Y$, $T_8 = T_Z$
			U 009	→ main routine

Constants

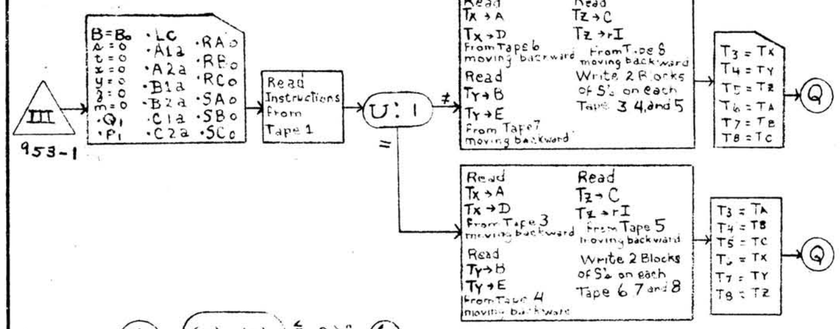
354	23	000	B	307	$T_3 \rightarrow$ rI
355	24	000	B	308	$T_4 \rightarrow$ rI
356	25	000	B	309	$T_5 \rightarrow$ rI
357	56	900	B	978	.P1
358	57	900	U	082	.P2
359	58	900	U	087	.P3

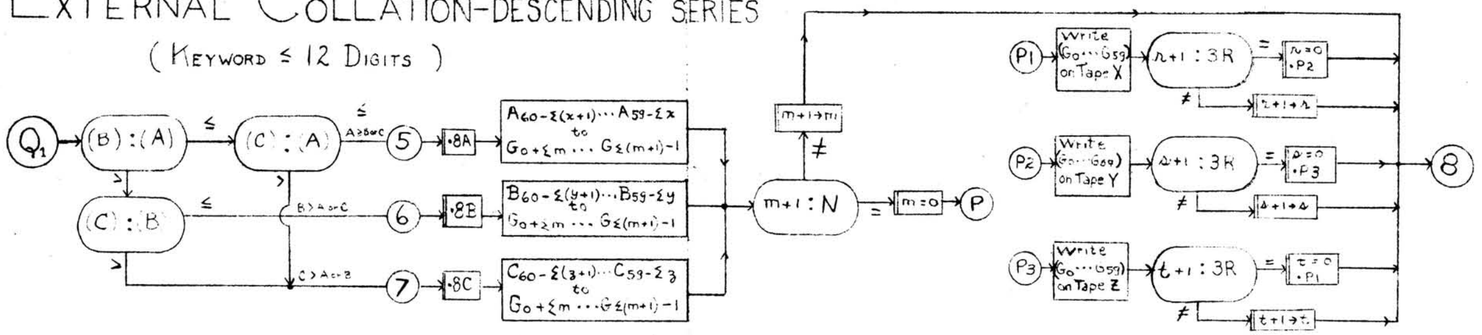
Variables

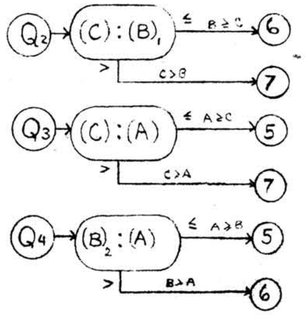
967	R	
971	Tape label	
972	H	
974	3R	
975	u	
976	v	
977	w	
978	r	
979	s	
980	t	
981	U = 0 or 1	1 = Special series program used

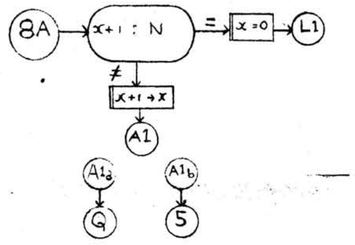
3 Tape External Collation-Descending Series

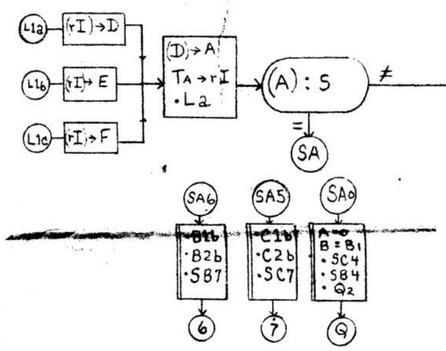
(Keyword ≤ 12 Digits)

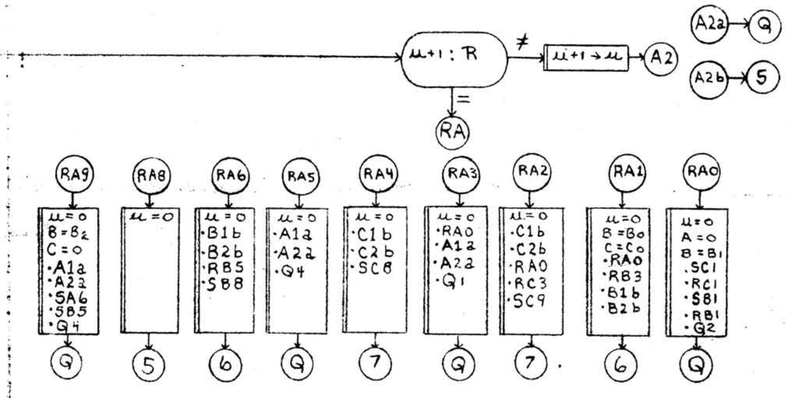


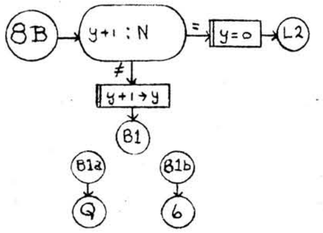


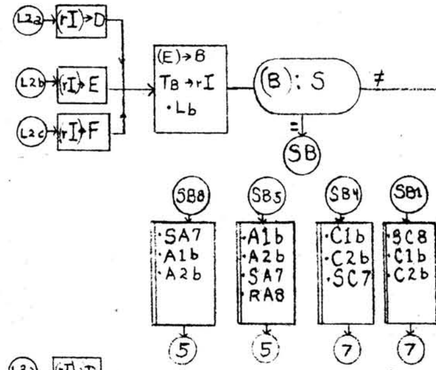


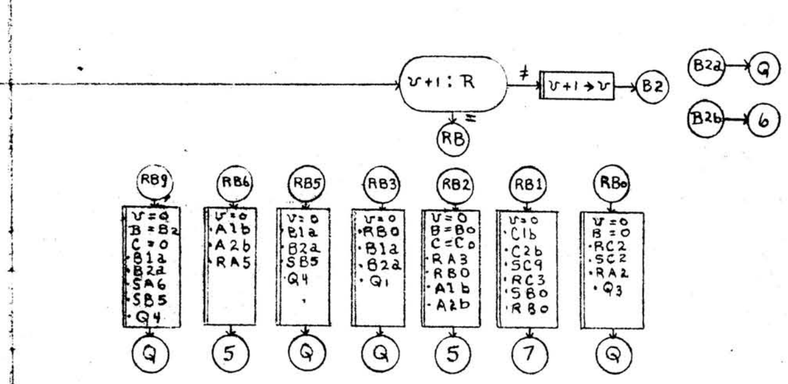


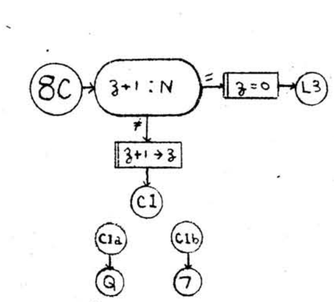


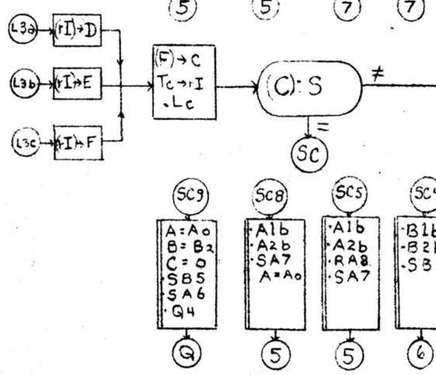


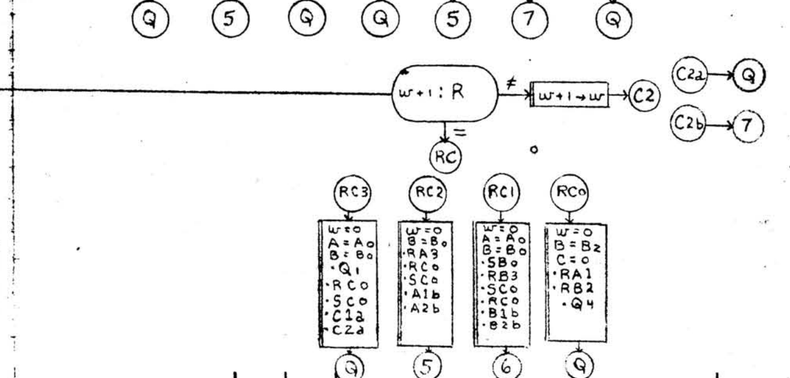


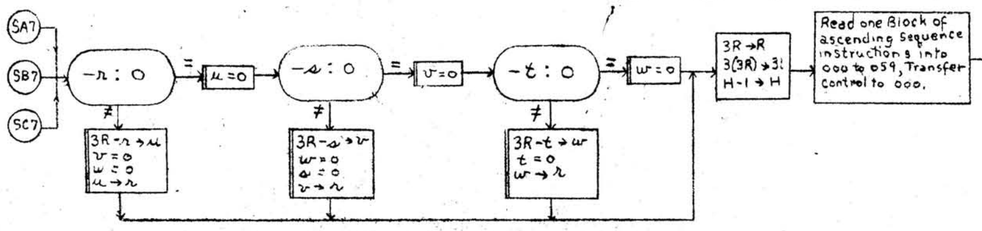












Legend

A	Input block to be collated
B	" " " " "
C	" " " " "
D	Additional input block for A string
E	" " " " B "
F	" " " " C "
G	Output block for collated data
H	No. of cycles needed to collate complete tape
N	No. of items in a block
R	No. of blocks to be collated together from a single input tape
S	End of tape sentinel
T	Tape
U	When U = 1 Special Descending cycle has been used
X	Output string or tape; becomes A on Ascending Series
Y	Output string or tape; becomes B on Ascending Series
Z	Output string or tape; becomes C on Ascending Series
Σ	No. of words per item
m	Counts no. of items in output block G
r	Counts blocks in a string on output tape X
s	Counts blocks in a string on output tape Y
t	Counts blocks in a string on output tape Z
u	Counts blocks in a string collated from input tape A
v	Counts blocks in a string collated from input tape B
w	Counts blocks in a string collated from input tape C
x	Counts no. of items collated from block A
y	" " " " " " " " B
z	" " " " " " " " C

Connectors

- ·L Read routine
- ·P Print routine
- ·Q Comparison routine
- ·R End of string routine
- ·S End of tape routine

Note:

Routines Q_2, Q_3 and Q_4 use same lines of coding as Q_1 with a limited number of changes. B_1 and B_2 in comparison boxes represent a change in the line of coding. A = 0 means, line of coding involving the A comparison is blanked out.

ITEM	QUAN.	DESCRIPTION	MATERIAL
		BILL OF MATERIAL	

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES TOL UNLESS SPECIFIED OTHERWISE: FRACT.	DEC.	HOLE	ANG.	MAT'L.
				UNIVAC C-10

3 Tape External Collation – Descending Series

DR. F.E.S	DATE 6/1/49	CA-953-2	
CH'K. MKL	SCALE		
APR. HAN	ENG. F.E. Snyder		

LET.	REVISIONS	DATE	CHK.
F.E.S.	First Rev (5/12/51) Minor changes	12/7	V

THREE-TAPE EXTERNAL COLLATION DESCENDING-FOLLOWING-DESCENDING FOR SPECIAL EVEN CYCLE RUN

Three-word Item
Key Digits in Second Word

Key Digits $\leq$ 12 Digits

At completion of Internal Collation first block of instructions in memory, second block in rI

```
000   31 060
                31 120
001   43 180
                00 000
002   56 200
                43 500
003   56 200
                44 560
004   57 200
                44 620
005   57 200
                45 680
006   58 200
                45 740
007   58 200
                U  00
008   00 000
                00 000
009   K  000
                F  173
```

Read remainder of instructions and constants.
Read data in backward: Tape 6 to locations A and D, Tape 7 to locations B and E, Tape 8 to location C and to rI,
write two sentinels on each output tape

rF = digit extractor

```
°Q1  010  E (501)
                K  000
     011  E (621)
                T  018
     012  E (741)
                T  025
```

rL = extracted digits of (A)
rA = extracted digits of (B)
If (B) > (A), transfer
rA = extracted digits of (C)
If (C) > (A), transfer to °7

End of A string or tape

```
°Q2* 011  E (621)  U  018
  * 012  E (741)  T  025
```

rA = extracted digits of (B). B = B1*

*1 and 2 indicate a change in the line of coding.

End of B string or tape

°03*	010	E (501)	K	000	rL = extracted digits of (A)
#	011	00 000	00	000	B = 0
#	012	E (741)	T	025	rA = extracted digits of (C)

End of C string or tape

°04#	010	E (501)	K	000	rL = extracted digits of (A)
#	011	E (621)	T	020	rA = extracted digits of (B) B = B2*
#	012	00 000	00	000	C = 0

°5	013	F 174	B	010	rF = 100000 111111
	014	R 040	U	031	•8A and transfer to transfer A item to output location

°8A	015	A 010	L	184	rA = x+1 rL = N
	016	[F 173	T	043]	If x+1 = N transfer

°A1a	017	[C 010	U	010]	x+1 → x Transfer to °Q

#	016	00 000	T	043	
°A1b*	017	H 010	U	031	Return to °5

	018	K 000	00	000	rL = extracted digits of (B)
	019	E (741)	T	025	rA = extracted digits of (C) If (C) > (B), transfer to °7

°6	020	F 174	B	011	rF = instruction extractor
	021	R 040	U	031	•85, and transfer to place B item in output location

°85	022	A 011	L	185	rA = y+1 rL = N
	023	[F 173	T	064]	If y+1 = N, transfer.

°B1a	024	[C 011	U	010]	y+1 → y Return to °Q

*1 and 2 indicate a change in line of coding

	##024	C	011	U	011	
	#023	00	000	T	064	
°B1	##024	H	011	U	031	Return to °6
°7	025	F	174			rF = instruction extractor
				B	019	
	026	R	040			•8C and transfer to place C item
				U	031	in output location
°8C	027	A	019			rA = z+1
				L	186	rL = N
	028	F	173			
				T	079	If z+1 = N, transfer.
°C1a	029	H	019			z+1 → z
				00	000	
	#029	C	019	U	011	
	#028	00	000	T	079	
°C1b	##029	H	019	U	031	Return to °7
	030	C	012			
				U	010	Return to °Q
	031	E	035			
				H	035	
	032	S	181			
				H	034	Build up instructions to transfer
	033	A	179			item
				C	036	
	034	B	(500)			
				C	(860)	
	035	B	(501)			Transfer item to output location
				C	(861)	
	036	B	(502)			
				C	(862)	
	037	E	036			
				A	179	rA = m+1
	038	L	183			rL = N
				Q	041	If m+1 = N, transfer to °P routine.
	039	C	035			m+1 → m
				B	177	

	040	00 000	U	015	Transfer to $^{o}8_{a}$
#	040	00 000	U	022	Transfer to $^{o}8_{b}$
#	040	00 000	U	027	Transfer to $^{o}8_{c}$
$^{o}P1$	041	5(6)860	B	209	Write one block on output tape - $^{o}P = {}^{o}P1$ to start
$^{o}P2$ #	041	57 860	B	209	
$^{o}P3$ #	041	58 860	B	209	
	042	C 035	U	040	m = 0 → m Transfer to $^{o}8$
	043	B 201	C	045	.L1
	044	40(800)	L	200	(rI) → Y (Y = F to start)
#	044	40 680	L	200	
#	044	40 560	L	200	
$^{o}L1$	045	Y 560	Z	500	
#	045	00 000	U	065	Transfer to $^{o}L2$
#	045	00 000	U	080	Transfer to $^{o}L3$
	046	Y 570	Z	510	Move contents of auxiliary block D to operation block A
	047	Y 580	Z	520	
	048	Y 590	Z	530	
	049	Y 600	Z	540	
	050	Y 610	Z	550	
	051	23 000	B	187	Read backward from tape 3 to rI Y = D
	052	C 044	B	500	rA = (A_o), rL = sentinel
	053	00 000	Q	150	Transfer to $^{o}SA_o$

#	053	00	000	Q	153	Transfer to °SA5
#	053	00	000	Q	156	" " °SA6
#	053	00	000	Q	136	" " °SA7

	054	00	000	00	000	Transfer to °RAo
#	054	B	221	U	095	" " °RA1
#	054	B	221	U	097	" " °RA2
#	054	F	173	U	101	" " °RA3
#	054	00	000	U	111	" " °RA4
#	054	00	000	U	114	" " °RA5, °RA9
#	054	00	000	U	126	" " °RA6
#	054	00	000	U	130	" " °RA8

°RAo	055	B	220	C	074	.RB1	
	056	B	233	C	073	.SB1	
	057	B	219	C	089	.RC1	
	058	B	236	C	088	.SC1	
	059	F	174	B	011	rF = instruction extractor	.Q2
	060	E	214	C	011	B = B1	
	061	B	215	C	024		
	062	B	216	C	029		
	063	F	173	U	011	rF = digit extractor Return to °Q	

	064	R	045	U	044	.L2

°L2	065	Y	680	Z	620	Transfer contents of auxiliary block E to operation block B
	066	Y	690	Z	630	
	067	Y	700	Z	640	

	068	Y	710	Z	650	Transfer contents of auxiliary block E to operation block B
	069	Y	720	Z	660	
	070	Y	730	Z	670	
	071	24	000	B	188	Read backward from tape 4 to rI Y = E.
	072	C	044	B	620	rA = (B_0); rL = sentinel
	073	00	000	Q	159	Transfer to °SBo
#	073	00	000	Q	111	" " °SB1
#	073	00	000	Q	153	" " °SB4
#	073	00	000	Q	163	" " °SB5
#	073	00	000	Q	136	" " °SB7
#	073	00	000	Q	130	" " °SB8
	074	00	000	00	000	Transfer to °RBo
#	074	B	221	U	097	" " °RB1
#	074	B	221	U	145	" " °RB2
#	074	F	173	U	101	" " °RB3
#	074	00	000	U	114	" " °RB5, °RB9
#	074	00	000	U	147	" " °RB6
°RBo	075	B	220	C	054	.RA2
	076	B	226	C	089	.RC2
	077	B	237	C	088	.SC2
	078	C	011	U	010	.Q3 Return to °Q
	079	R	045	U	044	.L3
°L3	080	Y	800	Z	740	

	081	Y 810	Z 750	Transfer contents of auxiliary block F to operation block C
	082	Y 820	Z 760	
	083	Y 830	Z 770	
	084	Y 840	Z 780	
	085	Y 850	Z 790	
	086	25 000	B 189	Read backward from tape 5 to rI; Y = F
	087	C 044	B 740	$rA = (C_o)$; rL = sentinel
	088	[00 000	Q 167]	Transfer to ^{o}SCo
#	088	00 000	Q 126	" " ^{o}SC1
#	088	00 000	Q 147	" " ^{o}SC2
#	088	00 000	Q 156	" " ^{o}SC4
#	088	00 000	Q 163	" " ^{o}SC5
#	088	00 000	Q 136	" " ^{o}SC7
#	088	00 000	Q 130	" " ^{o}SC8
#	088	00 000	Q 114	" " ^{o}SC9
	089	[00 000	00 000]	Transfer to ^{o}RCo
#	089	B 221	U 095	" " ^{o}RC1
#	089	B 221	U 145	" " ^{o}RC2
#	089	F 173	U 101	" " ^{o}RC3
^{o}RCo	090	B 219	C 054	.RA1
	091	B 226	C 074	.RB2
	092	C 012	00 000	.Q4
	093	B 011	A 180	
	094	C 011	U 010	Return to ^{o}Q

°RA1, °RC1	095	C	074	V	207	.RB3 .B1b
	096	W	023			
				U	020	Return to °6
°RA2, °RB1	097	C	089			.RC3
	098	C	088	B	239	.SC9
	099	W	028	V	212	.C1b
				U	025	Return to °7
	100	00	000			
				00	000	
°3R	101	B	232			.SBo (°RA3, °RB3, °RC3)
	102	B	235	C	073	.SCo
	103	C	054	C	088	.RAo
	104	C	089	C	074	.RBo .RCo
	105	W	028	V	210	.C1a
	106	W	023	V	205	.B1a
°9	107	Z	010	Y	190	.A1a, x = 0, y = 0, z = 0, .01
	108	L	218	B	217	Rotate •P and •9
	109	L	041	J	217	
	110	J	218	C	041	
				U	010	Return to °2
°RA4, °SB1	111	B	238	C	088	.SC8
	112	V	212	W	028	.C1b
	113	00	000			
				U	025	Return to °7
°2RS	114	B	230	C	053	.SA6 (°RA5, °RA9, °RB5, °RB9, °SC9)
	115	B	234	C	073	.SB5

	116	C	192	B	191	°Q = °Q4
	117	A	180	C	191	
	118	F	175	B	217	rF = 101111 111111
	119	H	041	E	008	Rotate °P
	120	.4	000	A	204	rA = basic function table instruction + T_p (shifted)
	121	C	124	Y	190	x = 0, y = 0, z = 0 , •Ala , •Q
	122	Z	010	V	205	•Bla
	123	W	023	B	182	
	124	[H	975	C	978]	u = 1, r = 1
#	124	H	976	C	978	v = 1, r = 1
#	124	H	977	C	978	w = 1, r = 1
	125	F	173	U	010	rF = digit extractor; Return to °Q
°RA6, °SC1	126	B	223	C	074	•RB5 or •RB9
	127	B	238	C	073	SB8
	128	V	207	W	023	•Blb
	129	00	000	U	020	Return to °6
°R2S	130	F	175	B	217	rF = 101111 111111 (°RA8, °SB8, °SC8)
	131	E	132	H	132	$T_{p+1} \rightarrow T_p$
	132	[5(6)500		E	008]	Write $(A_{0 \cdots 59})$ on T_p
#	132	57	500	E	008	
#	132	58	500	E	008	

	133	.4 000	A	204	rA = basic function table instruction + T_p (shifted)
	134	C 135	B	180	
	135	H (975)	C	978	u = 2, r = 2
#1	135	H 976	C	978	v = 2, r = 2
#1	135	H 977	C	978	w = 2, r = 2
$^{o}3S$	136	B 972	S	182	($^{o}SA7$, $^{o}SB7$, $^{o}SC7$)
	137	C 972	B	178	H - 1 → H
	138	H 967	X	000	3 → R
	139	X 000	C	974	9 → 3R
	140	41 000	L	176	(rI) → memory, T_1 → rI (backward) rL = no. blocks required to position asc. series instructions
	141	A 182	Q	143	If rA = rL, transfer
	142	41 000	U	141	(rI) → memory, T_1 → rI Transfer to test again
	143	31 000	31	000	Reverse direction of reading in instruction tape One block to memory, T_1 → rI
	144	K 000	U	000	Transfer to ascending series instructions
$^{o}RB2$, $^{o}RC2$	145	C 054	V	202	. RA3 . A1b
	146	W 016	U	013	Return to $^{o}5$
$^{o}RB6$, $^{o}SC2$	147	B 223	C	054	. RA5 or . RA9
	148	V 202	W	016	. A1b
	149	00 000	U	013	Return to $^{o}5$
$^{o}SA0$	150	B 229	C	073	.SB4
	151	B 230	C	088	.SC4
	152	00 000	U	059	Transfer to .Q2

^{o}SA5, ^{o}SB4	153	B	231			.SC7
				C	088	
	154	V	212			.C1b
				W	028	
	155	00	000			
				U	025	Return to ^{o}7
^{o}SA6, ^{o}SC4	156	B	231			.SB7
				C	073	
	157	V	207			.B1b
				W	023	
	158	00	000			
				U	020	Return to ^{o}6
^{o}SBo	159	B	222			.RA4
				C	054	
	160	B	229			.SA5
				C	053	
	161	B	234			.SC5
				C	088	
	162	C	011			.Q3 B = 0
				U	010	Return to ^{o}Q
^{o}SB5, ^{o}SC5	163	B	225			.RA8
				C	054	
	164	B	231			.SA7
				C	053	
	165	V	202			.A1b
				W	016	
	166	00	000			
				U	013	Return to ^{o}5
^{o}SCo	167	B	224			.RA6
				C	054	
	168	B	230			.SA6
				C	053	
	169	B	227			.RB6
				C	074	
	170	B	234			.SB5
				C	073	
	171	C	012			C = 0
				U	093	Transfer to .Q4

Constants

173			Digit extractor
174	100000	111111	Instruction extractor
175	101111	111111	" "
176			Number of blocks required to position first block of instructions, Three-tape ascending series
177	000003	000000	
178	000000	000003	
179	000002	000002	
180	000000	000002	
181	000001	000001	
182	000000	000001	
183	B 002	C 921	N (for m)
184	E 561	000000	N (for x)
185	E 681	000000	N (for y)
186	E 801	000000	N (for z)
187	40 560	L 200	Y = D
188	40 680	L 200	Y = E
189	40 800	L 200	Y = F
190	E 501	K 000	
191	E 621	T 018	x = 0, y = 0, z = 0
192	E 741	T 025	Q1
193	F 174	B 010	A1a
194	R 040	U 031	
195	A 010	L 184	
196	F 173	T 043	
197	C 010	U 010	

```
198   K  000   00 000
199   E  741   T  025
200                      End of tape sentinel
201   Y  560   Z  500     .L
202   00 000   T  043       .A1b
203   H  010   U  031
204   H  969   C  978     Basic function table instruction
205   F  173   T  064       .B1a
206   C  011   U  010
207   00 000   T  064       .B1b
208   H  011   U  031
209   B  000   C  861     m = 0
210   F  173   T  079       .C1a
211   H  019   00 000
212   00 000   T  079       .C1b
213   H  019   U  031
214   E  ( )   U  018
215   C  011   U  011       .Q2
216   C  019   U  011
217   57 860   B  209     Next print instruction :
                           (P2 to start)
218   58 860   B  209     Next print instruction but one :
                           (P3 to start)
219   B  221   U  095     .RA1, .RC1
220   B  221   U  097     .RA2, .RB1
221   F  173   U  101     .RA3, .RB3, .RC3, (3R)
222   00 000   U  111     .RA4
223   00 000   U  114     .RA5, .RA9, .RB5, .RB9 (2RS)
```

224	00 000	U	126	.RA6
225	00 000	U	130	.RA8 (R2S)
226	B 221	U	145	.RB2, .RC2
227	00 000	U	147	.RB6
228	00 000	00	000	
229	00 000	Q	153	.SA5, .SB4
230	00 000	Q	156	.SA6, .SC4
231	00 000	Q	136	.SA7, .SB7, .SC7 (3S)
232	00 000	Q	159	.SBo
233	00 000	Q	111	.SB1
234	00 000	Q	163	.SB5, .SC5
235	00 000	Q	167	.SCo
236	00 000	Q	126	.SC1
237	00 000	Q	147	.SC2
238	00 000	Q	130	.SC8, .SB8 (R2S)
239	00 000	Q	114	SC9 (2RS)

500 - 619	Operation block A, auxiliary block D, of data tape A
620 - 739	Operation block B, auxiliary block E, of data tape B
740 - 859	Operation block C, auxiliary block F, of data tape C
860 - 919	Storage block G for output data

THREE-TAPE EXTERNAL COLLATION DESCENDING FOLLOWING DESCENDING SERIES FOR SPECIAL EVEN CYCLE RUN

Connector	Purpose or Function	Entry Point
$^{o}Q1$	Three way comparison of (A) with (B) and (C)	Entered following initial tape read and write instructions. Re-entered from $^{o}A1a$, $^{o}B1a$, $^{o}C1a$, $^{o}3R$.
$^{o}Q2$	Comparison of (C) with (B)1 Used after A string or tape has been completed	Entered from ^{o}RAo, ^{o}SAo. Re-entered from $^{o}B1a$, $^{o}C1a$.
$^{o}Q3$	Comparison of (C) with (A) Used after B string or tape has been completed	Entered from ^{o}RBo, ^{o}SBo. Re-entered from $^{o}A1a$, $^{o}C1a$.
$^{o}Q4$	Comparison of (B)2 with (A) Used after C string or tape has been completed.	Entered from ^{o}RCo, ^{o}SCo. Re-entered from $^{o}2RS$, $^{o}A1a$, $^{o}B1a$.
$^{o}5$	Transfer of A data. Sets $^{o}8A$	Entered as a result of the comparison ($^{o}Q1$, $^{o}Q3$ or $^{o}Q4$) Re-entered from $^{o}RB2$, $^{o}RB6$, $^{o}SB5$, $^{o}RC2$, $^{o}SC2$, $^{o}SC5$, $^{o}A1b$.
$^{o}6$	Transfer of B data. Sets $^{o}8B$	Entered as a result of the comparison ($^{o}Q1$, $^{o}Q2$, or $^{o}Q4$) Re-entered from $^{o}B1b$, $^{o}RA2$, $^{o}SA2$, $^{o}SC6$, $^{o}RC1$
$^{o}7$	Transfer of C data. Sets $^{o}8C$	Entered as a result of the comparison ($^{o}Q1$, $^{o}Q2$ or $^{o}Q3$) Re-entered from $^{o}RA2$, $^{o}RA4$, $^{o}SA5$, $^{o}RB1$, $^{o}SB1$, $^{o}SB4$, $^{o}C1b$.
$^{o}P1$, $^{o}P2$, $^{o}P3$	Write block of collated data on tapes 3, 4 and 5 respectively. The current ^{o}P is initially $^{o}P1$, and is rotated sequentially through the others at the end of every string ($^{o}3R$).	Entered when equality results in the test for end of output block.

$^{o}8A$	Set by $^{o}5$. Advances A input item and tests for end of A input block. Sets $^{o}L1$ when equality results.	Entered following advancement of output item, and following ^{o}P routine.
$^{o}8B$	Set by $^{o}6$. Advances B input item and tests for end of B input block. Sets $^{o}L2$ when equality results.	Same as $^{o}8A$
$^{o}8C$	Set by $^{o}7$. Advances C input item and tests for end of C input block. Sets $^{o}L3$ when equality results.	Same as $^{o}8A$
$^{o}L1$	Set by equality test in $^{o}8A$. Sends auxiliary block D to operation block A, reads T_6 to rI backward, and sets address of (rI) at D. Tests for end of A tape.	Entered after sending the contents of rI to the proper location in the memory.
$^{o}L2$	Set by equality on test in $^{o}8B$. Sends auxiliary storage block E to operation block B. Reads tape 7 to rI backward, and sets the address of (rI) at E. Tests for end of B tape.	Same as $^{o}L1$
$^{o}L3$	Set by equality on test in $^{o}8C$. Sends auxiliary storage block F to operation block C; reads tape 8 to rI backward, and sets the address of (rI) at F. Tests for end of C tape.	Same as $^{o}L1$.
$^{o}A1a$ $^{o}B1a$ $^{o}C1a$	Originally set and reset by $^{o}3R$ routine, or $^{o}2RS$ routine. Used after the transfer of an item to return control to comparison routine.	Entered from the inequality side of test in $^{o}8A$, $^{o}8B$, $^{o}8C$ respectively.
$^{o}A1b$	Set by $^{o}RB2$, $^{o}RB6$, $^{o}SB5$, $^{o}RC2$, $^{o}SC2$, $^{o}SC5$. Used after collation of B and C blocks is complete and only A block remains to complete string. Transfers control to $^{o}5$.	Entered from inequality side of test in $^{o}8A$.
$^{o}B1b$	Set by $^{o}RA1$, $^{o}RA6$, $^{o}SA6$, $^{o}RC1$, $^{o}SC1$, $^{o}SC4$. Used after collation of A and C blocks is complete, and only B block remains to complete string. Transfers control to $^{o}6$.	Entered from inequality side of test in $^{o}8B$.

°C1b	Set by °RA2, °RA4, °SA5, °RB1, °SB1, °SB4. Used after collation of A and B blocks is complete, and only C block remains to complete string. Transfers control to °7.	Entered from inequality side of test in °8C.
°RAo	Initially set and reset at the beginning of every string in the °3R routine. Used only when block A ends prior to block B or C. Sets °Q2 comparison (C:B), and °RB1, °SB1, °RC1, °SC1. Returns to compare the remaining items in B and C.	Entered from the inequality side of the test in °L1, when the next (A_0) is not a sentinel.
°RA1	Set by °RCo. Used only when block A ends following the end of block C. Sets °RA3 and °B1b, and returns to transfer the items remaining in the current B block.	For this and all other °RA routines, see above.
°RA2	Set by °RBo. Used only when block A ends following the end of block B. Sets °RC3, °SC9, °C1b, and returns to transfer the items remaining in the current C block.	
°RA3	Set by °RC2, °RB2. Used only when block A ends following the ending of blocks B and C. Transfers immediately to °3R routine to reset initial conditions.	
°RA4	Set by °SBo. Used only when end of block A follows ending of B tape. Sets °SC8, °C1b and returns to transfer the item remaining in the current C block.	
°RA5	Set by °RB6. Used only when end of block A follows ending of tape C and ending of block B. Transfers immediately to °2RS to set connectors for comparison of items in remaining A and B blocks.	
°RA6	Set by °SCo. Used only when end of block A follows the end of tape C. Sets °RB5, °B1b and returns to transfer the remaining items in block B.	

^{o}RA8	Set by ^{o}SB5, ^{o}SC5. Used only when end of block A follows the end of tapes B and C. Transfers immediately to ^{o}R2S to write out remaining block on tape A.	
^{o}RA9	Set by ^{o}SC2. Used only when end of block A follows the end of block B and the end of tape C. Transfers immediately to ^{o}2RS.	
^{o}SAo	Initially set. Used only when end of tape A occurs prior to ending of tapes B or C. Sets ^{o}SB4, ^{o}SC4, and ^{o}Q2 comparison. Returns to compare the items remaining in the current B and C blocks.	Entered from the equality side of the comparison in ^{o}L1, when the next (A_o) is equal to sentinel.
^{o}SA5	Set by ^{o}SBo. Used only when the end of tape A occurs after the end of tape B. Sets ^{o}SC7, ^{o}C1b and returns to transfer the remaining items in the current C block.	For this and all other ^{o}SA routines, see above.
^{o}SA6	Set by ^{o}2RS; ^{o}SCo. Used when the end of tape A follows the end of tape C. Sets ^{o}SB7, ^{o}B1b and returns to transfers the items remaining in current B block.	
^{o}SA7	Set by ^{o}SB5, ^{o}SC5. Transfers immediately to ^{o}3S to advance counters for ascending series and to read in new instructions.	
^{o}RBo	Initially set, and reset at the beginning of every new string by ^{o}3R. Used only when end of block B occurs prior to the end of blocks A and C. Sets ^{o}Q3, ^{o}RA2, ^{o}RC2, ^{o}SC2. Returns to compare the remaining items in the current A and C blocks.	Entered from the inequality side of the test in ^{o}L2; when the next (B_o) is not equal to sentinel.
^{o}RB1	Set by ^{o}RAo. Used only when the end of block B follows the end of block A. Sets ^{o}RC3, ^{o}SC9, ^{o}C1b. Returns to transfer items remaining in current C block.	For this and all other ^{o}RB routines, see above.

°RB2 Set by °RCo. Used only when the end of block B follows the end of block C. Sets °RA3, °A1b, and returns to transfer items remaining in current A block.

°RB3 Set by °RA1, °RC1. Used only when block B ends following the ending of blocks A and C. Transfers immediately to °3R routine to reset initial conditions.

°RB5 Set by °RA6. Used only when the end of block B follows the end of tape C and end of block A. Transfers immediately to °2RS to set connectors for comparison of items in remaining A and B blocks.

°RB6 Set by °SCo. Used only when the end of block B follows the end of tape C. Sets °RA5, °A1b, and returns to transfer the remaining items in the current block A.

°RB9 Set by °SC1. Used only when the end of block B follows the end of block A and the end of tape C. Transfers immediately to °2RS.

°SBo Initially set and reset by °3R routine. Used only when the end of tape B occurs prior to ending of tapes A or C. Sets °RA4, °SA5, °SC5, °Q3 and return to compare the remaining items in the current A and C blocks. Entered from the equality side of the test in °L2. When the next (B_o) is equal to sentinel.

°SB1 Set by °RAo. Used only when the end of tape C follows the end of block A. Sets °SC8, °C1b and returns to transfer the items remaining in the current block C. For this and all other °SB routines, see above.

°SB4 Set by °SAo. Used only when the end of tape B follows the end of tape A. Sets °SC7, °C1b and returns to transfer the remaining items in the current block C.

^{o}SB5	Set by ^{o}SCo; ^{o}2RS. Used only when the end of tape B follows the end of tape C. Sets ^{o}RA8, ^{o}SA7 and ^{o}A1b. Returns to transfer the remaining items in the current block A.	
^{o}SB7	Set by ^{o}SC4, ^{o}SA6. Used only when the end of tape B follows ending of tapes A and C. Transfers immediately to ^{o}3S. routine to advance counters for ascending series and to read in new instructions.	
^{o}SB8	Set by ^{o}SC1, ^{o}RA6. Used only when the end of tape B follows the end of block A and the end of tape C. Transfers immediately to ^{o}R2S to write out remaining block of A data.	
^{o}RCo	Initially set. Reset at the beginning of every new string by ^{o}3R. Used only when the end of block C occurs prior to ending of blocks A or B. Sets ^{o}RA1, ^{o}RB2 and ^{o}Q4. Returns to compare items remaining in current A and B blocks.	Entered from the inequality side of the test in ^{o}L3, when the next (C_o) is not equal to sentinel.
^{o}RC1	Set by ^{o}RAo. Used only when the end of block C follows ending of block A. Sets ^{o}RB3, ^{o}B1b and returns to transfer the remaining items in the current block B.	For this and all other ^{o}RC routines, see above.
^{o}RC2	Set by ^{o}RBo. Used only when end of block C follows ending of block B. Sets ^{o}RA3, ^{o}A1b, and returns to transfer the remaining items in the current block A.	
^{o}RC3	Set by ^{o}RA1, ^{o}RB1. Used only when the end of block C follows ending of blocks A and B. Transfers immediately to ^{o}3R to reset initial conditions.	
^{o}SCo	Initially set and reset by ^{o}3R routine. Used only when the end of tape C occurs prior to ending of tapes A and B. Sets ^{o}RA6, ^{o}SA6, ^{o}RB6, ^{o}SB5 and ^{o}Q4. Returns to compare items remaining in current A and B blocks.	Entered from the equality side of the test in ^{o}L3, when the next (C_o) is equal to sentinel.

°SC1	Set by °RAo. Used only when the end of tape C follows the end of block A. Sets °RB9, °SB8, °B1b and returns to transfer remaining items in current block B.	For this and all other °SC routines, see above.
°SC2	Set by °RBo. Used only when the end of tape C follows the end of block A. Sets °RA9, °A1b, and returns to transfer remaining items in current block A.	
°SC4	Set by SAo. Used only when the end of tape C follows the end of tape A. Sets °SB7, °B1b, and returns to transfer remaining items in current block B.	
°SC5	Set by °SBo. Used only when the end of tape C follows the end of tape B. Sets °RA8, °SA7, °A1b and returns to transfer remaining items in current block A.	
°SC7	Set by °SB4, °SA5. Used only when the end of tape C follows the end of tapes A and B. Transfers immediately to °3S to advance counters for ascending series and to read in new instructions.	
°SC8	Set by °SB1, °RA4. Used only when the end of tape C follows the end of block A and tape B. Transfers immediately to °R2S to write out remaining A block.	
°SC9	Set by °RA2, °RB1. Used only when the end of tape C follows the end of blocks A and B. Transfers immediately to °2RS to set connectors for comparison of items in remaining A and B blocks.	
°3R	Routine for end of a string, when one block each from tapes A,B, and C have been collated together and the next block on each tape is not a sentinel block. Resets original endings °RAo, °RBo, °RCo, °SBo, °SCo, °A1a, °B1a, °C1a; the original 3-way comparison, °Q1; and resets all counters to zero. Also rotates the current print instruction by cyclicly rotating the three write instructions. Returns to compare items from the next block on each of the three input tapes.	Entered from °RA3, °RB3, °RC3.

^{o}2RS	Routine for end of a string when it occurs at the end of blocks A and B and the end of tape C. Resets ^{o}A1a, ^{o}B1a. Sets ^{o}Q4, ^{o}SA6, ^{o}SB5, and resets counters x and y to zero. Rotates print instruction as in ^{o}3R. Advances counters r and u,v, or w to 1 for next cycle. Returns ^{o}Q4 to compare items in remaining blocks on tapes A and B (one each).	Entered from ^{o}RA5, ^{o}RA9, ^{o}RB5, ^{o}RB9, ^{o}SC9.
^{o}R2S	Routine for end of string when it occurs at the end of tapes B and C and the end of block A. Writes remaining block from tape A on the next current output tape. Advances counters r and u,v, or w to 2 for next cycle. Transfers immediately to ^{o}3S to complete setting-up instructions for ascending cycle.	Entered from ^{o}RA8, ^{o}SB8, ^{o}SC8
^{o}3S	Routine for end of tapes when all input data has been collated. Advances counters H, R and 3R for ascending series. Positions first block of instructions for new cycle, and transfers control to location 000.	Entered from ^{o}SA7, ^{o}SB7, ^{o}SC7

Possible combinations of endings:

R = end of string S = end of tape

3R = end of 3 blocks (1 string) R2S = end of 1 block, end of 2 tapes

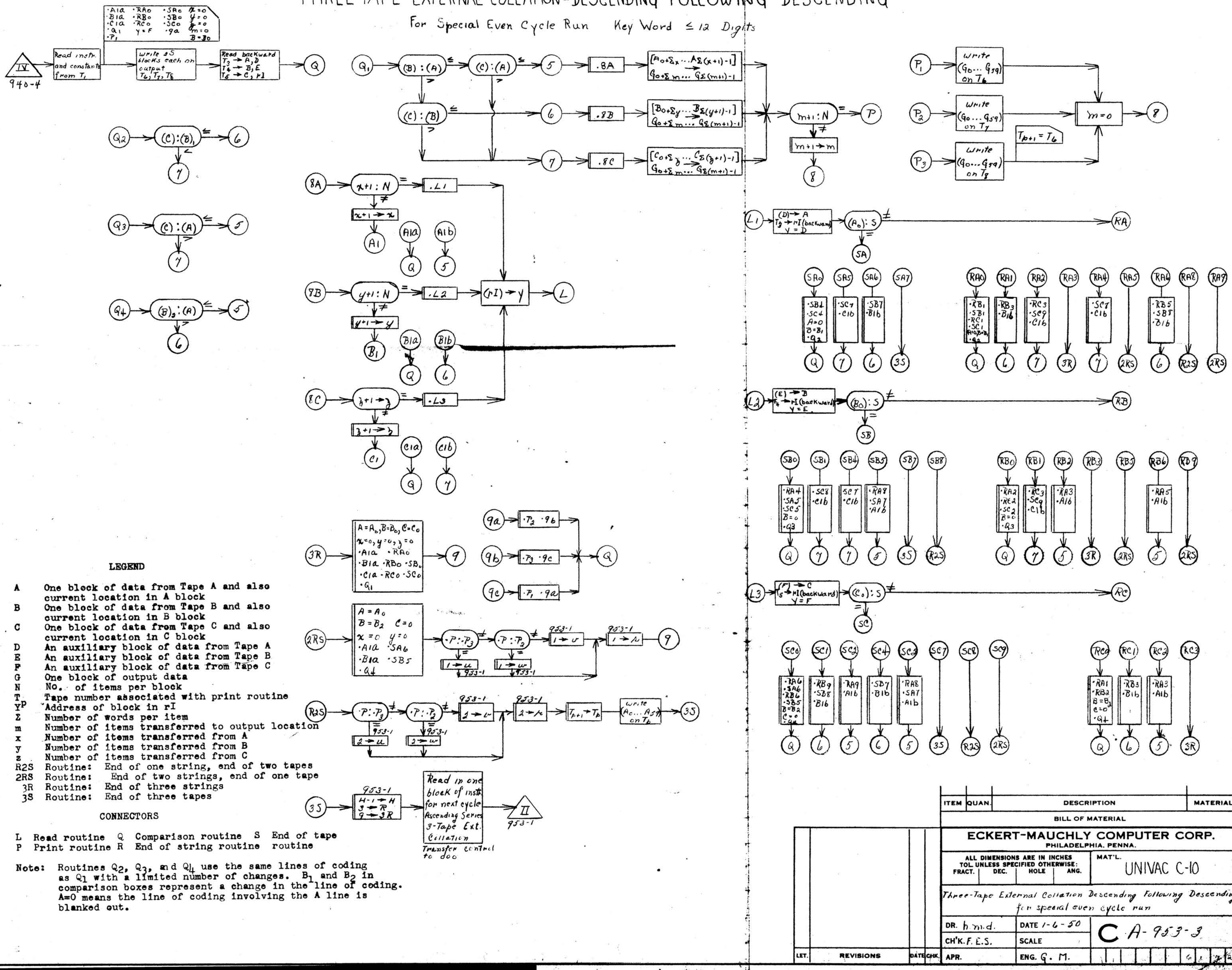
2RS = end of 2 blocks, end of 1 tape 3S = end of 3 tapes

RAo	RB1	RC3	RAo	SB1	SC8	(R2S)
RAo	RC1	RB3	RAo	SC1	SB8	(R2S)
RBo	RA2	RC3	SBo	RA4	SC8	(R2S)
RBo	RC2	RA3	SBo	SC5	RA8	(R2S)
RCo	RA1	RB3	SCo	RA6	SB8	(R2S)
RCo	RB2	RA3	SCo	SB5	RA8	(R2S)
SAo	SB4	SC7	RBo	SC2	RA9	(2RS)
SAo	SC4	SB7	RBo	RA2	SC9	(2RS)
SBo	SA5	SC7	RAo	SC1	RB9	(2RS)
SBo	SC5	SA7	SCo	RA6	RB5	(2RS)
SCo	SA6	SB7	SCo	RB6	RA5	(2RS)
SCo	SB5	SA7	RAo	RB1	SC9	(2RS)

2RS will be followed by
SA6 - SB7
or
SB5 - SA7

THREE-TAPE EXTERNAL COLLATION - DESCENDING FOLLOWING DESCENDING

For Special Even Cycle Run Key Word ≤ 12 Digits



LEGEND

A	One block of data from Tape A and also current location in A block
B	One block of data from Tape B and also current location in B block
C	One block of data from Tape C and also current location in C block
D	An auxiliary block of data from Tape A
E	An auxiliary block of data from Tape B
F	An auxiliary block of data from Tape C
G	One block of output data
N	No. of items per block
T	Tape number associated with print routine
Y^p	Address of block in rI
Z	Number of words per item
m	Number of items transferred to output location
x	Number of items transferred from A
y	Number of items transferred from B
z	Number of items transferred from C
R2S	Routine: End of one string, end of two tapes
2RS	Routine: End of two strings, end of one tape
3R	Routine: End of three strings
3S	Routine: End of three tapes

CONNECTORS

L Read routine Q Comparison routine S End of tape
P Print routine R End of string routine routine

Note: Routines Q_2, Q_3, and Q_4 use the same lines of coding as Q_1 with a limited number of changes. B_1 and B_2 in comparison boxes represent a change in the line of coding. A=0 means the line of coding involving the A line is blanked out.

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL. UNLESS SPECIFIED OTHERWISE:
FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

Three-Tape External Collation Descending Following Descending for special even cycle run

DR. h.m.d. | DATE 1-6-50
CH'K. F.E.S. | SCALE
APR. | ENG. G.M.

CA-953-3

LET.	REVISIONS	DATE	CHK.

A-962-3
3/29/50
Code C-10

TWO TAPE MERGE WITH TAPE IDENTIFICATION - TAPE INTERLOCK ELIMINATED - ASCENDING SERIES - EIGHT-WORD ITEM WITH KEY DIGITS IN FIRST WORD ≤ TWELVE DIGITS

Initial read start brings first block of instructions into locations 000-059.

	000	11 000	31 060	Read instructions and constants to memory, $T_5 \to rI$
	001	31 120	31 180	
	002	35 240	81 000	Rewind tape 1, signal
	003	10 240	B 241	Type one word to memory: $\alpha_n\beta_n\delta_1$
	004	C 940	B 240	End of tape sentinel $\to$ qo; rA = $\alpha_n\beta_n\delta_1$
	005	;8 000	.8 000	
	006	C 941	X 000	$\delta_1 \to$ q1
	007	.8 000	H 944	$\alpha_n \to$ q4
	008	F 243	E 244	rF = 000000 000011
	009	C 942	X 000	$\alpha_{n-n+1} \to$ q2
	010	;4 000	.8 000	
	011	H 945	E 244	$\beta_n \to$ q5
	012	C 943	50 941	$\beta_{n-n+1} \to$ q3
	013	50 942	50 943	Print on Supervisory Control: (q1),(q2),(q3),(q4),(q5)
	014	50 944	50 945	
	015	90 000	F 242	Stop UNIVAC and examine typing for errors; rF = digit extractor
ʾA1	016	36 520	B 521	(rI) $\to$ A, $T_6 \to$ rI; rA = (A_1)
	017	L 942	Q 022	rL = (q2); If (q2) = (A_1), tape 5 is the current A tape

	018	85 000	66 000	Rewind tape 5, signal Rewind tape 6, no signal
	019	50 521	50 942	Print on Supervisory Control: (A_1), (q2), T_5 instruction
	020	50 018	90 000	Stop UNIVAC to examine above; mount new tape A
	021	35 420	U 016	Clear (rI), T_5 → rI → °A1 to test new A tape
°B1	022	30 700	B 701	(rI) → B rA = (B_1)
	023	L 943	Q 028	rL = (q3) If (q3) = (B_1), tape 6 is the current tape B
	024	86 000	50 701	Rewind tape 6, signal
	025	50 943	50 024	Print on Supervisory Control: (B_1), (q3), tape 6 instruction
	026	90 000	00 000	Stop UNIVAC to examine above; mount new B tape.
	027	16 000	U 022	T_6 → rI → °B1 to test new tape B
	028	15 000	35 520	T_5 → A, C, rI T_6 → B, D
	029	36 580	36 700	
	030	35 760	K 000	
°Q	031	E (700)	K 000	rL = (B)
	032	E (520)	T 076	rA = (A) If (A) > (B) → °B2
°A2	033	F 245	B 032	rF = 110000 111111
	034	E 258	H 038	Build up transfer instructions
	035	A 247	H 039	
	036	X 000	H 040	
	037	X 000	C 041	
	038	[V (520)	W (880)]	Transfer (A) → G
	039	[V (522)	W (882)]	
	040	[V (524)	W (884)]	

	041	[V (526)	W (886)]		
	042	[R 075	U 072]	.8A → o7a	
#	042	R 075	U 067	→ o7b	
)8A	043	B 032			
			A 248	rA = x+1	
	044	L 262		rL = N	
			Q 046	x+1:N	
)A3a	045	[C 032	U 031]	x+1 → x → oQ	
)A3b #	045	C 032	U 033	→ oA2	
	046	B 261	C 032	x = 0	
	047	B 149	F 246	$T_K = T_A$	
	048	E 116	C 116		
)L1a	049	[Y 580	Z 520]		
#	049	B 060	U 060	rA = E, → oL1b	
	050	Y 590	Z 530	Transfer (C) → A	
	051	Y 600	Z 540		
	052	Y 610	Z 550		
	053	Y 620	Z 560		
	054	Y 630	Z 570		
	055	B 049	L 287	rA = C rL = oL1b	
	056	C 257	J 049	(rA) → Z+1 (rX) → oL1	
	057	L 241	B 520	rL = S rA = (A_o)	
	058	[F 242	Q 146]	rF = digit extractor (A_o):S	
)A4a	059	[K 000	U 031]	→ oQ	
#	058	00 000	Q 146		
)A4b #	059	00 000	U 115	→ o10	

°L1b	060	Y	640		
				Z 520	
	061	Y	650		
				Z 530	
	062	Y	660		
				Z 540	Transfer (E) → A
	063	Y	670		
				Z 550	
	064	Y	680		
				Z 560	
	065	Y	690		
				Z 570	
	066	L	286		rL = °L1a
				U 056	
°7b	067	B	880		
				C 946	(G_K) → q6
	068	B	032		
				C 947	x → q7
	069	B	031		
				C 948	y → q8
	070	B	265		
				H 042	.7a
	071	7(2)940			Write (q1...q8) on T_p (20/in)
				C 085	
°7a	072	B	258		
				A 249	rA = m+1
	073	L	260		rL = N
				Q 110	m+1:N, → °9a
#	073	L	260	Q 114	→ °9b
	074	C	258		m+1 → m
				F 242	rF = digit extractor
	075	00	000		
				U (c+1)	Return to °8
°B2	076	F	245		rF = 110000 111111
				B 031	
	077	E	258		
				H 081	
	078	A	247		
				H 082	Build up transfer instructions
	079	X	000		
				H 083	
	080	X	000		
				C 084	
	081	V	(700)		
				W (880)	
	082	V	(702)		
				W (882)	

	083	[V	(704)	W	(884)]	Transfer (B) → G
	084	[V	(706)	W	(886)]	
	085	[R	075	U	072]	.8B → ^{o}7a
#	085	R	075	U	067	→ ^{o}7b
$^{)}$8B	086	B	031			
				A	248	rA = y+1
	087	L	264			rL = N
				Q	089	y+1:N
$^{)}$B3a	088	[C	031			y+1 → y
				U	031]	→ ^{o}Q
$^{)}$B3b #	088	C	031	U	076	→ ^{o}B2
	089	B	263			
				C	031	y = 0
	090	B	180			
				F	246	$T_K = T_B$
	091	E	116			
				C	116	
$^{)}$L2a	092	[Y	760			
				Z	700]	
#	092	B	103	U	103	rA = F, → ^{o}L2b
	093	Y	770			
				Z	710	
	094	Y	780			
				Z	720	Transfer (D) → B
	095	Y	790			
				Z	730	
	096	Y	800			
				Z	740	
	097	Y	810			
				Z	750	
	098	B	092			rA = D
				L	289	rL = ^{o}L2b
	099	C	257			(rA) → Z+1
				J	092	(rX) → ^{o}L2
	100	L	241			rL = S
				B	700	rA = (B_o)
	101	[F	242			rF = digit extractor
				Q	177]	(B_o):S

B4a	102	[K	000		
				U 031]	→ °Q
	# 101	00	000	Q 177	
B4b	# 102	00	000	U 115	→ °10
L2b	103	Y	820		
				Z 700	
	104	Y	830		
				Z 710	
	105	Y	840		
				Z 720	
	106	Y	850		Transfer (F) → B
				Z 730	
	107	Y	860		
				Z 740	
	108	Y	870		
				Z 750	
	109	L	288		rL = °L2a
				U 099	
9a	110	B	928		Keyword of last item in output block
				L 254	rL = V
	111	00	000		
				Q 121	$(G_{o+\Sigma m}):V$
	112	B	269		
				C 115	.10b
	113	B	267		
				C 073	.9b
9b	114	B	259		
				C 258	m = 0
10a	115	[B	257		rA = Z+1
				E 116]	
	# 115	00	000	U 124	→ °10b
	116	3(6)(640)			(rI) → Z, T_K → rI
				C 116	Z+1 → Z
P1	117	[5(2)(880)			Write $(G_o \ldots G_{59})$ on T_2
				B 252]	rA = f
	# 117	52	700	B 252	
	# 117	52	520	B 252	

)P2	#	117	51(880)	B	252	Write ($G_0 \cdots G_{59}$) on T_1
	#	117	51 700	B	252	
	#	117	51 520	B	252	
		118	A 244	L	253	rI = M
)P3	#	117	V 281	F	242	
	#	118	W 117	U	075	.P1, → o_8
		119	H 252	Q	129	f+1 → f → o_{13}
)12a		120	F 242	U	075	rF = digit extractor → o_8
	#	120	B 261	U	208	→ o_{12b}
	#	120	B 263	U	216	→ o_{12c}
)12d	#	120	00 000	U	049	→ o_{L1}
)12e	#	120	00 000	U	092	→ o_{L2}
		121	V 283	W	117	.P3
		122	B 266	H	042	
		123	C 085	U	113	.7b
)10b		124	B (880)	C	946	(G_K) → q6
	#	124	B 700	C	946	
	#	124	B 520	C	946	
		125	B 261	C	947	x = 0 → q7
		126	B 263	C	948	y = 0 → q8
		127	B 268	C	115	.10a
		128	7(2)940	U	115	→ o_{10a}

013	129	F	246			rF = 101111 111111
				B	133	rA = T_P
	130	E	256			
				A	941	
	131	C	255			$C_R T_P$ LABE LA(q1) → T.S.
				50	255	Print two words on Supervisory Control:
	132	50	946			1. T_P, label, (q1) 2. (q6)
				X	000	
013a	133	52	940			Write 3 sentinel blocks on T_2
				52	940	
	#133	51	940	U	142	→ 013b
	134	52	940			
				82	000	Rewind tape 2, signal
014a	135	L	285			
				J	117	.P2
014b	#135	30	420	90	000	Stop program
	136	L	275			
				J	133	.13b $T_P = T_1$
	137	A	244			
				C	941	(q1)+1 → q1
	138	C	252			f = 0
				B	133	
016a	139	E	071			
				C	071	
	140	B	266			
				H	042	$T_P = T_1$
	141	C	085			.7b
				U	120	→ 012
016b	#139	E	128	C	128	$T_P = T_2$
	#140	B	269	C	115	.10b
	#141	F	245	U	120	→ 012
013b	142	51	940			
				51	940	Write 3 sentinel blocks on T_1
015a	143	81	000			Rewind tape 1, signal
				L	281	
015b	#143	81	000	U	135	→ Program stop

	144	J 117	L 274	.P1
	145	J 133	U 137	.13a $T_P = T_2$
	146	B 942	L 944	rA = (q2) When (A_o) = Sentinel rL = (q4)
	147	[F 246	Q 169]	rF = 101111 111111 (q2) : (q4), → °SAo
⇉	147	F 246	Q 224	⟶ °17, (°SA1)
	148	A 244	C 942	(q2)+1 ⟶ q2
	149	8(5)000	B 149	Rewind tape A, signal
	150	S 250	H 149	T_{A-a} ⟶ T_A
	151	J 250	E 158	-a → a
	152	H 158	E 160	
	153	H 160	E 163	
	154	H 163	E 164	
	155	H 164	E 116	New T_A → T_A
	156	H 157	00 000	
	157	[3(3)( )	C 116]	(rI) ⟶ Z, T_A → rI T_A ⟶ T_K
°A5	158	3(3)520	B 942	(rI) ⟶ A, T_A ⟶ rI
	159	L 521	Q 164	(q2) : (A_1)
	160	8(3)000	50 521	Rewind tape A, signal
	161	50 942	50 160	Print three words on Supervisory Control: (A_1),(q2),T_A instruction
	162	90 000	00 000	Stop UNIVAC, mount new tape A
	163	3(3)420	U 158	Clear (rI), T_A → rI ⟶ °A5
	164	3(3)520	F 245	(rI) ⟶ A, T_A ⟶ rI rF = 110000 111111
	165	B 286	H 049	.L1a 7.1.1.9

	166	E	116			
				C	116	C → Z
	167	B	060			
				C	257	E → Z+1
)A6a	168	[F	242			rF = digit extractor
				U	031]	→ ^{o}Q
)A6b #	168	00	000	U	115	→ $^{o}10$
)SAo	169	B	291			
				C	088	.B3b
	170	V	295			
				W	101	.B4b
	171	B	293			
				C	199	.B6b
	172	B	294			
				C	178	.SB1
	173	B	271			
				C	120	.12c
	174	V	278			
				W	140	
	175	B	280			.16b
				C	139	
	176	C	942			0 → q2
				U	076	→ $^{o}B2$
	177	B	943			rA = (q3) When (B_o) = Sentinel
				L	945	rL = (q5)
	178	[F	246			rF = 101111 111111
				Q	200]	(q3) : (q5) → ^{o}SBo
#	178	F	246	Q	224	→ $^{o}SB1$
	179	A	244			
				C	943	(q3)+1 → q3
	180	8(6)	000			Rewind tape B, signal
				B	180	
	181	S	251			
				H	180	T_{B-b} → T_B
	182	J	251			-b → b
				E	189	
	183	H	189			
				E	191	
	184	H	191			
				E	194	
	185	H	194			New T_B → T_B,
				E	195	
	186	H	195			
				E	116	
	187	H	188			
				00	000	

	188	[3(4)( )	C 116]	(rI) → Z, T_K → rI T_B → T_K
B5	189	3(4)700	B 943	(rI) → B, T_B → rI
	190	L 701	Q 195	(q3) : (B_1)
	191	8(4)000	50 701	Rewind tape B, signal
	192	50 943		Print three words on Supervisory Control:
			50 191	(B_1), (q3), T_B instruction
	193	90 000	00 000	Stop UNIVAC and mount new T_B
	194	3(4)420	U 189	Clear (rI), T_B → rI → $^oB5$
	195	3(4)700	F 245	(rI) → B, T_B → rI rF = 110000 111111
	196	B 288	H 092	.L2a
	197	E 116	C 116	D → Z
	198	B 103	C 257	F → Z+1
B6a	199	[F 242	U 031]	rF = digit extractor → ^oQ
B6b #	199	00 000	U 115	→ $^o10$
SBo	200	B 290	C 045	.A3b
	201	V 292	W 058	.A4b
	202	B 293	C 168	.A6b
	203	B 294	C 147	.SA1
	204	B 270	C 120	.12b
	205	V 278	W 140	.16b
	206	B 280	C 139	
	207	C 943	U 033	0 → q3 → $^oA2$

^{o}12b	208	E	117			rF = 110000 111111
				H	117	
	209	E	281			
				H	281	
	210	E	285			G = A
				H	285	$G_o = A_o$
	211	E	124			
				C	124	
	212	B	272			
				C	120	.12d
	213	F	246			
				B	149	
	214	E	116			$T_A = T_K$
				C	116	
	215	F	245			rF = 110000 111111
				U	049	→ ^{o}L1
^{o}12c	216	E	117			
				H	117	
	217	E	281			
				H	281	G = B
	218	E	285			$G_o = B_o$
				H	285	
	219	E	124			
				C	124	
	220	B	273			
				C	120	.12e
	221	F	246			
				B	180	
	222	E	116			$T_K = T_B$
				C	116	
	223	F	245			rF = 110000 111111
				U	092	→ ^{o}L2
^{o}17 (^{o}SA1, ^{o}SB1)	224	B	149			
				E	227	
	225	C	227			
				B	180	
	226	E	228			
				C	228	
	227	8(5)000				
				L	252	Rewind tape A, signal
	228	8(6)000				
				Q	232	Rewind tape B, signal f:0
	229	B	276			
				C	135	.14b
	230	B	277			
				C	143	.15b
	231	B	133			
				U	130	→ ^{o}13
	232	30	420			
				90	000	Stop program

Constants

240			Storage for $\alpha_n\beta_n\delta_1$
241			End of tape sentinel
242			Digit extractor
243	000000	000011	
244	000000	000001	
245	110000	111111	
246	101111	111111	
247	000002	000002	
248	000008	000000	
249	000000	000008	
250	[020000	000000]	a. A constant to alternate tapes 3 and 5 (plus to start)
251	[020000	000000]	b. A constant to alternate tapes 4 and 6 (plus to start)
252	[000000	000000]	f. Counter: Blocks of data on current output tape
253			M. Total number of blocks on output tape
254			V. A word of ignore symbols
255			T.S. for word
256	C ROLABE	LΔ0000	
257	[000820	000000]	Z+1 (F to start)
258	[V 000	W (880)]	m
259	V 000	W 880	m = 0
260	V 000	W 936	N (for m)
261	E 520	T 076	x = 0
262	E 576	T 076	N (for x)
263	E 700	K 000	y = 0
264	E 756	K 000	N (for y)
265	R 075	U 072	.7a 7.1.1.13

266	R	075	U	067	.7b
267	L	260	Q	114	.9b
268	B	257	E	116	.10a
269	00	000	U	124	.10b
270	B	261	U	208	.12b
271	B	263	U	216	.12c
272	00	000	U	049	.12d
273	00	000	U	092	.12e
274	52	940	52	940	.13a
275	51	940	U	142	.13b
276	30	420	90	000	.14b
277	81	000	U	135	.15b
278	B	269	C	115	.16b
279	F	245	U	120	
280	E	128	C	128	
281	52	880	B	252	.P1
282	A	244	L	253	
283	V	281	F	242	.P3
284	W	117	U	075	
285	51	880	B	252	.P2
286	Y	580	Z	520	.L1a
287	B	060	U	060	.L1b
288	Y	760	Z	700	.L2a
289	B	103	U	103	.L2b
290	C	032	U	033	.A3b
291	C	031	U	076	.B3b

292	00	000	Q	146	.A4b
293	00	000	U	115	.A6b, .B6b
294	F	246	Q	224	.SA1, .SB1
295	00	000	Q	177	.B4b
296	00	000	U	115	
297					
298					
299					

520-579	Storage block A	
580-639	" " C	Tape A
640-699	" " E	
700-759	" " B	
760-819	" " D	Tape B
820-879	" " F	
880-939	" " G	Output

940	qo = sentinel
941	q1 = Current output tape identification number
942	q2 = Current A tape identification number
943	q3 = Current B tape identification number
944	q4 = Final A tape identification number
945	q5 = Final B tape identification number
946	q6 = Keyword of first item on current output tape
947	q7 = Working location in A block at beginning of current output tape
948	q8 = Working location in B block at beginning of current output tape

A-962-3
3/22/50
Code C-10

TWO TAPE MERGE WITH TAPE IDENTIFICATION

TAPE INTERLOCK ELIMINATED

ASCENDING SERIES

Connector	Function and Purpose	Entry Point
°A1	Tests the identification number of the tape mounted on UNISERVO 5 with the identification number of the first of a string of A tapes. If they are equal, transfers control to °B1. If they are not equal, stops UNIVAC so that operator can mount correct tape on servo.	Entered from the initial routines of the program. Entered following the mounting of a new tape on UNISERVO 5, if the previous one was not the correct tape A.
°B1	Tests the identification number of the tape mounted on UNISERVO 6 with the identification number of the first of a string of B tapes. If they are equal, reads data tapes A and B to memory and transfers control to °Q. If they are not equal, stops UNIVAC so that operator can mount correct tape on servo.	Entered from the equality side of the test in °A1. Entered following the mounting of a new tape on UNISERVO 6, if the previous one was not the correct tape B.
°Q	Compares the magnitude of the current item A with that of the current item B. If the magnitude of A is smaller, transfers control to °A2; if that of B is smaller, transfers to °B2.	Initially entered from the equality side of the test in °B1. Entered from °A3a, °B3a when the item last transferred to the output location was not the last in its respective data block. Entered from °A4a, °B4a when the item last transferred was the last in the block, if that block was not the last on the respective current data tape. Entered from °A6a, °B6a when the item last transferred was the last item in the last block on the current tape, if that tape was not the last one of the respective string.

^{o}A2	Transfers the current item A to the current output location, sets ^{o}8A, and transfers control to ^{o}7.	Entered from ^{o}Q whenever the magnitude of the current item A is less than that of the current item B. Entered from ^{o}SB0 when the last tape in the B string has been completely exhausted, and there remains at least one A item to be transferred. Entered from ^{o}A3b when all B tapes have been exhausted, and the last item transferred to the output location was an A item which was not the last in the current A block.
^{o}B2	Transfers the current item B to the current output location, sets ^{o}8B, and transfers control to ^{o}7.	Entered from ^{o}Q whenever the magnitude of the current item B is less than that of the current item A. Entered from ^{o}SA0 when the last tape in the A string has been completely exhausted, and there remains at least one B item to be transferred. Entered from ^{o}B3b when all A tapes have been exhausted, and the last item transferred to the output location was a B item which was not the last in the current B block.
^{o}7a	Initially set and reset by ^{o}7b. Tests for end of output block. If end has not been reached, increases m and transfers control to ^{o}8. If end has been reached, transfers control to ^{o}9.	Entered from ^{o}A2 or ^{o}B2 following the initial transfer of an item to the first output location, and following the transfer of any item which is not the first for the current output tape. Entered from ^{o}7b following the writing of tape identification on a new output tape.
^{o}7b	Set by ^{o}9a, ^{o}16a. Sets ^{o}7a, and writes identification block on current output tape. Transfers control to ^{o}7.	Entered from ^{o}A2 or ^{o}B2 following the transfer to the output location of the first item for any current output tape after the first in the string and following the transfer of the first item for the first tape, if a complete block of ignore symbols has been discarded.

›8A	Set by °A2. Tests for the end of block A. If the end has not been reached, increases x and transfers control to °A3. If the end has been reached, sets x = 0, $T_A = T_K$ and transfers control to °L1.	Entered from °7a, following the transfer to the output location of an A item which does not complete the output block. Entered from °12a when the A item just transferred to the output location completed the output block. Entered from °P3 when the A item just transferred to the output location completed a full block of ignore symbols.
›8B	Set by °B2. Tests for the end of block B. If the end has not been reached, increases y and transfers control to °B3. If the end has been reached, sets y = 0, $T_B = T_K$ and transfers control to °L2.	Entered from the same points as °8A, when the item last transferred to the output location was a B item.
›L1a ›L1b	°L1a is initially set and is reset by °L1b. Transfers the contents of auxiliary block C to data block A, sets Z + 1= C, °L1b, and tests the contents of the current A_o for the presence of sentinel. If sentinel is not present, transfers control to °A4. If sentinel is present, tests to determine whether the current tape A is the last in the string. If it is the last, transfers control to °SA. If it is not the last, rewinds the current tape A, transfers the contents of rI to Z, reads the next A tape to rI, increases (q_2), substitutes T_{A-a} for T_A and T_K and transfers control to °A5. °L1b is set by °L1a and performs similar operations to those in °L1a, except that it transfers the contents of auxiliary block E to data block A, and sets Z + 1 = E, °L1a.	°L1 is entered from the equality side of the test in °8A when both strings are still in operation, and the current A block has been exhausted. °L1 is entered from °12b following the printing of an output block, when the B string has just been exhausted and the remaining A data is to be transferred to output block by block. °L1 is entered from °12d following the printing of an output block, when the B string has been exhausted previously and the remaining A data is being written out block by block. °L1a is entered when the next block of data from the current tape A has been stored in auxiliary location C, and °L1b is entered when the next block of data has been stored in auxiliary location E.

L2a L2b	^{o}L2a is initially set and is reset by ^{o}L2b. Transfers the contents of auxiliary block D to data block B, sets Z + 1 = D and ^{o}L2b, and tests the contents of the current B_o for the presence of sentinel. If sentinel is not present, transfers control to ^{o}B4. If sentinel is present, tests to determine whether the current tape B is the last in the string. If it is the last, transfers control to ^{o}SB. If it is not the last, rewinds the current tape B, transfers the contents of rI to Z, reads the next B tape to rI, increases (q3), substitutes T_{B-b} for T_B and T_K and transfers control to ^{o}B5. ^{o}L2b is set by ^{o}L2a and performs similar operations to those in ^{o}L2a, except that it transfers the contents of auxiliary block F to data block B, and sets Z + 1 = F, ^{o}L2a.	^{o}L2 is entered from the equality side of the test in ^{o}8B, when both strings are still in operation and the current block B has been exhausted. ^{o}L2 is entered from ^{o}12c following the printing of an output block, when the A string has just been exhausted, and the remaining B data is to be transferred to output block by block. ^{o}L2 is entered from ^{o}12e, following the printing of an output block, when the A string has been exhausted previously and the remaining B data is being written out block by block. ^{o}L2a is entered when the next block of data from the current tape B has been stored in auxiliary location D, and ^{o}L2b is entered when the next block of data has been stored in auxiliary location F.
9a	Initially set. Tests to determine whether the current output block is completely filled with ignore symbols. If so, sets ^{o}P3, ^{o}9b, ^{o}7b, and transfers to ^{o}9. If not, sets ^{o}10b, ^{o}9b and transfers to ^{o}9.	Entered from ^{o}7a at the completion of the first output block for the first output tape of a string.
9b	Set by ^{o}9a. Sets m = 0 and transfers control to ^{o}10.	Entered from ^{o}7a at the completion of every output block after the first.
10a	Initially set, and reset by ^{o}10b. Transfers contents of rI to storage specified by Z, and reads another block from T_K. Substitutes Z + 1 for Z and transfers control to ^{o}P.	Entered from ^{o}9b when the current (first) output block consists entirely of ignore symbols (not to be printed on output tape). Entered from ^{o}9b whenever an output block has been filled with

		data by means of single item transfers. Entered from ^{o}A4b, ^{o}B4b, ^{o}A6b, ^{o}B6b whenever all tapes of one string have been exhausted and the remaining data from the tapes of the other string is being transferred block by block, if the current data block will not be the first block on the current output tape. Entered from ^{o}10b following the writing of the tape identification, on the first tape of the output string if the current output block is not a complete block of ignore symbols. Entered from ^{o}10b following the writing of the tape identification, on a tape of the output string whenever all tapes of one input string have been exhausted and the remaining data from the tapes of the other input string is being transferred block by block if the current data block will be the first block on the current output tape.
^{o}10b	Set by ^{o}9a, ^{o}16b. Writes tape identification on current output tape, sets ^{o}10a, and transfers control to ^{o}10.	Entered from ^{o}9a if the first block for the first tape of the output string is not a full block of ignore symbols. Entered from ^{o}A4b, ^{o}B4b, ^{o}A6b, ^{o}B6b when the data from the tapes of the remaining A or B string is being transferred directly to the output tape, if the current data block will be the first on the current output tape.
^{o}P1, ^{o}P2	^{o}P1 is initially set and is reset by ^{o}15a. Writes current block of output data on tape 2, and tests to determine whether tape 2 is complete. If it is not, increases f and transfers to ^{o}12. If it is complete,	Entered from ^{o}10a when there is a complete block of output data to be written out.

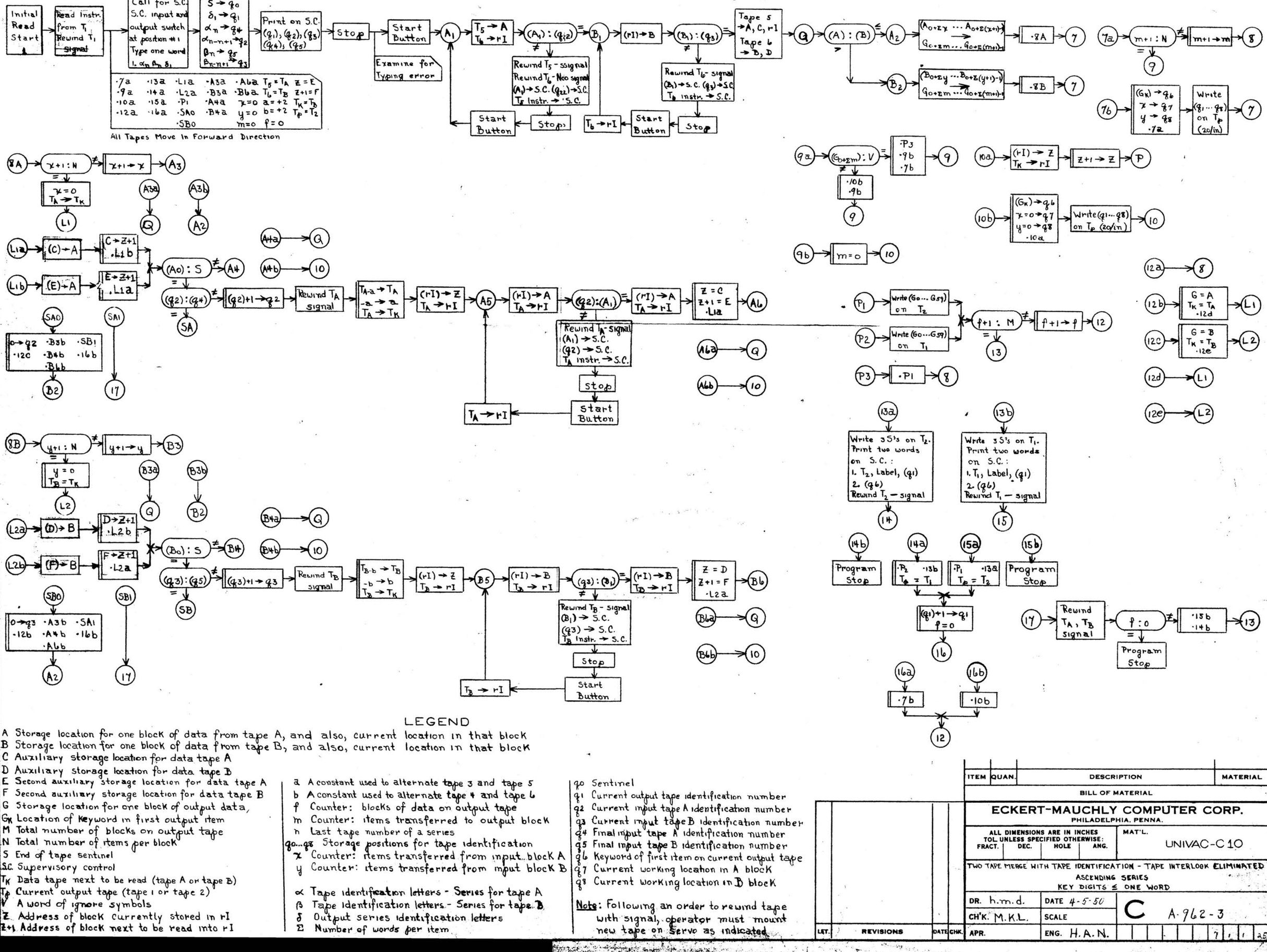
	transfers control to $^{o}13$. $^{o}P2$ is the alternate tape-write routine, similar to $^{o}P1$ in all respects except that it operates on output tape 1, and is set by $^{o}14a$.	
$^{o}P3$	Set by $^{o}9a$. Resets $^{o}P1$ and returns to $^{o}8$.	Entered from $^{o}10a$ when the first output block is a complete block of ignore symbols, and is to be discarded.
$^{o}12a$	Initially set. Transfers control to $^{o}8$.	Entered following the writing of an output block on the current output tape, at any time prior to the exhaustion of all tapes of either of the input strings. Entered from ^{o}P if the last block written out was not the last on the current output tape; entered from $^{o}16$ if the last output block completed an output tape.
$^{o}12b$	Set by $^{o}SB0$. Sets G = A, $T_K = T_A$ and $^{o}12d$. Transfers to $^{o}L1$.	Entered from ^{o}P or $^{o}16$ under the same conditions as described for $^{o}12a$ if the block just written out was the first to be completed subsequent to the exhaustion of all tapes in the B string.
$^{o}12c$	Set by $^{o}SA0$. Sets G = B, $T_K = T_B$ and $^{o}12e$. Transfers to $^{o}L2$.	Entered from ^{o}P or $^{o}16$ under the same conditions as described for $^{o}12a$ if the block just written out was the first to be completed subsequent to the exhaustion of all tapes in the A string.
$^{o}12d$, $^{o}12e$	Set by $^{o}12b$ and $^{o}12c$ respectively. Transfer to $^{o}L1$ and $^{o}L2$ respectively.	Entered from ^{o}P or $^{o}16$ under the same conditions as described for $^{o}12a$, if all tapes of the B or A string respectively have been exhausted, and the data of the remaining string is being transferred block by block to the output tape.

o_{13a}, o_{13b}	o_{13a} is initially set and is reset by o_{15a}. Writes 3 sentinel blocks on tape 2, prints the tape label on Supervisory Control, and rewinds tape 2. Transfers to o_{14}. o_{13b} is a similar routine in all respects, except that it is set by o_{14a}, operates on output tape 1, and transfers to o_{15}.	Entered from o_P when the block just written on the output tape completed the current output tape. o_{13a} is entered from o_{P1}; o_{13b} is entered from o_{P2}.
o_{14a}, o_{15a}	Initially set. Set o_{P2}, o_{13b}, $T_P=T_1$ and o_{P1}, o_{13a}, $T_P=T_2$ respectively. Both routines increase (q1) and reset f=0, preparatory to starting a new output tape, and both transfer control to o_{16}.	Entered following the final operations on a completed output tape, if all tapes in both input strings have not yet been exhausted. o_{14a} is entered from o_{13a}; o_{15a} is entered from o_{13b}.
o_{14b}, o_{15b}	Set by o_{17}. Both routines stop program.	Entered from the same points as o_{14a}, o_{15a} following the final operations on a completed output tape which is the last in the string.
o_{16a}	Initially set. Sets o_{7b} and transfers to o_{12}.	Entered following the routines which rewind the completed output tape and prepare to start a new one, prior to the exhaustion of all the tapes of either input string.
o_{16b}	Set by o_{SA0}, o_{SB0}. Sets o_{10b} and transfers to o_{12}.	Entered from the same point as o_{16a} when all the tapes of one string have been exhausted, and there remains only the data from the tapes of the other string to be transferred.
o_{17}	Rewinds T_A, T_B and tests to determine whether or not the current output tape contains data. If so, sets o_{14b}, o_{15b} and transfers control to o_{13}. If the current output tape is blank, stops program.	Entered from o_{SA1}, o_{SB1}, when all tapes of both input strings have been exhausted.

^{o}A3a, ^{o}A3b ^{o}B3a, ^{o}B3b	^{o}A3a and ^{o}B3a are initially set: both transfer control to ^{o}Q. ^{o}A3b and ^{o}B3b are set by ^{o}SB0 and ^{o}SA0 respectively and transfer control to ^{o}A2 and ^{o}B2 respectively.	Entered from the inequality side of the test for the end of the input block in ^{o}8 when the last item transferred was not the last in its respective block. ^{o}A3a and ^{o}B3a are entered as long as there are items from both strings to compare. ^{o}A3b is entered following the exhaustion of all B tapes, when only A items remain to be transferred. ^{o}B3b is entered following the exhaustion of all A tapes, when only B items remain to be transferred.
^{o}A4a, ^{o}A4b ^{o}B4a, ^{o}B4b ^{o}A6a, ^{o}A6b ^{o}B6a, ^{o}B6b	^{o}A4a, ^{o}B4a, ^{o}A6a, ^{o}B6a are initially set: all transfer control to ^{o}Q. ^{o}A4b, ^{o}A6b are set by ^{o}SB0 and ^{o}B4b, ^{o}B6b are set by ^{o}SA0: all transfer control to ^{o}10.	^{o}A4 and ^{o}B4 are entered from the inequality side of the test for the end of input tape in ^{o}L1 and ^{o}L2 respectively. ^{o}A6 and ^{o}B6 are entered from ^{o}A5 and ^{o}B5 respectively, following the read-in of a new tape in the string concerned. ^{o}A4a, ^{o}B4a, ^{o}A6a and ^{o}B6a are entered as long as there remain items from both strings to be compared. ^{o}A4b, ^{o}A6b, or ^{o}B4b, ^{o}B6b are entered following the exhaustion of a full block of the respective string and all tapes of the other string, when the remaining data is to be transferred to the output tape block by block.
^{o}A5	Brings the first block of a new tape in the A string into the memory. Tests the identification number of this tape with the identification number of the next A tape as indicated by (q_2). If they are equal, reads one block of data to memory, and one to rI, sets ^{o}L1a, Z = C, Z + 1 = E, and transfers to ^{o}A6.	Entered from ^{o}L1 following the initial read in to rI of the next tape in the A series.

	If they are not equal, stops UNIVAC in order to allow the operator to mount a new tape on the servo and transfers to ^{o}A5 to test again.	
^{o}B5	Brings the first block of a new tape in the B string into the memory. Tests the identification number of this tape with the identification number of the next B tape as indicated by (q3). If they are equal, reads one block of data to memory and one to rI, sets ^{o}L2a, Z = D, Z + 1 = F, and transfers to ^{o}B6. If they are not equal, stops UNIVAC in order to allow the operator to mount a new tape on the servo and transfers control to ^{o}B5 to test again.	Entered from ^{o}L2 following the initial read in to rI of the next tape in the B series.
^{o}SA0	Initially set. Sets ^{o}12c, ^{o}16b, ^{o}B3b, ^{o}B4b, ^{o}B6b, ^{o}SB1 and q2 = 0. Transfers control to ^{o}B2.	Entered from the equality side of the tests in ^{o}L1, when all tapes in the A string have been exhausted, prior to the ending of the last tape in the B string.
^{o}SB0	Initially set. Sets ^{o}12b, ^{o}16b, ^{o}A3b, ^{o}A4b, ^{o}A6b, ^{o}SA1 and q3 = 0. Transfers control to ^{o}A2.	Entered from the equality side of the tests in ^{o}L2, when all tapes in the B string have been exhausted, prior to the ending of the last tape in the A string.
^{o}SA1, ^{o}SB1	Set by ^{o}SB0, ^{o}SA0 respectively. Transfer immediately to ^{o}17.	Entered from the same points as ^{o}SA0 and ^{o}SB0 respectively when all tapes of both strings have been exhausted.

TWO TAPE MERGE WITH TAPE IDENTIFICATION – TAPE INTERLOCK ELIMINATED
ASCENDING SERIES
KEY DIGITS ≤ ONE WORD



LEGEND

A Storage location for one block of data from tape A, and also, current location in that block
B Storage location for one block of data from tape B, and also, current location in that block
C Auxiliary storage location for data tape A
D Auxiliary storage location for data tape B
E Second auxiliary storage location for data tape A
F Second auxiliary storage location for data tape B
G Storage location for one block of output data,
GK Location of keyword in first output item
M Total number of blocks on output tape
N Total number of items per block
S End of tape sentinel
S.C. Supervisory control
TK Data tape next to be read (tape A or tape B)
Tp Current output tape (tape 1 or tape 2)
V A word of ignore symbols
Z Address of block currently stored in rI
z+1 Address of block next to be read into rI

a A constant used to alternate tape 3 and tape 5
b A constant used to alternate tape 4 and tape 6
f Counter: blocks of data on output tape
m Counter: items transferred to output block
n Last tape number of a series
q0...q8 Storage positions for tape identification
x Counter: items transferred from input block A
y Counter: items transferred from input block B

α Tape identification letters - Series for tape A
β Tape identification letters - Series for tape B
δ Output series identification letters
Σ Number of words per item

q0 Sentinel
q1 Current output tape identification number
q2 Current input tape A identification number
q3 Current input tape B identification number
q4 Final input tape A identification number
q5 Final input tape B identification number
q6 Keyword of first item on current output tape
q7 Current working location in A block
q8 Current working location in B block

Note: Following an order to rewind tape with signal, operator must mount new tape on servo as indicated

LET.	REVISIONS	DATE	CHK.

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

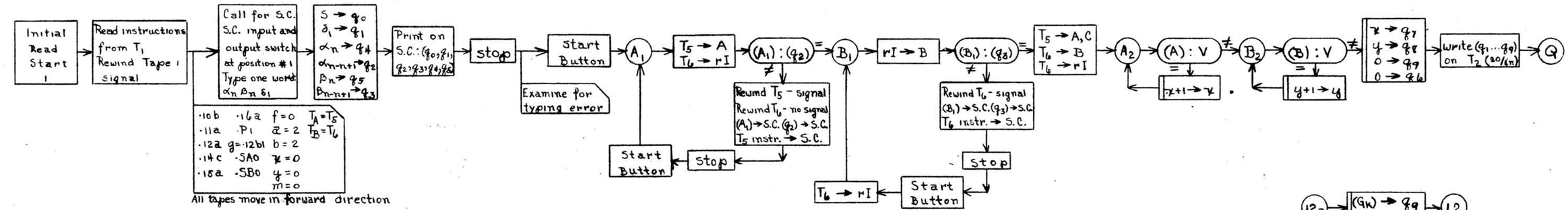
ALL DIMENSIONS ARE IN INCHES
TOL. UNLESS SPECIFIED OTHERWISE:
FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC-C 10

TWO TAPE MERGE WITH TAPE IDENTIFICATION - TAPE INTERLOCK ELIMINATED
ASCENDING SERIES
KEY DIGITS ≤ ONE WORD

DR. h.m.d.	DATE 4-5-50	C	A-962-3
CH'K. M.K.L.	SCALE		
APR.	ENG. H.A.N.		

TWO TAPE MERGE WITH TAPE IDENTIFICATION – ASCENDING SERIES
FINAL CYCLE – KEY DIGIT ≤ 12 DIGITS – TAPE INTERLOCK NOT ELIMINATED



LEGEND

- A Storage location - One block of data from tape A, also current location in block A
- B Storage location - One block of data from tape B, also current location in block B
- C Auxiliary Storage Location - Data tape A
- D Auxiliary Storage Location - Data tape B
- G Storage location - One block of output data
- GK Location in output block of Keyword of first item
- GN Location in output block of Keyword of last item
- M Total number of blocks on output tape
- N Total number of items per block
- S End-of-tape sentinel
- S.C. Supervisory Control
- T Tape
- V A word of ignore symbols
- a A constant used to alternate tape 3, tape 5
- b A constant used to alternate tape 4, tape 6
- f Counter: blocks of data on output tape
- g Intermediate storage for 12b connector
- m Counter: Items transferred to output block
- n Last tape number in a series
- x Counts: A items which have been processed
- y Counts: B items which have been processed
- α Tape identification letters - tape A
- β Tape identification letters - tape B
- δ Output tape identification
- Σ Number of words per item
- q0 ... q9 Storage positions for tape identification
- q0 Sentinel
- q1 Current output tape identification number
- q2 Current A input tape identification number
- q3 Current B input tape identification number
- q4 Final A input tape identification number
- q5 Final B input tape identification number
- q6 Keyword of last item on previous tape
- q7 Current location in A block
- q8 Current location in B block
- q9 Keyword of first item on current output tape

Note: Operator to mount new blank tape on UNISERVOS 1 and 2 following a rewind order with signal. Operator to mount new data tape in routines °A1, °B1, °A4, °B4 prior to Start Button.

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES TOL UNLESS SPECIFIED OTHERWISE: FRACT.	DEC.	HOLE	ANG.	MAT'L.
				UNIVAC C-10

TWO TAPE MERGE WITH TAPE IDENTIFICATION – ASCENDING SERIES FINAL CYCLE – KEY DIGIT ≤ 12 DIGITS – TAPE INTERLOCK NOT ELIMINATED

DR. h.m.d	DATE 3-30-50	C A-962-4
CH'K. M.K.L.	SCALE	
APR.	ENG. H.A.N	

LET.	REVISIONS	DATE	CHK.

THREE TAPE MERGE WITH TAPE IDENTIFICATION

ASCENDING SERIES

TWELVE-WORD ITEM - KEYWORD IS FIRST WORD

Initial read brings first block of instructions into memory locations 000...059

```
000   11 000   31 060
001   31 120   31 180
002   31 240   31 300
003   00 000   31 420
004   36 480   10 500
005   10 501
```

Instructions and constants to memory, $T_6 \longrightarrow rI$

```
      B  429
006   C  940   B  501
007   C  941   F  518
008   B  500   .8 000
009   H  945   E  519
010   C  942   X  000
011   ;4 000   .8 000
012   H  946   E  519
013   C  943   X  000
014   ;8 000   .8 000
015   H  947   E  519
016   C  944   50 941
017   50 942   50 943
018   50 944   50 945
```

Type 2 words into memory: 1. α_n, β_n, γ_n, 2. zero, δ_1

Sentinel to q0

$\delta_1 \longrightarrow$ q1
000000 000011

$\alpha_n \longrightarrow$ q5

$\alpha_{n-n+1} \longrightarrow$ q2

$\beta_n \longrightarrow$ q6

$\beta_{n-n+1} \longrightarrow$ q3

$\gamma_n \longrightarrow$ q7

$\gamma_{n-n+1} \longrightarrow$ q4

Print out on S.C.: (q1...q7)

019	50 946		
		50 947	Stop to examine typing (start button required to continue)
020	90 000		
		L 942	(q2)
021	37 520		(rI) → A, T_7 → rI
		00 000	
022	B 521		(A_1):(q2)
		Q 027	
023	86 000		Rewind T_6, signal
		67 000	Rewind T_7, No signal
024	50 521		(A_1) → S.C.
		50 942	(q2) → S.C.
025	50 023		T_6 instruction → S.C.
		90 000	Stop UNIVAC to examine above; mount new tape A
026	36 520		Clear rI, T_6 → rI
		U 021	Return to test identification of new tape A
027	38 640		(rI) → B, T_8 → rI
		B 641	(B_1)
028	L 943		(q3)
		Q 033	(B_1):(q3)
029	87 000		Rewind T_7, signal
		68 000	Rewind T_8, no signal
030	50 641		(B_1) → S.C.
		50 943	(q3) → S.C.
031	50 029		T_7 instruction → S.C.
		90 000	Stop UNIVAC to examine above; mount new tape B
032	37 640		Clear rI, T_7 → rI
		U 027	Return to test identification of new tape B
033	30 760		(rI) → C
		B 761	(C_1)
034	L 944		(q4)
		Q 039	(C_1):(q4)
035	88 000		
		50 761	(C_1) → S.C.
036	50 944		(q4) → S.C.
		50 035	T_8 instruction → S.C.
037	90 000		Stop UNIVAC to examine above; mount new tape C
		18 000	T_8 → rI
038	00 000		
		U 033	Return to test identification of new tape C
039	B 509		
		C 949	x = 0 → q9
040	B 508		
		C 950	y = 0 → q10

	041	B 507	C 951		z = 0 ⟶ q11
	042	C 948	C 952		0 ⟶ q8 0 ⟶ q12
	043	72 940	16 000		Write (q1...q12) on T_2, 20/in T_6 ⟶ rI
	044	36 520	37 580		(rI) ⟶ A, T_6 ⟶ rI (rI) ⟶ D, T_7 ⟶ rI
	045	37 640	38 700		(rI) ⟶ B, T_7 ⟶ rI (rI) ⟶ E, T_8 ⟶ rI
	046	38 760	81 000		(rI) ⟶ C, T_8 ⟶ rI Rewind T_1, signal
11	047	[B (520)	00 000]		(A)
	048	[L (640)	T 079]		(B) Transfer to compare (C):(B)
	049	[L (760)	T 080]		(C) Transfer to C routine ⟶ o_7

12	#047	00 000	00 000	
	#048	L (640)	U 079	
	#049	L (760)	T 080	(not used)

13	#047	B (520)	U 049	
	#048	L (640)	T 079	(not used)
	#049	L (760)	T 080	(not used)

14	#047	B (520)	00 000	
	#048	L (640)	T 112	
	#049	00 000	00 000	

A Routine

	050	B 515	F 516	
	051	E 047	H 057	
	052	A 504	H 058	
	053	X 000	H 059	
	054	X 000	H 060	Set up transfer of (A) ⟶ G

7.1.2.3

	055	X 000	H	061	
	056	X 000	C	062	
	057	[V (520)	W	(880)]	
	058	[V (522)	W	(882)]	
	059	[V (524)	W	(884)]	
	060	[V (526)	W	(886)]	$(A_{0+\Sigma x} \ldots A_{0+\Sigma(x+1)-1})$ to $G_{0+\Sigma m} \ldots G_{0+\Sigma(m+1)-1}$
	061	[V (528)	W	(888)]	
	062	[V (530)	W	(890)]	
	063	B 047	A	505	x x+1
	064	L 512	T	066	N x+1:N
	065	C 047	U	140	x+1 → x → o8

	066	B 509	C	047	x = 0 x+1 = N
	067	B 496	A	493	
	068	C 069	B	497	
10	069	[3(6)(820)	C	496]	(rI) → F, T_A → rI .10a
11	070	Y 580	Z	520	
	071	Y 590	Z	530	
	072	Y 600	Z	540	
	073	Y 610	Z	550	(D) → A
	074	Y 620	Z	560	
	075	Y 630	Z	570	
	076	B 520	L	429	(A_o) S
	077	00 000	Q	184	(A_o):S
	078	00 000	U	140	→ o8

	079	B (760)	T 112	(C):(B)
7	080	B 515		C Routine
	081	E 079	F 516	
	082	A 504	H 087	
	083	X 000	H 088	Set up transfer of (C) ⟶ G
	084	X 000	H 089	
	085	X 000	H 090	
	086	X 000	H 091	
	087	[V(760)	C 092	
	088	[V(762)	W(880)]	
	089	[V(764)	W(882)]	
	090	[V(766)	W(884)]	$(C_{O+\Sigma z} \cdots C_{O+\Sigma(z+1)-1})$
	091	[V(768)	W(886)]	$\longrightarrow$
	092	[V(770)	W(888)]	$G_{O+\Sigma m} \cdots G_{O+\Sigma(m+1)-1}$
	093	B 049	W(890)]	z
	094	A 505	L 510	N
	095	C 049	T 098	z+1
	096	A 079	X 000	z+1:N
	097	00 000	C 079	z+1 ⟶ z
			U 140	⟶ °8
	098	B 507	C 049	z+1 = N
	099	B 506	C 079	z = 0
	100	B 496	A 495	
	101	C 102	B 499	

°10	102	[3(8)(820)	C	496]	(rI) → F, T_C → rI .10c
°L3	103	Y 820	Z	760	
	104	Y 830	Z	770	
	105	Y 840	Z	780	
	106	Y 850	Z	790	(F) → C
	107	Y 860	Z	800	
	108	Y 870	Z	810	
	109	B 760	L	429	(C_0) S
	110	00 000	Q	220	(C_0) : S
	111	00 000	U	140	→ °8

°6	112	B 515			B Routine
	113	E 048	F	516	
	114	A 504	H	119	
	115	X 000	H	120	Set up transfer of (B) → G
	116	X 000	H	121	
	117	X 000	H	122	
	118	X 000	H	123	
	119	[V(640)	C	124	
	120	[V(642)	W(880)	]	
	121	[V(644)	W(882)	]	
	122	[V(646)	W(884)	]	
	123	[V(648)	W(886)	]	$(B_{O+\Sigma y} \cdots B_{O+\Sigma(y+1)-1})$ → $G_{O+\Sigma m} \cdots G_{O+\Sigma(m+1)-1}$
	124	[V(650)	W(888)	]	
	125	B 048	W(890)	]	
	126	L 511	A	505	y y + 1
	127	C 048	T	128	N y + 1 : N
			U	140	y + 1 → y → °8

---

y+1=N

	128	B	508	C	048	y=0
	129	B	496	A	494	
	130	C	131	B	498	
°10	131	[3(7)(820)		C	496]	(rI) → F, T_B → rI .10b
°L2	132	Y	700	Z	640	
	133	Y	710	Z	650	
	134	Y	720	Z	660	(E) → B
	135	Y	730	Z	670	
	136	Y	740	Z	680	
	137	Y	750	Z	690	
	138	B	640	L	429	(B_O) S
	139	00	000	Q	202	(B_O):S

°8a	140	[B	515	A	503]	m m+1

°8b	*140	00	000	U	147	→ °P
°8c	*140	7()	940	B	440	Write (q1...q12) on $T_{p(}{}^{20}/_{in}$)
	*141	C	140	U	147	→ °P

	141	[L	513	Q	143]	m+1:N → °9a
	*141	L	513	Q	146	m+1:N → °9b

°14d	142	[C	515	U	047]	m+1 → m → °Q

°14a	*142	C	515	U	050	→ °5
°14b	*142	C	515	U	112	→ °6
°14c	*142	C	515	U	080	→ °7

°9a	143	B 928			$(G_{O+\Sigma m})$
			L	483	V
	144	00 000			
			Q	182	$(G_{O+\Sigma m}):V$
	145	B 477			
			C	141	.9b

°9b	146	B 514			
			C	515	m=0
°P1	147	[52 880			Write one block on T_2
			B	479]	f

°P2	#147	51 880	B	479	Write one block on T_1
	#147	5( )520	B	479	G=A
	#147	5( )640	B	479	G=B
	#147	5( )760	B	479	G=C

	148	A 519			f+1
			L	478	M
	149	H 479			f+1 ⟶ f
			Q	155	f+1:M Transfer to °11
°12a	150	[00 000			
			B	880]	(G_K)

	#150	00 000	B	520	$G_O=A_O$
	#150	00 000	B	640	$G_O=B_O$
	#150	00 000	B	760	$G_O=C_O$
'12b1	#150	00 000	U	047	⟶ °Q
'12b2	#150	00 000	U	308	⟶ °A1
'12b3	#150	00 000	U	322	⟶ °B1
'12b4	#150	00 000	U	336	⟶ °C1
'12b5	#150	00 000	U	067	⟶ °10a
'12b5	#150	00 000	U	129	⟶ °10b
'12b5	#150	00 000	U	100	⟶ °10c

	151	C 958			(G_K) ⟶ q12
			B	476	g
	152	C 150			g=12b1 ⟶ .12
			U	150	⟶ °12

	153	00 000	00	000	
	154	00 000	00	000	

°11a	155	[52 940			
			52	940]	

°11b	#155	51 940	U	174	⟶ °11b
	156	52 940	B	941	Write 3S on T_2
	157	A 475	C	428	
	158	50 428	50	952	T + label +(q1) ⟶ S.C.
	159	82 000	B	473	(q12) ⟶ S.C. Rewind T_2
°15a	160	[C 147	B	471]	.P2
°15b	#160	30 520	90	000	Clear rI; stop program
	161	C 155	B	426	.11b $T_p = T_1$
	162	C 502	00	000	
	163	C 479	B	150	f = 0
	164	C 476	B	444	12b1 ⟶ g
	165	C 150	B	941	.12a
	166	A 519	C	941	(q1) + 1 ⟶ q1
	167	[B 928	C	948]	(G_N) ⟶ q8
	#167	B 568	C	948	$G_N = A_N$ ⟶ q8
	#167	B 688	C	948	$G_N = B_N$ ⟶ q8
	#167	B 808	C	948	$G_N = C_N$ ⟶ q8
	168	B 047	C	949	x ⟶ q9
	169	V 048	W	950	y ⟶ q10; z ⟶ q11
	170	C 952	B	502	0 ⟶ q12
°17a					

	171	[A 489			
			C 172]		
	172	[7()940			
			U 476]	→ °12b1	

°17b	#171	A 438	C 140		
	#172	00 000	U (067 129 100)	→ °10	

	173	00 000	00 000		

°11b	174	51 940			
			51 940	Write 38 on T_1	
	175	B 941			
			A 474		
	176	C 428		T + label + (q1) → T.S.	
			50 428	T + label + (q1) → S.C.	
	177	50 952		(q12) → S.C.	
			81 000	Rewind T_1	
°16a	178	[B 472			
			C 147]	.P1	

°16b	#178	30 520	90 000	Clear rI, stop program	

	179	B 470			
			C 155	.11a	
	180	B 427		$T_p = T_2$	
			U 162		

	181	00 000	00 000		

	182	B 514			$(G_{O+\Sigma m}) = V$
			C 515	m = 0	
	183	00 000			
			U 047	→ °Q	

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Code C-10
5/11/50

184	B 942		(q2)	$(A_0) = S$
		A 519	(q2) + 1	
185	[L 945		(q5)	
		T 238]	→ °SA0	
#185	L 945	T 260	→ °SA1	
#185	L 945	T 278	→ °SA2	
#185	L 945	T 296	→ °SA3	
186	S(6)000		Rewind T_A, signal	
		H 942	(q2) + 1 → q2	
187	3(3)520		Clear (rI), T_{A-a} → rI	
		3(3)520	(rI) → A, T_{A-a} → rI	
188	L 521		(A_1)	
		Q 192	(q2) : (A_1)	
189	S(3)000		Rewind T_{A-a}, signal	
		50 521	(A_1) → S.C.	
190	50 942		(q2) → S.C.	
		50 187	T_{A-a} instr. → S.C.	
191	90 000		Stop and replace T_{A-a}	
		U 187	Return to read in new T_{A-a}	
192	3(3)520		(rI) → A, T_{A-a} → rI	(q2)=(A_1)
		B 186		
193	S 490			
		C 186		
194	J 490			
		X 000		
195	A 493			
		C 493		
196	B 189			
		S 490		
197	C 189		T_{A-a} → T_{A-a} → a	
		X 000		
198	A 192			
		C 192		
199	B 187			
		S 480		
200	C 187			
		J 480		
201	00 000			
		U 140	→ °S	

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$(B_0)=8$

202	B 943	A 519	(q3) (q3) + 1
203	[L 946	T 245]	(q6) $\rightarrow$ °SB0
#203	L 946	T 266	$\rightarrow$ °SB1
#203	L 946	T 284	$\rightarrow$ °SB2
#203	L 946	T 300	$\rightarrow$ °SB3
204	8(7)000	H 943	Rewind T_B, signal (q3) + 1 $\rightarrow$ q3
205	3(4)640	3(4)640	Clear (rI), $T_{B-b} \rightarrow$ rI (rI) $\rightarrow$ B, $T_{B-b} \rightarrow$ rI
206	L 641	Q 210	(B_1) (q3) : (B_1)
207	8(4)000	50 641	Rewind T_{B-b}, signal $(B_1) \rightarrow$ S.C.
208	50 943	50 205	(q3) $\rightarrow$ S.C. T_{B-b} instr. $\rightarrow$ S.C.
209	90 000	U 205	Stop and replace T_{B-b} Return to read in new T_{B-b}

$(q3)=(B_1)$

210	3(4)640	B 204	(rI) $\rightarrow$ B, $T_{B-b} \rightarrow$ rI
211	S 491	C 204	
212	J 491	X 000	
213	A 494	C 494	
214	B 207	S 491	$T_{B-b} \rightarrow T_{B-b} \rightarrow$ b
215	C 207	X 000	
216	A 210	C 210	
217	B 205	S 481	
218	C 205	J 481	
219	00 000	U 140	$\rightarrow$ °8

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$(C_0) = S$

220	B 944	A 519	(q4) (q4) + 1
221	[L 947	T 252]	(q7) $\longrightarrow$ °SCO

#221	L 947	T 272	$\longrightarrow$ °SC1
#221	L 947	T 290	$\longrightarrow$ °SC2
#221	L 947	T 304	$\longrightarrow$ °SC3

222	8(8)000	H 944	Rewind T_C, signal (q4) +1 $\longrightarrow$ q4
223	3(5)760	3(5)760	Clear (rI), $T_{C-c} \longrightarrow$ rI (rI) $\longrightarrow$ C, $T_{C-c} \longrightarrow$ rI
224	L 761	Q 228	(C_1) (q4) : (C_1)
225	8(5)000	50 761	Rewind T_{C-c}, signal $(C_1) \longrightarrow$ S.C.
226	50 944	50 223	(q4) $\longrightarrow$ S.C. T_{C-c} instr. $\longrightarrow$ S.C.
227	90 000	U 223	Stop and replace T_{C-c} Return to read in new T_{C-c}

(q4) = (C_1)

228	3(5)760	B 222	(rI) $\longrightarrow$ C, $T_{C-c} \longrightarrow$ rI
229	S 492	C 222	
230	J 492	X 000	
231	A 495	C 495	$T_{C-c} \longrightarrow T_{C-c} \longrightarrow$ c (lines 228–236)
232	B 225	S 492	
233	C 225	X 000	
234	A 228	C 228	
235	B 223	S 482	
236	C 223	J 482	
237	00 000	U 140	$\longrightarrow$ °8

SAO	238	B 464	C 203	.SB1
	239	B 467	C 221	.SC1

```
       240   B  186    C  243
       241   B  488    H  508 ⎫   .Q2
       242   E  048    C  048 ⎭   rF = 000111  000000
       243 [ 8(6)000   H  942]    Rewind T_A, signal
                                  0 ⟶ q2
       244   C  047    U  140     .Q2
                                  ⟶ °8
-------------------------------------------------------
°SBO   245   B  461    C  185     .SA1
       246   B  468    C  221     .SC2
       247   B  204    C  250
       248   B  425    H  509 ⎫   .Q 3
       249   E  047    C  047 ⎭   rF = 000111  000000
       250 [ 8(7)000   H  943]    Rewind T_B, signal
                                  0 ⟶ q3
       251   00 000    U  140     ⟶ °8
-------------------------------------------------------
°SCO   252   B  462    C  185     .SA2
       253   B  465    C  203     .SB2
       254   B  222    C  255
       255 [ 8(8)000   H  944]    Rewind T_C, signal
                                  0 ⟶ q4
       256   B  487    H  508 ⎫   rF = 000111  000000
       257   E  048    C  048 ⎭   .Q4
       258   C  049    U  140     ⟶ °8
       259   00 000    00 000
-------------------------------------------------------
°SA1   260   B  469    C  221     .SC3
       261   B  486    C  142     .14o
       262   B  186    C  263
```

	263	[8(6)000	H 942]	Rewind T_A, signal 0 → q2 °12b4 = °12bi → °13
	264	F 460	U 350	
	265	00 000	00 000	
°SB1	266	B 469	C 221	.SC3
	267	B 486	C 142	.14c
	268	B 204	C 269	
	269	[8(7)000	H 943]	Rewind T_B, signal 0 → q3 °12b4 = °12bi → °13
	270	F 460	U 350	
	271	00 000	00 000	
°SC1	272	B 466	C 203	.SB3
	273	B 485	C 142	.14b
	274	B 222	C 275	
	275	[8(8)000	H 944]	Rewind T_C, signal 0 → q4 °12b3 = °12bi → °13
	276	F 459	U 350	
	277	00 000	00 000	
°SA2	278	B 466	C 203	.SB3
	279	B 485	C 142	.14b
	280	B 185	C 281	
	281	[8(6)000	H 942]	Rewind T_A, signal 0 → q2 °12b3 = °12bi → °13
	282	F 459	U 350	
	283	00 000	00 000	
°SB2	284	B 463	C 185	.SA3
	285	B 484	C 142	.14a

	286	B 204		
			C 287	
	287	[8(7)000	H 943]	Rewind T_B, signal 0 → q3
	288	F 458		°12b2 = °12bi
			U 350	→ °13
	289	00 000	00 000	
°SC2	290	B 463		
			C 185	.SA3
	291	B 484		
			C 142	.14a
	292	B 222		
			C 293	
	293	[8(8)000	H 944]	Rewind T_C, signal 0 → q4
	294	F 458		°12b2 = °12bi
			U 350	→ °13
	295	00 000	00 000	
•SA3	296	B 186		
			C 297	
	297	[8(6)000	H 942]	Rewind T_A, signal 0 → q2 (not needed)
	298	B 457		
			H 160	.15b
	299	C 178		.16b
			U 353	→ °18
SB3	300	B 204		
			C 301	
	301	[8(7)000	H 943]	Rewind T_B, signal 0 → q3 (not needed)
	302	B 457		
			H 160	.15b
	303	C 178		.16b
			U 353	→ °18
·SC3	304	B 222		
			C 305	
	305	[8(8)000	H 944]	Rewind T_C, signal 0 → q4 (not needed)
	306	B 457		
			H 160	.15b
	307	C 178		.16b
			U 353	→ °18

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A1	308	B	455	F	517	G = A
	309	E	147	C	147	
	310	V	454	W	472	
	311	B	453	C	444	
	312	B	456	C	167	
	313	B	440	C	140	.8b
	314	B	439	C	141	
	315	V	435	W	171	.17b
	316	B	430	C	353	.18b
'13	317	L	479	F	441	f °12b5 = °12b1; °10 = °10a
	318	00	000	Q	320	f:0
	319	G	150	U	147	°12b5 → °12b → °P
	320	G	476	B	453	°12b5 → g
	321	C	150	U	147	G = A in °12a → °P

B1	322	B	451	F	517	G = B
	323	E	147	C	147	
	324	V	450	W	472	
	325	B	449	C	444	
	326	B	452	C	167	
	327	B	440	C	140	.8b
	328	B	439	C	141	
	329	V	433	W	171	.17b
	330	B	430	C	353	.18b
13	331	L	479	F	442	f °12b5 = °12b1, °10 = °10b

	332	00 000			
			Q	334	f : 0
	333	G 150			°12b5 = °12b
			U	147	→ °P
	334	G 476			°12b5 → g
			B	449	
	335	C 150			G = B in °12a
			U	147	→ °P
C1	336	B 447			
			F	517	
	337	E 147			
			C	147	
	338	V 446			
			W	472	
	339	B 445			G = C
			C	444	
	340	B 448			
			C	167	
	341	B 440			
			C	140	.8b
	342	B 439			
			C	141	
	343	V 431			
			W	171	.17b
	344	B 430			
			C	353	.18b
13	345	L 479			f
			F	443	°12b5 = °12bi, °10 = °10c
	346	00 000			
			Q	348	f ≠ 0
	347	G 150			°12b5 → °12b
			U	147	→ °P
	348	G 476			°12b5 → g
			B	445	
	349	C 150			G = C in °12a
			U	147	→ °P
13	350	L 479			f
			Q	352	f : 0
	351	G 150			°12bi → °12
			U	140	→ °g
	352	G 476			°12bi → g
			U	140	→ °g

018a	353	[B 437	C 479]	M-1 ⟶ f
018b	353	L 479	U 355	
	354	00 000	U 147	⟶ °P
	355	00 000	Q 457	If f=0, stop program
	356	00 000	U 155	⟶ °11

CONSTANTS

425	B	520	U	049	.Q3
426	71	940	00	000	$T_p = T_1$
427	72	940	00	000	$T_p = T_2$
428					T.S. for T + label + (q1)
429					Sentinel
430	L	479	U	355	.18b
431	A	438	C	140	.17b (for C)
432	00	000	U	100	
433	A	438	C	140	.17b (for B)
434	00	000	U	129	
435	A	438	C	140	.17b (for A)
436	00	000	U	067	
437					M - 1
438	00	000	B	440	.8c
439	C	140	U	147	
440	00	000	U	147	.8b
441	00	000	U	067	→ °10a, °L1
442	00	000	U	129	→ °10b, °L2 .12b5
443	00	000	U	100	→ °10c, °L3
444	00	000	B	(880)	.12a
445	00	000	B	760	Constant for G = C
446	52	760	B	479	" " "
447	51	760	B	479	" " "
448	B	808	C	948	
449	00	000	B	640	Constant for G = B
450	52	640	B	479	" " "
451	51	640	B	479	" " "
452	B	688	C	948	
453	00	000	B	520	Constant for G = A
454	52	520	B	479	" " "
455	51	520	B	479	" " "
456	B	568	C	948	
457	30	520	90	000	.15b, .16b
458	00	000	U	308	.12b2 (→ °A1)
459	00	000	U	322	.12b3 (→ °B1)
460	00	000	U	336	.12b4 (→ °C1)
461	L	945	T	260	.SA1
462	L	945	T	278	.SA2
463	L	945	T	296	.SA3
464	L	946	T	266	.SB1
465	L	946	T	284	.SB2
466	L	946	T	300	.SB3
467	L	947	T	272	.SC1
468	L	947	T	290	.SC2
469	L	947	T	304	.SC3

```
470    52 940     52 940          .11a
471    51 940     U  174          .11b
472  [ 52(880)    B  479 ]        .P1
473  [ 51(880)    B  479 ]        .P2
474    C R1 LABE  LΔ0000          Label for T1
475    C R2 LABE  LΔ0000          Label for T2
476  [ 00 000     U  047 ]        g (°12b1 to start)
477    L  513     Q  146          .9b
478                                M
479  [ 000000     000000 ]        f
480    030000     030000          a (minus to start)  Constants
481    030000     030000          b (minus to start)  for alter-
482    030000     030000          c (minus to start)  nating Tapes
                                                      A, B, and C
483                                A word of ignore symbols = V
484    C  515     U  050          .14a
485    C  515     U  112          .14b
486    C  515     U  080          .14c
487    L  640     T  112          .Q4
488    L  640     U  079          .Q2
489    00 000     U  476          .17a
490    030000     000000          a (plus to start)   Constants
491    030000     000000          b (plus to start)   for alter-
492    030000     000000          c (plus to start)   nating Tapes
                                                      A, B, and C
493  0(6)0000     000000          TA
494  0(7)0000     000000          TB
495  0(8)0000     000000          TC
496  [ 30 820     C  496 ]        °10 (°10c tostart)
497    30 580     C  496          .10a
498    30 700     C  496          .10b
499    30 820     C  496          .10c
500                                Storage for αn, βn, γn
501    000000     00[δ1]          Storage for δ1
502  [ 7()940     000000 ]        Write (q1...q12) on Tp 20/in
503    000000     000012          Constant for increasing m
504    000002     000002          Constant for increasing x,
                                  y, z, m
505    000012     000000          Constant for increasing x, y, z
506    B  760     T  112          z = 0
507    L  760     T  080          z = 0
508  [ L  640     T  079 ]        y = 0
509  [ B  520     00 000 ]        x = 0
510    L  819     00 000          N for z
511    L  699     00 000          N for y
512    B  579     00 000          N for x
513    V  000     W  940          N for m
514    V  000     W  880          m = 0
515  [ V  000     W  880 ]        m (variable)
```

516	000111	000000	Instruction extractor
517	010000	000000	Extractor for tape no.
518	000000	000011	Digit extractor for q
519	000000	000001	Constant for q, f

520...579	A block	input
580...639	D block	
640...699	B block	
700...759	E block	
760...819	C block	
820...879	F block	
880...939	G block (output)	

940	q0 = Sentinel
941	q1 = Current output tape identification no.
942	q2 = Current A input " " " "
943	q3 = Current B " " " " "
944	q4 = Current C " " " " "
945	q5 = Final A input tape identification no.
946	q6 = Final B " " " " "
947	q7 = Final C " " " " "
948	q8 = Key word of last item on previous output tape
949	q9 = Current location in A block
950	q10 = " " " B "
951	q11 = " " " C "
952	q12 = Keyword of first item on current output tape

THREE TAPE MERGE WITH TAPE IDENTIFICATION

ASCENDING SERIES

12-WORD ITEM - KEYWORD IS FIRST WORD

nnector	Function and Purpose	Entry Point
^{o}Q1	Main comparison routine. Initially set. Compares the magnitude of the current A,B and C items and transfers to the routine which places the item of least magnitude in the output block.	Entered following the initial input routines, and re-entered as long as A,B and C tapes are still in use. Entered from ^{o}14d when the item last transferred was not the last in the current output block. Entered from ^{o}9a if the item last transferred was the last in the current output block, and that block is completely filled with ignore symbols. Entered from ^{o}12b1 when the item last transferred was the last in the current output block, and that block is not completely filled with ignore symbols.
^{o}Q2	Set by ^{o}SA0. Compares the magnitude of the current C and B items and transfers to the routine which places the item of least magnitude in the output block.	Entered from ^{o}14d and ^{o}12b1 under the same conditions as ^{o}Q1 whenever the A string has been exhausted, and only items from the B and C strings remain to be compared.
^{o}Q3	Set by SB0. Compares the magnitude of the current A and C items and transfers to the routine which places the item of least magnitude in the output block.	Entered from ^{o}14d and ^{o}12b1 under the same conditions as ^{o}Q1 whenever the B string has been exhausted and only items from the A and C strings remain to be compared.
^{o}Q4	Set by ^{o}SC0. Compares the magnitude of the current A and B items and transfers to the routine which places the item of least magnitude in the output block.	Entered from ^{o}14d and ^{o}12b1 under the same conditions as ^{o}Q1 whenever the C string has been exhausted and only items from the A and B strings remain to be compared.

$^{o}5$	Transfers the current item from input block A to output block G. Tests for the end of the current A block. If the end hasn't been reached, transfers to test for the end of the current output block. If the end of the input block has been reached, transfers to read in a new block of data from tape A.	Entered from ^{o}Q when the current A item is the item of least magnitude. Entered from $^{o}14a$ when the B and C strings have been exhausted and only items from the A string remain to be transferred to output.
$^{o}6$	Transfers the current item from input block B to output block G. Tests for the end of the current B block. If the end has not been reached, transfers to test for the end of the current output block. If the end of the input block has been reached, transfers to read in a new block of data from tape B.	Entered from ^{o}Q when the current B item is the item of least magnitude. Entered from $^{o}14b$ when the A and C strings have been exhausted and only items from the B string remain to be transferred to output.
$^{o}7$	Transfers the current item from input block C to output block G. Tests for the end of the current C block. If the end has not been reached, transfers to test for the end of the current output block. If the end of the input block has been reached, transfers to read in a new block of data from tape C.	Entered from ^{o}Q when the current C item is the item of least magnitude. Entered from $^{o}14c$ when the A and B strings have been exhausted and only items from the C string remain to be transferred to output.
$^{o}8a$	Initially set. Tests for the end of the current output block, transferring to $^{o}9$ if the end has been reached or to $^{o}14$ if it has not.	Entered from $^{o}5$, $^{o}6$ or $^{o}7$ after transferring an item which was not the last in its respective input block. Entered from $^{o}L1$, $^{o}L2$, $^{o}L3$ after transferring an item which was the last in its respective input block, if that block was not the last on its respective tape; or after transferring an item which was the last in the final block on the current tape if that tape was not the last in its respective

		string. Entered from °SA0, °SB0, °SC0 after transferring an item which was the last one in the last block of the final tape in its respective string, if that string was the first to be exhausted. Entered from °13 after transferring an item which was the last one in the last block of the final tape in its respective string, if this string was the second to be exhausted.
°8b	Set by °A1, °B1, °C1 and °8c. Transfers directly to °P.	Entered from °13 when two strings of tapes have been exhausted and the remaining input data is to be transferred to output in units of one block. Entered from °L1, °L2 or °L3 when the block of data just transferred to output was not the last on its respective input tape, or when it was the last on the tape and that tape was not the last in its respective string, if the next block to be transferred will not be the first on the current output tape.
°8c	Set by °17b. Writes identification block on new output tape, sets °8b and transfers to °P.	Entered from °L1, °L2, °L3 when the block of data next to be transferred to output will be the first on the current output tape.
°14a	Set by °SB2, °SC2. Transfers directly to °5.	Entered from °8a when the end of the B and C strings has been reached, and the item last transferred from an input block did not complete the current output block.
°14b	Set by °SA2, °SC1. Transfers directly to °6.	Entered from °8a when the end of the A and C strings has been reached, and the item last transferred from an input block did not complete the current output block.

$^{o}14c$	Set by $^{o}SA1$, $^{o}SB1$. Transfers directly to $^{o}7$.	Entered from $^{o}8a$ when the end of the A and B strings has been reached, and the item last transferred from an input block did not complete the current output block.
$^{o}14d$	Initially set. Transfers directly to ^{o}Q.	Entered from $^{o}8a$ when at least two strings of data tapes remain and the item last transferred from an input block did not complete the current output block.
$^{o}9a$	Initially set. Tests keyword of last item in output block for ignore symbols. If ignores are present, sets m equal to zero and transfers to ^{o}Q. If ignores are not present, sets $^{o}9b$ and transfers to $^{o}9$.	Entered from the equality side of the test for the end of the output block in $^{o}8a$ as long as all complete blocks of ignore symbols have not been discarded.
$^{o}9b$	Set by $^{o}9a$. Sets m=0 and transfers to ^{o}P.	Entered from the inequality side of the test in $^{o}9a$, when the current output block is the first one to contain items of true data. Entered from the equality side of the test in $^{o}8a$ when the output block is known to contain items of true data.
$^{o}10a$	Set by $^{o}L1$. Transfers the contents of rI to storage block D.	Entered from the equality side of the test for the end of the input block in $^{o}5$, $^{o}6$, and $^{o}7$ if the data stored in rI is a block from tape A. Entered from $^{o}12b5$ when both B and C strings have been exhausted and the remaining data from the A string is being transferred to the current output tape, block by block. Entered from $^{o}17b$ when the first block on a new output tape will be a complete block of data from the A input tape.

$^{o}10b$	Set by $^{o}L2$. Transfers the contents of rI to storage block E.	Entered from the equality side of the test for the end of the input block in $^{o}5$, $^{o}6$, and $^{o}7$, if the data stored in rI is a block from input tape B. Entered from $^{o}12b5$ when both A and C strings have been exhausted, and the remaining data from the B string is being transferred to the current output tape, block by block. Entered from $^{o}17b$ when the first block on a new output tape will be a complete block of data from the B input tape.
$^{o}10c$	Initially set. Reset by $^{o}L3$. Transfers the contents of rI to storage block F.	Entered from the equality side of the test for the end of the input block in $^{o}5$, $^{o}6$, and $^{o}7$, if the data stored in rI is a block from input tape C. Entered from $^{o}12b5$ when both A and B strings have been exhausted, and the remaining data from the C string is being transferred to the current output tape, block by block. Entered from $^{o}17b$ when the first block on a new output tape will be a complete block of data from the C input tape.
$^{o}L1$, $^{o}L2$, $^{o}L3$	Set by $^{o}5$, $^{o}6$, $^{o}7$, respectively. $^{o}L1$ transfers the contents of storage block D to operation block A, reads T_A to rI, sets $^{o}10a$ and tests the new data block for sentinel. If sentinel is not present, transfers control to $^{o}8$. If sentinel is present, tests to determine whether the current A tape is the last. If so, transfers control to ^{o}SA. If the current data tape is not the last in the string, reads from the next tape in the A string, and tests to determine whether it is the correct one. If it is	Entered from $^{o}10$.

	correct, reads the first block of data into memory, adjusts tape instructions and transfers to $^{o}8$. If the new tape is not the correct one, rewinds the incorrect tape, prints out on S.C. the necessary information, and stops UNIVAC until the operator locates and mounts the correct tape. Returns then to test whether the new tape is the correct one. $^{o}L2$ and $^{o}L3$ are analogous routines which operate on T_B (storage blocks B, E) and T_C (storage blocks C, F) respectively, and transfer to ^{o}SB and ^{o}SC at the end of the respective strings.	
$^{o}P1, ^{o}P2$	$^{o}P1$ is initially set and is reset by $^{o}16a$. $^{o}P2$ is set by $^{o}15a$. These are similar routines for writing one block of output data on tape 2 and tape 1 respectively. Both routines test for the end of the current output tape. If the end has not been reached, they increase the output tape block counter and transfer to $^{o}12$. If the end has been reached, $^{o}P1$ transfers to $^{o}11a$, and $^{o}P2$ transfers to $^{o}11b$.	Entered from $^{o}9b$ when the current output block is complete. Entered from $^{o}8b$ when two strings of tapes have been exhausted, and the data from the remaining string is being transferred to output, block by block; if the next block will not be the first on the current output tape. Entered from $^{o}8c$ under similar conditions as from $^{o}8b$, if the next block will be the first on the current output tape. Entered from $^{o}18a$ when the final items from the last two input strings have been transferred to the same output block and that block must be written out before stopping the program.
$^{o}12a$	Initially set, and reset for the beginning of each new output tape. Stores the keyword of the first item on the output tape in the identification block, and sets $^{o}12b$. Transfers to $^{o}12$.	Entered from the inequality side of the test in ^{o}P when the block just written out was the first on the current output tape.

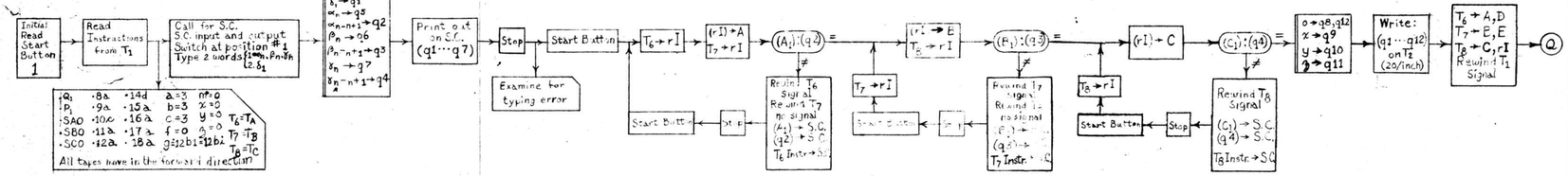
$^{o}12b1$	Initially stored in location g. Set and reset by $^{o}12a$ as long as there are at least two input strings in use.	Entered from the inequality side of the test in ^{o}P when the block just written out was neither the first nor the last on an output tape. Entered from $^{o}12a$ if the last output block was the first on the current output tape. Entered from $^{o}17a$ if the last output block was the last on the previous output tape.
$^{o}12b2$, $^{o}12b3$, $^{o}12b4$	Set by $^{o}SB2$, $^{o}SC2$; $^{o}SA2$, $^{o}SC1$; and $^{o}SA1$, $^{o}SB1$ respectively. Transfer to $^{o}A1$, $^{o}B1$ and $^{o}C1$ respectively.	Entered from the same points as $^{o}12b1$ if all the data from two strings of tapes has been exhausted and the data from the remaining string is to be transferred to output, block by block.
$^{o}12b5$	Set by $^{o}A1$, $^{o}B1$, $^{o}C1$. Transfers to $^{o}10$.	Entered from $^{o}12a$, or ^{o}P under conditions similar to those outlined for $^{o}12b1$ when a complete block of data from the remaining input string has just been written on the output tape. Not entered when the block just written out was the last block on the output tape.
$^{o}A1$, $^{o}B1$, $^{o}C1$	Similar routines; all set $^{o}8b$, $^{o}12b5$, $^{o}17b$, $^{o}18b$. $^{o}A1$ sets G=A and $^{o}L1$. $^{o}B1$ sets G=B and $^{o}L2$. $^{o}C1$ sets G=C and $^{o}L3$. All transfer to $^{o}13$.	Entered from $^{o}12b2$, $^{o}12b3$, $^{o}12b4$, respectively when two of the three strings of data tapes have been exhausted, and the remaining one is to be transferred to the output tape in units of one block.
$^{o}11a$, $^{o}11b$	Analogous routines. $^{o}11a$ is initially set, and is reset by $^{o}16a$. $^{o}11b$ is set by $^{o}15a$. Write three sentinel blocks on T_2 and T_1 respectively, print a label for the output tape, rewind the tape, and transfer to $^{o}15$ and $^{o}16$ respectively.	Entered from the equality side of the test for the end of the output block in $^{o}P1$ and $^{o}P2$ respectively.
$^{o}15a$	Initially set. Sets $^{o}P2$, $^{o}11b$, $T_P = T_1$, clears tape block counter to zero, stores current $^{o}12b$ instruction in location g,	Entered from $^{o}11a$, as long as there is additional data to be written on the next output tape.

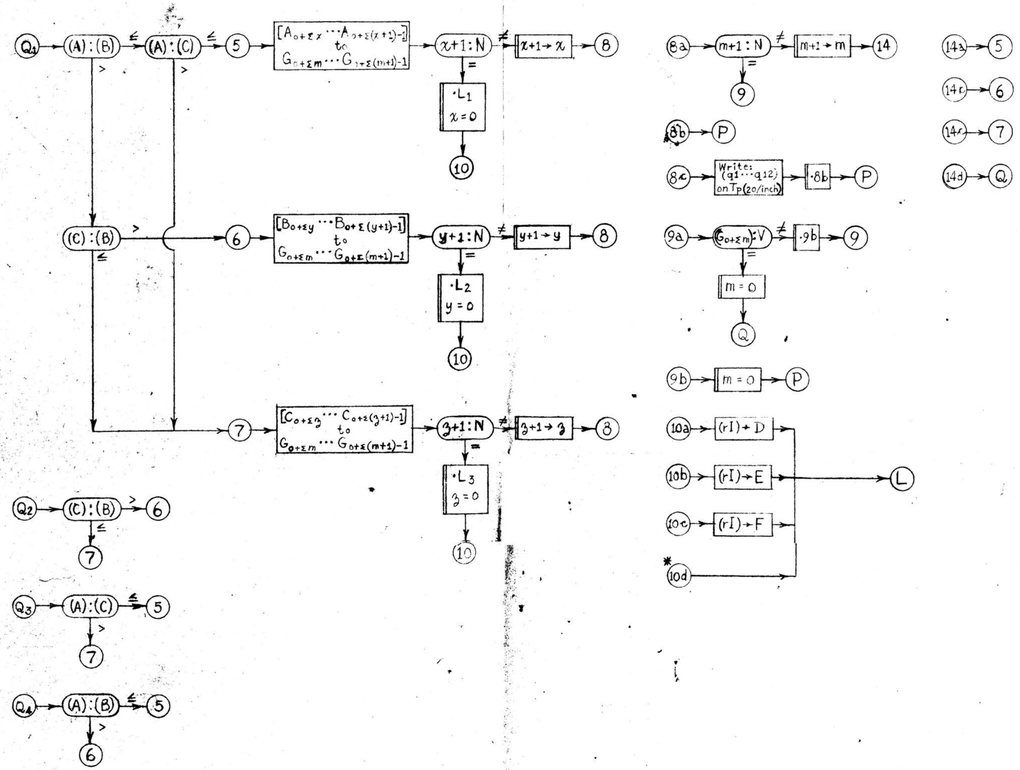
	sets $^{o}12a$, changes contents of identification locations as necessary for new output tape and transfers to $^{o}17$.	
16a	Initially set. Similar to $^{o}15a$ except that $^{o}16a$ sets $^{o}P1$, $^{o}11a$ and $T_P = T_2$.	Entered from $^{o}11b$ under the conditions outlined above for $^{o}15a$.
15b, 16b	Set by $^{o}SA3$, $^{o}SB3$, $^{o}SC3$. Stop program.	Entered from $^{o}11a$ and $^{o}11b$ respectively, when the final block of output data has been written on an output tape.
17a	Initially set. Writes identification block on the new output tape and transfers to $^{o}12b$.	Entered from $^{o}15a$ or $^{o}16a$ following the completion of an output tape, as long as there are at least two strings of tapes in operation.
17b	Set by $^{o}A1$, $^{o}B1$, $^{o}C1$. Sets $^{o}8c$ and transfers to $^{o}10$.	Entered from the same points as $^{o}17a$ when two strings of tapes have been exhausted, and the remainder of the third is being transferred to output.
13	Tests to determine whether the current output tape contains any data. If it does, the new $^{o}12b$ is inserted in $^{o}12$. If it does not, $^{o}12$ equals $^{o}12a$, and the new $^{o}12b$ is stored in location g.	Entered from $^{o}SA1$, $^{o}SA2$, $^{o}SB1$, $^{o}SB2$, $^{o}SC1$, $^{o}SC2$ when the second string of data tapes is exhausted, leaving the remainder of the third to be transferred to output. Entered from $^{o}A1$, $^{o}B1$, $^{o}C1$ following completion of the changes required in order to transfer the data from the remaining input string to output in units of one block.
18a	Initially set. Sets output tape block counter equal to the maximum number of blocks less one and transfers control to ^{o}P.	Entered from $^{o}SA3$, $^{o}SB3$, $^{o}SC3$ when the last items from the last two input strings have been transferred to the same output block, and the program is to be stopped when that block has been written out on an output tape.

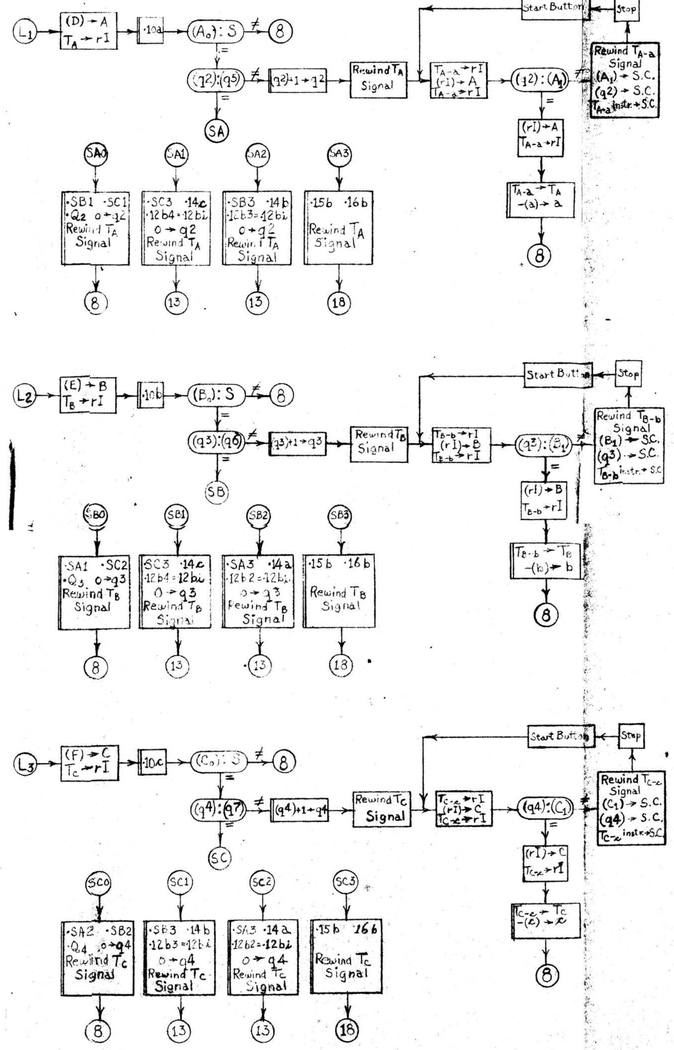
18b	Set by °A1, °B1, °C1. Tests to determine whether there is any data on the current output tape. If not, stops program. If there is data on the tape, transfers to °11 to write sentinel blocks on tape and stop program.	Entered from °SA3, °SB3, °SC3 when the last block of the last remaining string has been transferred to output, and the program is to be stopped.
3A0	Initially set. Sets °SB1, °SC1, °Q2 and q2 = 0, rewinds tape A and transfers control to °8.	Entered from °L1 when all the tapes in the A string have been exhausted prior to the ending of the last tape in either the B or C string.
3A1	Set by °SB0. Sets °SC3, °14c, q2=0, °12b4, rewinds tape A and transfers control to °13.	Entered from °L1 when all the tapes in the A string have been exhausted following the ending of the B string and prior to the ending of the C string.
3A2	Set by °SC0. Sets °SB3, °14b, q2 = 0, °12b3, rewinds tape A and transfers control to °13.	Entered from °L1 when all the tapes in the A string have been exhausted following the ending of the C string and prior to the ending of the B string.
3A3	Set by °SC2, °SB2. Sets °15b, °16b, rewinds tape A and transfers to °18.	Entered from °L1 when all the tapes in the A string have been exhausted after the ending of both the B and C strings.
3B0	Initially set. Sets °SA1, °SC2, °Q3, q3 = 0, rewinds tape B and transfers control to °8.	Entered from °L2 when all the tapes in the B string have been exhausted prior to the ending of the last tape in either the A or C string.
3B1	Set by °SA0. Sets °SC3, °14c, q3 = 0, °12b4, rewinds tape B, and transfers control to °13.	Entered from °L2 when all the tapes in the B string have been exhausted following the ending of the A string and prior to the ending of the C string.
3B2	Set by °SC0. Sets °SA3, °14a, q3 = 0, °12b2, rewinds tape B, and transfers control to °13.	Entered from °L2 when all the tapes in the B string have been exhausted following the ending of the C string and prior to the ending of the A string.

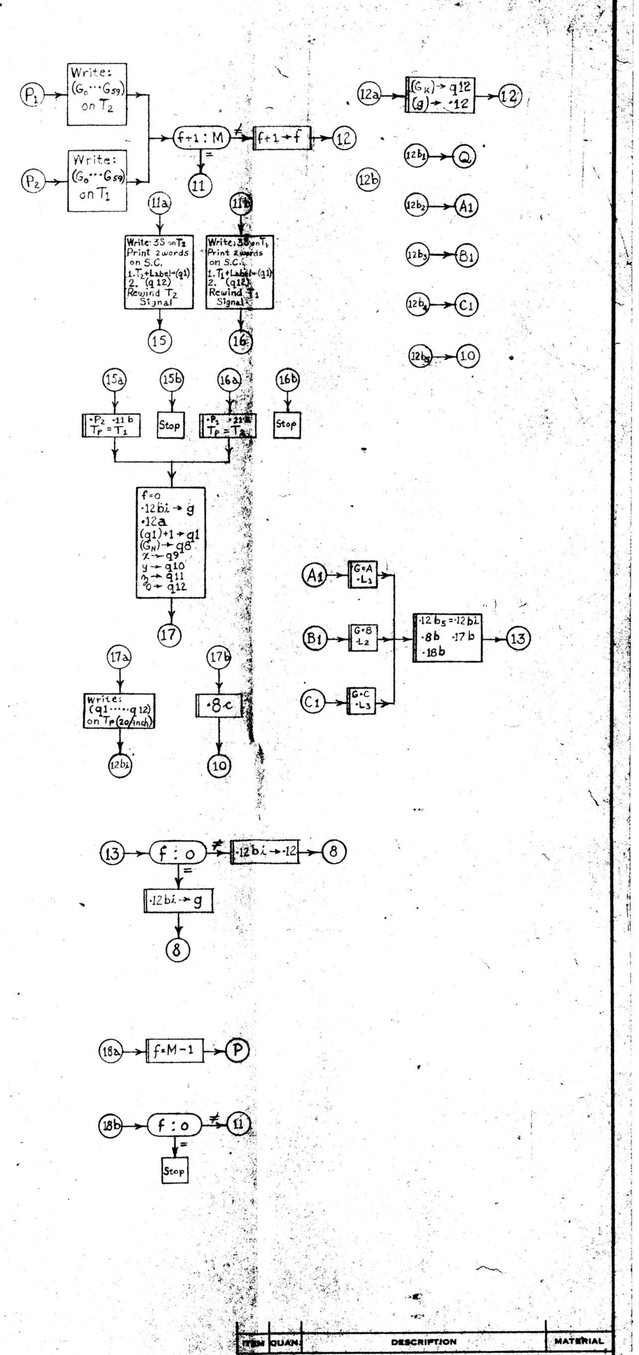
3B3	Set by ^{o}SA2, ^{o}SC1. Sets ^{o}15b, ^{o}16b, rewinds tape B and transfers control to ^{o}18.	Entered from ^{o}L2 when all the tapes in the B string have been exhausted after the ending of both the A and C strings.
3C0	Initially set. Sets ^{o}SA2, ^{o}SB2, ^{o}Q4, q4 = 0, rewinds tape C and transfers control to ^{o}8.	Entered from ^{o}L3 when all the tapes in the C string have been exhausted prior to the ending of the last tape in either the A or B string .
3C1	Set by ^{o}SA0. Sets ^{o}SB3, ^{o}14b, q4 = 0, ^{o}12b3, rewinds tape C and transfers control to ^{o}13.	Entered from ^{o}L3 when all the tapes in the C string have been exhausted following the ending of the A string and prior to the ending of the B string.
3C2	Set by ^{o}SB0. Sets ^{o}SA3, ^{o}14a, q4 = 0, ^{o}12b2, rewinds tape C and transfers control to ^{o}13.	Entered from ^{o}L3 when all the tapes in the C string have been exhausted following the ending of the B string and prior to the ending of the A string.
3C3	Set by ^{o}SA1, ^{o}SB1. Sets ^{o}15b, ^{o}16b, rewinds tape C and transfers control to ^{o}18.	Entered from ^{o}L3 when all the tapes in the C string have been exhausted after the ending of both the A and B strings.

THREE TAPE MERGE WITH TAPE IDENTIFICATION - ASCENDING SERIES
KEY DIGITS ≤ 12 DIGITS









LEGEND

A - Storage for one block of input data from T_A, and also current location in that block.
B - Storage for one block of input data from T_B, and also current location in that block.
C - Storage for one block of input data from T_C, and also current location in that block.
D - Auxiliary storage location, T_A
E - Auxiliary storage location, T_B
F - Auxiliary storage location, T_C
G - Storage for one block of output data
G_K - Location of key word of first item in output block.
G_N - Location of key word of last item in output block.
M - Total number of blocks per tape.
N - Total number of items per block.
S - End of tape sentinel.
S.C. - Supervisory Control.
T - Tape
T_b - Current output tape.
V - A word of ignore symbols.

a - A constant to alternate T_6 and T_5.
b - A constant to alternate T_7 and T_4.
c - A constant to alternate T_8 and T_5.
f - Counter: Number of blocks in current output tape.
g - Intermediate storage for ·12b when ·12 < ·12a.
i - Designation of current ·12b.
m - Counter: Number of items transferred to output block.
n - Last tape number of a series
q0···q12 - Storage positions for tape identification.
x - Counter: Number of items transferred from block A.
y - Counter: Number of items transferred from block B.
ϑ - Counter: Number of items transferred from block C.

α - Tape identification letters, T_A
β - Tape identification letters, T_B
γ - Tape identification letters, T_C
δ - Output tape identification letters
Σ - Number of words per item.

q0 - Sentinel
q1 - Current output tape identification number.
q2 - Current A input tape identification number.
q3 - Current B input tape identification number.
q4 - Current C input tape identification number.
q5 - Final A input tape identification number.
q6 - Final B input tape identification number.
q7 - Final C input tape identification number
q8 - Key word of last item on previous tape
q9 - Current location in A block
q10 - Current location in B block
q11 - Current location in C block
q12 - Key word of first item on current output tape.

* Used only in special program for rerunning merged tapes.

Note: Following an order to rewind tape with signal, operator must mount new tape on servo as indicated

ITEM	QUAN.	DESCRIPTION	MATERIAL

BILL OF MATERIAL

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES TOL. UNLESS SPECIFIED OTHERWISE: FRACT. DEC. HOLE ANG.

MATL. UNIVAC C-10

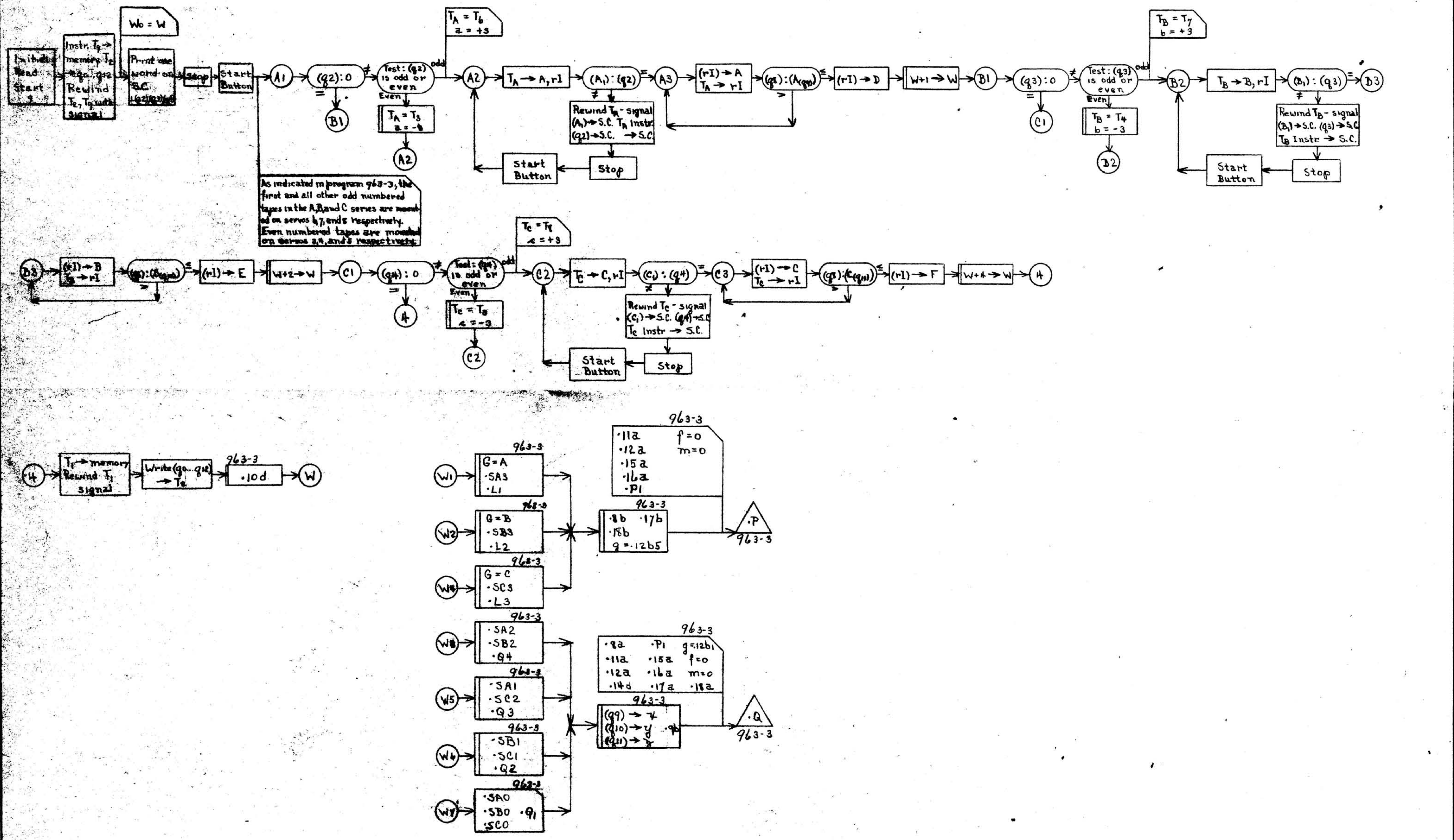
THREE TAPE MERGE WITH TAPE IDENTIFICATION ASCENDING SERIES - KEY DIGITS ≤ 12 DIGITS

DR. [illegible] DATE 5/15/50
CH'K. RAM SCALE
APR. ENG. FES

DA963-3

LET.	REVISIONS	DATE	CH'K.

PREPARATORY ROUTINE FOR RERUNNING OF MERGED TAPES
THREE TAPE MERGE WITH TAPE IDENTIFICATION



LEGEND

- A Storage Location for one block of data from tape A
- B Storage Location for one block of data from tape B
- C Storage Location for one block of data from tape C
- D Auxiliary Storage for data tape A
- E Auxiliary Storage for data tape B
- F Auxiliary Storage for data tape C
- T Tape
- T_e Tape which is to be remade
- T_f Instructions for 3-tape-merging program
- Flowchart table base
- q... Storage positions for tape identification

- q_0 Sentinel
- q_1 Current output tape identification number
- q_2 Current A input tape identification number
- q_3 Current B input tape identification number
- q_4 Current C input tape identification number
- q_5 Final A input tape identification number
- q_6 Final B input tape identification number
- q_7 Final C input tape identification number
- q_8 Keyword of last item on previous tape
- q_9 Current working location in A block
- q_{10} Current working location in B block
- q_{11} Current working location in C block
- q_{12} Keyword of first item on current output tape

Note: Following an order to rewind tape with signal, Operator must mount new tape on servo as indicated. If only one merged tape is to be remade, failure to replace tape 1 in routine °4 of this program will interrupt program 963-3 before the conclusion of °15a. In this event it will be necessary to manually rewind all data tapes in use at the time.

ITEM	QUAN.	DESCRIPTION	MATERIAL
		BILL OF MATERIAL	

ECKERT-MAUCHLY COMPUTER CORP.
PHILADELPHIA, PENNA.

ALL DIMENSIONS ARE IN INCHES
TOL UNLESS SPECIFIED OTHERWISE:
FRACT. | DEC. | HOLE | ANG.

MAT'L. UNIVAC C-10

PREPARATORY ROUTINE FOR RERUNNING OF MERGED TAPES
THREE TAPE MERGE WITH TAPE IDENTIFICATION

Revised Edition of A-963-2 (2/9/50) 3/16

LET.	REVISIONS	DATE	CHK.

DR. h.m.d. DATE 4-19-50
CH'K. M. K. L. SCALE
APR. ENG. H.A.N.

C A-963-4

A 1 2 34